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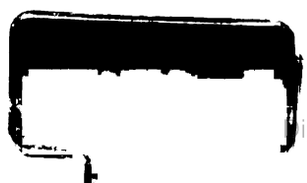

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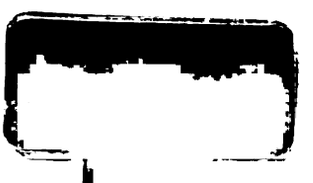

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NOTES.

THE subject of radio-activity is one which is occupying the minds of our leading physicists at the present moment, and yet the actual research in connection with it rests in the hands of a few investigators only. This is largely due to the fact that the details of the method of manufacturing radium itself and other intensely radio-active compounds are not widely known, and that the methods of investigation are novel, somewhat difficult, and require special training. Moreover, the novelty of the subject is such, that no complete history of it up to date has yet been written, the contributions to it being scattered in various English and foreign journals. With a view to removing some of these difficulties we have arranged with Mr. FREDERICK SODDY for the publication of a series of articles on the subject, and for their subsequent amplification and publication in what may practically be regarded as a Text-book on Radium and Radio-activity. Mr. SODDY has himself done valuable research work in this new branch of physics, especially in conjunction with Prof. RUTHERFORD; and, moreover, he has the advantage of considerable knowledge and experience with regard to the chemistry of the subject. The first of the series of articles is published on p. 7 of this issue. It will be seen that they approach the subject from the beginning, and we can confidently recommend their perusal to all who wish to study this newest development in physical science.

MR. ESSON in a note on "A Basis for the Comparison of Dynamo Designs," makes some observations on Mr. HOBART'S article on this subject, published in *The Electrician* of September 11th, and points out that a definition of "output coefficient" attributed therein to Mr. KAPP was put forward by himself some 12 years ago. Mr. ESSON goes on to criticise Mr. HOBART'S proposal to define the ratio $W/\pi DL \times$ r.p.m. as "specific output." Unfortunately, writers seldom agree in matters of terminology; and here, as often, the suitability of the expression seems to depend on the writer's particular point of view. Mr. ESSON does not dispute the utility of Mr. HOBART'S results, and the point of Mr. HOBART'S article was that πDL, when L is taken as the length of the armature *over the end connections*, is a true criterion of the cost; so that the ratio $W/\pi DL \times$ r.p.m. measures the efficiency of design in regard to cost, if the output is considered to be proportional to speed. Mr. HOBART did not, however, seem to contemplate applying his criterion over such large ranges of speed as Mr. ESSON takes in his example, and the latter is, perhaps, right in maintaining that, if widely different speeds are to be compared, a formula with D^2 in it gives a ratio more justly entitled than Mr. HOBART'S to be called "specific output."

TWO companies' meetings held last week were occasions for two interesting speeches, the subject of both being the immediate outlook in the electrical industry. The first of these was the interesting statement made by Mr. MARK ROBINSON at the Willans and Robinson meeting, a report of which appeared in our last issue. This firm has already suffered by the impending change in engineering practice—or shall we say engineering fashion—involved in the frequent adoption in new schemes of gas engines or steam turbines instead of reciprocating steam engines, for driving dynamos. The attitude of British engineers in this matter has been remarkable. We were the pioneers in fast-speed engine practice, and the pioneers in the application of engines of the very fastest speed—viz., steam turbines—to dynamo driving. The first gas-driven electricity works of a large size was a British one, and our leading writers on applied thermodynamics have consistently pointed out the relative economy of gas engines. Yet for some reason, whether the fault was that of our own manufacturers, their customers, or their customers' advisers, we did not pursue our advantage. Slow-speed engines became fashionable largely because we had got into the habit of buying our traction plants in America, steam turbines

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were looked upon as a fad which could occasionally be indulged for small units and in particular cases in which vibration had to be avoided absolutely, and the advocates of gas engines for generating stations either lacked sufficient energy or sufficient encouragement to overcome the first difficulties that beset them.

CONTINENTAL engineers took up the problem of gas engine design where we left it, and American engineers found it expedient to test the capabilities of the steam turbine principle for large units. In both cases their enterprise was attended with satisfactory results, so British engineers are now taking up again what they discarded several years ago. It is gratifying that British firms are now making large gas engines, and that the manufacture of the steam turbine is also to be extended, but let us hope that our own manufacturers will realise more than they have done the importance of a large experimental construction department, so that we may develop our new ideas for ourselves.

AT the meeting of the Underground Electric Railways Co. of London last week, Mr. YERKES gave an account of the rapid progress which is being made in the "electrification" of the District Railway, and in the construction of the "tube" lines which are in the hands of his Company. The precautionary measures to be taken against the spread of fire are interesting. All the platforms are to be of cement—wood being completely discarded, and even the wooden staircases on the District Railway are to be replaced by iron ones. It is, moreover, gratifying to learn that the Directors are using every endeavour to place their orders for plant and material as far as possible in this country. At first sight it may seem peculiar that we should have to go to America for the designs of the Parsons steam turbines to be employed at the Lots-road station, when the Hon. C A. PARSONS, their inventor, has been manufacturing them in this country for years; but if they are being built in England there is, after all, little cause for complaint.

THE Ryde electricity undertaking, like others of a similar nature employing gas plant, has already made enemies. Certain residents have complained that the works are the cause of much annoyance to the neighbourhood, owing to noise and smells. An action has been commenced against the Isle of Wight Electric Light and Power Co. to restrain it from working, and so urgent did the plaintiff think the matter that an interim injunction was applied for, but was refused by Mr. Justice JOYCE on Wednesday. Naturally, a station such as this, when first starting up, must be more or less of a nuisance, but when once it gets fairly under-way it should cause no more annoyance than a modern station operated by steam; and, as a matter of fact, when we inspected the plant for the purpose of preparing the description appearing in this issue, we completely failed to detect any objectionable odour or noise either within the works or in their surrounding neighbourhood. Moreover, the time of our visit covered periods when everything was shut down, when the producers were being prepared and when the plant was running under normal working conditions. It is a curious fact that the persons who allege the nuisance live within a quarter of a mile of the gas works, and yet have not complained of any odour arising from them. These difficulties, however, are not the only ones the Company has had to face. The first site chosen for the works proved unsuitable owing to it being impossible to sink proper foundations; the Corporation of Ryde refused to allow the construction of the station on the second site chosen; and residents in the neighbourhood of where the works now stand objected to a tall chimney. We trust that, with these, the worst storms are over, and that the undertaking will now enter upon the calm and prosperous part of its voyage.

THE Marylebone Borough Council, having failed to secure its loan for electric lighting purposes from the London County Council, and having been unable to obtain either an Electric Lighting Licence from the Board of Trade or a pronouncement from the Local Government Board reversing the London County Council's decision, has now drafted a Bill for the next Parliamentary Session, in which its electric lighting powers will be properly defined. The objects of this measure are set out in full in another column of this issue. To be precise, the Bill is not drafted by the Borough Council, but by its Electric Lighting Committee, and there is ample opportunity for further complications being introduced before the draft has been adopted by the Council itself, as well as being sanctioned by a mass meeting and by a poll of the whole body of ratepayers. Undoubtedly the Borough Council of Marylebone should have taken steps to convince itself that the scheme of taking over the electric lighting of that district from the Metropolitan Electric Supply Co. was popular among its ratepayers, before it embarked upon the enterprise which has involved the recent costly arbitration proceedings, terminating with so costly an award.

WE commented in a leading article on September 4th on the facts elicited at the recent Local Government enquiry in Hull with regard to a loan for the erection of a municipal telephone exchange. To-day we are able to announce that the loan has been sanctioned by the Local Government Board, and that it is repayable in 25 years. The telephone licence of the Hull Corporation expires in 1911, however. We take this opportunity of quoting, for the benefit of those interested in municipal telephony, two clauses which appear in the Hull licence—and, in fact, with alteration of date, they appear in every municipal telephone licence. Particular notice should be taken of the italicised passages :—

29. Purchase of Plant by Postmaster-General.—(1) On or so soon as may be after the 31st day of December, 1911, aforesaid (unless these presents shall have been previously revoked and determined as in this indenture provided) the Postmaster-General shall buy and the local authority shall sell and convey all such plant as is at the date aforesaid in use by the local authority for the purpose of supplying the means of telephonic communication under these presents, and *as is suitable for the actual requirements at the date aforesaid of the telephonic service of the Post Office within the licensed area.*

(2) *No plant shall in any case be considered suitable for the requirements of the telephonic service of the Post Office which has been brought into use without the sanction in writing of the Postmaster-General*, but, subject as aforesaid, if any question arises as to the suitability of any of the plant of the local authority for the requirements of the telephonic service of the Post Office within the licensed area, such question shall, in case of difference, be determined by arbitration.

30. Valuation of Plant.—The value of all plant purchased by the Postmaster-General under the foregoing articles shall be deemed to b

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its fair market value at the time of the purchase, due regard being had to the nature and then condition of such plant, and to the state of repair thereof, and to the circumstance that it is in such a position as to be ready for immediate working, and to its suitability to the purposes of a telephonic service, and *no additions hall be made to such value in respect of compulsory purchase or of goodwill or of any profits which might have been or be made by the local authority from the use of such plant.* In case of difference, such value as aforesaid shall be determined by arbitration.

EVEN assuming that the Local Authority obtains the approval *in writing* of the Postmaster-General of the plant after it has been put down—a precaution which, we have heard, is sometimes forgotten—it is seen that there is no actual obligation on the Postmaster-General to buy it at the expiry of the licence. If the competing National Telephone Co., on the other hand, follows its present policy of keeping its plant completely up to date with the newest developments in telephone engineering, there is little doubt that the Post Office will prefer to buy the Company's plant in 1911, and will have little use for the greater part of the municipal plant. The Company is putting in central battery exchanges of the same pattern as those employed by the Post Office in all its new work, whereas the plant employed in municipal exchanges up till now has been of a cheaper nature. Certainly, therefore, the Hull Corporation should write off heavy sums for depreciation, sufficient to pay off the greater part of its capital by 1911. But if it does this it will be difficult, each year, to make both ends meet, and the undertaking will become a burden on the ratepayers. This difficulty has been evaded for the present in Glasgow, for instance, by writing off nothing for depreciation (in fact, there the capital account was even swelled by including in it the cost of canvassing), but evidently this is merely deferring the day when the rates will be called upon to pay the cost of an unsuccessful experiment.

Wireless Telegraphy in China.—The Italian wireless telegraph apparatus between Pekin and Taku is now working.

A Moving Staircase on the Great Northern and City Railway.—A correspondent writing to *The Times* states that a moving staircase is to be installed at the Lothbury Station of the Great Northern and City Railway now under construction.

Queen Victoria National Memorial.—This memorial, which is to be erected in front of Buckingham Palace, will be illuminated at night by means of electricity obtained from the Westminster Electricity Supply Co.'s mains.

Gramme Monument.—*Nature* states that a monument to the electrician, Zénobe Gramme, is shortly to be raised in Brussels. Owing to the efforts of M. Léon Janssen, the general manager of the tramways of Brussels, a committee has been appointed to accomplish this purpose.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Guadeloupe—Martinique	May 9, 1902 ..	—
Puerto Plata—Martinique....	July 10, 1902 ..	Oct. 19, 1903
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Nagasaki—Fusan	Oct. 19, 1903 ..	—

Radium Ore.—The *Electrical World* of New York announces that a company is being organised to extract radium ore from a mine in Routt County, Colorado. Specimens of the ore have been reported upon, it is said, by Prof. and Mme. Curie and Prof. Becquerel, and, the report continues, they pronounced the Routt County to be the best in the country for the purpose of producing radium. It is said that the ore was found to be almost entirely free from gold, and to be carnotite, in combination with uranium, vanadium, copper, baranium and polonium.

Historical Exhibits at St. Louis.—A committee of the American Institute of Electrical Engineers has been appointed to arrange an exhibit showing the evolution of the chief features which are the basis of electrical engineering. Any person having in their possession or knowing of interesting historical electrical machines or appliances are requested to communicate with the committee immediately. The exhibit will be given a prominent place in the Electricity Building, where the headquarters of the Institute will also be situated. The members of the committee are: T. C. Martin, chairman, 114, Liberty-street, New York city; W. J. Hammer, J. S. J. S. Anthony and Henry Noel Potter, also of New York, and Cloyd Marshall of St. Louis.

Electric Railway Troubles in America.—There appears to be a certain amount of jealousy between the steam and electric railways of the United States, and the following incident is described by the *Electrical World* of New York:—

Recently, at a point near Trenton, N.J., in order to prevent the Pennsylvania Railroad from interfering with its work while it put in a new trolley crossing over the tracks of the railroad company on a siding of the Belvidere Division in that city, the Johnson Trolley Co., building links between New York and Philadelphia, erected a barricade of Belgian blocks and ties on the tracks. As soon as the local railroad officials heard of it they had a freight train made up at Coalport, 2 miles distant, and backed at full speed against the barricade. The effort was successful in stopping the work. The two rear cars were wrecked, but the barricade went down like paper cards and the cars plunged through, tearing up the trolley company's crossing. Head officials of each company were called, and both sides stopped work pending an agreement by which the trolley could cross the tracks.

Opening of the Elland Municipal Electricity Works.—The small electricity works which have been erected by the Elland Urban District Council were put into operation on Saturday last. The power-house equipment consists of two 140kw. direct-driven sets and a storage battery of 700 ampere-hour capacity. A two-cell Meldrum refuse destructor is worked in conjunction with the scheme, and a Lancashire boiler, which at present supplies the necessary steam, is heated by this means. There is also a B. and W. boiler installed as a stand-by. A three-wire continuous-current system of distribution is employed. The capacity of the present plant is 10,500 8 c.p. lamps, and the applications for current so far amount to the equivalent of 2,000 8 c.p. lamps for lighting and 11 H.P. for power. The price for lighting is 4d. per unit. Plenty of accommodation for extensions has been allowed for in view of a possible supply for traction when the Halifax Corporation extends its tramways to Elland.

New London Telephone Exchange.—The Mayfair exchange of the London Post Office telephone service has been opened with 500 subscribers. The exchange is situated at the parcels sorting office in Bird-street, Oxford-street, the exchange itself being on the top floor and the power plant below. Central battery switchboards are employed similar in all respects to those at the Victoria and Western exchanges, already described in *The Electrician*. As in these exchanges, the switchboards are fitted with local jacks for 180 subscribers per operator's position, but, of course, all the 180 have not been taken into use. We have reason to believe that even on the older exchanges 180 subscribers per operator is still too much at the busiest parts of the day. The exchange will serve an area bounded by Regent's Park on the north, Knightsbridge and Pall Mall on the south, Regent-street on the east, and Bayswater on the west, and will include Oxford-street, Regent-street, Piccadilly, and the residential district of Mayfair.

International Fire Prevention Congress.—An official report of the proceedings of the International Fire Prevention Congress has been issued this week. Approximately one-third of the members were Government or municipal officials or held civil office, one-third were architects, engineers, surveyors and insurance officials, and one third were professional and volunteer fire brigade officers. The Congress considered both, on the one hand, that special courses of study dealing with fire prevention should be instituted in all architectural and engineering schools and colleges; and also, on the other, that every attempt should be made to popularise the subject by the formation of local branches of the existing fire prevention

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societies. Fires caused by lightning and spontaneous combustion were also subjects recommended by the Congress for careful study. It is interesting to note that by a unanimous vote the Congress expressed its wishes to employ the metric system when publishing records or calculations side by side with any local system.

The Royal Commission on Coal Supplies.—The Royal Commission on Coal Supplies, which was appointed in December, 1901, resumed its sittings, after the holidays, on Tuesday. The terms of reference to this Commission include an inquiry into the possibility of a reduction in cost of coal by cheaper transport or by the avoidance of unnecessary waste in working by the adoption of better methods and improved appliances. On Tuesday evidence was given as to the use of electric coal-cutting machines. Mr. G. E. Stringer, of the Park Mill and Elmley Moor Collieries, Yorkshire, stated that such machines had been in use in these pits, both for heading and cutting purposes, since 1886, and had been found much more satisfactory, both from the point of view of working expenses and safety, than compressed air. The disadvantages were first cost and repairs. But electric coal-cutting machines enabled the working of thinner seams than was the case at present. In addition, a greater or more regular output for a given area was obtainable with less damage to overlying seams and surface property.

The Stretford Municipal Electricity Works.—A supply of electrical energy is now being given in Stretford although the formal opening of the works will not take place for a few days. The Stretford Urban District Council obtained an electric lighting provisional order in 1897 and a year or two later engaged Mr. C. H. Wordingham to prepare a scheme. He advised a three-wire continuous-current system with 440 volts between the outers. The power house, which has been designed with a view to giving a supply for traction, contains two Lancashire boilers having a total evaporative capacity of 13,500lb. per hour, and four high-speed double-acting engines directly-coupled to multipolar compound-wound generators. The station runs condensing, the condensing plant consisting of an ejector condenser with motor-driven centrifugal pumps and overhead tanks. Lead-covered paper-insulated feeders have been employed with vulcanised bitumen distributors laid solid. The tariff adopted for lighting is £8 per annum per kilowatt plus 1½d. per unit, and for power 3d. per unit for intermittent use and 1½d. per unit for factories. For lighting, the price in no case is to exceed 6d. per unit.

The Incorporated Municipal Electrical Association.—We have received the *Proceedings* of this Association for 1903. The volume contains in full the various Papers read at the Association's annual meeting last summer, and sufficiently full reports of the discussions on these Papers and of the proceedings at the business meeting, together with the reports of the Council and the various committees. The two Papers which gained the associates' prizes are also included in the volume. The first prize was awarded to Mr. C. L. E. Stewart, assistant electrical engineer at Rochdale, for a Paper on "Low tension Continuous current Switch Gear," which describes briefly the various patterns which have been adopted in standard practice. On the whole, it is fairly complete, but we notice that, although seven systems of connecting up cells, boosters and regulating switches are described, the method of regulating by the middle cells adopted in most of the Hammond stations, and some others, is not included. Mr. F. W. Hewitt, assistant electrical engineer at Darlington, who received the second associate's prize, has written a pithy Paper on "Fuses," in which he strongly recommends the employment of zinc as a fuse metal.

The Electrical Smelting of Copper Ores.—According to the *Zeitschrift für Elektrotechnik* the Chilian Government recently commissioned M. Ch. Vattier, one of its engineers, to visit France with a view of inspecting and studying the electrical smelting processes carried out in that country. Amongst other works M. Vattier visited those of Héroult, Keller and Leleux, and conducted experiments with various ores, but chiefly of Chilian origin. The first experiments were made in the works of Héroult in La Praz with copper ores containing 7 per cent. of copper, and it is stated that 18 tons of ore were smelted in 24 hours, the current varying between 3,500 and 4,000 amperes at a pressure of 110 volts. Between 43 and 45 per cent of the molten mass consisted of copper, only about 0·1 to 0·2 per cent. of the slag consisting of this metal. In the large works of Keller and Leleux in Livet, 8 tons of Chilian copper ores, containing between 5 and 7 per cent. of metal, were melted in eight hours, the corresponding expenditure of electric energy being 300kw., at a power-factor of 0·9. The waste in electrodes amounted to about 6kg. to 7kg. per ton of ore, and the molten mass contained 43 per cent. of copper, only 0·1 per cent. of the slag being metal. M. Vattier, in his report, gives the following comparative figures bearing on the subject:—In the coke furnaces at present in vogue in Chili, 3,200kg. of coke, costing 320fr. (about £13) are required for each ton of copper produced. On the other hand, a consumption of energy of 1·25kw.-year is reckoned to be sufficient to smelt 16 tons of ore, corresponding to 1 ton of copper, in the electric furnace. Taking the cost of 1kw.-year to be 30fr. (24s.), a price in keeping with the abundance of water power in Chili, the costs for energy per ton of copper produced would amount to 38fr. (30s.), and, by adding to this 45fr. for waste of electrodes, &c., the total costs of production per ton of metal would come to 83fr. (66s.).

Trains for the New York Subway.—Tests have been made recently on the Manhattan Elevated Railway with a five-car train of the style intended by the Interborough Railway Co. for the underground line. Some details are given in the *Electrical World* of New York. The automatic brake system on the cars is as follows:—The cars carry two lines of air pipes, known as a main reservoir and a train-line pipe. When the train is in motion the main reservoir line is charged with 90lb. of compressed air to the square inch. The air is compressed by means of electrically-driven compressors, which are installed under each motor car. When the train is in motion the train-line pressure is so regulated that 70lb. pressure to the square inch is carried, and any reduction in the train-line pressure causes the brakes on the entire train to set automatically and simultaneously. The train-line pressure is coupled with the electric controller, and if at any time while the current is being fed into the motors the motorman should, for any reason, take his hand off the controller when the train is in motion, the brakes are at once set on the entire train. Just before the brake is automatically set the current is cut off from the motors on the entire train. This also is done automatically. The cars are also equipped with what is known as the conductor valves. These valves are provided with cords which run through the trains and upon the platforms, so that any conductor anywhere on the train can set the brakes immediately. In addition, there is an automatic stop valve on each truck. Should any motorman at any time run past a danger signal the brake will immediately set and the current be cut off, thus making it impossible for him to run far beyond a danger signal. There are no gates on the cars, but sliding doors in the vestibules. They are opened and closed by means of levers. The windows open from the top, instead of the bottom, as on the elevated cars. Each train will have eight cars, five of them motor cars, and three trailers. 500 cars are at present being built.

Swiss Electric Railway.—According to the *Zeitschrift für Elektrotechnik*, the first Swiss railway to use the third-rail system for conducting current to moving trains is that connecting Freiburg, Murten and Ins. The line, which is of standard gauge and has a maximum grade of 3 per cent., connects three existing trunk lines. Its length is 32·3km., the difference in altitude between extreme points being 195 metres. Speed is limited on the level to 35km., on inclines to 23km. and on down gradients to 45km. per hour. Three-phase current at 8,000 volts is generated in a central power station, from whence it is transmitted to two sub-stations, each being provided with transforming plant of 300 H.P. capacity. This is sufficient for one train, and the time-table has been so worked out that trains pass each other only between the sub-stations, thus avoiding any excessive power demand on one of them. Each sub-station possesses a 150 H.P. 8,000-volt 25 ~ three-phase motor, built by the Oerlikon Company, directly coupled to a continuous-current generator producing 125 amperes at

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800 volts, and to a four-pole exciter. A buffer battery, consisting of 400 Pollak accumulator cells, the capacity of which is 207 ampere-hours, is also provided. Vignoles rails, weighing 23kg. to the metre, have been adopted for the third-rail construction, and are laid at a distance from the outer rail of 660mm. The top of the third rail is 135mm. above that of the track rails, and it is supported every 4 metres by ambroin insulators, the cast-iron caps of which are not rigidly connected to the insulator body, but allow of a certain movement. These caps receive the rail, and, in order to minimise the detrimental effect of shocks, washers of linoleum are laid in between. The cast-iron socket of the insulator is bolted to wooden sleepers. At level crossings, the third-rail is interrupted, electrical connection between the sections being maintained by means of cables drawn underground through gas pipes. Wooden sideboards, leaving open at the top a slot 7cm. wide, guard the rail. Four contact shoes, two at each side of the car, are provided, and the line is divided into three sections. At the stations energy is conducted to the cars from overhead wires by means of bow collectors. The cars, containing seating room for 48 passengers, are 17·3 metres long, 3·03 metres wide, and weigh 33 tons. They have hand and Westinghouse air brakes, the compressors being driven from the car axles. Two 150 H.P. Oerlikon motors, running at from 400 to 450 revs per min. with an impressed voltage of 750 volts, transmit their power through gearing with a ratio of 1 : 6 to the car wheels, which are 1·1 metres in diameter. Speed regulation is effected on the ordinary series-parallel system. The resistances consist of constantan wire, wound around porcelain plates, the windings being insulated from each other by asbestos.

Electric Moving Platforms for New York City.—The Extensions Committee of the New York Rapid Transit Commission has recommended that approval be given to the plan of the Continuous Transportation Syndicate for a moving platform system through a tunnel in New York and then across the Williamsburg Bridge. The moving platform idea is outlined as follows in a recent issue of the *Electrical World* of New York. The tunnel in Manhattan will be divided into two sections by a partition, so that trains will run in but one direction in each. Electricity will be the motive power. The wheels are not to be on the cars themselves, but are to be stationary. The rails, instead of the wheels, will "run." There are to be three platforms. A passenger getting aboard would step from the station platform on to the first, which is going one-third as fast as the third, whereon are moving platform seats. Then he would step from the first to the second, going in the same direction, but a third again as fast as the first. From the second he would step to the third and last, which is made up of many short cars, so closely joined together that they form a single train. The seats are to be crosswise of the car, as at Chicago in 1893, so that the passenger will always be facing the direction of the motion of the train. They will be about 3ft. apart, and each will seat three persons comfortably. When a passenger approaches a station at which he wishes to get off, he steps from the third platform to the second, and sees the seat in which he sat speed on ahead. Then he steps to the first and finds himself hardly moving. When the station is reached he alights. For those who might lose their balance, standards or posts will be fixed at points on all the platforms as at Paris in 1900. The seats being 3ft. apart and holding three passengers, will mean one passenger for each lineal foot. When the platforms are moving at, say, 9 miles an hour, and that is a fair average and one perfectly possible, the line could carry 47,520 an hour —nine times the 5,280 passengers in the mile. In the present plans for the tunnel and trains it is proposed to use nothing inflammable except the wooden backs of the seats ; and steel may be substituted for the wood there when it comes to the construction. The motors and all the wires are separated from the passenger tunnel by a thick wall of concrete. A modern system of artificial ventilation will be installed which will provide fresh air for the tube, and, in case of the burning of a wire or motor, smoke would be carried out of the tunnel immediately. The lighting plant will be separate from the power plant, so that an accident to one would not affect the other. Along the side of the tunnel, below the platforms, and on a level with the motors will extend a small passageway for inspectors, who will be on watch all the time for trouble. The wheels and all of the machinery are to be reached from below, so that repairs can be made without interference with the platforms or passengers. No attendants on the trains will be necessary. The fare, it has been tentatively determined, will be 3 cents. for a single ticket and 5 cents. for two.

Separation of Brass from Iron by Electrolysis.—A description of the process whereby brass is separated from iron was given in a Paper by Prof. C. F. Burgess, before a recent meeting of the American Electrochemical Society, and a brief abstract of the Paper appears in the *Engineering News* of New York. The author commenced by pointing out that iron and steel may be made to assume the passive state by employing the material as an anode in suitable electrolytes, such as sodium nitrate and other soluble nitrates, when it is no longer attacked by the anode products. Iron has a position considerably above copper in the electrochemical series of elements, and where two different metals are in contact the natural tendency is for the more electropositive one to go into solution with the greater ease. The idea presented itself of making the iron more electronegative than the copper by causing it to assume the passive state, and upon using the sodium nitrate solution in which this state could be developed, it was found that the brass could be completely removed from brass-covered iron tube and the iron left intact. This method of electrolytic stripping was installed and operated with success in various factories, and is now an important adjunct to the dip-brazing method. This same electrolytic stripping process may be applied equally well in removing silver, lead, tin and other metals more electronegative than iron from an iron surface. Nickel cannot be removed in this way, however, since nickel, as well as the iron, assumes the electronegative or passive state. In removing brass from iron the current should remove it at the approximate rate of 1 gramme per ampere-hour, provided that all of the current enters the solution from the brass and none of it utilises the iron as an anode surface. To determine how nearly this is the case when iron and brass in contact are exposed simultaneously to the solution, a brass and an iron anode, each having dimensions of 1in. by 2·75in., were immersed in a sodium nitrate solution, and each was connected through an ammeter to the same source of current. It was found that on first closing the circuit almost all of the current passed through the iron anode, but after operating for a few seconds the iron became passive, after which the brass took all of the current. By using very high current densities, however, the iron may begin to conduct a small portion of the current, thus causing a liberation of oxygen on the iron surface. From these tests it was shown that the current has a high efficiency in the removal of the brass, and a practical trial has demonstrated that a small percentage only is wasted by flowing from the iron surface, provided the solution be maintained in good working condition and the applied electrical pressure be kept within suitable limits. In order to prove that the iron anode became, not merely a non-conductor, but actually electronegative, the author made a series of experiments on an electrode of iron in various sodium nitrate solutions by measuring the "single potential" of the electrode both before current was passed through and after different currents had been passed. It was shown that the iron becomes strongly electronegative after appreciable current has begun to flow. In answer to a question the author expressed the opinion that the action is due to formation of a film of iron peroxide, similar to the case of lead ; the film on the iron is, however, too fine to be detected.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TO-DAY (Friday), October 23rd.

PHYSICAL SOCIETY.

5 p.m. Meeting in the Physical Laboratory of the Royal College of Science, Exhibition-road, South Kensington. Agenda: 1. "The Bending of Magnetometer Deflection Bars," by Dr. C. Chree. 2. "On the Magnetisation of Basalt and the Magnetic Behaviour of Basaltic Bars when Heated in Air," by Dr. G. E. Allen. 3. "Some Experiments with Electrical Oscillations," by Dr. W. Watson.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Annual General Meeting at the Westminster Palace Hotel.

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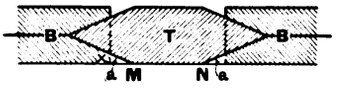
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Action of Iodine on Copper Films.—Cathode projection gives a convenient means of obtaining metallic deposits of any required thickness. L. Houllevigue measures the thickness by converting the film of, say, copper into iodide by suspending close to it a grain of iodine. Newton's rings are produced, and from their colour and configuration the thickness of the deposit may be deduced. A remarkable fact brought out by the experiments is that when the thickness of the film is below $40\mu\mu$ it cannot be converted into iodide. The author kept a film averaging $30\mu\mu$ in thickness immersed in iodine vapour for three hours without noting a sign of combination. The film showed the characteristic absorption of light in the violet and the blue. Brought into contact with air and heated, it was immediately oxidised. The author found also that if, after producing a set of Newton's rings on the film by partial iodisation, the film was completely iodised, there was always a ring of unaltered copper round the central patch. This is explained by the annexed diagram, where T is



the portion first iodised, and B the portion iodised by the final operation. The first operation leaves metallic copper outside MN, while the final iodisation is not capable of converting the thin copper layer at *aa* into iodide. A similar phenomenon is observed in the case of silver. The author summarises his results as follows :—The smallest molecule of copper capable of chemically combining with iodine has linear dimensions of the order of $40\mu\mu$. Its weight is of the order of $5 \times^{-13}$ milligrammes.

[L. HOULLEVIGUE, *Journal de Physique*, October, 1903.]

Dispersion of Dielectric Constants.—Under this name E. Marx treats of the change in the capacity of a liquid condenser with the frequency of the discharging current. Drude has shown that for waves having a period of a thousand million per second the dielectric constants of some liquids vary with the frequency. The author has dealt with longer waves, having periods of from 10^{-8} to 10^{-7} per second. In constructing his apparatus, the author utilised the difference of behaviour towards rapidly alternating currents shown by metals and electrolytes respectively. While an electrolyte has the same resistance for Hertzian waves as it has for continuous currents, the resistance of a metallic conductor depends upon the frequency. If an electrolyte is connected in parallel with an inductance, the ohmic resistance of the latter, and its counter E.M F., vary markedly with the frequency. On regulating the resistance of the electrolyte so that both branches have equal current and develop an equal amount of heat, a very simple relation between the electrolytic resistance and the inductance gives the frequency of the current. The results obtained in the case of petroleum and benzol show no dispersion within the region specified—*i.e.*, for waves ranging from 10 to 34 metres in length. In water, also, no dispersion of the dielectric constant can be traced. The search for proper oscillations in the electric spectrum is therefore fruitless so far. It will probably only be rewarded in the region of very small wave-lengths.

[E. MARX, *Ann. der Physik.*, No. 11, 1903]

Cathode Fall in Helium.—In connection with the work of Mey (see *The Electrician*, Vol. LI., p. 357), R. Defregger has studied the cathode fall of a number of metals in helium, where a chemical action between the metal and the gas is excluded. The helium was generated in a vacuum, and cleaned by passing it over red-hot magnesium shavings and copper oxide, and finally freed from remaining impurities by means of the potassium sodium alloy. The metals were put into the form of highly-polished wires, and included copper, platinum, silver and steel, all of which had a cathode drop of 160 to 180 volts, and zinc (143), mercury (142·5), aluminium (141), bismuth (137), and magnesium (125). What is remarkable is how slight the fall is generally in helium. Again, the succession found by Mey is not maintained in helium. The nobler metals have similar values of the cathode fall, and what differences there are cannot be connected with any other physical or chemical property of the metals. The value found for platinum—viz., 168 volts—differs considerably from Strutt's 226 volts. The difference may be due to the fact that the author's helium contained a small proportion of argon, which it is extremely difficult to separate completely from the helium. In the vacuum tube only the lines of helium and mercury could be discovered. No special effort was made to eliminate the mercury, since it is well known that its presence does not influence the cathode fall.

[R. DEFREGGER, *Ann. der Physik*, No. 11, 1903.]

Dark Cathode Space.—G. C. Schmidt has formulated an interesting theory of the dark cathode space, which is modelled on the Nernst theory of the electrolysis of aqueous solutions If, in an ionised gas, the current-density is increased, the regions near the electrodes will be made comparatively poor in ions, since they are not formed with infinite rapidity and diffused towards the electrodes. Since the positive ions very probably move more slowly than the negative, it is natural that the impoverishment should be greatest at the cathode, towards which the positive ions migrate. The dark space is therefore the district of impoverishment. That this is actually the case is proved by a simple experiment. On introducing into the dark space the terminal of an electrometer connected with a capacity, it is found that it takes a long time to get charged. It charges itself all the quicker, the more the electrode or probe is approached to the glow-light, and thus brought into a region of greater ionisation. Anything that ionises the gas in the dark cathode space, or that increases the number of ions in it, reduces the cathode fall of potential. Cathode rays and canal rays, when made to fall upon the dark cathode space, have that effect, but cathode rays are the more effective of the two. The cathode rays belonging to the cathode itself, if thrown back upon it by a metallic mirror, have the effect of reducing the dark space and the cathode fall of potential. The author traces some striking analogies between these phenomena and what happens in the electrolysis of copper sulphate.

[G. C. SCHMIDT, *Ann. der Physik.*, No. 11, 1903.]

Association of Municipal Corporations.—The autumn meeting of the Association of Municipal Corporations was held on Wednesday, Sir Albert K. Rollitt presiding. In his speech, the chairman expressed the opinion that proper active co-operation in spreading the benefits over the country of an educational system with the powerful means and organisation possessed by municipalities would be more valuable than discussing fiscal changes. The application of science to industry might be the means of permanently maintaining the commercial pre-eminence of Great Britain. The Town Clerk of Birmingham then proposed that the report of the Municipal Trading committee should be referred to the Council of the Association for consideration. He thought municipal corporations had no reason to be dissatisfied with this report, although it must be left to the future to decide whether all the recommendations were practicable. The Town Clerk of Leeds supported the motion, and, speaking on the broad question of municipal trading, said that Corporations desired the fullest publicity of their affairs and criticism of them. This was the attitude which municipalities had always taken up. Attention was then drawn to the surcharges made by the Local Government Board auditors, and to other financial restrictions placed upon the London Borough Councils, and the following resolution was adopted :—"That it be referred to the Council to promote legislation in the next session of Parliament to place Metropolitan Borough Councils in an equivalent position to that of the provincial Corporations." The chairman next moved that the President of the Local Government Board be asked to receive a deputation on a number of subjects approved by the Council. After a vote of thanks to the chairman, the proceedings terminated.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

The subject of radio-activity is one of the later developments of a new era in the progress of the physical sciences which may be said to date from the discovery of the X-rays by Röntgen in 1895. The X-rays so nearly resemble the Becquerel rays in their experimental properties that it will be instructive to preface our study of the latter by a consideration of the former, and to trace the historic connection between the two discoveries. The X-rays represented a new departure, in that they are a type of radiation, invisible to the unaided eye, but capable of easy detection, to which our ordinary ideas of transparency and opacity do not apply. The transparency or opacity of matter to ordinary light is a very arbitrary property, depending almost entirely on the nature of the substance. But in the case of the X-rays the power of penetrating matter was found to be very largely a question of density, and had little to do with nature. To express this result another way, the proportion of the X-rays absorbed by matter is controlled, mainly at any rate, by the absolute quantity or mass of matter through which the rays have to penetrate, and it does not make much difference whether the matter in question is made up of glass or metal, or even of a gas.

Since the X-rays are invisible, indirect means of investigation must be adopted, and these fall into three divisions: (1) Electrical methods; (2) photographic methods; (3) fluorescence methods.

The first depends on a most important property of the rays, the nature of which we shall have to consider later in some detail, of rendering any gas through which they are made to pass a conductor of both positive and negative electricity to a definite limited extent, so that the extent of conductivity can be used as the basis of measurement of the intensity of the rays. The second and third methods are almost too well known to need description, the second depending on the power of the rays to affect a photographic plate prepared from an emulsion of bromide of silver in gelatine, which is precisely analogous to the action of ordinary light, and the third on the property of various substances, of which barium platinocyanide is the most commonly used, of visibly fluorescing under the action of the X-rays, whereby, by introducing into their path screens coated with this substance, the rays can be made to all intents and purposes visible to the eye.

The origin of the production of X-rays claim a brief consideration. In an electric discharge through an exhausted bulb, when the vacuum is sufficiently high, what are now known as cathode rays are propagated normally to the surface of the cathode through the exhausted space. The direction of these rays has no relation to the position of the corresponding anode, which may be placed anywhere, even directly behind the cathode. With a flat cathode they are propagated more or less as a parallel pencil, but if the cathode surface is made concave, the path of the rays from the different parts of the surface can be made to intersect at a certain point or "focus." If at this focus is placed any obstacle to the path of the cathode rays it is found that the X-rays are propagated radially from this obstacle or "anti-cathode," and the greater the resistance offered by the latter to the passage of the cathode rays, the more intense are the X-rays that result. These cathode rays have been exhaustively investigated by Crookes and by Lenard; and the latter in a series of researches showed that they also can penetrate matter to a certain limited extent, and he succeeded in making them pass through a window in the vacuum tube made of thin aluminium foil. By investigating them outside the tube, Lenard found that the same law held for the cathode rays which holds for the X-rays. The transparency of matter to their passage is a function only of the absolute mass of matter employed and is independent of its nature. But, compared with the X-rays, the cathode rays are vastly less penetrating and are stopped with great ease even by gases. Now, since the intensity of X-rays in a focus tube increases with the density of the material of which the anti-cathode is made, it follows that the X-rays are the result of the sudden stoppage of the cathode rays—the more suddenly the latter are stopped the more intense are the X-rays produced. The X-rays are propagated from the anti-cathode radially in all directions, and this is the chief point of distinction between the two types of rays, for the cathode rays proceed from a flat cathode in parallel lines. Another point of distinction is that the path of the cathode rays is deviated by a magnet, whereas the path of the X-rays is not known to suffer deviation. In this way it is easy to show that the cathode rays are the cause and the anti-cathode the source of the X-rays, for if the former are deviated by a magnet so as to no longer impinge on the latter, the production of X-rays to a large extent ceases.

When we come to deal with the so-called β-rays of radio-active substances, we shall see that they resemble in nature the cathode rays of a Crookes tube, and we shall have to consider carefully some of the arguments on which the nature of the cathode ray is based. But at present it may be stated that this evidence points to the conclusion that the cathode rays consist of discrete particles of excessively small size travelling with enormous velocity and carrying a charge of negative electricity. The X-rays, on the other hand, are the pulses or disturbances in the ether of an electromagnetic nature which result when the velocity of the charge carried by the cathode ray is suddenly accelerated, the object of the anti-cathode being to reduce this velocity to zero in the least possible time. Thus the X-rays, like light, are ether pulses, and the difference seems to be that in the former the disturbances are of the nature of sudden pulses very rapidly dying away, whereas in light there is a regular succession of undulations of the same kind. This would account for the fact that the X-rays have not been reflected or refracted or polarised, although in their nature they so nearly resemble light rays. But the cathode rays are of such a totally different nature that some justification is needed in still retaining the word "ray" for this phenomenon. Now, in many of their experimental characteristics the X-rays, cathode rays, Becquerel rays and even the ultra-violet light waves are very similar, despite the fundamental difference in their nature, some of the types being vibrational and others corpuscular in character. It is, therefore, practically expedient to designate them all as "rays"; but to avoid misunderstanding, it may be pointed out that in these lectures the use of the word "ray" does not presuppose anything of the nature of the disturbance propagated, but is used as a convenient term to express effects propagated to some distance in a straight line from their source without the lapse of a sensible period of time.

M. Henri Becquerel, in 1896, made the first discovery of the property of radio-activity for the element uranium, and the circumstances that led him to the experiment are historically very interesting. At that time less was known of the origin of the X-rays than we know now. M. Poincaré had suggested, since the source of the X-rays was apparently in the fluorescence of the glass bulb, that possibly X-rays always accompany fluorescence. This was, of course, a confusion between cause and effect. In the old X-ray tube, before Mr. Jackson's focus tube came to be used, the anti-cathode was absent, and the source of the X-rays was the glass on which the cathode rays directly impinged, and which was caused to fluoresce strongly in consequence. The fluorescence was thought to be the source of the X-rays.

M. Becquerel, acting on this idea, examined some fluorescent compounds of uranium. His method was to place the bare salt above a photographic plate, which was carefully wrapped up in opaque material, and so protected completely from the direct action of light, and to expose the salt to direct sunlight, so as to cause it to fluoresce. He found that his plate was affected in these circumstances, even when a layer of copper foil or aluminium was interposed between the substance and the plate. But M. Becquerel also soon found that the exposure to sunlight was unnecessary, and the same effect was obtained in absolute darkness, even when compounds were

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.
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employed which, since their preparation, had never been exposed to light. Moreover, he found he obtained the same result whatever compound of uranium was employed, whether it was fluorescent or not, and he soon satisfied himself that he was investigating an entirely new property of the element uranium, which was completely unconnected with the property of fluorescence (see *Comptes Rendus*, CXXII., 1896, pp. 420, 501, 559, 609, 762 and 1,086). The characteristics of this radiation from uranium are very similar to those of the X-rays. The penetrability of the rays for ordinary matter is, as a first approximation, a function of the density of the matter and not of its nature. The rays make the air, or other gases, limited conductors of electricity, or, as we shall say, "ionise" them. This can be easily shown by a gold-leaf electroscope, which is discharged in the presence of any uranium salt. It may be pointed out that the same instrument would retain its charge indefinitely in vacuo even in the presence of uranium, or when acted upon by the X-rays—*i.e.*, the gas present plays a direct part in the transport of the electricity. The uranium rays fail to excite fluorescence (for example, in barium platino-cyanide), but this almost certainly is because of their excessively feeble character compared with the X-rays from an ordinary tube. Rutherford has also conclusively shown (*Phil. Mag.*, 1899, V., 47, p. 111, and *The Electrician*, Vol. XLII., p. 399) that the uranium rays are like X-rays, non-polarisable and non-refrangible.

The property of radio-activity is new and fundamentally important on account of its apparent spontaneity and persistence. To ionise the air, or even to fog a photographic plate, requires energy. In the case of the cathode rays and the X-rays they produce, the source of the energy is directly traceable to the electric field in the tube, and particularly to the great drop of potential that always exists in the "dark space" around the cathode. But in the case of uranium the source of the energy is not apparent. It is true that the emission of energy is small, amounting, as Rutherford and McClung (*Phil. Trans.*, 1901, 196, p. 55) have shown, to 0·03 gramme-calorie per year for the case of 1 gramme of uranium oxide. But when we come to consider the case of the element radium we have to deal with radiations incomparably more powerful, and we shall find that this number has to be multiplied at least a million times. It is obvious that the source of this energy must either be an external unknown or unrecognised form of energy,* or it must be derived from the internal energy of the substance itself which is undergoing some change. Both views find supporters, but it is the main object of these lectures to show that the radio-active elements are undergoing continuous change, and that, therefore, energy changes must, theoretically, also occur. Until external sources of energy have been discovered, it is allowable to consider the energy change observed as due to the material change that is taking place.

Other Radio-active Substances.—Soon after M. Becquerel's discovery Mme. Curie (Thesis presented to the Faculté des Sciences de Paris, *Chem. News*, 1903, p. 85, *et seq.*) made a careful examination of practically all the known elements, and found that only one—viz., thorium—was, like uranium, radio-active. Schmidt simultaneously discovered the radio-activity of thorium. With regard to the other elements, Mme. Curie states that if they possess radio-activity it can only be to an extent at least 100 times more feeble than that possessed by uranium and thorium, which are of very similar activity. But although none of the known elements in the pure state possessed appreciable radio-activity, Mme. Curie observed that certain ores of uranium and thorium, notably the pitchblendes, were several times as radio-active as the element uranium or any of its compounds. The following is a list of the minerals examined and their activities :—

	$\times 10^{-11}$ amperes.		$\times 10^{-11}$ amperes.
Pitchblende (Johanngeorgen-stadt)	8·3	Thorite	1·4
Do. (Joachimsthal)	7·0	Crangeite	2·0
Do. (Pzibran)	6·5	Monazite	0·5
Do. (Cornwall)	1·6	Æschynite	0·7
Clèveite	1·4	Fergusonite	0·4
Chalcolite	5·2	Samarskite	1·1
Autunite	2·7	Niobite	0·3
		Carnotite	6·2

* If, for example, all space were permeated by a type of radiant energy to which ordinary matter was completely transparent, but to which the radio-active substances were more or less opaque, it is possible that this source might explain the energy emitted by the latter class of substances.

The method of measurement will be considered later, but the activity is expressed by the current in amperes which was enabled to pass through the air, under the action of the rays, from a layer of the substance of area 64 sq. cm.

The following table gives the radio-activity, on the same scale, of uranium and its pure compounds :—

	$\times 10^{-11}$ amperes
Metallic uranium (containing carbon)	2·3
Black oxide, U_3O_8	2·6
Green oxide, U_2O_5	1·8
Uranic hydrate, $UO_3 . 2H_2O$	0·6
Sodium uranate, $Na_2U_2O_7$	1·2
Potassium uranate, $K_2U_2O_7$	1·2
Ammonium uranate, $(NH_4)_2U_2O_7$	1·3
Uranium sulphate, $UO_2SO_4, 3H_2O$	0·7
Potassium uranyl sulphate, $UO_2SO_4, K_2SO_4, 2H_2O$	0·7
Uranium nitrate, $UO_2(NO_3)_2 . 6H_2O$	0·7
Phosphate of copper and uranium	0·9
Uranyl sulphide, UO_2S	1·2

It will be seen from the above table that the radio-activity depends mainly on the percentage of uranium present in the compound, although the density and state of division of the compound must, by altering the proportion of the rays absorbed in the substance itself, exert an influence on the observed activity. But metallic uranium itself is only one-fourth as active as the Johanngeorgenstadt pitchbende, which probably contains about 70 per cent. of uranium. Mme. Curie next tried whether an artificial mineral, prepared from pure materials, would show any higher activity than the materials of which it is compounded. She chose chalcolite for the purpose, which is a phosphate of copper and uranium, and she found the artificial preparation possessed an activity corresponding to its composition—viz., 0·9, compared with 5·2, the activity of the natural mineral.

Mme. Curie came to the conclusion, as the result of these experiments, that *radio-activity is an atomic property* which is independent of the physical or chemical state of the active element, but is, when compounds of similar density and states of division are compared, proportional only to the quantity of active element present. On this view, the high activity of the natural minerals examined could only be explained by supposing them to contain a new element (since none of the known elements except uranium and thorium are radio-active) many times more active than uranium, which had hitherto escaped detection by the analyst.

M. and Mme. Curie then proceeded to the decomposition of pitchblende, and its separation by chemical analysis into its constituent elements. Each preparation was tested for radio-activity, and as was to be expected, if the high activity of pitchblende is due to the presence of highly active new elements, the radio-activity was found to increase in certain of the fractions at the expense of the activity of the others. The result was the discovery of two new very strongly radio-active substances, named by the Curies "polonium" and "radium."

It will be convenient to consider the case of radium first, in the discovery of which M. Bemont was associated with M. and Mme. Curie. Radium is the only new radio-element that has so far been isolated in the pure state, or which has been found to give a new spectrum. It was discovered that the barium separated from pitchblende possessed marked activity, and if the active barium chloride was fractionally crystallised, the activity tended to concentrate in the least soluble fraction. The active barium preparations were, as soon as possible, submitted to M. Demarçay for spectroscopic examination in order that the hypothesis of the existence of a new element might be confirmed. In the first specimens a new line in the ultra-violet ($\lambda = 381{\cdot}47\mu\mu$) of considerable intensity was detected, and as preparations were obtained of higher and higher activity, this line became stronger and new lines appeared. As the fractionation of large quantities of material was proceeded with, small quantities of intensly active products were prepared in which the new spectrum predominated and only the three strongest barium lines were visible. Finally a product was obtained, in the spectrum of which the presence of barium lines was scarcely detectable. The following table shows the measurements of Demarçay of the spark spectrum of radium

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between the limits $\lambda = 500{\cdot}0$ and $\lambda = 350{\cdot}0\mu\mu$. The intensity of the strongest line is put at 16 :—

λ	Intensity.	λ	Intensity.
482·63	10	460·03	3
472·69	5	453·35	9
469·98	3	443·61	8
469·21	7	434·06	12
468·30	14	381·47	16
464·19	4	364·96	12

In addition there are two well-marked misty bands in the spectrum, and in general the spectrum is similar in its characteristics to those of the other alkaline earth metals. Runge

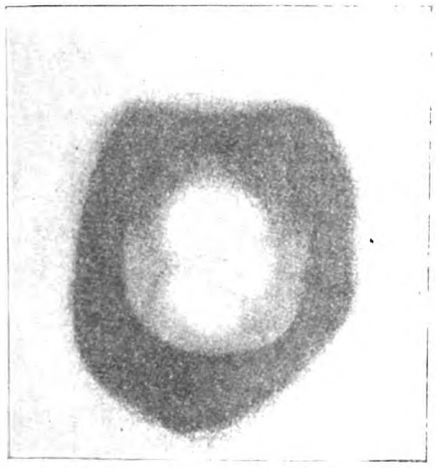

Fig. 1.—Radiograph of an Aluminium Medal taken by M. Becquerel with the Uranium Rays. Exposure: A fortnight.
(From "Rapports du Congrès International de Physique, 1900" Tome III., p. 51.)

and Precht (*Phil. Mag.*, 1903, VI., 5, p. 476) have examined the spark spectrum of radium in a magnetic field, and have found that the strongest lines are exactly analogous to the strongest lines of barium and to the corresponding lines of the related elements magnesium, calcium and strontium, and, like them, may be grouped into three series, a pair of lines in each series, the

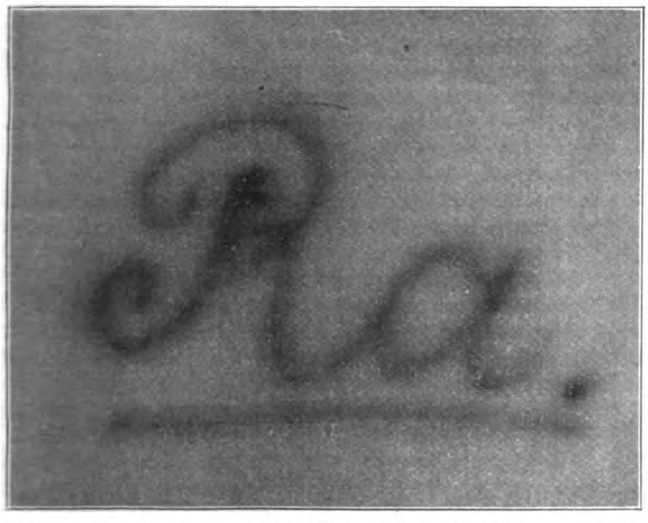

Fig. 2.—Negative produced by Writing with a Glass Tube containing a few milligrammes of Pure Radium Bromide on a Photographic Plate wrapped in Black Paper.

distance apart of the two lines being the same for all three series of any one element. In the second series of each element there occurs besides the two lines a third, which they term a "satellite." In calculating the distance apart, the oscillation-frequency which is the reciprocal of the wave-length is employed. The following table shows the corresponding lines in the spectra of magnesium, calcium, strontium, barium and radium, expressed in Ångstrom units.

——	Mg.	Ca.	Sr.	Ba.	Ra.
Primary series.....	2,803	3.969	4,216	4,934	4,682
	2,796	3,934	4,078	4,554	3,815
1st secondary series	—	3,181	3,475	4,166	4,436
	2,798	3,179	3,465	4,131	4,341
	2,791	3,159	3,381	3,892	3,650
2nd secondary series	2,937	3,737	4,306	4,900	5,814
	2,929	3,706	4,162	4,525	4,533

The following is a table of the distances apart of the three pairs in the case of radium measured on the scale of frequency :—

——	λ	$10^7/\lambda$	Difference.
Primary series	4,682·35	21,356·8	4,858·3
	3,814·59	26,215·1	
1st secondary series	4,436·45	22,540·5	4,858·5
	3,649·77	27,399·0	
2nd secondary series	5,813 9	17,200·2	4,858·6
	4,533·33	22,058·8	

Now the distances apart of the lines increases as the atomic weight of the element increases, and from the values in the case of Mg, Ca, Sr and Ba Runge and Precht have extrapolated for the case of radium, and obtained for the atomic weight of radium, the number 257·8. This, as we shall see, is considerably above the experimental number found by Mme. Curie. On the other hand, Marshall Watts (*Phil. Mag.*, 1903, VI., 6, p. 64) has deduced for the atomic weight of radium from independent relations between its spectrum and those of the other alkaline earths the number 225, which is identical with Mme. Curie's number. This matter needs further investigation, but for the present we must accept the experimental value, especially as it is that required by the periodic law.

The line 4,826·14 in the radium spark spectrum is stated by Runge and Precht to be the one most prominent in the flame spectrum, and is analogous to the strongest flame lines Ba 5,535, Sr 4,607, Ca 4,426, for all these lines are resolved into triplets by a magnetic field, the lines in each case being equidistant from one another on the scale of frequency. We thus see that the spectrum of radium, when subjected to the strictest investigation by the modern methods of spectroscopy, is the normal spectrum to be expected for an alkaline-earth element heavier than barium. Radium shows in its spectrum no indication of any special peculiarities which might be connected with its many unique radio-active properties, and this is the more surprising when it is considered that the methods of spectroscopy have thrown a great deal of light on the internal mechanism of the chemical atom.

Mme. Curie states that the strongest line of radium cannot be observed with specimens less active than fifty times that of uranium. Since radio-activity $\frac{1}{150000}$th of this can be easily detected (compare Strutt, *Phil. Mag.*, 1903, VI., 5, p. 683), it follows that for radium the radio-active test is 150,000 times more sensitive than the spectroscopic. Nevertheless, Demarçay classes radium among the bodies which possess the most sensitive spectrum reaction. In pitchblende itself the quantity of radium is probably about one-twentieth of the minimum quantity detectable by the spectroscope. The use made by M. and Mme. Curie of the property of radio-activity as a means of detecting and separating new elements is strictly analogous to the use made by Bunsen and Kirchhoff in the early sixties of the spectroscope for the same purpose. Thus 44,200kg. of Dürkheim water were worked up by these investigators and 7·272 grammes of caesium obtained therefrom, the sole guide to the existence, and in the early stages of the separation, to the analytical behaviour of this new element being the two bright blue lines in the flame spectrum.

The recognition by Mme. Curie of radio activity as an atomic property is the most remarkable feature of her work. For if we except *inertia* there is, strictly speaking, only one other "atomic property," and that is *weight*, which alone is an additive property of the atoms, each constituent atom contributing its quota without possibility of its being changed by any agency we know of. This is shown by the fact that this is the only property that can be used universally as the basis of chemical analysis. Of other properties spectrum reactions represent probably the nearest approach to an atomic property, for within certain limits of temperature the spectrum of an element

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is the same whatever the compound employed. But the spectrum reaction is not an additive property, and the intensity of a spectrum is by no means a sure indication of the quantity of element present, for many spectra are "masked" by comparatively small quantities of impurities. Nevertheless, by spectrum analysis it is frequently possible to get a rough quantitative estimate of the amount of an element present.

In spite of the discovery of many new facts, which at first sight seemed to contradict the view that radio activity is an atomic property, there seems no doubt of its truth at the present time. It has not been found possible to influence radio-activity by any known agency any more than it has been found possible to alter weight, and the more free from disturbing causes (such as absorption) the measurements are, the more accurately this result holds good. Hence radio-activity is fitted in every respect as a property upon which a method of quantitative chemical analysis could be based. We shall see later that radio-activity furnishes a means of qualitative analysis also. There are certain peculiarities which enable us instantly to recognise thorium, or radium, from uranium (even were all these elements mixed) without performing a single chemical or spectroscopic test with the substance.

(To be continued.)

THE RYDE ELECTRICITY WORKS.

The new electricity works formally opened by the Mayor of Ryde on October 1st possess features of peculiar interest in several respects. In the first place, the generating sets are operated entirely by producer gas, the erection of the station was only commenced last March, and an action to restrain the company from working any longer has already been partly heard. There is also the unpleasant fact to be faced, that the load-curve can never be of the most profitable nature; the district is essentially residential, with very little load due to business and trade premises, and the consequence is that even in winter the load will only extend from 4 p.m. to 11 p.m., while in summer it will be less than half this length of time. These circumstances limited the capital expenditure very considerably, and the promoters have, therefore, put down plant of the least expensive type, and of the only kind, excepting water power, which is not available, calculated to pay its way. Accumulators have been installed to deal with light loads, when the station is shut down entirely and left to take care of itself. It will require exceedingly careful management to make the undertaking a success, both engineering and financial, and the task is no enviable one.

The gas producer plant consists of two steel-cased generators, lined with firebrick and fitted with a hopper at the top, through which fuel is fed. There are also two vertical boilers for blowing air and steam into the generators, a cooler, refuse box, scrubber and brick gas-holder. Each generator has a capacity of 200 H.P., and can generate 18,000 cubic ft. of gas per hour. Best anthracite cobble coal at 29s. 6d. per ton is used, but after the present stock is exhausted pea nuts at 24s. 6d. will be employed. For one Board of Trade unit delivered by the dynamos, 1·9lb. of coal is required, in addition to 0·04lb. of coke for the boilers. These figures, however, only apply to the most favourable conditions—*i.e.*, when working on full load; they become considerably larger on partial load. Steam at 75lb. per square inch is taken from the boilers, and after being superheated by passing through the hot gas-pipe from the generator, is fed into the bottom of the generator. The resulting gas is then passed through the cooler, which is merely a cylindrical tank containing the gas main surrounded by water. The effect of this operation is to deposit tar and refuse in a refuse box at the base of the cooler. After passing a valve, the gas enters the scrubber by means of a water seal at its base, and from thence to the holder, which is 15ft. in diameter by 10ft. in height. The length of 12in. gas main from the holder to the engines is about 65ft., and approximately 2 gallons of water per day are pumped out of this pipe.

It is customary, when not actually generating gas, to allow draught to pass through the furnace and out by a blow-off pipe controlled by a valve. This entails the escape of a very small quantity of gas, and the smell therefrom may be unpleasant to surrounding residents; but, as a matter of fact, it has been found quite unnecessary to follow this practice at Ryde, so that when the producers are not at work they are sealed up entirely, making it impossible for any gas to escape. In spite of being sealed in this fashion, which effectually prevents any draught passing through, the furnaces are found to be in working order after being shut down for 36 hours. The steam pipes from the steam boilers to the producers are in duplicate.

There are two sets of Tangye three-cylinder vertical gas engines of 200 maximum brake-horse-power each, for a continuous working load of 150 B.H.P. at 210 revs. per minute, each coupled directly to a six-pole dynamo of 480-530 volts, 200 amperes capacity, supplied by Thomas Parker (Ltd.). The engines work on the "Otto" cycle, and are fitted with three

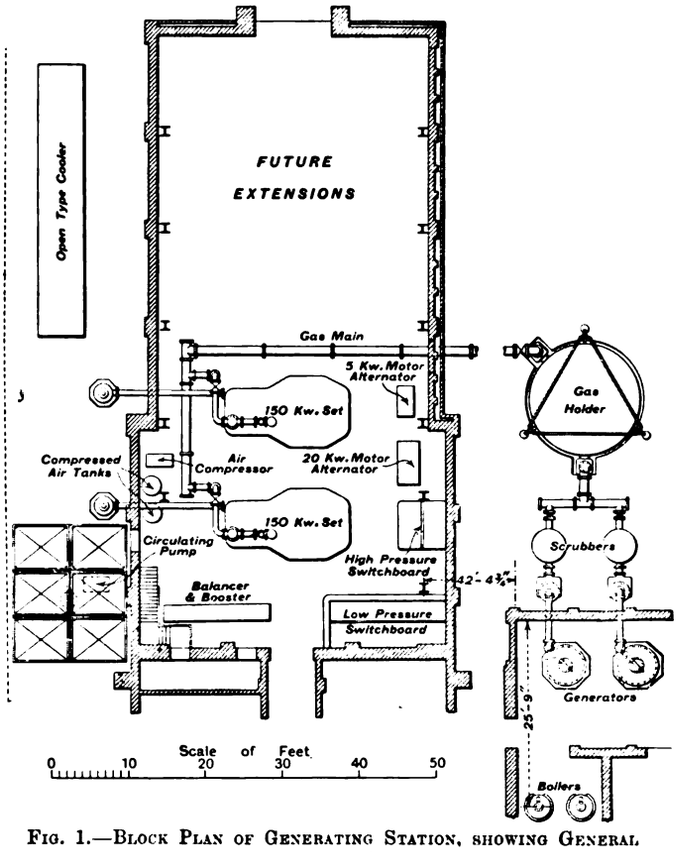

FIG. 1.—BLOCK PLAN OF GENERATING STATION, SHOWING GENERAL ARRANGEMENT OF PLANT, &C.

cylinders, the cranks being set to receive an impulse at every two-thirds of a revolution. Governing is effected by "throttling" the explosive mixture; the frequency of the impulses is the same for all loads, the predetermined ratio of gas and air remains constant, but the quantity of mixture admitted to the cylinders is controlled by the governor, and thus the consequent strength of the impulse is in proportion to the load carried by the engine. The gas is reduced from 1¼in. or 1¾in. to atmospheric pressure by means of a suitable pressure regulator, and is mixed with the air just before passing through the balanced valve which is operated by the engine governor, the latter being of the flywheel type and very sensitive in its action. The use of three cylinders and consequent frequency of explosions, coupled with the method of governing by "throttling," results in a very even turning movement of the crankshaft, and renders the engine particularly suitable for coupling directly to dynamos. By the adoption of the vertical type of construction, vibration is reduced to a minimum, and thus very heavy foundations are unnecessary. The cylinders are carried on the top of a cast-iron standard of the enclosed type, this being bolted to a massive cast-iron base,

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which carries the main bearings for the crankshaft and also forms an oil bath. The end of the connecting rod works into the oil bath, and the oil is thrown over the whole of the internal working parts, the cylinders and bearings thus being efficiently lubricated. Each cylinder jacket is cast in one piece with its combustion chamber and exhaust valve box, thus doing away with all troublesome face joints and leaky water passages. Ample space is provided for the free circulation of cooling water around the walls and valve seats mostly exposed to the high temperature of the burning gases. The open end of the cylinder is carefully fitted into the standard and held in position by bolts. The valves are operated from two horizontal cam shafts driven by a vertical side shaft and machine cut gearing from the crankshaft. The upper shaft carries two cams for each cylinder. One engages with a roller at the end of a lever and operates the inlet valve for the admission of the mixture of gas and air. The other is to work the igniter; this at the proper instant operates the mechanism for breaking the electric circuit at the terminals of the igniter. The low shaft carries the exhaust valve cams, each of which actuates an exhaust lever for opening an exhaust valve. Ignition is effected by means of a magneto-electric machine of the rotary type, driven at a suitable speed by gear wheels from the upper cam shaft; this speed, although not excessive when the engine is working at full load, is sufficiently fast for starting, and no batteries or accumulators are required. It should be understood that the ignition employed on these engines is not of the ordinary form; the spark does not "jump," but is drawn out in the form of an arc by the terminals first making actual contact and then being drawn apart.

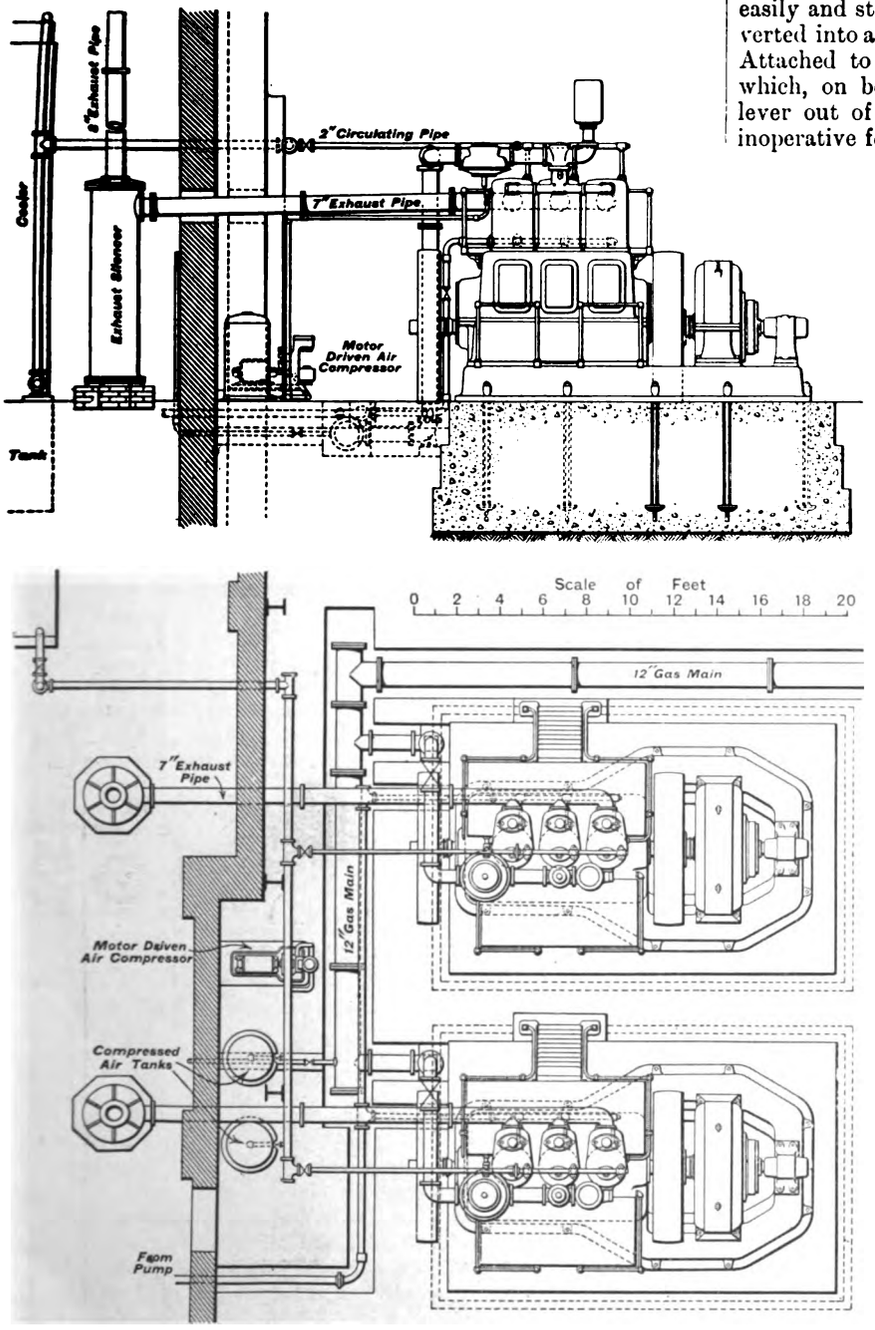

FIG. 2.—DETAILED PLAN AND ELEVATION OF THE TWO 150KW. SETS, SHOWING THE ARRANGEMENT OF GAS MAINS AND PIPING, &C.

A Reavell air compressor coupled through gearing to a 4 H.P. motor charges two receivers with air to a pressure of about 150lb. per square inch; this is sufficient to start the engine easily and steadily. For starting, one of the cylinders is converted into a compressed air motor in the following manner:—Attached to one of the admission valve levers is a handle which, on being moved over from right to left, throws the lever out of gear with the cam and renders the inlet valve inoperative for the time being; at the roller end of the exhaust valve lever for the same cylinder is a small relief lever which on being pulled into a vertical position will be actuated by a cam at the side of the regular exhaust cam, which is arranged to open the exhaust valve during every upstroke of the piston; similar relief levers are fitted to the exhaust levers of the other cylinders for reducing the compression when starting. A pipe conveys the compressed air from the receiver to the starting valve which is attached to the cylinder; this valve is actuated by a cam on the vertical side shaft and timed so as to open at the commencement of each down stroke of the piston. The crank corresponding to the starting cylinder is set a little past the upper centre, gas supply turned on, starting valve opened, and engine will start and continue to be run by the compressed air until explosions are taking place in the other cylinders. The compressed air supply is shut off and the inlet and exhaust valve levers and cams put back in their ordinary working position. The starting valve is put out of gear by moving the lever away from the cam, and is kept in this position by means of the peg provided. It is possible to vary the quality of the mixture by causing the inlet apertures of air and gas to vary in size. This is effected by a sleeve which fits over a cylinder in each of which there are two slots. On rotating the sleeve about the cylinder it is clear that the areas of the apertures will be varied, thus increasing or decreasing the value of air or gas at will.

The circulating water for the cylinder jackets will be obtained from a deep well pump of 6in. bore, at a depth of 330ft., which has just been sunk, and gives a practically unlimited supply Should the circulating pump fail, however, there are two alternative methods, one of which is in the town mains. The third method depends upon gravity; water would be taken from storage tanks situated above the pump room, through the cylinder jackets, and then, instead of passing through the cooler, it would flow direct into the tank below the cooler in order to obtain sufficient fall.

The engines run with remarkable smoothness, and as far as noise is concerned it is extremely difficult to distinguish them from steam engines. A silencer is employed for the exhaust, and consists of an iron cylinder with a pipe projecting into the atmosphere from the top. The exhaust pipe from the engines enters the cylinder at the side near the top, and immediately turns downwards at a right angle, till within a few inches of the bottom, where it stops. Where the separate exhaust pipe from each engine cylinder joins the main exhaust pipe there is sprayed up inside the latter a jet of water from the circulating pipe, thus tending to cool the exhaust gases long before

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they reach the atmosphere. The result of this is that, in addition to the aquæous vapour inseparable from a large gas engine exhaust, this water is vaporised and emitted from the exhaust pipe in the form of a small cloud of steam. No noise

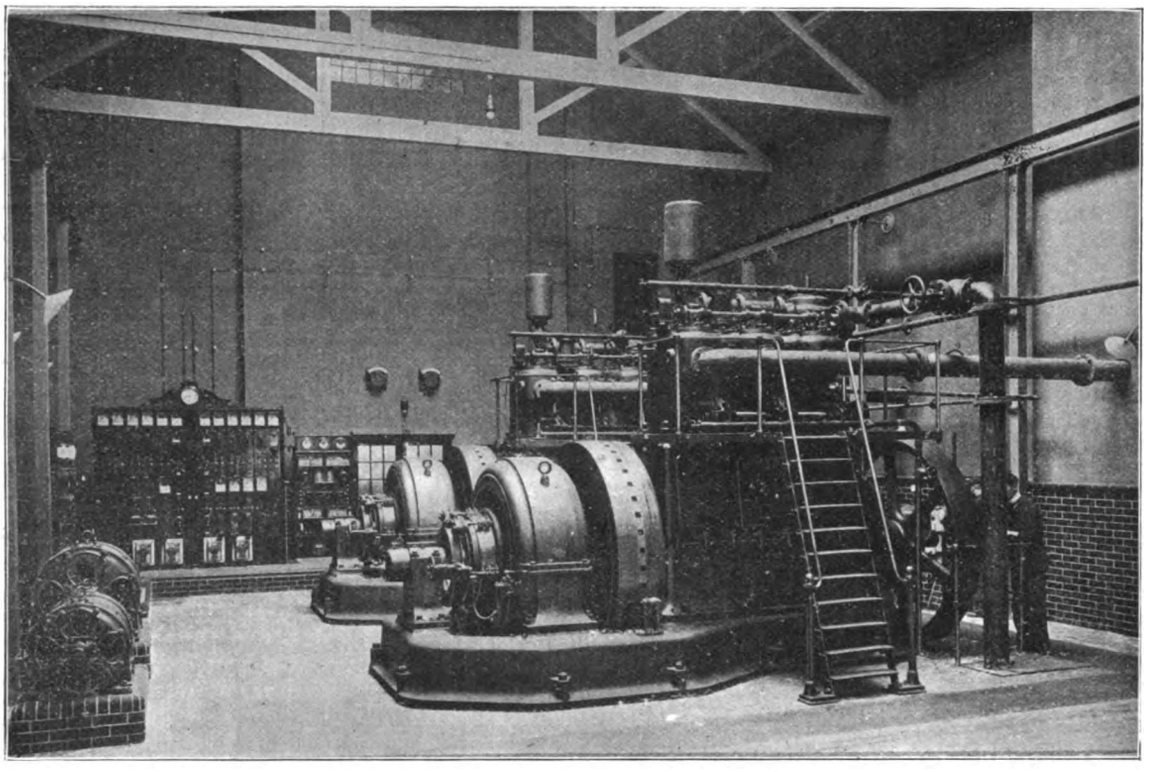

Fig. 3.—Engine Room.

or smell results, and the effect is considerably less than that caused by the atmospheric exhaust of a 20 H.P. steam engine.

The dynamos do not possess any features of particular interest, with the exception of the pole shoes, which are laminated and slotted with a view to reducing sparking. The arrangement of the laminations, between which are sandwiched non-magnetic and non-conducting materials, is such that the flux is concentrated just where required.

Coming now to the purely electrical side of the equipment, a balancing transformer, consisting of two separate dynamos, has been provided, each armature being arranged to take an E.M.F. of 240 to 265 volts, with a current of 60 amperes, the balancer being capable of dealing with an out-of-balance current of 100 amperes when not driving the two boosters, or of dealing with 15 amperes when driving these at full power. The balancing transformer is coupled directly to two booster dynamos for charging accumulators, each being capable of giving out a current of 100 amperes at 85 volts. These four machines are fitted on one girder bedplate, all armatures being coupled together. The low-tension switchboard is of the ordinary standard type manufactured by Messrs. Edmundsons, with the exception that it has been wired throughout with bare copper rod. There is no cable whatever, and absolutely nothing inflammable at the back of the board. Like everything else in the station, it was constructed with the prevailing idea of economy, and no money has been wasted in high finish or superfluous equipment. The D.P. 260-cell battery has a capacity of 750 ampere-hours at the 75-ampere rate. The low-tension mains consist of 12 miles of distributors and two feeders, one to the centre of the town, and the other to the chief residential quarter. All cables were manufactured by Messrs. Callenders and are lead-covered and armoured, and laid direct in the ground. The distributors are three-core cables having sections of 0·05, 0·03, 0·05, and the lead sheathing and steel armouring is bonded to all boxes. The feeder supplying the centre of the town is similar to the distributors, but has a section of 0·4, 0·2, 0·4, triple concentric, and ends in a feeder pillar having eight distributor ways. The other feeder has a section of 0·2, 0·1, 0·2, and ends in a feeder pillar having five distributor ways. By means of fuses the system is divided into three, so that should a fault occur on one section the fuse blows and the other sections remain unaffected.

About 3 miles from Ryde is the village of Sea View, and Spring Vale lies in between. Both these places, and the road which joins them with Ryde, are lighted by the Ryde station. There are installed in the station two motor-alter-

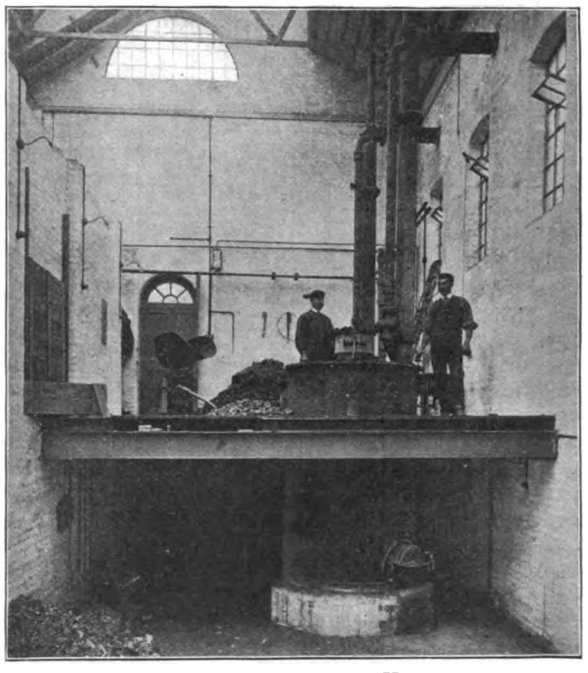

Fig. 4.—Gas Generator House.

nators by the Electric Construction Co. of 5kw. and 20kw. respectively. These supply current at 2,500 volts, single-phase and a frequency of 50~ per sec. to a concentric high-tension main having a section of 0·025 sq. in. By the side of this main, however, a low-tension main has been laid having four

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cores of 0·05, 0·03, 0·05 and 0·012 sq. in. section respectively. Both these mains are looped into three transformers, two situated on the way and the third at Sea View. The first three cores of the latter cable form the low-tension alternating distributors for private lighting between Ryde and Sea View, while the 0·012 sq. in. core, with the neutral (0·03), is employed solely for public lighting in the form of incandescent lamps along the road to Sea View. The transformers are situated in the top chamber of the feeder pillars supplied by Messrs. Callender's and are shown in Fig. 5. These feeder pillars are of a very ingenious design, and are divided into three main compartments—viz., one at the top, of sufficient size to contain a 30kw. transformer; a second in the lower part, in which are placed the low-tension switch, links, &c.; and a third, divided from the second by an iron partition, and containing the high-tension switch and fuses.

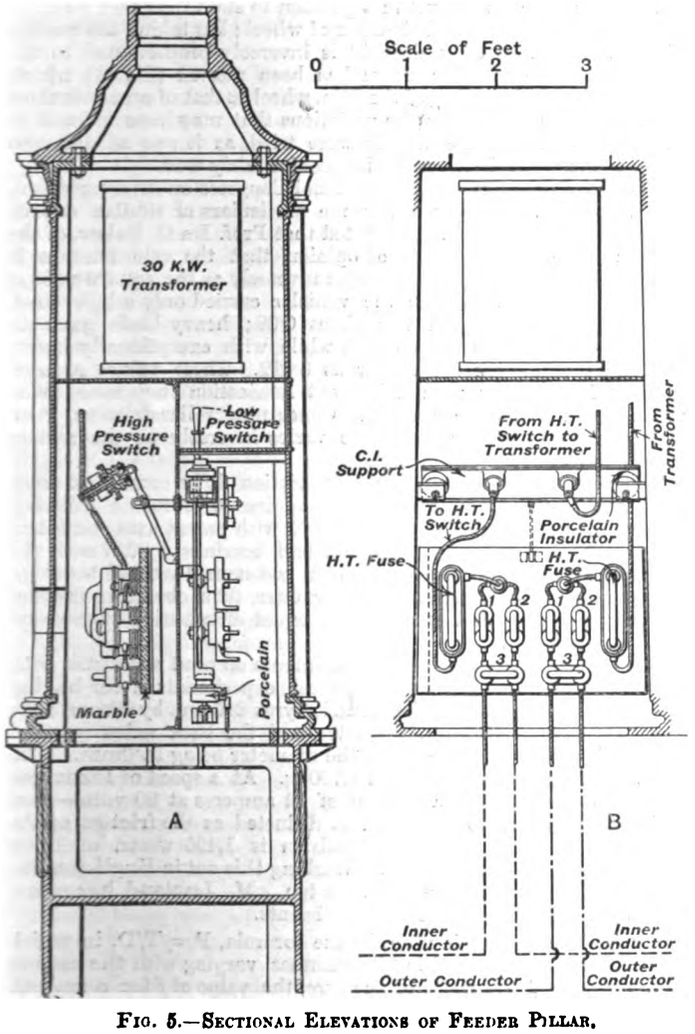

Fig. 5.—Sectional Elevations of Feeder Pillar.

The third compartment is also sub-divided into two by a steel shelf, through which projects the handle of the switches, as seen on the right hand of A, Fig. 5. Access to this small upper compartment may be obtained by means of a small door let into the large one. It is proposed to disconnect two transformers out of the three during hours of light load and switch them in again at night. This may be effected by an unskilled labourer, who will be given the key to the small upper compartment only. He will thus switch on or off both secondary and primary without being able to get at any live part whatever. The public lighting will also be controlled by a switch situated in this small compartment.

It will be observed that the low and high-tension switches are mechanically coupled by levers joined by means of a pin working in slots. This arrangement ensures the "breaking" of the secondary before the primary, and the "making" of the primary before the secondary, so that the transformer is always cut in and out of circuit when unloaded. On reference to B, Fig. 5, it will be seen that the inner conductor of the concentric high-tension main may be cut off from the transformer by removal of links 1 and 2; the same applies to the outer, which is earthed at the station. This facilitates testing, and in the event of a fault occurring on either conductor the section may be isolated and the transformer fed back.

We are indebted to Mr. A. E. Mayes, the chief engineer of the Isle of Wight Electric Light and Power Co., for enabling us to view the works, and to Mr. F. H. Merritt, the resident engineer, for his courtesy in explaining many of the details of the undertaking included in the above description.

List of Contractors.

Tangyes Limited	Gas producers, boilers and engines.
Thomas Parker Limited	Dynamos.
Klein Engineering Co.	Cooling tower.
Electric Construction Co.	Motor alternators.
D.P. Battery Co.	Storage battery.
Callender Co.	Cables.

THE RESISTANCE OF ROAD VEHICLES TO TRACTION.*

Traction experiments with iron-shod wheels were first undertaken, and were conducted on a portion of Regent-road, Bootle, which is paved with setts 6in. by 3in., having a regular but fairly rough surface, with a 1in. gap between the joints. Regent-road runs along the line of docks, and is, in consequence, free from gradients. The wheel used was a light lurry wheel, 40in. diameter, having a 3in. iron tyre slightly rounded in section. The axle was tilted up out of the horizontal at one end so that the wheel—which was slightly coned—could take up a position exactly similar to the lurry wheels in general use; it was mounted on a pair of springs 3ft. 2in. between the centres of attachment, each spring comprising six plates $2\frac{1}{4}$ in. by $\frac{5}{16}$in.

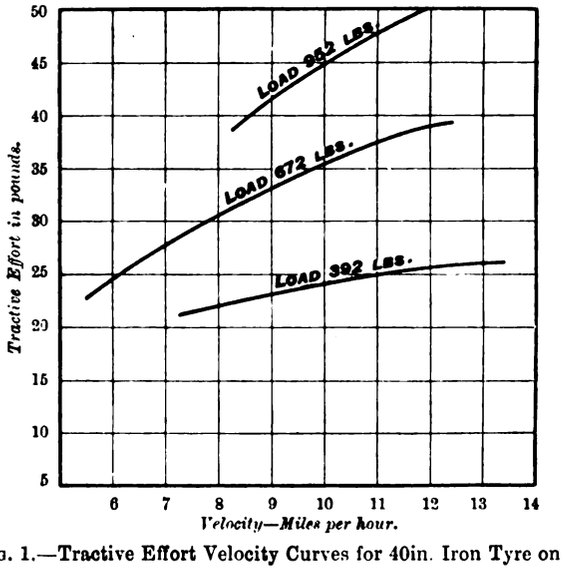

Fig. 1.—Tractive Effort Velocity Curves for 40in. Iron Tyre on Setts.

Three runs were made over this particular route with loads of 392lb., 672lb., and 952lb. respectively, at speeds of from 5 to 14 miles per hour. The results of these trials are plotted in Fig. 1, with total tractive effort (inclusive of axle friction, &c.), as ordinates, and velocity as abscissæ. It will be noticed that for each curve the tractive effort increases with the velocity, but these curves and all subsequently obtained are concave downwards, showing that the rate of increase of tractive effort diminishes with the velocity. This may be due to the fact that as the wheel travels faster it has less time to fall into the little hollows in the roadway, merely skimming along the tops of the ridges. Well-laid setts under these circumstances, even with wide deep gaps, form a perfectly smooth track at high speeds. This is well brought out in Fig. 3, which shows a smaller tractive

* Abstract of a report of a committee of the British Association, consisting of Sir J. I. Thornycroft (chairman), Prof. H. S. Hele-Shaw (secretary), Mr. T. Aitken, Mr. T. C. Aveling (treasurer), Prof. T. Hudson Beare, Mr. W. Worby Beaumont, Mr. J. Brown, Col. R. E. B. Crompton, Mr. B. J. Diplock, Mr. A. Mallock, Prof. J. Perry, Sir D. Salomons, Mr. A. R. Sennett and Mr. E. Shrapnell Smith. (Drawn up, at the request of the committee, by the secretary, assisted by Mr. J. F. Gill, B.Sc.)

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effort for setts than for macadam. On looking into the matter, this is as it should be. Consider two perfectly level roads, one made with setts and the other with macadam; the setts present a surface which is extremely hard, although irregular, but this irregularity with well-laid setts is more apparent than real, as the tops of the setts themselves are smooth and level and all in the same plane. The macadam, on the other hand, although quite level, is not nearly so hard as the stone surface, and is, moreover, covered with a thin layer of dust or fine gravel, which, as is well known, retards the progress of a vehicle.

A series of experiments were made with a pneumatic-tyred wheel 24in. diameter, 2¾in. tyre. This was a wire-spoked wheel of the type used on light voiturettes; it was mounted on the same springs as the lurry-wheel mentioned previously, but they were reduced in strength by the removal of four plates, so that each spring consisted of two plates 3ft. 2in. long, 2¼in. wide and $\frac{5}{16}$in. thick. This series

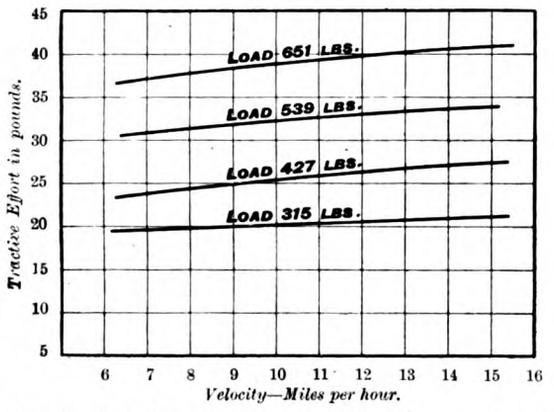

FIG. 2.—Tractive Effort Velocity Curves for 24in. × 2¾in. Pneumatic Tyre on Macadam.

of experiments was conducted on a level stretch of macadam road, the surface of which was in fairly good condition, slightly wet in places; runs were made with loads of 315lb., 427lb., 539lb. and 651lb. respectively. Fig. 2 shows tractive effort and velocity plotted for each of these loads. It will be noticed that the ratio of tractive effort to load for these curves is very nearly constant, and that the tractive effort increases slightly with the velocity. Assuming for the time that the tractive effort is directly proportional to the load, a curve has been plotted between tractive effort per ton and velocity (Fig. 3) which is useful for comparison with similar curves for wheels of different diameters.

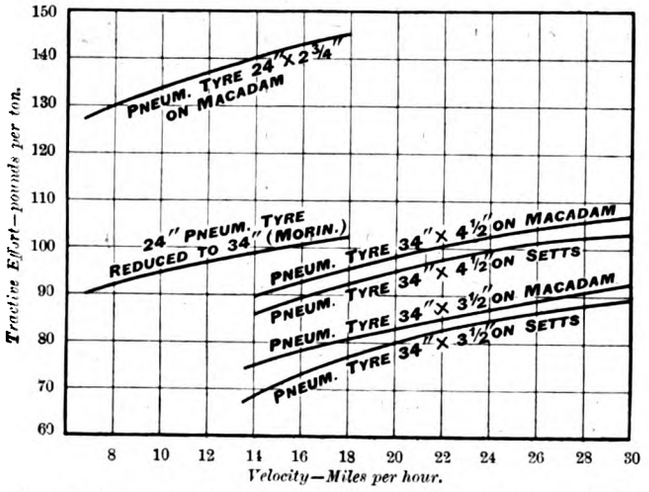

FIG. 3.—Curves showing Tractive Efforts per Ton for Pneumatic Tyres.

(NOTE.—The macadam on which the 24in. wheel was run was older than that on which the 34in. wheels were tried.)

Additional experiments were made on pneumatic tyres under the auspices of the Automobile Club of Great Britain and Ireland. For these trials it was found that the car used by the committee was not of sufficient power; a 24 H.P. Panhard and Levassor car was, therefore, temporarily used.

In this car the springs supporting the experimental wheel have been placed above the frame, thus enabling the centre of gravity of the trailer to be brought very near to the ground. This alteration was found necessary owing to a sidelong oscillation taking place at high velocities when the frame was in the position as first arranged. The altered position proved quite successful. These experiments were made with two sizes of tyres, one 34in. diameter by 3½in. and the other 34in. diameter, with a mean diameter of cross-section of 4½in. Runs were made at speeds of from 12 to 35 miles per hour, over both good macadam, frozen hard, and good dry setts. The springs supporting the trailer were 3ft. 2in. long, each having four plates 2¼in. by $\frac{5}{16}$in., and the tyres were in all cases pumped to a pressure of 60lb. per square inch, the total load on the wheel being 896lb. The results obtained and plotted in Fig. 3 show that the tractive effort under similar conditions as to road surface and speed is less for the tyre of smaller cross-section than it is for that having the larger section. This may be due to the fact that the tread of the larger tyre was much thicker than the smaller, rendering it in consequence more after the nature of a solid tyre, it being well understood that a perfect pneumatic tyre should have as little inelastic, or comparatively inelastic, material about it as possible; or, the greater tractive effort may have been due to the greater cross-section. Repeated experiments alone can definitely settle this question.

This committee is not yet in a position to state the exact relation between tractive effort and diameter of wheel; but taking the results of Gen. Morin, that the draught is inversely proportional to the diameter of the wheel, a curve has been plotted (Fig. 3) which reduces the tractive effort of the 24in. wheel to that of an equivalent 34in. wheel. Considering the variations that may have existed in the roads on which the wheels were tried, as it was at different times of the year, these results harmonise fairly well.

In a Paper, read at the International Congress on Automobilism, Paris, 1903, M. Lavergne gave some particulars of similar experiments made in America. He stated that Prof. Ira O. Baker, of the Illinois State University, is of opinion that the axle friction is independent of the speed but varies inversely as the square root of the load supported. Where the vehicles carried only a light load, the coefficient of friction was about 0·02; heavy loads gave an average of not more than 0·015, while with exceptionally heavy loads this coefficient fell as low as 0·012. These values assume efficient lubrication; with indifferent lubrication they rose to as much as six times the amount. Concerning roller friction, Prof. Baker believes that the resistance varies inversely as the square root of the diameter of the wheels.

The values above given for axle friction differ somewhat from those published by M. Forestier, who gives 0·10 for an ordinary bearing lubricated with cart grease, 0·01 with patent axle-box lubricated with oil, 0 005 with lubricated ball bearings, 0·0025 with the lubricated "Philippe" bearings (which last-named are ball bearings having small balls between the larger ones, thus obviating friction amongst the latter and ensuring an equal distribution of pressure upon all the balls).

M. Jeantaud has made some experiments on road resistance with an electric vehicle. He used for these experiments a car having four equal wheels fitted with Michelin tyres 840mm. by 90mm.; the front axles were 40·0mm. diameter, and the back axles were of tempered steel on bronze hubs, the diameter being 55·0mm. The car with four persons weighed 1,780kg. At a speed of 15km. per hour, this car required a current of 22 amperes at 80 volts—that is, 1,760 watts. If 15 per cent. is deducted as the friction of the motor itself, the energy of propulsion is 1,496 watts, or 149·6 kilogramme-metres per second. Working this out in English units, we have a tractive effort of 46lb. per ton. M. Jeantaud has calculated with Morin's formulæ and coefficients.

First.—The rolling friction, by the formula, $F_r = fP/D$, in which f is a coefficient expressed in kilogrammes, varying with the nature of the road and the width of the tyre, the value of f for a smooth dry road being 0 010; F_r is the rolling friction, P is the total load on the vehicle in tons, and D is the diameter of the wheel.

Second.—The axle friction by the formulæ, $F_s = sd/Dp$, in which s is a coefficient expressed in kilogrammes (varying with the mode of lubrication and the nature of the rubbing surfaces) and being taken as equal to 0·015. d is the diameter of the axle, and p the weight of the car without the wheels. Adding these two resistances and multiplying the total effort by 4·16, the velocity in metres per second corresponding to 15km. per hour, the work done per second is 182·274 kilogramme-metres. This figure would be that given for an iron-tyred vehicle, the only kind employed at the time of Gen. Morin. According to M. Michelin, the advantage obtained by using pneumatic tyres over iron tyres on a road similar to the above would be at least 15 per cent. Taking 15 per cent. off the figure obtained, the work expended on traction is reduced to 154·933 kilogramme-metres per second. This value is very near to that actually obtained—viz., 149·6 kilogramme-metres per second, and this proves the correctness of the values given for the coefficients f and s. In January, 1903, M. Jeantaud, with the same electric automobile, showed that the tractive effort for a road covered with thick mud was, as Gen. Morin had found, quite double that on a dry road, it having been actually found to be 74lb. per ton. On January 21st, when the route was hardened by the frost and very smooth, the tractive effort was found to be 42·7lb. per ton.

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Thus the tractive effort was 42·3 per cent. less on the hard road than on the muddy road at about the same speed of 10 miles per hour.

When pneumatic tyres are used, it must not be thought that springs can be dispensed with, as the duty performed by the tyre is quite different from that of the springs. The pneumatic tyre does away with the slight vibration caused by the wheel encountering gravel, stones and small obstacles generally, but the height of the axle from the ground scarcely varies, as the tyre absorbs within itself these small objects. Experience has proved that these small vibrations, if not absorbed by the tyre, would be transmitted through the springs to the body of the car to the great discomfort of its occupants, and would tend to reduce the life of the motor, owing to the crystallisation of the parts subjected to strain.

But the pneumatic tyre will not yield greatly, and is, in consequence, unable to save the car from vibration when passing over a large obstacle or a deep rut; whereas the springs, with a resilience of, say, 4in., will be well adapted for this purpose. Spiral springs have been tried with unsatisfactory results, and they can practically only be used where heavy weights are carried. Plate springs must necessarily be employed when ease and comfort are desired.

It may be pointed out here that the method of attaching plate springs to the frame is a matter of considerable importance. The ordinary practice is to use clips which are pivoted to a bracket depending from the frame, these clips being outside of and lower than the normal plane of the spring. From the bracket they rise at an angle of about 45deg. and meet the ends of the spring to which their upper ends are pivoted. The result is, when the wheel passes over an obstruction of any appreciable size, the axle rises under the centre of the spring, the plates of which lengthen (theoretically) and tend to form a straight line, and at once the load above is thrown upward in the same proportion. On the other hand, where the clips are so connected with the spring as to work within its length and under its ends, instead of beyond them, any shock given to the wheel causes the load to fall, and the loss of mechanical energy is less. M. Gaillardet is of opinion that the springs should be so arranged that each wheel is free to rise or fall independently of the others. When this is done, an obstacle under one wheel will raise that wheel only, and the centre of gravity of the whole car is raised a smaller distance than would otherwise be the case. To attain this result he proposes to mount the front axle on a single transverse spring, thus reducing the number of springs on the car to three. When the springs have been depressed by an obstacle in the roadway, they only return to the position of equilibrium after a number of oscillations of decreasing amplitude have taken place. It is advisable to spare the vehicle this continued oscillation, as at high speeds it causes the wheels to leave the ground, and consequently reduces the effective power of the motor. M. Truffault has taken out a patent for an arrangement to remedy this defect. The friction between two metal surfaces prevents the oscillations from arising. This spring has given very good results, enabling one to travel rapidly even over the worst of paved roads.

The experiments of M. Michelin have shown that the tractional resistance is reduced from 15 to 30 per cent., according to the nature of the road, by the use of pneumatic tyres in place of metal tyres, and Prof. Baker's experiments seem to show that on good roads the width of tyre has little effect on the resistance, and that even on bad roads the advantage lies sometimes with the wide tyres and sometimes with the narrow ones, according to circumstances. Arguments have been advanced in favour of both wide and narrow tyres, but nothing very definite seems to be known on the subject.

The air resistance is a retarding force of the highest importance, especially where speed is concerned, and there is unfortunately great uncertainty both as to the formulæ to be applied, and the values of the coefficients which appear in them.

The best known formula is $R = KSV^2$, in which R equals resistance in kilogrammes, S equals projected area in square metres of total surface of vehicle on a plane normal to direction of motion, V equals velocity in metres per second, and K is a numerical coefficient which varies between very wide limits according to the form and the speed of the vehicle.

Signor Canovetti had made some experiments at Zossen to determine the value of K. He had a copper wire, 380 metres long, stretched between the summit of the fortifications at Brescia and a point in the plain, about 70 metres below. Along this wire different surfaces were allowed to descend freely. A circle, with a surface of 0·073 sq. metres, moving with a velocity of 12 metres per second, gave a resistance of 84 grammes. The same circle, having a spherical cap in front, offered a resistance of only 21 grammes. When this hemisphere was followed by a cone, whose height was five times its diameter, the resistance fell to 13 grammes, or one-sixth of that of the plane circle. With this same solid, turned the other way about—that is, with the apex of the cone towards the direction of motion—the resistance rose to 18 grammes. Signor Canovetti has recognised that a rectangular surface, placed with its long sides horizontal, offers a sensibly greater resistance to the air than when its short sides are horizontal. His experiments seem to show that the coefficient K diminishes somewhat as the speed increases, but investigations carried out at Zossen point to the conclusion that the resistance may increase tenfold when the velocity is only tripled. It is thus clear that air resistance is a matter of no small importance when speeds up to 60 or 80 miles an hour are attained. At 85km. (53 miles) per hour, the energy required to overcome the air resistance on a vehicle, with an opposing surface of 1 sq. metre, may be 7, 11, or 20 H.P., according to the coefficient K given as 0·0288, 0·0648 or 0·116 by MM. Forestier, Bourlet, or Thibault. The question then arises, What is the best shape for a car? The answer depends on several things—as, for example, the necessity of placing the radiator in such a position that it may be efficiently cooled by the air rushing through it. Only general principles may be laid down. The front of the car ought to taper, and the back be more pointed still, like the form of a fish; transverse rectangular surfaces that cannot be dispensed with should, as far as possible, have the longer sides vertical; and it is well to have doors on the car to prevent the air from rushing in between the dashboard and the seat. These conditions are quite neglected in most of the present-day cars. With a radiator of the honeycomb type a transverse position is necessary for cooling purposes, and Signor Canovetti has shown evidence that a perforated surface will offer less resistance to the air than a plane one of similar area. This is not of much advantage with an automobile, as the air, after having passed through the holes in the radiator, meets with further obstacles in the mechanism inside the hood.

As regards the power required by automobiles, M. Lavergne has shown the enormous reduction of weight per horse-power that has taken place during the last eight years. In 1895, Levassor made the run from Paris to Bordeaux in a 4 H.P. car weighing about 1 ton, or 1 H.P. per 550lb. dead weight. In 1896 this weight was reduced to 365lb. per horse-power; in 1900 it fell to 90lb. per horse-power. In the recent Paris-Madrid race M. Gobron Brillie appeared with a 100 H.P. car, the weight of which represented only 22lb. per horse-power. This weight has been still further reduced in the case of motor bicycles, reaching as low a figure as 17·5lb. per horse-power. But there is not a corresponding increase in speed. In 1901 M. Fournier made over 53 miles per hour with a 28 H.P. Mors; last year M. de Knyff only slightly exceeded 58½ miles per hour with a 70 H.P. motor; that is an additional 40 H.P.

To what must this relatively small increase of speed be attributed? Air resistance is responsible for some increase, but certainly not all.

An extremely powerful motor must be accompanied by a comparatively heavy load, otherwise the wheels do not "bite" well and energy is wasted. It is well known that the modern racing car skims along the surface of the course, without sufficiently close contact between the wheels and the ground; in any case, driving wheels should be more heavily weighted and springs made less elastic.

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"Elementary Telegraphy and Telephony." By Arthur Crotch. (London: E. and F. N. Spon, Ltd.) 4s. 6d. net.

"Proceedings" of The Royal Society, No. 482. Vol. LXXII. (London: Harrison & Sons). 4s. 6d.

"La Tecnica delle Correnti Alternate." By Giuseppe Sartori. Vol. II. (Milan: Ulrico Hoepli.) 12 lire.

"Opere di Galileo Ferraris." Compiled by the Associazione Electtrotecnica Italiana. Vol. II. (Milan: Ulrico Hoepli.) 12 lire.

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LEGISLATION FOR WIRELESS TELEGRAPHY.

In this issue will be found an article in which the action taken by a number of Crown Colonies with regard to wireless telegraph legislation is set forth at length. It will be seen that the result of this legislation is practically to reserve to the Government of each of these colonies a monopoly in wireless telegraphy—a monopoly in some cases of a more extensive nature than that hitherto enjoyed by any State for ordinary telegraphy through wires or cables. Not only is the transmission of commercial messages forbidden, as in the Telegraphs Act, except under licence, but the actual erection or use of any wireless telegraph apparatus is made illegal unless with express authorisation. This step has been taken on the advice of the Home Government, which has realised the dilemma in which this country will be placed if, as it is not unreasonable to suppose, wireless telegraphy receives extended application for the transmission of messages and signals. It is evident that, unless specific protective measures are enforced, a single wireless telegraph station could render useless all stations within a certain radius endeavouring to receive messages transmitted by means of Hertzian waves. This fact has been realised by all our scientific experts from the outset, and has been repeatedly referred to in our own columns, although it was not until the famous "rats" incident in London, and the fiasco in connection with reporting the result of the international yacht race off New York, that it was brought home to the general public. It is evident, therefore, that to obtain the maximum advantage for the Hertzian wave method of telegraphy, rendered popular by Mr. MARCONI, this means of communication must be subject to a supreme and rigorous control by a central authority, and naturally the State itself is the only authority that could exercise this effectively. It will indeed be necessary to go further than this, for, since wireless telegraphy is destined to afford a means of communication between ships at sea beyond the territorial waters of the various States, the only effective means of control will be an international one. Some settlement with regard to this matter will doubtless be arrived at next year when the International Wireless Telegraph Conference takes place, to which the conference held in Berlin last August was the preliminary. The Colonies, which have passed the wireless telegraph acts alluded to, will be in a position to enforce without further fundamental legislation whatever regulations and safeguards may be decided upon by international agreement; but the Home Government is not in such a favourable position, and it is doubtless because it realised this that the Colonies were urged to take the steps to which we have referred.

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An examination as to the extent of the telegraph monopoly in this country and its application to wireless telegraphy will, therefore, not be out of place. By a curious chance, the original Telegraphs Act of 1869 gave the Government a monopoly over wireless telegraphic communications within Great Britain and Ireland. We need not cite the clauses of the Act which cover this; it will be sufficient to quote from Lord Justice STEPHENS' judgment in the famous case of the Attorney-General *v.* the Edison Telephone Co., which was fought in 1880: "The result of the definition [of a telegraph] seems to be that any apparatus for transmitting signals is a telegraph, whether a wire is used or not; and that any apparatus, of which a wire used for telegraphic communication is an essential part, is a telegraph, whether the communication is made by electricity or not. *It would include, on the one hand, electric signals made, if such a thing were possible, from place to place, through the earth or the air;* and, on the other, a set of common bells worked by wires and pulled by the hand, if they were so arranged as to constitute a code of signals." Thus, evidently, the State possesses the sole right to employ "wireless" telegraphy commercially within the United Kingdom—but within the United Kingdom only. Messages transmitted to a station within the United Kingdom from a point outside the 3-mile limit of the territorial waters do not come within this monopoly. Nor would it appear that, under existing law, individuals or a company could be prevented from erecting wireless telegraph stations for their own use and not for the transmission of messages as a business, even if such stations were a source of considerable annoyance and disturbance to the wireless telegraphic service of the Admiralty or any similar service that may be installed for the protection of vessels around our coasts. Moreover, under the existing law of the land there is nothing to prevent a giant station like the one at Poldhu from creating such a disturbance in the ether, with the view, for instance, of endeavouring to transmit signals across the Atlantic, as to render impossible the receipt of a Hertzian wave message at any other point on the coast. It would not have been difficult to pass a law in this country to rectify this state of affairs, and to extend the telegraph monopoly of the Government sufficiently to provide for all these contingencies. The Government, however, has doubtless feared that it might be accused of confiscating or injuriously affecting the business of the Marconi Company by doing this; although it is evident that the step will have to be taken sooner or later, and, the longer it is delayed, the greater of course will be the compensation expected by the company which has been first in the field. The Government, however, has taken steps to enable the Colonies to profit by its experience, with the result that the various colonial Wireless Telegraph Acts to which we allude have been called into existence.

THE COLONIES AND WIRELESS TELEGRAPHY.

For the past two or three years, a considerable amount of correspondence respecting wireless telegraphy has been passing between the Imperial Government of Great Britain and Ireland and the Governments of the Colonies of the Empire, and suggestions have been made by the Home Government to the effect that the Colonies should legislate with a view to prevent the indiscriminate use of wireless telegraphy within their territories, at any rate for the present. The acts, which have been promulgated in several colonies as a result of this advice, cannot fail to be of interest to those connected, whether directly or remotely, with wireless telegraphy.

First in alphabetical order comes the Bahamas, whose Government passed an act, which received assent on May 14, 1902, making it unlawful for any person to transmit or receive messages across the seas by means of wireless telegraphy unless such person shall have previously received the consent in writing of the Colonial Secretary of the Governor-in-Council authorising the same. A penalty not exceeding £200 will be enforced upon conviction. On May 11, 1903, an amendment to this act was passed, whereby it is made unlawful to erect, construct, establish or maintain any instrument or apparatus for the purpose of transmitting or receiving such messages. Thus it will be seen that not only is the operation of wireless telegraph apparatus prohibited, but its actual manufacture is not allowed.

On June 23, 1903, Bermuda passed an act similar in many respects to that of the Bahamas, one difference being with regard to the penalty, which in this case is £25 for the first offence and £100 for each subsequent offence. The licence may also be revoked by the Governor by notice in writing or by publication of revocation in the *Gazette*. Search warrants may be issued by justices of the peace, on information on oath by credible persons, and instruments used illegally for wireless telegraphy may be seized and forfeited. The Governor may dispose of the instruments thus seized as he may think fit.

An act entitled the "Telegraph Ordinance, 1903," passed by the Court of Policy of British Guiana received assent on January 31, 1903, and its object was to confer on the Governor-in-Council the exclusive right to establish, maintain and work telegraphic communication with places abroad. The word "telegraph" is defined as meaning an electric, galvanic or magnetic telegraph, and includes apparatus for transmitting or making telegraphic, telephonic or other communication by means of electricity, galvanism or magnetism, whether transmitted by wires or without wires. The ordinance empowers the Governor-in-Council to grant licences, on such conditions and in consideration of such payments as he thinks fit, to any person or body to establish, maintain or work a telegraph between the colony and any place outside the colony; and there is a proviso to the effect that nothing in the ordinance shall in any way affect the rights already granted to the West India and Panama Telegraph Co.

Perhaps the most important act with which we shall deal in this article was that which was passed by the Government of the Cape of Good Hope in 1902, and received assent on Nov. 14th of that year. This act is entitled "The Electric Telegraphs Amendment Act, 1902," and is intended to amend and extend the provisions of the Electric Telegraph Act of 1861. It directs that wherever the term "electric telegraph" is used in the old act (1861), or any law amending that act or relating to electric telegraphs, it shall be interpreted as including any system or means of conveying signs, signals or communications by electricity, magnetism, electromagnetism or other like agency, and whether with or without the aid of wires; including the system commonly known as wireless telegraphy or ætheric signalling, and any improvements or developments of such system; and the term "line of electric telegraph" shall be interpreted as including any apparatus, instrument, mast, standard, wire, substance, matter or thing whatever, which is or may be used for the purpose of sending, transmitting, conveying or receiving such signs, signals or communications. The word "person" in the old act is also to be extended so as to mean any body or persons corporate or incorporate. By the amendment, the territorial waters of the colony, in addition to the colony itself, are also included in the old act. The effect of the amendment is, therefore, to prevent any person carrying on wireless telegraphy in the Cape of Good Hope or its territorial waters, without a licence or an Act of Parliament. Regulations for licences are to be made, altered or revoked from time to time by the Governor. No licence will be issued for a longer period than seven years, but a licence may be renewed from time to time with the approval of the Minister, and subject to such further conditions as may be considered necessary in the public interest. Applications for licences must be made to the Postmaster-General.

Next in alphabetical order is Gambia, where the "Telegraphic Establishments (Maintenance of Control) Ordinance,

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1903," was assented to on February 19, 1903. This ordinance secures the control of all telegraphic establishments within the colony and protectorate, in so far as may be necessary for the public safety, to the Government. It also applies to the territorial waters surrounding the colony and protectorate. No persons or company shall, within the limit to which the Ordinance applies, establish, maintain or use any telegraphic apparatus, mechanism or contrivance without due permission and licence from the Governor. "Wireless telegraphy," including the Marconi apparatus and any similar or other mechanism for the transmisson of telegraphic messages without the employment of wires or cables, is expressly declared to be a telegraphic apparatus within the meaning of the act. As usual, the Governor-in-Council is empowered to make rules regarding licences, whether for the service of the public or for any private purpose. He is also empowered to make rules regarding penalties, to the limit that for any one offence the penalty (over and above forfeitures) shall in no case exceed a fine of £200, or in default 12 months' imprisonment, with or without hard labour. The ordinance does not invalidate any previous agreements with companies with reference to cables, &c.

The Gold Coast Legislature have also considered the question, and their act, entitled "The Wireless Telegraph Ordinance, 1903," received assent on September 22, 1903, just one month ago. The wording of this ordinance differs only very slightly from that of other colonies. No person is allowed to use any apparatus or installation for the purpose of wireless telegraphy without a licence from the Governor, under liability to a penalty not exceeding £100, or in default six months' imprisonment, with or without hard labour, or both fine and imprisonment. The apparatus by which the offence was committed will be forfeited and the Governor may at any time alter or revoke rules for the better carrying into effect of the ordinance.

Hong Kong has also evidently accepted the suggestions made by the Imperial Government, for it has passed "The Wireless Telegraph Ordinance, 1903," which is for the purpose of authorising and regulating the establishment and use of installations for the purpose of wireless telegraphy. This ordinance provides that the Governor may, whenever he shall deem it expedient to do so, license the establishment and use within the colony of installations for the purpose of wireless telegraphy. Every person using wireless telegraphy must possess a licence.

The island of Jamaica has legislated, and "The Wireless Telegraph Law, 1903," is the result. This law received assent on March 12, 1903, and stipulates that no person shall erect, maintain or use within the island of Jamaica or any of its dependencies any apparatus or machine whereby communication by wireless telegraphy can be held between the island or its dependencies and any place outside the same without having first obtained the sanction of and a licence from the Governor in Privy Council. The penalty for infringement of this law is a sum not exceeding £1,000, in addition to a further penalty of £50 per day for every day during which the offender continues to offend. Apparatus may be seized by the police and destroyed. The Governor may make any rules with regard to licences, and in case of war or emergency he may take possession of the stations and apparatus of any licensee under this law, and may keep possession thereof for so long as he may think fit. He may work the apparatus by Government servants during that time, but compensation out of general revenue is to be paid to the licensee, and all disputes regarding the amount of compensation are to be settled by arbitration.

"The Wireless Telegraph Ordinance, 1903," of Lagos, received assent on August 28, 1903, and provides that no person shall establish or use wireless telegraphy without previously obtaining from the Governor a licence setting forth the terms and conditions upon which the same is granted. Upon summary conviction before the Chief Justice a fine of £1,000, or, in default, 12 months' imprisonment, may be imposed. The Governor may prescribe conditions upon which licences will be issued from time to time.

Malta is undoubtedly a very important British possession, and it is therefore only in keeping with things that it should be in the most favourable position regarding wireless telegraphy. Like the Cape, it has amended its old Telegraph Ordinance of 1875, and the new enactment received assent on June 30, 1903. The words "and any work or apparatus intended for transmitting or receiving messages or other communications by means of electric signals," are to be inserted after the first paragraph of Art. I. chap. ii. of 1875. Now in the old ordinance the paragraph in question defines the word "telegraph" as meaning any work intended for the transmission of signals or messages from one place to another through one or more wires. The use of telegraphs was also prohibited without licence from the head of the Government, and by the amendment wireless telegraphy comes under this rule. A fine of £5 may be imposed upon offenders, and if the apparatus be not removed upon conviction, the police are empowered to seize it. An additional penalty of £2 per day may also be inflicted for every day on which the apparatus is worked after conviction.

The last colony to be mentioned is the Seychelles Islands. "The Telegraph and Electrical Stations Ordinance, 1903," passed by the Government of these islands, received assent on May 2, 1903, and embraces more than does any one of the new acts considered in this article. It provides that no telegraph or electrical apparatus, machinery, or implements whatsoever, whether for the purpose of electrical communications by what is generally known as "wireless telegraphy," or for any other purpose connected with the transmission, emission or reception of messages between the Seychelles Islands and any place within or outside, shall be erected or used in any place in the Seychelles Islands, whether on private property or not, without the sanction of the Administrator previously obtained. The Administrator may refuse or grant such sanction under such conditions or restrictions as he may think fit. The word "place" shall include any ship or floating conveyance within or without the Seychelles Islands' waters, except vessels of His Majesty's navy. The penalty is not to exceed 5,000 rupees, in addition to forfeiture of apparatus, all of which, together with buildings, may be destroyed.

A BASIS FOR THE COMPARISON OF DYNAMO DESIGNS.

BY W. B. ESSON.

In the present note some observations are made on an interesting article contributed by Mr. H. M. Hobart, under the above title, to *The Electrician* of September 11th last. Fortunately Mr. Hobart writes with unusual lucidity, so that he who runs may read, a great thing in these days when the majority of electrical men have, figuratively speaking, to run so fast.

First, I would point out that the output coefficient said by Mr. Hobart to have been suggested by Kapp and published in his 1898 book, was fully worked out by me in a possibly forgotten Paper entitled "Notes on the Design of Multipolar Dynamos," read before the Institution of Electrical Engineers in 1891.* In this Paper was given the $D^2LR\phi$ law for output, and not only the value of the coefficient ϕ for continuous-current dynamos of the drum and ring types, but the coefficient for alternators as well. These have altered in value in the course of 12 years, but the argument given in the Paper as to how they were arrived at still holds good. This same expression for output has been, I understand, claimed by Dr. Arnold recently, and though it is quite possible that both the gentlemen named may have arrived at it independently, there is no harm in pointing out that it is much more ancient than is generally supposed.

The law referred to has not been always correctly interpreted. Thus, in the discussion on my Paper read before the Institution this year, Prof. S. P. Thompson says: "The output coefficient is based on the assumption that the output of a core is in proportion to its volume. The Steinmetz coefficient proceeds on the view that the output is proportional to the surface." D^2L certainly contains the volume of the armature,

* *The Electrician*, Vol. XXVI., pp. 702, 733, 793.

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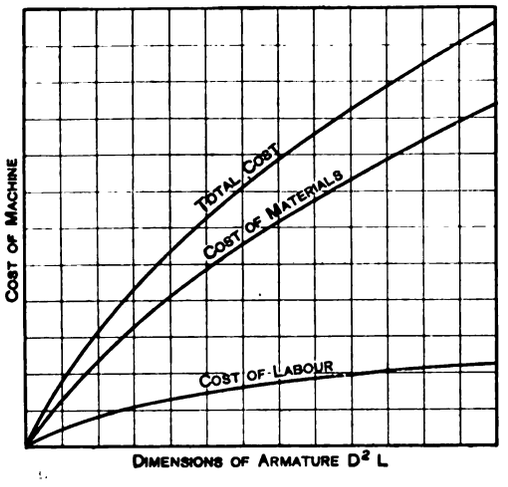
but the formula really expresses the fact that the output is proportional to the product of the total armature surface (DL) and the surface velocity (DR). As Prof. Thompson puts it, the statement is a trifle misleading, the output depending on the surface or volume, just according to how one looks at it, and just as one considers the surface velocity or the revolutions per minute.

It comes to this, that we have an active surface of certain dimensions moving in a magnetic field with a certain velocity, and the goodness or badness of the design is indicated by the magnitude of a coefficient which expresses the generative value of each square inch of surface moving at that particular velocity. This value, as is easily seen, depends on the magnetic induction in the gap, on the spread of the poles, on the relation between the iron and the copper on the active surface, on the current-density in the conductors and so on. Mr. Mavor's expression, it is not difficult to see, is but another form of the expression already referred to, the only difference being that he complicates matters somewhat by the introduction of a term for the depth of the slots. Anyhow, the factors essential to any expression for output are *the extent of the active surface and the velocity of that surface.*

Coming to Mr. Hobart's graphics, as a matter of every-day estimating there has been used in Messrs. Johnson and Phillips' offices at Old Charlton for some time, a set of curves connecting the cost of the machine with its D^2L dimensions, and in the figure is shown the form these take. The reason for taking D^2L instead of DL is because, in connecting the dimensions with the output, the latter involves taking into account



the surface velocity while in estimating, revolutions per minute are always dealt with, and the curves are, therefore, in a handier form for estimating purposes than would be the DL curve. Mr. Hobart prefers the latter, however, and the pith of his article is to show that it approximates in practice, taking the overall dimensions of the armature, a straight line. This may prove a very useful coincidence.

So far, no fault can be found with Mr. Hobart's proposals. If he prefers to show the cost in the terms of the total armature surface, there is nothing against it, and every office should, of course, adopt the plan it finds easiest. But to Mr. Hobart's description of the expression $W/\pi DL \times$ r.p.m. as "specific output," there are serious objections, as in no sense can such an expression by itself indicate the degree to which the material of the armature has been usefully employed.

The objection to the use of the term "specific output" for Mr. Hobart's expression are twofold. First, the dimensions of the space on the armature taken up by end connections have no place in an expression which purports to show whether the active surface has been utilised to advantage, for the simple reason that the space so taken up is not active. Secondly, the expression, while containing in πD r.p.m. the surface velocity, does not contain the other essential factor which is the extent of the surface, but only one dimension thereof. Or if we allow that πDL contains the surface, one of the terms for the surface velocity is absent. The truth is, that for an expression which can be legitimately named "specific output" Mr. Hobart wants another D, which will give it the ancient D^2L shape, and consequently make it right.

That the term "specific output" does not apply to the expression as it stands will be obvious from an example. Consider a machine B, having an armature double the diameter of another A, and running at half the revolutions per minute. Both machines have the same surface velocity, and in each L is assumed to be similar. If the output coefficient is the same for each, B will give twice the output of A, because it has double the surface, and in this case in both machines the generative value per square inch of surface is equal. Now, in such a case, Mr. Hobart's formula would say that the watts and the surface being doubled and the revolutions per minute being halved, the "specific output" would have in B twice the value it has in A. That is to say, though the surface velocity remains the same, the mere doubling of the surface has doubled the value of a constant which is meant to indicate generally the goodness of the design. But as we have seen, the doubling of D has done no such thing, for each square inch of surface is just as effective as before. Consequently, though the expression suggested by Mr. Hobart may be of considerable use to him, the name of "specific output" which he applies to it appears to be a misnomer and, under the circumstances, misleading.

SOME NOTES ON STEAM TURBO-ELECTRIC GENERATING PLANTS.*

BY GEO. WILKINSON.

Almost since the first power station was established in this country, in 1889, under provisional order for the supply of electricity for lighting and power purposes, turbo-electric generating plants have been employed in the generating station. The share they have taken in the work of public electricity supply has not been large, but it has shown a steady and healthy growth. Until recent times an opinion prevailed in many quarters that generators of this class were to be tolerated only in places and under conditions where no other plant could be employed, that the capacity of steam turbines in the way of steam consumption was unapproached by any other class of plant, and that with use they went from bad to worse in this respect. Grave doubts were also entertained as to the mechanical and electrical stability of electric generators running at the high speeds which are inherent in the steam turbine. How far these suppositions have been justified by past experience and practice, it does not come within the province of this Paper to show, but it is becoming generally recognised that where condensing water is available the steam turbo-generator has to-day established a record for reliability, efficiency and durability, which constitute it a formidable rival to all generating plant in which reciprocating engines are employed, be they slow, medium or high speed.

On April 23, 1884, the Hon. Charles A. Parsons filed his first applications for letters patent for turbine engines; one of these patents is entitled "Improvements in Rotary Motors actuated by Elastic Fluid Pressure, &c.," and the specification sets forth many of the essential details to the construction of a successful and economical turbine engine, such as devices for reducing cost of construction, for preventing vibration, for drawing off leaking steam and for providing efficient lubrication; this attention to details has always been a feature in the Parsons turbine, and has promoted in no small degree the immense success of the present-day turbo-generator. Mr. Parsons' original patent rights having expired, the way has been opened for the manufacture of steam turbines by other engineers, and already such eminent firms as Messrs. Willans and Robinson, the Brush Engineering Co., the Westinghouse Company and the British Thomson-Houston Co. have commenced to manufacture steam turbo-electric generators, while Messrs. Greenwood and Batley, of this city, have for years made and supplied turbo-generators of the De Laval type. To describe in detail the plants made by these firms is beyond the scope of this Paper, and I purpose to note some of their leading characteristics only, devoting the remainder of the Paper to remarks and suggestions based on my own experience, in the hope that they may be of service to some members of the Institution and form the basis for a useful and instructive discussion.

The De Laval Turbine.—About 1882 Dr. Gustav de Laval invented a reaction turbine originally constructed for direct driving of milk separators; the driving wheel was a pipe bent in **S** form, to which steam was admitted through a stuffing box in the centre, where the

* Paper read yesterday before the Leeds Local Section of the Institution of Electrical Engineers.

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shaft was also fixed. The steam issued from the open ends of the pipe, thus driving the engine round. Steam turbine engines of this simple type are, I believe, still working, but they are obviously crude and uneconomical. In the modern construction of the De Laval the steam is blown divergent from stationary nozzles, where expansion takes place, against vanes or buckets fixed in the circumference of a wheel, and the steam thus impinging on the vanes drives the wheel round and causes it to rotate at high velocity. There is only one row of buckets or vanes on the wheel upon which the steam delivers most of its energy, and is afterwards exhausted either to the atmosphere or to a condenser in the ordinary way. The steam nozzles are placed in very close proximity to the vanes of the turbine wheel, the clearance being only 2mm., and consequently there is practically no loss of velocity between the steam jets leaving the nozzles and entering the vanes of the turbine wheel. The peripheral velocity of the wheel in the largest De Laval turbines does not exceed 1,380ft. per second, while steam expanded from 150lb. pressure into a 28in. vacuum can attain a velocity of over 4,000ft. per second, thus the wheel falls far short of the theoretically economical speed.

The turbine wheel is adapted by an ingenious construction and method of suspension to operate at a very high peripheral velocity, and the speed is reduced and made available for dynamo driving by very perfectly made spiral-cut gears, which effect a ten to one speed reduction. The dynamo armature is direct-coupled to the gear-wheel shaft of the turbine. The larger sizes of turbine dynamos have two armatures so as to obtain a better distribution and balance in the turning effort; two sets of field magnets are provided, and the armatures can be coupled either parallel or in series, or the machines can work direct on a three-wire system of distribution. The speed is maintained constant by an exceedingly ingenious and compact centrifugal governor, mounted on the slower-running gear wheel, which controls a double-seated valve on the steam admission.

The following tables show the high efficiency obtained with the De Laval generators; they are, however, made up to 300 H.P. only, which is too small a unit for most public electricity supply stations, and so far as I am aware only direct-current generators are supplied with these turbines.

Table I.—*Results of Tests with De Laval Steam Turbo-generators at different Loads.*

Turbine machine.	Pressure of admission steam. Lbs. per sq.in.	Vacuum. Inches of mercury.	No. of nozzles open.	Output in kw.	Lbs. of steam per kw.-hour.
50 H.P. turbine dynamo. The test made in April, 1895.	113·8	26·3	6	37·0	32·8*
	113·8	26·3	5	30·1	33·9*
	93·9	26·9	4	18·7	37·2*
	74·0	27·5	3	9·5	43·3*
				B.H.P.	Lbs. steam per B.H.P.
150 H.P. turbine dynamo. The trial made in November, 1897.	113·8	26·4	7	163·0	17·6†‡
	116·9	25·9	6	138·4	18·2†
	113·8	26·2	5	114·5	17·9†
	114·3	26·5	4	88·3	18·7†
	112·4	27·0	3	64·1	19·0†
	116·2	25·7	2	37·5	22·3†
300 H.P. turbine dynamo. The test made in June, 1900.	126·6	26·98	8	337 45	15·68†
	126·4	26·99	7	293·7	15·76†
	125·0	27·24	6	249·1	15·92†
	125·0	27·62	4	162·7	16·25†
	125·0	27·91	3	118·9	16·70†
	125·0	28·16	2	73·5	18·00†
	125·0	28·25	1	30·4	21·77†

* Work for condensing included.
† Work for condensing not included.
‡ To get approximate pounds of steam per kilowatt-hour, multiply by 10 and divide by six.

The Parsons Turbine.—This turbine, which is by far the most important and extensively used at the present day, is of the parallel flow type. The turbine motor consists of a cylindrical case with rings of inwardly projecting vanes, within which revolves a concentric shaft carrying rings of outwardly projecting vanes. The rings of vanes on the case nearly touch the shaft, and the rings of vanes on the revolving shaft lie between those on the case and nearly touch the case. The steam passes first through a ring of fixed guide vanes, and is projected in a rotational direction upon the succeeding ring of moving vanes, imparting to them a rotational force; it is then thrown back upon the succeeding fixed ring of guide vanes, and the reaction upon the next ring of moving vanes increases the rotational force. The same process takes place at each of the successive rings of guide and moving vanes.

The energy to give the steam its high rotational velocity, is, in each successive ring, supplied by the drop in pressure, so that the steam expands gradually by small increments. In the earlier types the steam was taken in at the centre of the fixed cylinder, and operated on successive fixed and moving vanes, both right and left, exhausting at each end of the fixed cylindrical chamber, thus obtaining an approximate balance and little or no end thrust on the bearings; in the later designs the steam flows and operates upon fixed and moving vanes, in one direction only; the diameters of the fixed and revolving vanes are usually increased at least twice, and the three chambers thus formed are generally designated the high-pressure, intermediate and low-pressure cylinders.

To balance the end thrust imparted to the shaft by the steam operating upon the moving vanes, grooved pistons or dummies are used which rotate within corresponding seatings; the diameters of these pistons correspond with the diameters of the working cylinders and a passage connects each working cylinder to the back of its corresponding balancing piston, and thus the end thrust is neutralised. The balance pistons also act as a practically steam-tight joint, since the clearance between the grooves can be adjusted longitudinally by a thrust block in the end bearing. In order that the turbine shaft may set itself accurately in the centre of gravity, the bearings are constructed of a number of concentric loose fitting sleeves immersed in oil in such a manner that any transverse movement of the shaft is resisted by the fluid friction of the thin films of oil which have to be squeezed from the parts where the tubes are pressed against each other, thus the flexibility of the bearings is sufficient to compensate for any slight variation between the centre of the revolving cylinder and its true centre of gravity.

The armature of the electric generator is directly coupled to the turbo-shaft by means of a steel sleeve; the shaft also carries a worm which drives a worm wheel, which in turn operates the lubricating oil force pump, and also the steam admission governor, by means of an eccentric or cam; when necessary the condenser air and circulating pumps are driven also from this slow-running worm wheel.

The governing of the machine is as follows: Steam is admitted to the turbine in a series of gusts by the periodic opening and closing of a double beat valve. This valve is operated by means of a steam relay in mechanical connection with the turbine shaft. The duration of each gust is controlled by an electric solenoid, which is connected as a shunt to the field magnets. The core of the solenoid is hung from the end of a long lever. The fulcrum of this lever is periodically moved up and down by means of a link connecting it with the eccentric, which receives its motion from the worm on the sleeve coupling, the eccentric also serving to work the oil pump. The short end of the lever controls the valve of the steam relay. Each periodic movement causes a gust of steam to be admitted to the turbine, the duration of the gust depending on the height of the distant end of the long lever.

With alternating-current generators an ordinary centrifugal governor takes the place of and fulfils the functions performed by the before-mentioned solenoid; a second centrifugal governor is also provided which comes into action should the generator through any cause obtain an excessive and dangerous speed, when a trip gear is operated thereby and the steam automatically cut off from the plant. One important factor which in the early times prevented the use of the Parsons turbine in alternating-current stations was that the makers were unable to guarantee satisfactory parallel running of the plants. About the year 1894 this difficulty was surmounted by modifying the governing in such a manner that the steam admissions were increased in frequency and shortened in duration, thus obtaining a more even angular velocity. The first single-phase turbo-alternator to be successfully run in parallel with slow-speed generators was one of the radial flow type of 150kw. output installed in the Portsmouth Corporation works in 1894. Mr. Quin shortly afterwards succeeded in operating paralled flow single-phase plants in phase with slow speed plant at Blackpool, and to-day the successful operation of the plants in parallel with each other and with plant of other types is common practice.

The first Parsons steam turbine and generator was built in 1884. It developed 10 H.P. at 18,000 revs. per min. It ran for several years in Gateshead-on-Tyne, supplying current for the manufacture of incandescent lamps. It is now in the South Kensington Museum. It consisted of two groups of 15 turbines each, the steam entering between them and passing in opposite directions through each group. In 1889 the radial flow type of steam turbine was introduced, and in 1892 a 100kw. set, running at 4,000 revs. per min., was tested with a steam pressure of 100lb. slightly superheated and a vacuum of 28in., when the consumption was found to be 25lb. per kilowatt-hour.

About two years later the parallel flow type of turbine was again adopted in which were introduced the modifications already described. Various improvements were also made in the design and construction of the vanes, which resulted in a considerably greater economy of steam. About this time several turbines of the non-condensing type were put down in the Manchester-square station of the Metropolitan Electric Supply Co. of London, where an injunction had been obtained against the company on account of the vibration caused by the reciprocating engines already installed.

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These turbo-alternators were of 350kw. capacity, and gave complete satisfaction.

Since that date the size of turbines has gradually increased, units of 500kw. being put down in Newcastle, Scarborough, Cambridge, London and other places. In 1900, two alternators, each of 1,250kw. capacity were made for the city of Elberfeld, Germany. The turbines were of the tandem type, consisting of high and low-pressure cylinders, and ran at 1,500 revs. per min. The dynamos were 4-pole, and supplied single-phase current at 4,000 volts and 50 periods. The steam consumption with slight superheat was 18·8lb. per kilowatt-hour at full load, or 11·9lb. per indicated horse-power, including the power required to drive the condenser pumps. These dynamos run perfectly in parallel with the 1,500 H.P. Sulzer engines which are coupled to 1,000kw. Brown-Boveri alternators running at 83 revs. per min. In fact, the turbines steady the reciprocating engines, even when the latter are running on traction load.

During the last few years new designs have been brought out in which the consumption obtained has been further reduced, giving, especially in the larger sizes, some very remarkable results. A few examples of the amount of steam used by various sizes of turbines are given below.

50kw. Steam Alternator for the Blackpool Corporation.

Pressure of steam above atmosphere at stop valve. Lbs. per sq.in.	Superheat at stop valve. F.O.	Vacuum in turbine cylinder. Bar = 30in. In. of mercury	Revs. per min.	Load. Kw.	Steam used. Lbs. per hour.	Steam used. Lbs. per kilowatt-hour.
126·0	0	28·0	5,044	52·7	1,480	28·0
132·0	0	28·5	4,880	0	320	..

300kw. Three-phase Alternator, for De Beers' Mines, South Africa.

150·0	53·3	27·8	3,000	312·1	6,260	20·06
153·0	50·0	27·8	3,000	231·8	4,960	21·45
150·5	40·2	27·9	3,000	154·5	3,670	23·75

500kw. Single-phase Alternator (2,200 volts) for Hastings.

115·0	93·0	27·4	3,000	501·9	9,776	19·47
148·0	90·0	28·1	3,000	255·1	5,612	22·00

A disadvantage in the Parsons plant is its great length, and there appears to be no good reason why it should not be shortened, the discs carrying the vanes being made larger in diameter to compensate. A convenient arrangement would be to place the plant thus shortened vertically, instead of horizontally, and I venture the opinion that the vertical type of turbo-electric generator will eventually displace the horizontal type. Returns published by Messrs. C. A. Parsons & Co. in May, 1903, show that the firm have supplied 50 turbines to Corporations, ranging from 50kw. to 1,800kw., and aggregating 20,900kw.; also 73 turbines to electric supply companies, ranging from 50kw. to 3,500kw., and amounting to 31,880kw. in the aggregate.

Westinghouse-Parsons Steam Turbine.—This steam turbine built by the Westinghouse Company is practically the same as the Parsons type, with the exception that the governor is placed between the turbo and the electric generator. A fly-ball type of governor is made use of, which has several features conducive to good regulation. The ball levers are swung on knife edges in lieu of pins. The governor works both ways—that is to say, the mid-position of the levers is admitting a full head of steam to the turbine. A movement from this in either direction is tending to cut off the supply. This serves a useful purpose in the event of a very excessive load coming on the turbine, such as a short circuit, which has the effect of bringing down the speed more than the percentage variation permitted by the adjustment of the spring, when the steam immediately becomes shut off. Again in such an event as some of the governor driving mechanism becoming broken, and the governor balls slowing up independently of the turbine, the steam is shut off before any damage could take place.

It may be of interest to note that the Westinghouse Company have on order and are building about 85,000 B H.P. nominal capacity of turbines for use in this country. These include, among others, three 3,500kw. turbo-alternators for the Metropolitan Railway of London, and eight 5,500kw. turbo-alternators for the Underground Electric Railway Co. of London. In addition, large sets are being built for the Corporations of Brighton and Liverpool.

The guaranteed maximum steam consumption of the 5,500kw. plants at 165lb. steam pressure, and 27in. vacuum per kilowatt-hour, is as follows:—

Full load, 20·8lb. saturated steam, 17·7lb. with 150°F. superheat.
Half load 25lb. saturated steam, 21·2lb. with 150°F. superheat.

The plants are also designed to take an overload of 50 per cent.

In these large turbines a departure is made from the regulation practice, inasmuch as steam is admitted at the centre of the casing and exhausts at both ends; a balance is thus obtained upon the duplicate sets of revolving vanes, and no steam balancing dummies are used

Willans and Robinson Steam Turbine.—This is practically a Parsons turbine, with the following modifications:—While efficiency in the Parsons turbine depends upon the small clearances between the outer ends of the turbo vanes and the cylinder casing, and also between the ends of the fixed vanes and the revolving cylinder, in the Willans these peripheral clearances are disregarded, and reliance for efficiency is had upon the small clearances on the sides of the vanes at their outer ends. The rotating rings of vanes (and also the fixed ones) are enclosed by a double hoop of thin metal, which moves with the vanes; the edge of this ring comes fairly close to the continuous collar, which forms the root of the next fixed ring of vanes. The clearance is very small, and it is claimed that if the hoop touches the fixed collar it will do no harm, but will almost immediately wear itself into the proper position. There are other minor details in connection with the governors, bearings and casing introduced with a view to simplification, and the makers are prepared to guarantee, with high-pressure superheated steam and a good vacuum, a steam consumption not exceeding 17lb. to 18lb. per kilowatt-hour on a 1,000kw. turbine coupled to an alternating-current generator.

Brush-Parsons Turbo-Generator.—So far as the steam portion of this plant is concerned, it is built to the Parsons designs, with one or two detail modifications in connection with the oil circulation and cooling; the alternator is of the fixed armature type with revolving field magnets. Although the Brush Company have only recently taken up the manufacture of this class of plant an examination of the various parts during construction convinces me that the Brush Company's production will prove itself to be one of the best and most reliable of turbo-generators.

The Curtis Steam Turbine.—The shaft in this turbine is vertical, the lower end carrying discs of large diameter within the steam casing on the periphery of which the steam vanes are carried, the stationary rings of vanes being fixed to the cylinder casing. On the upper end of the shaft the revolving field magnets are mounted and the stationary single or polyphase armature coils are located in grooves formed in the laminated iron discs surrounding field magnets, the whole being protected by a metal casing in the shape of an inverted basin; at the extreme upper end of the shaft the centrifugal governor is located, which controls the plant in the novel manner described later. The Curtis generator is of recent development and retains some of the features of both the De Laval and Parsons types, also a number of novel and practical innovations are introduced which make the plant specially interesting at the present time, and which the manufacturers claim make possible a lower speed, less weight, fewer and simpler parts, high economy, less cost in manufacture and other important advantages.

Velocity is imparted to the steam in an expanding nozzle or nozzles, so designed as to efficiently convert into velocity nearly all the expansive force of the steam between the pressure limits used. After leaving the nozzles, the steam passes successively through two or more lines of vanes on the moving element, which are placed alternately with reversed vanes on the stationary element. In passing successively through these moving and stationary elements, the velocity acquired in the nozzle is abstracted, and largely given up to the moving element. Thus the steam is first thrown against the first set of vanes of the moving element, and then rebounds alternately from moving to stationary vanes until it is brought nearly to rest. By this means, and by virtue of the large diameter of the discs carrying the vanes a high steam velocity is made to efficiently impart motion to a comparatively slowly moving shaft. The steam inlet area is made up of a number of expanding nozzles adjacent to each other, so that the steam passes to the wheels in a broad belt when all the nozzle sections are in flow.

This process of expansion in nozzles and subsequent abstraction of velocity by successive impacts with wheel vanes is repeated two or more times, the devices for each repetition being designated as a stage. The number of stages and the number of lines of vanes in a stage are governed by the degree of expansion, the peripheral velocity which is desirable or practicable, and by various conditions of mechanical expediency. Generally speaking, lower peripheral speeds entail more stages, more lines of vanes per stage, or both. The general practice is to so divide up the steam expansion that all stages handle about equal parts of the total power of the steam.

The governing is effected by the successive opening or closing of the high-pressure set of steam nozzles and consequent widening or narrowing of the active steam belt. The first expansion nozzle is controlled by a throttling device operated by the governor, and the remaining nozzles are opened or closed electrically by a small electric controller which is moved round by the governor. The downward thrust due to the pressure of steam against the vanes is not balanced by steam pistons or dummies, as in the Parsons type, but the whole revolving mass is floated up on a thin film of oil which is forced up beneath the footstep bearing by an oil force pump.

High efficiencies are obtained with this plant, and with 125lb. steam pressure superheat of 100°F. and 28in. vacuum, the makers guarantee maximum steam consumption per kilowatt-hour, exclusive

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of the power required for operating the condenser pumps and driving the exciter, as follows :—

Size of plant. Kw.	Full load. Lbs.	Half load. Lbs.	Quarter load. Lbs.
750	19·9	20·9	24·0
1,500	19·3	20·2	23·2

Under the same conditions, but with 140lb. steam pressure and 28½in. vacuum, a 600kw. Curtis generator at 1,500 revs. per min. gave on test a consumption of 19¼lb. of steam per kilowatt output on full load, 19½lb. on 25 per cent. overload, 20¾lb. on half, and 22½lb. on a quarter load.

The following are some of the distinctive features of the Curtis turbo-generator :—

(*a*) The short vertical height occupied by the steam portion of the plant, as compared with the horizontal length of the steam portion of the Parsons type generator, and the strength and substantial section of the steel turbine vanes.

(*b*) The extremely small floor space occupied by reason of the electric generator being built vertically over the turbine.

(*c*) The excellent ventilation obtained in the alternator owing to its being built vertically over the turbine.

(*d*) The uniform turning movement obtained by the continuous supply of steam to the turbine and speed regulation by varying the volume thereof.

Possible disadvantages are that the generator carries no exciter and the condenser pumps cannot be driven direct from the turbo shaft.

It is probable that the reciprocating steam engine will still maintain its superiority over the steam turbine for driving direct-current generators of large size, inasmuch as at the high speeds necessary with turbines there is difficulty in constructing a satisfactory direct-current revolving armature; the armature reaction necessitates either a special compensating winding or the shifting of the brushes for changes in load, and the excessive peripheral velocity and vibration of the commutator precludes the use of carbon brushes, which would probably soon become red hot. Hitherto most of the high-tension alternating-current turbo-generators have been constructed with revolving armatures, a practice which is to be condemned, inasmuch as with the excessive centrifugal strains and vibration due to high velocity it is difficult to maintain good insulation of the high-pressure generating coils; also the excessive velocity of the collecting rings causes cutting of both the rings and the collecting brushes; a considerable amount of metal dust is thrown off at the point of contact, and in long continuous runs this metal dust is apt to collect and break down the insulation of the high-pressure collecting rings or brushes. In the writer's experience both these causes have produced breakdowns in turbo-generators with revolving armatures. The ideal arrangement is a fixed armature, with the field magnets revolving within same, and this is now becoming standard practice in single and polyphase turbo-generators; the result is an absolutely reliable plant, which in point of first cost, economy of operation, and steam consumption, is in advance of the best practice with slower-speed generators driven by reciprocating engines.

Economy of Space and Buildings may be readily set forth by comparing the 3,500kw. Sulzer-Kolben two-phase generators at the Willesden works of the Metropolitan Electric Supply Co. with turbo-generators of equal output. The Sulzer-Kolben plant weighs, with condensers, approximately 585 tons; the space occupied by the foundations is 60ft. 2in. in length by 21ft. 6in. in width, with a vertical height above the engine room floor to the top of the piston tail rods of 33ft. 4½in. A Parsons turbo-generator of the same output weighs approximately 148 tons, and the space occupied does not exceed 37ft. 1in. in length by 8ft. in width and 14ft. 6in. in height, plus about an equal depth for the condenser room beneath. A Curtis turbo-generator of 5,000kw. output weighs approximately 175 tons, and the space occupied does not exceed 20ft. by 15ft., with a vertical height not exceeding 30ft. In this size, the condenser, turbine and generator are arranged vertically, the condenser forming the base of the plant.

Economy in Steam Consumption.—According to the published data the maximum steam consumption guaranteed by the builders of the Sulzer-Kolben plant works out with saturated steam at 150lb. pressure and a vacuum of 24in. at 22·2lb. per kilowatt-hour at full load; 23lb. per kilowatt-hour at half load.

The makers of the Parsons turbo-generator guarantee the steam consumption, with steam at 150lb. pressure, vacuum of 28in. and superheat of 100°F., 17·5lb. per kilowatt-hour at full load; 20lb. per kilowatt-hour at half load.

I have not the exact steam consumption of the 5,000kw. Curtis turbine which is running in Chicago, but it is a much more economical plant in this respect than the Sulzer-Kolben plant referred to above. At low loads the efficiency of turbo plants is shown by published returns to be superior to that of ordinary steam engine generators of equal capacity.

A further interesting comparison in this respect is given below between the most economical of the two 1,400kw. two-phase plants with triple vertical engines recently installed in the Leeds electricity works, and the 1,750 H.P. direct-current turbo plants installed last year in the works of the Newcastle and District Electric Lighting Co. :—

—	Speed.	Superheat.	Kw.	Steam pressure. Lbs.	Vacuum Ins.	Water per kw.-hour. Lbs.
Leeds	200	76°F.	1,400	183	25·6	19·9
Newcastle ..	1,710	237°F.	897	145	26·5	17·73

Other advantages which may be named are as follows :—

1. No expensive cylinder oil is necessary such as is demanded by reciprocating engines using superheated steam.
2. There is no oil in the condensed water, and it may be used for boiler feed without the provision and use of expensive and troublesome oil separators.
3. There are no "big ends," packings, and bearings to take up.
4. There is less difficulty in maintaining a good vacuum, there being no piston and valve rod packings through which air may gain admission to the condenser. The importance of a good vacuum is obvious in view of the fact that every 1in. of vacuum above 25in. or 26in. has been found to reduce the steam consumption by about 4 per cent.
5. A greater degree of superheat may be maintained with a great gain in efficiency and no danger.

Tests on a 500kw. turbo-generator have shown an improvement in steam consumption resulting from a superheat of 50°F. of about 8 per cent., and at 100°F. it averages about 12 per cent.

There are no figures, so far as I can find, showing the economy effected by using very high superheat, but I believe further economy in steam will be obtained in this direction provided the vanes at the high pressure end of the turbo are made of a metal which does not become brittle at high temperatures. In the case of large engines of the usual types it is not advisable to superheat the steam by more than 200°F., and in some cases there is much trouble with the valves if the superheat exceeds 150°F., but in the steam turbine there are no such limitations. In a recent Paper read before the Institution of Naval Architects, Prof. W. H. Watkinson made the following interesting observations on this subject :—

"The steam turbine is the only engine in which condensation of the steam by previously cooled internal surfaces does not take place; but the steam in turbines is, of course, wet from another cause—namely, on account of the expansion it has undergone while doing work—and the efficiency of this type of motor is very considerably increased when the steam is superheated prior to its admission to the engine. In steam turbines the reduction in the amount of steam required when superheated steam is used is due mainly to the increased volume and the decreased frictional resistance between the rotating vanes and the steam. In steam turbines of the De Laval type, using saturated steam, the discharge from the nozzle is generally more or less intermittent, due to the intermittent choking of the nozzle with the water in the steam. When the steam is superheated the discharge from the nozzle is free and continuous, and the velocity, and, therefore, the efficiency of the steam, is on this account still further increased.

So long as proper adjustments are maintained between the fixed and moving vanes the efficiency as to steam consumption appears to be well maintained. This is shown by comparing a test made by Prof. Ewing on a 500kw. turbo-alternator, driving its own air and circulating pumps, which had done heavy duty at the Cambridge electricity works for a period of 12 months, with a test made on the same plant 14 months earlier by the Cambridge Electric Supply Co.'s engineer, as set out below :—

Date of test.	Steam pressure. Lbs.	Vacuum. Ins.	Load in kw.	Lbs. steam per kw.-hour.
Prof. Ewing's tests, Jan., 1901.	148	27·8	518	25·0
	151	28·2	273½	28·3
Engineer's tests, October, 1899.	139	24·5	526·4	24·1
	145	26·6	256·1	27·5

In Prof. Ewing's tests the steam was not superheated, and there was no water separator, but water which collected in a pocket under a vertical limb of the steam pipe leading to the engine was from time to time blown off. In the case of the engineer's tests in 1899 dry steam was used, and the turbine was not driving its own pumps. Prof. Ewing concludes his report as follows :—"Considering the altered conditions in these two respects, I am of opinion that the results of the present trials show that there has been no deterioration due to wear." This view is confirmed by the following tests taken on a 300kw. Parsons turbo-generator under my own control, in which the tests made at the Harrogate electricity works in February, 1902, are compared with tests made in the same works and under precisely the same conditions after over 19 months' heavy work.

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Date of Test.	Steam pressure. Lbs.	Superheat. Lbs.	Vacuum. Ins.	Load in kw.	Speed.	Lbs. steam per kw.-hour.
Feb. 19, 1902.						
Full load ..	130·5	41·9°F.	28	309·5	3,010	22·76
Half load ..	131	45°F.	28·8	157·4	3,010	25·1
Sept. 30, 1903.						
Full load ..	130	35°F.	28	307·5	3,080	21·12
Half load ..	130	33°F.	28	127·1	3,080	23·24

It will be noted that the results of the 1903 tests are better than those of 1902, which may be partially owing to the increased speed, but chiefly to the fact that a number of the vanes in the high pressure end were found broken off on opening out after the tests of 1902.

In concluding these notes I have to express my thanks to Messrs. Parsons & Co., the Brush Electrical Engineering Co., the Thomson-Houston Co., and to Messrs. Greenwood and Batley, who have willingly placed data at my disposal.

CORRESPONDENCE.

COMPENSATED AND COMPOUNDED ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

[Translation.]

SIR: In reading through Mr. H. S. Meyer's article on the above subject, and published in *The Electrician* of October 16th, it appeared to me that he has misunderstood my communication on the self-exciting and compounded alternators. My remarks related to generators already made and fully tested, and the suppositions advanced by Mr. Meyer are, for the most part, fallacious. Mr. Meyer, I believe, will convince himself of this when he has had the opportunity of inspecting a finished machine.—Yours, &c., HEYLAND.

Brussels, Oct. 19.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Reading through Mr. Meyer's notes "On the Compensation and Compounding of Alternating-current Generators" in your issue of the 16th inst., I am inclined to think that only a very small saving indeed can be achieved in the width of an alternator by increasing the armature ampere-turns, in the case of a machine excited in the ordinary way, since it will be necessary to work with less density at no load, so as to keep the increase in the exciting ampere-turns required to uphold the voltage at full load within reasonable limits. Nothing but a very material reduction of the self-induction of the armature winding can lead to a real saving in such a case. Then, with regard to the new invention referred to in the article, it seems to me, judging from the few data available, to be very much the same scheme as that adopted by me in 1896 or 1897 for the automatic regulation of an alternator in the south of England. In that case, constancy of voltage only was required, and I therefore used an arrangement similar to a hot-wire voltmeter, of the Hartmann and Braun type, carrying a horizontal lever instead of the usual pointer, and travelling through a comparatively wide angle for a very small alteration in voltage. This lever closed the circuit of one or the other of two magnetic clutches, determining the travel of a spindle which cut resistance in or out of the exciting circuit as necessary to keep the voltage constant. The main voltage transformed down to a suitable value was applied to the relay terminals. Had compounding been required, an electro-magnetic relay would have been used. The arrangement worked very well and, of course, kept the voltage of the alternator constant, within the limits of the machine, for all loads and power-factors. I did not think there was anything particularly new about the scheme, even at that time, and presume, therefore, that Mr. Meyer's remarks have conveyed a wrong impression to me. It would be interesting to have more details of his scheme.—Yours, &c., VAL. A. FYNN.

Bradford, Oct. 29.

[As the difference of opinion between Herr Heyland and Mr. Meyer appears to be largely on the question of the actual cost of the machines in question, it occurred to us that it could be settled, satisfactorily to the purchaser of dynamos at any rate, by asking the firm who sells Heyland's machines in England (Messrs. Witting, Eborall & Co.) and Mr. Meyer (who is connected with the British Thomson-Houston Co.) both to quote for two machines of a standard size. We therefore asked each of them to name a price for two 500kw. three-phase alternators built for 3,000 volts and 50~., the machines to be driven by an engine with a cylic irregularity not exceeding one-third per cent. One quotation to be for driving by an engine running at 250 revs. per min., the other for a speed of 94 revs. per min. Prices, which were to be f.o.b. London, were to include, in the case of the Heyland machine, any transformers that might be necessary for using with the machine, and in the case of the B.T.-H. machines, the exciter, and in both cases the flywheel was also to be included.

Messrs. Witting, Eborall & Co. sent us the following quotations:—

One compound three-phase alternator capable of developing a normal output of 500kw. ($\cos\phi=1$) at 3,000 volts 50 cycles when running at a speed of 250 revs. per min. The machine will be complete with outer bearing, bedplate, shaft and half coupling, suitable for bolting up to a high-speed engine, for the sum of £1,200. Net weight, 20 tons.

One compound three-phase alternator capable of giving a normal output of 500kw. ($\cos\phi=1$) at 3,000 volts 50 cycles when running at a speed of 94 revs. per min. This machine would be supplied without bearings or shaft suitable for mounting between the cranks of a cross-compound engine; the necessary foundation sole plates, however, are included.

The above alternator for the sum of £2,350. Net weight, 45 tons.

The above prices are strictly net., include the necessary transformers, and are f.o.b. London.

From Mr. Meyer, however, we have received the following letter in reply to our request:—

In answer to your letter of October 12th, I am exceedingly sorry that I have to disappoint you by not complying with your request for a quotation on two 500kw. standard revolving field generators running at 250 and 94 revs. per min. respectively. My reasons for this are as follows:—

You say that these prices were to be used for comparison with those obtained from the English agents of the Heyland machine of exactly the same rating. Now I feel that such a comparison of two quotations from different firms on the basis of a plant which will never be in existence, is of very little practical use, To arrive at conclusions of any value, the quotations for both types of machines should be made at least on the same basis of profit, guarantees and workmanship. Therefore, the two quotations should come from the same firm, of course, with the understanding that the same profit is added to the true factory cost in both cases. My remarks have the more weight in our case, as the Heyland generators at present are not manufactured in this country, and therefore the basis of wages and manufacturing conditions is radically different.

I furthermore beg to repeat that the question of first cost is not the only issue, as you suggest in your letter of October 12th, but, as I tried to explain in my notes, there is among others, the important question of how a breakdown in the exciting arrangement of the generator affects the operation of the plant. With the standard type, provisions are always made for a spare source of excitation, but with the Heyland type, a complete generator has to be kept as spare, and since the starting of the engine and the parallelling will take some time, it may mean a serious overload on the station, quite aside from the extra cost of a spare set consisting of prime mover and generator. I think you will agree with me that there is as much chance for a breakdown in the exciting arrangement as proposed by Mr. Heyland as with the exciter as used for the standard revolving field type.

Trusting you will understand my position in this matter.—Yours, &c., H. S. MEYER.

We must therefore leave it to our readers to form their own opinions on the matter from the data already published.—ED. *E.*]

IRON LOSSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With regard to the Paper on "Iron Losses" in your issue of October 16th, may I be permitted to remark that the factor two and-a-half times refers to eddy loss entirely, since for the same maxima and no re-entrancy, the hystersis losses depend merely on the maxima attained. In the machines in question the total experimentally determined iron losses were found to follow such a law that, with a fair degree of accuracy, could be split up into two algebraic components, one dependent directly on the frequency for a given density and the other dependent upon the square of the frequency. The component depending directly on the frequency was found to agree very well with what would be expected to occur by measuring the hysteresis losses by means of the ordinary laboratory ring experiments. The component, however, depending on the square of the frequency

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(presumably the eddies) was found to be two and a-half times what would be expected, assuming a sine wave of flux. Thus it was inferred that, so far as the hysteresis loss was concerned, there was nothing to explain, but the curious factor two and a-half times was a source of annoyance, since one had always to depend on experiment alone, and not on calculation. It is when analysing the flux distribution curves and taking note of the character of the flux wave that this factor two and a-half times is practically accounted for. Furthermore, the mysterious full-load incremental iron loss is also explained, since it is known to depend upon the ampere-turns in the armature, and as the frequency squared of the cyclic change of flux. It is, of course, obvious that the skewing or change of shape should vary in some way with the ampere-turns in the armature.

Apropos transformer iron loss, a further note may be of interest. Mr. Steinmetz declares that the *hysteresis* loss in transformers may be diminished by going to distorted sine waves; *he does not mention anything with regard to eddy loss in this connection.* Plotting E.M.F. and corresponding flux wave we get Fig. 1. But, going to a flatter top wave with the same frequency but, say, twice the area, and having the same maximum E.M.F., Fig. 2 holds good.

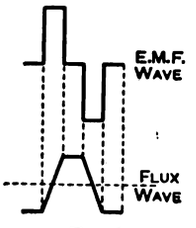

FIG. 1.

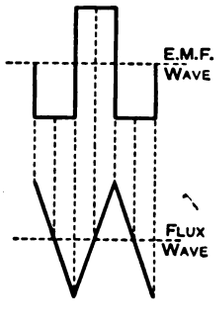

FIG. 2.

It is seen that, observing the slopes of flux, the eddy loss is increased twice, but the hysteresis is increased about four times assuming that the hysteresis depends upon the square of the ordinate, and about three times if the hysteresis goes up as the 1·6th power. Hence the declaration for pointed waves in transformers.—Yours, &c. A. PRESS.

London, Oct. 16th.

OIL-BREAK SWITCHES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Reverting to Mr. Woodhouse's letter in your recent issue, the oil-break switches designed by Mr. Partridge in 1891 were used for service in street boxes, whereas I read Messrs. Ferranti's letter of the previous issue to refer to central station switch gears of importance. I am open to correction, but I do not think Mr. Partridge intended to apply the idea in its initial stages to large central station switches, otherwise he would have done so on the important extra high tension switchboard work which he designed for the London Electric Supply Co. and also for the Metropolitan Company, about the period in question. However, whilst agreeing that considerable credit is due to Mr. Partridge, it will be remembered that others have experimented with the idea; for example, it was used some 25 years ago in connection with Prof. Pepper's induction coil at the old Polytechnic in Regent-street. Messrs. Ferranti were, I believe, the first to apply the idea for the purpose of central station switchboards of moment. In any case, it would appear that this great feature in switch gear design emanated from British and not from the continental designers.—Yours, &c., H. W. CLOTHIER.

Hollinwood, Oct. 20.

THE QUESTION OF THE HOUR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your note to my letter which you so courteously published in your last issue, you complain of the lateness of its arrival. I need scarcely assure you that this belatedness covered no sinister design, and was due to nothing more mysterious than "press of other work." If it caused you the slightest inconvenience, I most sincerely regret it. This epistle, at any rate, will come into your hands in ample time to enable you to demolish me at your leisure.

You remark that "Mr. Bond only quotes partially" a certain passage in your leading article on "The Question of the Hour." A partial quotation is not in itself condemnable; it is only so, if it misleads, and I cannot agree that the last sentence of the first paragraph of my letter in any way fails to do you justice.

I quite admit that an electrical journal is not the place for a lengthy and technical discussion of "The Question of the Hour" in its broadest aspects, and I rejoice in the admission, for although profoundly important, the fiscal question is nevertheless apt to become tedious by its persistent intrusion anywhere and everywhere, even into the philosophic calm of a Whist Club. On the other hand, I venture to think you would be fulfilling your natural scientific function if you would fill in the gap between your premiss and the gloomy conclusion referred to in my letter.

Unless, Sir, you have as yet no "settled convictions," you must either be "for" or "against" Protection, and the policy of the paper, whatever it may be, would surely carry more weight if its readers were in posession of a concise and clear statement of the reasons by which you have been led to sit either on the hedge, in the ditch or in the field.

Looking at the question in the very narrowest way, the action which the suggested "Electrical Trades' Defence Committee" may decide to take will depend upon the fiscal views of the majority of the members composing it. To assist the committee to take action in the right direction everyone who has influence should surely state his convictions and the arguments supporting them, so that there can be no mistake about the matter.—Yours, &c., W. G. BOND.

London, Oct. 16.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I would beg to be allowed to point out that in your able and reasonable article on the tariff question in your issue of Oct. 9 you make one capital error in the following sentence:—

> . . . protective tariffs have never been known yet to force other nations to Free Trade. This is hardly an argument against Protection, however; to take a parallel case, increasing our army and navy does not induce other nations to a general disarmament, yet no politician would argue seriously that our army and navy should be abolished.

The assumption of any parallelism between commerce and war is at the root of most mistakes in the ideas of Protectionists, especially in the ideas of those persons who are the more aggressive and noisy as they are the less-informed!

The only real parallel to increase of armament for war is the increase of education and opportunity for commerce—that is, for instance, no more 1882 Electric Lighting Acts!—Yours, &c., J. SAYERS.

Derby, Oct. 15.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Bond's vigorously worded letter in your last issue has one merit absent from the utterances of the so-called fiscal reformers, in that it leaves us in no doubt as to his meaning, and argues the question from a broad and comprehensive point of view rather than in the narrow interests of any particular industry, electrical or otherwise.

The complaint now so suddenly sprung upon us is that our manufacturers' products generally are being undersold and supplanted in the world's markets.

If such be the case, which is not proven, the cost of production here must simply be higher than abroad.

How is this to be remedied? Surely not by the plan now suggested of taxing food and the countless grades and descriptions of imports, ranging from the crudest raw material to partially manufactured articles. Such a course must of necessity only aggravate the evil, for while further increasing the cost of manufacture, it would also curtail the spending power of the worker, and thus indirectly injure other home trades and consumers in general.

Amongst our innumerable industries which have attained world-wide pre-eminence under Free Trade, the submarine cable enterprise may be fairly cited as an instructive instance. Compare its enormous development and prosperity in this country

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under the present proved system of free imports, which it is now suddenly proposed to reverse, with the insignificant proportions of cable enterprise in other and subsidised and highly-protected countries.

In order to maintain our present position, we need wise business methods, and not the bolstering up or protection of industries of any sort.—Yours, &c., H. C. D.

Oct. 21.

A NEW STEAM TRAP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You show an interesting steam trap in your issue of October 9th. But how is it possible for the steam to operate the device if the *inlet* is at the end where the hot vapour is shut off? Should not the words *inlet* and *outlet* be transposed?

If, as shown in your drawing, steam flows through the cold trap the then expanding tube will cut off the flow, thus leaving the steam on the outlet side of the mushroom valve free to expand out of the outlet at once, thus cooling the working tube and opening the trap again. This would not be a workable condition. On the other hand, if the trapped steam is held on the "outlet" side of the mushroom, the trap would operate when the entrapped steam became condensed, which would be satisfactory.—Yours, &c., TRANSPOSED.

London, Oct. 14.

[We have forwarded the above letter to the maker of the steam trap referred to, and he states that "Transposed" is wrong in his idea, as the inlet must be at the end where the steam is shut off. The trap is adjusted by tightening the screw on the back of the lever, which operation brings the valve off its conical face; the water then leaks past the valve, and, as steam follows, it heats and expands the brass tube, and thus shuts off the steam. As it cools down again, the water again begins to flow, the steam follows, the trap closes, and the same cycle of operations continues.—ED. *E.*]

THE UNION ELECTRIC CO. (LTD.)

We recently had the opportunity of inspecting some of the products of this company under working conditions. Their arc lamps are certainly worthy of special mention. It would be quite impossible to describe the many ingenious devices employed on the various patterns, but a brief description of the "PV" and "PVW" type lamp may be of interest. This is a special type of enclosed arc lamp for photographic purposes. The arc is enclosed in a cylinder and has a length depending upon the line voltage. In the case of 200-volt circuits, 165 volts can be used across the circuit, and the arc is then approximately 2½in. in length. The result of this long arc is that the beam is intensely rich in ultra-violet rays, so that the efficiency of an arc on this voltage is considerably greater than that of one of a similar type burning on 100-volt circuits. The lamps are usually constructed for 10 or 12 amperes continuous current, and 15 and 18 amperes alternating current. The alternating-current lamp has the advantage of being quite suitable for all usual lighting frequencies.

Another lamp, called the "Excello" arc lamp, is an enlargement upon the company's "Flame" arc lamp now largely used for the lighting of interiors of all classes of buildings and many interiors of places of entertainment and public amusement. The lamp as now constructed will burn with either continuous or alternating current of any usual frequency, and is arranged so as to burn up to 19 hours without change of carbons, thus rendering it suitable for street lighting. It is particularly suitable for the lighting of large open spaces, such as yards and works and railway stations, as the maximum illumination is much larger than in the ordinary arc lamp, the maximum rays being projected to a greater distance, thus enabling the lamps to give a more even illuminating effect.

Among the measuring instruments made by the company we noticed an automobile type of combined ampere and voltmeter in one dust-proof aluminium case. The ampere-meter was made with the zero about one-fifth of the way up the scale, so as to permit the indication of the reverse current charging the cells when running down hill. Both the ampere-meter and voltmeter will give perfectly dead-beat readings, and are said to be independent of the vibrations of the car.

The company also had some motors of various sizes running very quietly and with a notable absence of sparking. These machines are constructed in three types—viz., open, semi-enclosed and totally enclosed; the brushes are fixed, permanent adjustments being made to the pole-shoes to obviate sparking before the machines leave the works

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Rotherham Education committee invite applications for the position of lecturer in engineering (including geometry and mathematics) in the Technical Institute. Salary £120. Particulars from the director of Higher Education (Mr. C. H. Burkhardt, M.Sc.), Town Hall, Rotherham, to whom applications by Nov. 10. See advertisement.

King's Norton and Northfield Urban District Council require a clerk of works to superintend the erection of overhead equipment and laying of mains for about 3½ miles of electric tramway. Applications to clerk (Mr. Edwin Docker), 10, Newhall-street, Birmingham, by Nov. 2. See advertisement.

A junior assistant is required in the physics department of Merchant Venturers' Technical College, Bristol. Applications to the registrar by Oct. 29. See advertisement.

There is a vacancy for an improver at the Barnsley electricity works. Applications to borough electrical engineer, Mr. E. A. Barker. See advertisement.

A switchboard attendant is required at Tynemouth electricity works, North Shields. Applications to chief borough electrical engineer, Mr. C. Turnbull. See advertisement.

A switchboard attendant is required at Fulham Borough electricity works. Applications to borough electrical engineer (Mr. Arthur J. Fuller), Townmead-road, Fulham, S.W., to-day (Friday). See advertisement.

A demonstrator is required in physics department of Northern Polytechnic Institute, Holloway, London, N., four evenings a week. Applications to secretary.

An assistant demonstrator is required two days per week in physics laboratories of South-Western Polytechnic, Chelsea, London, S.W. Apply to principal.

A lecturer in physics and electrical engineering is required for the Auckland (N.Z.) Technical School. Salary £250 per annum, for at least three years. Particulars from Dr. W. Garnett, 116, St. Martin's-lane, London, W.C.

London County Council have appointed Mr. F. K. Bruce traffic manager of their tramways department at a salary of £700 per annum, rising by annual increments to £800.

Mr. G. E. Gittins has been appointed lecturer and Mr. A. W. Holden assistant lecturer on electrical engineering at the Harris Institute, Preston. Mr. E. C. Moyle, A.R.C.Sc., has been appointed assistant in mechanical engineering.

Mr. Ashton Bremner has been appointed resident electrical engineer to Burslem Corporation at £200 per annum.

Mr. Mercier and Mr. Hawkins have been appointed assistant engineers at Watford electricity works, in succession to Messrs. F. S. Collings and A. N. Pitcairn, resigned.

Mr. C. B. Futt of Barking has been appointed junior assistant engineer at Aldershot electricity works.

Mr. C. H. Yeaman, who was recently selected as borough electrical engineer at Morecambe, having declined that appointment, Morecambe Council have now appointed Mr. W. H. Hall, chief assistant engineer at Bootle, to the position.

We refer in another column to the probable selection of Mr. A. L. C. Fell, of Sheffield, to fill the vacant post of general manager to the London County Council tramways.

Arbroath.—Negotiations are still proceeding with companies in regard to the erection of electricity works.

Ashton-under-Lyne.—The Council have adopted a scheme for letting out electric motors on hire.

Barking.—The official inspection of the new electric tramway to Beckton is fixed for Tuesday next.

Barry.—An extension of time for carrying out the terms of the Council's electric lighting order, 1901, has been applied for.

Bath.—At a special meeting of the City Council on Tuesday the following motion was adopted:—

That, having regard to the unsatisfactory condition of the money market, and the high rate of interest which will have to be paid in respect of the additional Bath Corporation stock to be hereafter issued, no work to be charged to capital account other than work already actually commenced be undertaken, notwithstanding that it may have received the sanction of the Council, until the question has been re-considered by the Council.

Bermondsey (London).—On Tuesday the Lighting committee reported that, owing to the increasing demand for electric current, some of the distributing mains had become considerably overloaded. They recommended that some of the adjacent dead ends of the cable be connected, so as to form additional paths from the feeding points to those parts of the distributing network where relief is required. In due course it would be necessary to lay down additional feeders, but the work now proposed, which would have to be done in any case, at an estimated cost of £435, would suffice for the time being. The recommendation was adopted.

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Bootle.—An unfortunate accident occurred at the electricity works on Wednesday morning while a superheater was being placed in position, resulting in the death of one man and injuries to three others.

Bournemouth.—The Corporation have decided to apply for powers to construct an extension of their tramways from Pokesdown to Southborne and Christchurch at an estimated cost of £50,000.

Bridlington.—On Thursday last an inquiry was held into the proposed borrowing by the Council of £26,500 for electric lighting.

The town clerk (Mr. A. E. Matthewman) gave particulars of the population, assessable value, &c. The Council obtained electric lighting powers in 1900. A canvass had shown that a considerable number of persons were desirous of adopting electric lighting, and the Corporation would themselves be large consumers. They at present, for the Prince's-parade, had a small installation. The Board of Trade had approved the low-tension, three-wire system it was proposed to adopt. In May the Corporation accepted provisionally eight tenders amounting in all to £24,313. 14s. 11d. Engineering fees, costs and contingencies brought the amount proposed to be borrowed up to £26,500. The plan of the buildings was explained by Mr. E. R. Matthews, borough surveyor. The buildings were so designed as to be easily capable of extension. In the absence through illness of Mr. F. H. Medhurst, his partner, Mr. C. E. Lloyd, gave technical information as to the system, machinery, mains, &c. There was no opposition.

Brighton.—The Council on Thursday last fixed the charge for electric energy to outside authorities at 7d. per unit for the first 200 hours' maximum demand per half-year, and 1d. after. After the first year the price is to be fixed by agreement or by a Board of Trade arbitrator, the Corporation reserving the right to fix a minimum charge. It was resolved to apply for sanction to a further loan of £175 (repayable in 13 years) to meet cost of additions to the storage battery recently decided upon.

Trial trips were made on the London-road electric tramway route on Tuesday, and the line will probably be opened next week.

Budleigh Salterton.—A letter from Messrs. J. and W. Purves as to an application for a provisional electric lighting order is being considered by a committee.

Buenos Ayres.—The whole of the Anglo-Argentine Tramway Co.'s lines have been converted to electric traction, the last of the horse cars coming off in September.

The *Review of the River Plate* states that the Public Works committee have reported favourably on the petition of the La Nueva Tramway Co. to convert their line to electric traction. The concession is to be for 55 years, but the company is to give free lighting en route to 200 16 c.p. lamps per kilometre.

Buenos Ayres Municipality have also granted various extensions of line to the Buenos Ayres Electric Tramway Co. in Belgrano and Flores, the concession being also for 55 years.

Calverley.—The District Council have decided to apply for a provisional tramways order.

Canterbury.—An unopposed inquiry was held last week into the application of the Council for sanction to borrow £4,000 for electric lighting extensions.

Cardiff.—The borough electrical engineer, Mr. Arthur Ellis, reports that there are now 901 private consumers connected to the mains, equivalent to 89,438 8 c.p. lamps, an increase of 54 per cent. over this time last year. A deputation of tradesmen, which waited upon the Electrical committee on Tuesday, urged that electric lighting be substituted for the present inadequate gas lighting in Clifton-street, and was informed that plans had already been drawn for the erection of 13 arc lamps, to be erected as soon as possible.

Chilton (Middlesbrough).—The Council are to approach the colliery managers of the district with a view to the electric lighting of various important colliery properties.

Church Lighting.—Electric has been substituted for gas lighting in Christ Church, Cheltenham (the largest church in the town), as the painting in the apse was suffering from the effects of gas. The gas fittings have in most cases been adapted for the electric lighting and 150 lamps are used. The work was carried out to specification of the borough electrical engineer (Mr. M. H. Kilgour) by Messrs. R. E. and C. Marshall.

Clitheroe.—A sub-committee has been authorised to consult an electrical engineer in regard to the proposed application for an electric lighting order. The Council have now appointed Mr. Thomas Barton, M.I.E.E., consulting electrical engineer.

Colchester.—Yesterday (Thursday) the ceremonial laying of a portion of the permanent way of the electric tramways was performed by the mayor.

Colne.—In view of the notice served by the Southern District Electricity Corporation the Council are considering the advisability of themselves applying for a provisional electric lighting order.

Connaught Electric Power Scheme.—Last week a further meeting of influential persons interested in the promotion of this scheme was held at Castlebar. The Rev. P. Lyons, P.P., presided, and among those who spoke in support of the project was Dr. R. Ambrose, M.P. Resolutions were passed approving the scheme, and calling upon the various local bodies to support it.

Croydon.—An inquiry was held on Thursday last into the application of the Corporation for power to borrow £27,975 for electric lighting extensions.

The town clerk (Mr. F. C. Lloyd) gave particulars of the progress of the electricity undertaking, and the borough electrical engineer (Mr. J. Gray Scott) supplied technical details. It was proposed to put in a 750kw. set, and to build a new boiler house, chimney shaft, &c. No opposition.

Depreciation of Municipal Undertakings.—At the autumnal conference of the Society of Incorporated Accountants at Liverpool last week, Mr. F. Walmsley read a Paper on "Depreciation and Sinking Funds in Municipal Undertakings."

He said this question had been brought into greater prominence by the extraordinary growth of so-called municipal trading, and the large increase in the amount of capital embarked by corporations in gas, water, electricity, tramways, markets and similar undertakings. The universal and continued demand for money by municipal authorities at a time when money was scarce and consequently dear had also accentuated the interest in the question, and in its treatment generally by corporations. Having regard to the fact that a debt of something over £300,000,000 sterling had been created by corporate bodies, he thought they might profitably consider the whole question from the aspect of the present and future incidence of the burden on the community. The security and credit of local government were based chiefly on rateable value, and it was plain that the debt was too rapidly outrunning the rateable value. Was there not a fear that, consequently, municipal security was to some extent being shaken? It would be said that if the debt grew the assets grew also; that to some extent modified the situation; but he considered the spending of the nation, Imperially and locally, was gradually becoming a serious menace to their national financial stability, and called for the urgent attention, not only of all those concerned in municipal life and work, but of every citizen. Under the circumstances justice and prudence alike dictated that no permanent debt should be possible in respect of any assets now created, and that, as a principle, all capital should be repaid by sinking fund, concurrently with the creation of ample reserve for replacement of worn-out or obsolete assets of the undertaking, so that, in other words, there should be no re-borrowing or permanent continuation of capital debt in respect of an old undertaking. The sinking fund was a contribution in repayment of capital borrowed, while depreciation was a fund for the preservation and restoration of assets so as to prevent the raising of further capital for the maintenance and continuance of the status quo. All capital expenditure should be charged to capital so long as it was for extension purposes; and so long as it was, beyond all doubt, in its nature adding to the power of production or of service it was capital, and must be so charged. If it was expenditure in substitution, or renewal, or repair, it must go against revenue. Whether the sinking fund should be assisted by payment out of the depreciation fund, as some urged, was another question, but even if such a course were taken, the two accounts, sinking fund and depreciation, should be kept separate and distinct, so that at any time the position of the total capital expenditure and the total depreciation fund should be clearly shown. As to the amount of depreciation to be charged, he feared that generally, the depreciation of trading undertakings was not at present adequate, and, therefore, not in the best interests nor for the permanent credit of municipal administration. That conclusion was borne out by some figures quoted in a recent Paper by Prof. Turner of Glasgow University, read at the British Association meeting in September, figures taken from Sir Henry Fowler's return, which was submitted to Parliament last December, from which it appeared that, out of a total expenditure of £9,443,741 on tramway undertakings in England and Wales up to 1902, the average annual depreciation fund was £50,307, or only slightly over ½ per cent. As to the question whether sinking fund should be paid out of depreciation, he believed that it should not, for they involved two separate and distinct principles. He suggested that depreciation should be charged in all undertakings liable to waste, obsolescence or supersession, repairs being charged direct to revenue year by year; that longer periods should be allowed for repayment of loans, especially in undertakings of a permanent character, where there were no risk of obsolescence; that sinking fund should be charged separately, without regard to depreciation; and that all these matters should be settled by conference, so as to establish a uniform treatment of depreciation and sinking fund in the accounts of all corporations.

East Molesey (Surrey).—The District Council have consented to the application of Edmundson's Electricity Corporation for a provisional electric lighting order, provided purchase clauses are inserted on the Council's behalf at seven, 14 or 21 years. The company are to supply current for private lighting at 7d. per unit for the first hour's maximum demand and 3d. after, and for public lighting at 2½d. Should, however, the corporation give at any time better terms to any place within 20 miles of Molesey, then the Council are to have the benefit of such terms.

Edinburgh.—The accounts of the electricity department for the year ended May 15 show total capital expenditure £800,710. 8s., increase £35,098. 8s. 6d. during year. The receipts amounted to £103,365, including £81,007 from private lighting (at 3¾d. per unit, less discounts), £10,547 from motor supply (at 1½d., less abatements), £11,505 from public lighting (at £13 per arc lamp per annum and £13 for private arc lighting). The balance was made up of meter rentals, rents of properties and miscellaneous. Generation expenses were £20,878, cost of distribution £3,956, maintenance of public arc lamps £4,070, rents, rates, and taxes £7,037, and management expenses £4,396, making, with miscellaneous expenses (£784), £41,120, and leaving a surplus of £62,245. Interest amounted to

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£20,161, sinking fund instalment to £25,437, and, after setting aside an additional contribution of £1,994 to meet unredeemed capital expenditure for rectifiers now disused, and paying income tax (£120), the balance (£14,532) has been carried forward. During the year 10,196,954 units were generated, against 8,819,254 in previous year; 6.019,815 were supplied for private lighting, 1,695,153 for motive power, 1,280,840 for arc lighting, and 390,624 were used in stations. Since the accounts were presented the charge for electricity for motive power has been reduced to 1½d. per unit, and the charge for arc lamps to £11 per annum. 115 new arcs are being erected, which will bring the total of public street arc lamps to 995.

The Electric Lighting committee have been experimenting with the Bremer arc lamp for public lighting in Princess-street, and now report that they have decided to discontinue the experiments on the ground that the lights flicker badly; that, while they give a better light within a narrow area, they have not as much illuminating power at a distance as the ordinary lamp; and that the carbons would cost, for Princess-street alone, from £80 to £90 a year more than at present.

Farnworth (Lancs.).—The accounts of the electricity department for the quarter ended Sept. 30 show total receipts £1,029, expenditure £892. 131,364 units were generated, including 57,995 for private lighting, 7,475 for street lamps, 79,554 for tramways, and 5,959 for works' lights, motors, &c. During the quarter 88 H.P. in motors was connected, bringing the total to 282½ H.P.; the equivalent 8 c.p. lamps connected were 2,794, making (with 99 radiators already connected) a total of 16,939 8 c.p.

The tramway receipts amounted to £1,953, equivalent to 7·7d. per car-mile run. 401,240 passengers were carried at an average of 1·14d. per passenger. 78,137 units were used for power, equal to 1·28 per car-mile. The expenditure on repairs and maintenance was £170 (less £16 for scrap brass, &c., sold) or 0·61d. per car-mile. Traffic expenses, including £331 for current (or 1·32d. per car-mile), wages £563, and materials £28 (but less receipts from advertising £36) came to £550, equal to 2·21d. per car-mile. The expenses of cleansing and overhauling, rent, rates and taxes, insurance and general establishment expenses, management, &c., brought the total working expenses to £1,373, equal to 5·46d. per car-mile. Interest and sinking fund are estimated at £700, and rent of Kearsley track at £325 increased the total expenditure to £2,398. 1s. 5d., leaving a net deficiency of £444. 17s. 8d. The maximum load was 153kw. for lighting and motors, and 210kw. for traction. The load-factor was 18 3.

Folkestone.—The Council wish to adopt the overhead trolley instead of the surface-contact system of traction (which is specified in their provisional order) on their projected tramways, and application is to be made for leave to amend the order.

Gillingham.—Application has been made for a further loan of £20,000 for electric lighting.

Great Grimsby.—The borough electrical engineer (Mr. W. A. Vignoles) has presented a report to the Electric Lighting committee in which he announces that the laying of the cables is now complete.

With reference to the proposal that a power consumer should be supplied with current during the day-time at 1d. per unit under certain conditions, Mr. Vignoles suggests that a rental be charged for the time switch, to cover not only cost of switch, but also a portion of the interest on the service connection and office expenses. These charges might be:—For motors up to 5 H.P., £2 per annum; above 5 H.P. and up to 10 H.P., £2. 10s.; above 10 H.P. and up to 20 H.P., £3; and above 20 H.P. £4 per annum. He proposed to cut off from dusk until 10 p.m., but he anticipated that after experience had been obtained it might be found possible to renew the supply at 9:30, or even nine o'clock, but he did not think it would be possible in Grimsby to renew it earlier than that. The supply to be taken by this consumer was about 30,000 units per annum.

Greenock.—The award in the dispute between the local tramway company and the Council (referred to in our last issue) as to the price to be paid by the former for electric energy in excess of 500,000 units per annum, has fixed the charge at $\frac{7}{10}$d. per unit. The company is also to pay the Council £125 per annum for the use of the cables, commencing from May 1, 1901.

At Tuesday's meeting of the Corporation it was decided to adopt a scheme for the wiring of premises on the hire-purchase system.

Hackney (London).—The Electricity committee have offered to supply electric current to the Great Eastern Railway for lighting the company's stations in the borough at 8d. per unit for the first 100 units per kilowatt maximum demand per quarter, and 2d. per unit after. The mains are to be extended to the Eastern Hospital, which is to be lighted electrically.

Hampstead (London).—During the quarter ended September, 136 new customers, representing 8,881 8 c.p. lamps were connected to the electric lighting mains, compared with 132 customers and 6,450 lamps connected in the same period of 1902.

Handsworth.—The London and North-Western Railway Co. will construct a siding to the site acquired by the Distric Council for electricity works at a cost of £935.

The price to be paid by the Council for the portion of the undertaking of the South Staffordshire Tramways Co. within the district, has been agreed at £5,250, and the electrical engineer has been instructed to proceed with the preparation of plans, &c., for the conversion of the system to electric traction.

Hanley.—An inquiry was held on Tuesday into the application of the Corporation to borrow £17,600 for electricity extensions. The town clerk (Mr. A. Challinor) asked for a period of 25 years for the loan. Technical details were supplied by the electrical engineer (Mr. C. A. Cowell). No opposition.

Heavitree.—The District Council have asked Messrs. Frank Suter & Co. to state their terms for giving a supply of electricity in this district.

Hemel Hempstead.—The Corporation on Wednesday declined to consent to an application by a company for an electric lighting order.

Hornsey.—The Council are trying a new smoke preventer with satisfactory results. Slack coal at 8s. a ton is being used as fuel. The first year's working of the electricity undertaking shows a deficit of £2,000. It has been decided to purchase two 300kw. steam dynamos, one to be delivered in October, 1904, and the other in March, 1905.

Hove.—An inquiry was held on Thursday last into the application of the Town Council for sanction to a loan of £15,000 for the electric lighting of Aldrington.

The town clerk (Mr. Endacott) asked that the period of the loan should be 30 years. £11,145 was required for cables, conduits and trench-work, £1,600 for 200 house services and meters, £600 for buildings and land, £667 for engineer's fees and £988 for contingencies. Mr. Hancock (Hancock and Dykes, consulting engineers) stated that it was proposed to take current in bulk from Brighton Corporation or the Hove Electric Lighting Co. A number of applications for current had been received, and it was estimated that the quantity of current required would be at first 100,000 units per annum, but he expected this would be exceeded before long. Estimating interest and sinking fund at £900 and wages and sundries at £200 per annum, the cost of distribution would be 2·64d. per unit, and supposing the Council had to pay 3d. per unit for the current required they would provide against all contingencies by charging 6d. per unit to consumers at the outset. It was, however, expected that current would be obtained at less than 3d. Many houses have been already wired.

Hull.—The public service of electric tramcars over the new Whitefriargate Bridge to Victoria Pier route was commenced on Tuesday.

Ince (Lancs.).—The local tramways have been leased to Wigan Corporation for 21 years.

Islington (London).—At the meeting of the Borough Council last week the Lighting committee recommended, as stated in our last issue, that, in order to encourage an increased day load, the uniform flat rate of 2d. per unit be modified for all electricity for power consumed between midnight and 6 p.m. in winter (October to March) and 7 p.m. in summer (April to September) by the following scale:—For all units up to 500 per quarter, 2d., from 500 to 5,000, 1½d., from 5,000 and over per quarter, 1¼d. per unit. The recommendation was adopted, as was one to apply for a loan of £1,900 for laying mains in the Belleisle district.

The chairman of the same committee announced that the artesian well at the electricity works had been a success. For the last six weeks they had drawn 50,000 gallons of water per day. In a short time the new boiler house would be connected up, and then they would not require any water from the New River Co., which was now costing them £800 per year. Water from the new supply would cost them 1d. per 1,000 gallons, or £100 per annum.

The special committee on wages at the Eden-grove station reported that they had considered the memorials presented by the deputations from the trade union organisations and were waiting for certain documents. Upon receipt of these further consideration would be given to the matter.

On the question of the system of electric traction to be adopted on the tramways through Islington and other districts of London, the Works committee recommended that a conference should be convened of representatives of the Councils affected to consider the question with a view to united action being taken. This recommendation was adopted without discussion.

Leigh (Lancs.).—The electrical engineer (Mr. D. M. Kinghorn) recommends the extension of the electricity works at an estimated cost of £10,780.

Leith.—The salary of the borough electrical engineer (Mr. A. Peden Rutherford) has been increased from £270 to £400 per annum, to induce him to withdraw his resignation consequent upon the offer of a similar appointment at Aston.

Light Railways.—As a result of the recent inquiry the Light Railway Commissioners have sanctioned the application of Stretford District Council for lines from the junction of King-street and Barton-road to Cheshire Lines railway bridge and to Urmston-lane. The application for a line into Trafford Park was refused, but the Council are granted the powers sought by the company for the portion

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of the proposed railway from the railway bridge to the boundary of the park, upon condition that if the company construct the remainder of the railway the Council must construct the line to connect such railway and the railway from the junction of King-street and Barton-road to the railway bridge, failing which the company will be entitled to construct the section. The company are given authority for the portion of railway in Trafford Park, and failing their carrying out the work the Council will have power to do so. In view of the fact that additional tramways through Urmston have recently received Parliamentary sanction, the Commissioners refused the Council's application as to four lengths of railway. The company's application relating to two other railways (8 and 9) is granted.

Woking District Council have reconsidered the scheme for the construction of light railways in the district, and have now given it a conditional approval. Mr. G. T. Harrap is consulting engineer for the scheme.

The Board of Trade have, after modification, confirmed the Burton and Ashby Light Railway and the Dover and River Light Railway orders.

An inquiry was held at Lowestoft on Wednesday into the application of the Corporation for an order to amend the East Anglian Light Railways Order.

The town clerk (Mr. R. B. Nicholson) said the application was for power to transfer to the Corporation the 1902 order for constructing an electric railway to Kessingland. The only opponents were the Great Western Railway Co., on the ground of competition.

Evidence in support was given by the consulting engineer (Mr. W. C. C. Hawtayne), who said that they asked for the same capital powers as were set out in the original order (£61,000.)

The Commissioners announced that they would recommend the granting of the application.

Sir Herbert Jekyll heard objections to the Quarry Bank, Brierley Hill and Rowley Regis Light Railway Order on Tuesday. The order was granted to the Councils of the three districts mentioned, and the objectors were the Dudley, Stourbridge and District Electric Traction Co. After consultation, the following clause was inserted for the protection of the company :—

Nothing in this order shall authorise the Councils to alter or interfere with any of the tramways or light railways of the Dudley, Stourbridge and District Electric Traction Co. (Ltd.) without the consent in writing of that company, or without like consent to construct certain other lines.

A scheme is being prepared for the construction of a light railway to connect Llandilo, Lampeter and Aberayron. The consulting engineer for the promoters is Mr. Yockney.

Lisburn.—The District Council are considering a scheme of a firm of electrical engineers for the introduction of electricity supply into the district.

Liverpool.—During the year ended Aug. 31 last the equivalent of 16 c.p. lamps connected to the mains had increased from 203,282 to 244,244, and the number of consumers from 4,138 to 4,790. The total output had increased by 12 per cent. over the previous year. Over 70 places of worship are now lighted electrically, and are fitted with more than 10,000 lamps.

Liskeard.—An application by Messrs. Thompson & Co., electrical engineers, Plymouth, for permission to erect overhead lines in some of the main streets for supplying electric current for lighting has been referred by the Town Council to a committee.

London County Council.—At Tuesday's meeting electric lighting loans were granted to Hampstead, £1,273, and St. Pancras, £23,960.

Tramways.—The adjourned report of the Highways committee was submitted recommending the construction of a double line of tramway, 6 furlongs 6·5 chains in length, along St. John-street and St. John-street-road to the Angel at Islington, on the conduit system, at an estimated cost of £30,500.—The recommendation was agreed to.

North Metropolitan Tramways.—The Highways committee further reported that there were certain short lengths of tramways in the county of London, forming part of the North Metropolitan Company's system, which were not included in the lease to the company of the Council's (northern) tramways. The company has recently taken steps to re-construct, for electric traction, these portions, the work being carried out under the powers conferred by the North Metropolitan Tramways Act, 1897. The act, however, limits the period for the completion of the work to two years, and the company is (the committee are advised) acting illegally in proceeding with the work. As the tramways affected are purchasable by the Council, and will probably be worked in conjunction with the lines that are the subject of the lease, the committee urge that it is most important the Council should have a voice in the system of traction to be adopted. The committee have, therefore, given instructions for an action to be instituted to prevent the company proceeding with the works. The report was adopted.

London County Council Tramways.—On Thursday last Finsbury Council agreed to allow the County Council to construct a tramway through Rosebery-avenue at the same time as the lines in St. John-street and St. John-street-road, for which statutory powers have been obtained.

L.C.C. Tramway Managership.—It is stated that the Highways committee of the London County Council recommend the appointment of Mr. A. L. C. Fell, of Sheffield, for the position of general manager of their tramways at £1,500 per annum. The other candidates in the final list were Mr. J. B. Hamilton, of Leeds, and Mr. C. J. Nicholson, passenger superintendent of the L. and Y. Railway Co.

Londonderry-Moville Electric Railway.—An inquiry was held last week into the engineering merits of the scheme for the construction of an electric railway along the shore of Lough Foyle from Londonderry to Moville. The consulting engineer (Mr. A. M'C. Stewart), said the line would start near the terminus of Lough Swilly Railway and follow the road the entire distance, except at two points where there would be deviations. The line presented no engineering difficulties, the sharpest curve was 3 chains, and the steepest gradient 1 in 15, the ruling gradient being 1 in 25. The generating station would be at Rery Reel, about midway.

Lowestoft.—Sanction to a loan of £2,000 has been obtained by the Council for the extension of the electric lighting mains. £1,000 is for cables for 30 years, and £1,000 for meters and demand indicators for 10 years.

Manchester.—The report of the general manager of the tramways department (Mr. J. M. McElroy) for the half-year to Sept. 30 states that

The total revenue was £320,268, of which £315,970 was from traffic. Working expenses (including £35,027 for depreciation) were £228,496, leaving gross profit £91,771, and net profit (after providing for interest, sinking fund, rent of lines, &c.), £43,405. The depreciation allowed for is on the following basis :—Permanent way £400 per mile of single track per annum, the estimated life of the track being 10 years ; rolling stock and overhead equipment 5 per cent. on outlay. The trolley line will be efficiently maintained out of revenue. Operating expenses per car-mile during the half-year were 6·67d., compared with 6·95d. in 1902. Electric energy cost 1·82d., compared with 1·94d. ; traffic expenses (wages, cleaning, &c.) were 3·43d., compared with 3·53d. ; management expenses were reduced from 0·75d. to 0·68d. ; and repairs and maintenance rose from 0·73d. to 0·74d. There was an increase in wages (due to an advance given to the men at the commencement of the year) and in rents, rates and other matters, resulting from the increased assessment of the track and equipment.

The electric tramway route from Piccadilly along Oldham-street and Bradford-road has been opened for traffic.

Mansfield.—The Council last week decided to extend the electric supply mains at an estimated cost of £972. The electrical engineer (Mr. E. H. Hewlett) was instructed to obtain samples of prepay ment meters.

Marylebone (London).—We recorded in our last issue the proceedings at the overnight meeting of the Marylebone Borough Council. This was, we think, the last regular meeting of the Council prior to its dissolution, but as we announced, there will be a special meeting of the full Council on Oct. 29, to discuss the bill prepared for presentation to Parliament next session to enable the Council to give effect to the award of the arbitrators recently decided. The following are the objects and purposes of the proposed measure :—

1. To empower the Borough Council to borrow the necessary moneys for enabling them to purchase the St. Marylebone undertaking and business of the Metropolitan Electric Supply Co. (Ltd.) as defined in the Electric Lighting Order Confirmation (No. 1) Act, 1901, and other capital moneys for and in connection with the purchase of the undertaking, the erection of electricity works, and other electricity purposes.

2. To make special provision in regard to the repayment of the moneys borrowed, and for the application of the revenue arising from the undertaking.

3. To authorise an increase in the maximum charge for the supply of electricity ; to alter the method of charging for the same ; to empower the Borough Council to change the pressure and mode of supply, and to make special provision in the case of premises having a separate supply.

4. To authorise the Borough Council to enter into arrangements with wiring contractors for the purchase, loan and installation on consumers' premises of electric motors, fitting apparatus, wires and things.

5. To empower the Borough Council to purchase, by compulsion or agreement, lands in or near Richmond, Capland and Salisbury-streets, in the neighbourhood of the stone-yard of the Borough Council, and to empower the Borough Council to erect generating stations on such lands and on parts of such stone-yard.

6. To authorise the Borough Council to construct a short line of railway or siding connecting the proposed generating station with the Great Central Railway.

7. To alter, amend or render inapplicable provisions of the Electric Lighting Acts, 1882 and 1888, the Electric Lighting (Clauses) Act, 1899, and the Electric Lighting Order Confirmation (No. 1) Act, 1901, and the St. Marylebone Electric Lighting Order, 1901, scheduled thereto.

8. And in other respects to make provision for the carrying on of the undertaking, when in the hands of the Borough Council, with economy and efficiency ; and also for the purpose (if deemed expedient to promote such bill) of passing a resolution charging the expense of promoting such bill upon the general rate of the borough or on such other rate as the Council shall deem advisable.

Before the bill can be presented to Parliament the Council have to resolve, at the special meeting referred to, by an absolute majority

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of the whole number of members of the Council, to promote the bill. This having been duly accomplished, and the bill deposited, the new Council appointed in November, if it decides to proceed with the measure, will be called upon to confirm, by an absolute majority, the propriety of the promotion of the bill. A public meeting of the electors must also be held, after the bill has been deposited for inspection, to consider the question of its promotion. At this public meeting the mayor or chairman is required to give an explanation of the bill. Then the question of the promotion of the bill may be put either by a single resolution in favour of the whole bill or by separate resolutions in favour of any part or parts of the proposed bill. Unless a poll is demanded by not less than 100 electors, or by the Council, the decision of the meeting on the resolution or resolutions will be final. The Council can, if authorised by a resolution passed within seven days after the meeting of electors, require a poll. This poll may be taken on the whole or any part or parts of the bill, but the poll on any number of resolutions may be taken at the same time and by means of the same voting paper.

Municipal Telephony.—Hull Corporation have now received sanction to a loan of £43,202 for establishing a municipal telephone service in the Hull area. It will be remembered that, at the recent inquiry into the application for sanction to borrow there was considerable opposition by a section of the ratepayers, and that the inquiry extended over several days. Tenders for plant and material had already been let conditionally and the work will now be proceeded with forthwith. The period of the loan is, we are informed, 25 years, and the telephone licence expires on Dec. 31, 1911.

New Electrochemical Works.—It is announced that an electrochemical company has acquired the large salt deposits on Walney Island, Barrow-in-Furness, where it is proposed to establish electrochemical works for the manufacture of caustic soda and chlorine products direct from the brine.

New Zealand.—Geraldine Town Board are considering the practicability of utilising the water power of the River Rangitata in the generation of electrical energy, and a representative of Messrs. A. and T. Burt, electrical engineers of Dunedin, has been called in to report upon the matter.

Outside Tramcar Seats.—Halifax Corporation tramcars are now fitted with roof seats composed of reversible bars to ensure dry seats in wet weather.

Personal.—Mr. Frederick S. Grogan, A.M.I.E.E., who has been with the British Thomson-Houston Co. for the past three years, has been appointed chief assistant engineer to the British Electric Equipment Co. in London. Mr. Grogan, during his association with the B.T.-H. Co., has been chiefly engaged in tramway construction work at, among other places, Huddersfield and Croydon, but latterly has been attached to the company's construction department at Rugby. Previously he was for five years an assistant engineer at Belfast Corporation electricity supply station.

Perth.—The Council, on Monday, considered the question of appointing an electric tramway engineer to advise on the desirability of altering the gauge of and cost of reconstructing existing lines, &c., and also to superintend the work of conversion and electrical equipment. Before making the appointment it was decided to ask the Reconstruction committee to ascertain more definitely what the duties of the engineer would be.

Portsmouth.—The salary of the tramway engineer, Mr. Lironi, has been increased from £200 to £250 per annum.

The special sub-committee appointed to consider the project to construct the Portsmouth-Hayling Island Railway have reported in its favour, and recommend the Corporation to extend their present tramway system, at a cost of £10,000, from Eastney to the borough boundary, so as to connect up with the light railway.

The Tramways committee have ordered as an experiment one tram-car with roof cover.

Presentation.—Mr. O. Hughes, inspector, on his departure for Ipswich, was presented with a number of valuable articles by the Sunderland tramway staff.

Reigate.—An inquiry was held on Tuesday last into the application of the Council to borrow £8,165 for electric lighting extensions. The Town Clerk (Dr. C. Grece) said the extensions were originally estimated to cost £8,165, but an examination of the tenders submitted showed that the work could be done for less. Technical particulars were supplied by the electrical engineer (Mr. W. S. Ross). No opposition.

St. Louis Exhibition.—For an immense artificial cascade at this exhibition the pumping machinery will consist of three 36in. single-stage, turbine centrifugal pumps, each driven by a 2,000 H.P. Westinghouse alternating-current motor. This will be the largest electric pumping station in the world. The machinery is now being installed.

Saxony.—An extensive scheme of electricity supply for power and other purposes at Crimmitzschau (Saxony) has been prepared by the Allgemeine Elektrizitäts Gesellschaft. The proposal is that current shall be sold in bulk to electricity supply undertakings, to the owners of the street railway and tramway systems, and to the vast number of factories situated within the district surrounding Crimmitzschau and Werdan, towns situated 6 miles distant.

Southport.—The Council have abandoned the letting of electric light fittings on the hire-purchase system.

Spain.—The Tranvia del Este Co. of Madrid are extending their system of electric tramways in the districts of Argulles.

Stoke Newington (London).—The Borough Council will participate in the conference to be called at the instance of Islington Borough Council to discuss the question of the system of electric traction to be adopted on the County Council's North London tramways.

Stratford-on-Avon.—Notices have been served by the Empire Electric Light and Power Co. and the National Provincial Electricity Corporation of intention to apply for provisional electric lighting orders. An offer has also been received from Messrs. Baker, Lees & Co. on behalf of a company to carry out the terms of the Council's order. The Council has decided not to accept the offer, but to apply for an extension of time for carrying out the order.

Swinton and Pendlebury.—The Board of Trade have deferred the revocation of the provisional electric lighting order for another year.

The Telephone in "Motor" Catching.—The Norfolk police are using the telephone in testing the speed of motor cars on the public roads. The times of leaving and arrival are compared by officers at the two ends of a measured distance. Two 25-miles-an-hour "culprits" have recently been captured by this means.

Thornaby-on-Tees.—The Sir Hiram Maxim Electrical and Engineering Co. have offered to take the lease of the Council's electric lighting order.

Torquay.—The Dolter Electric Traction Co. have been authorised by the Council to construct a length of experimental line on their surface-contact system, and the company will, therefore, apply for Parliamentary powers.

Tunstall.—Messrs. Baker, Lees & Co. have offered, on behalf of a company, to take a transfer of and to carry out the terms of the Council's electric lighting order, 1900.

Underground Electric Railway for Manchester.—The Parliamentary sub-committee had before them on Thursday last a proposal from Mr. W. A. Jackson for the construction of an underground line to connect the five railway stations in the town. The committee decided not to approve the scheme, which was estimated to cost £750,000 if single-deck cars only were adopted.

Village Lighting.—The village of Bedwellty Pitts is to be lighted electrically, current being supplied by the Tredegar Iron and Coal Co. at 4d. per unit.

Walthamstow.—Electric current will be supplied to the local theatre of varieties for the equivalent of about 2,000 8 c.p. lamps.

Walton.—The District Council have come to terms with the Urban Electric Supply Co. for the supply of electric current in the district.

Water-power Scheme for Perthshire.—Representatives of a syndicate which is promoting a scheme for utilising water-power in Perthshire in the generation of electric energy have had an interview with members of the Perth Council to ascertain whether the Council will take current in bulk from the syndicate, and the matter has been referred to the borough electrical engineer, Mr. John Lambert. Mr. J. C. Vaudrey is consulting engineer to the syndicate.

Watford.—The salary of the chief assistant engineer (Mr. J. R. Weston) has been increased by £20 per annum. The Council have fixed the price for charging automobile cells at 4d. per cell up to 15 ampere-hours' capacity and pro rata for larger cells, minimum of 1s.

West Bromwich.—An unopposed inquiry was held on Friday last into the application of the Corporation for sanction to a loan of £12,217 for extensions of the electricity supply.

Westminster.—The General Purposes committee reported to the City Council on Tuesday that they had considered the charges made to the Council by the five companies supplying electricity in the district for lighting municipal buildings, &c. These charges were:—

Charing Cross and Strand Electricity Supply Corp. (four establishments), lighting 6d. per unit, power 2½d.; London Electric Supply Corp., lighting 4d., power 3d.; Metropolitan Electric Supply Co. (four), lighting 4d.; St. James' and Pall Mall Electric Light Co. (four), lighting 4d. and 6d., power 4d.: Westminster Electric Supply Corp. (12), lighting 4d. and 6d., power 3d. and 4d. The latter company allow a rebate of 8 per cent., and the St. James' and Pall Mall Co. a rebate on accounts paid before the end of the month in which it is rendered.

The Council have now entered into a yearly agreement with the Westminster Corporation to supply current for lighting at 3½d. per unit, and for power at 1½d., without guarantee as to minimum consumption. Under this agreement, in the event of a general reduction in price to the company's consumers, a proportionate reduction will be made to the Council.

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The City Council, in reference to an application made by the Charing Cross and Strand Company, consider that the local governing bodies of London should be furnished with increased powers of control over the breaking up of the streets in all future provisional orders issued for the metropolitan area, and that conditions should be inserted in such orders making it obligatory upon electricity supply companies to supply current for light and power to public buildings or for public lighting at rates not greater than the lowest rates charged to any consumer on their books.

Whitehead (Ireland).—Progress is being made with the scheme for obtaining a provisional order for this district. A local company is being formed, and several prominent residents (including Col. M'Calmont, M.P., and Col. Duncan M'Neill, J.P.) are identified with the undertaking. Messrs. W. B. Galway & Boas of Belfast are solicitors for the company. It is proposed to erect a generating station with an initial capacity of about 3,000 8 c.p. lamps. The maximum price to be charged for current for private lighting will be 6d. per unit.

Whitehaven.—The Harbour Commissioners have renewed the contract for the electric lighting of the harbour. The charge for electric current supplied on the prepayment meter principle has been fixed at 4½d. per unit

Whitley Upper.—Negotiations are proceeding between the Council and the Yorkshire Electric Power Co. for a supply of electricity in bulk.

Willesden.—There are now 295 private consumers connected to the Council's mains, and 95 are awaiting connection, which represented 15,086 8 c.p. lamps. For street lighting there are 2,690 8 c.p. connected, and 230 8 c.p. awaiting connection. Originally the estimate of the electrical engineer (Mr. E. T. Ruthven-Murray) that they would have a total of 19,833 8 c.p. connected at the end of the first year was much criticised, but at the end of the first quarter 8 c.p. lamps connected and awaiting connection were equivalent to 18,006. The extension of mains in several roads, at a cost of £1,029 has been agreed to.

Mr. Ruthven-Murray has informed the Council that he has received the draft agreements for the sale of the electricity works to the North Metropolitan Electric Power Supply Co., and for the supply by them to the Council of current in bulk. The Electricity committee will report upon these at an early date.

Workhouse Lighting.—Bridgend Guardians intend to light their workhouse electrically.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday: New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Bermondsey (London) Borough Council invite tenders for the supply of low-tension triple-concentric feeder cables, arc circuit and pilot cables and sundry connection boxes; also cast iron arc lamp standards and accessories, arc and incandescent lamps, switchboxes and sundry fittings for same. Specifications, &c., from the Town Hall, Spa-road, Bermondsey, and a copy may be inspected (but not obtained) at the office of the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson), 29, Great George-street, Westminster, S.W. An advertisement contains further particulars. Tenders to the town clerk (Mr. Frederick Ryall), by noon Nov. 9.

Beckenham Urban District Council invite tenders for the electric wiring of houses in their district under a "free" wiring scheme. Specifications, &c., from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, or the surveyor (Mr. John Angell), Council Offices, Beckenham. Tenders to the clerk (Mr. F. Stevens) by 4 p.m. Nov. 9. See advertisement.

Chorley Corporation invite tenders for the transfer of their electric lighting order, 1896. Further particulars from the town clerk (Mr. Jno. Mills), Town Hall, Chorley, to whom tenders are to be sent. See advertisement.

Leeds Lighting committee invite tenders for the supply and erection of about 45 tons of steel or wrought-iron and cast-iron pipes and valves, oil extractors, &c. Conditions and specifications from the manager of the electric lighting department (Mr. Harold Dickinson), 1, Whitehall-road. Tenders to the town clerk (Mr. W. J. Jeeves), Town Hall, Leeds, by Nov. 13. See advertisement.

Blackpool Electricity and Tramways committee invite tenders for a new 450kw. traction set. Forms of tender, &c., from the borough electrical and tramways manager, Mr. Charles Furness. Tenders to chairman of committee, Town Hall, Blackpool, by Nov. 14. See also advertisement.

London County Council invite tenders for supply and erection of (*a*) engine, dynamo, switchboard, &c., and (*b*) electric wiring, mains and fittings required for the installation of the electric light at the Abbey Mills pumping station, West Ham. Tenders to clerk (Mr. G. L. Gomme) by 10 a.m. Nov. 3.

Swansea Corporation invite tenders for laying of permanent way, including rail bonding, rails and fish plates, &c., overhead electrical equipment and ducts, troughs, cables, &c. Tenders by noon Oct. 31.

Swansea Corporation also invite tenders for supplying and connecting up of ducts, troughs, cables, wires, street boxes, &c. Tenders by noon Oct. 31.

Todmorden Corporation invite tenders for one Lancashire boiler, two steam dynamos and balancing booster, two feed pumps, and one injector, economiser, surface and jet condenser, switchboard and instruments, storage battery, cable work, and overhead hand crane. Tenders to chairman of Electricity committee by Oct. 31.

Kilmarnock Corporation invite tenders for three Lancashire boilers, engines and dynamos, overhead travelling crane, storage battery and switchboard. Tenders to town clerk (Mr. W. Middlemas) by Nov. 18.

Wakefield Corporation require a 400kw. two-phase generator (engine, alternator, exciter and accessories). Tenders by Nov. 7.

Wednesbury Corporation invite tenders by noon Nov. 20 for wiring and fitting up various public buildings for the electric light.

Manchester Paving committee invite tenders by Nov. 5 for laying underground telephone pipes.

Tenders are invited for the concession for lighting the town of Culiacan, Mexico, by electricity. Proposals will be received by letter until Dec. 31, at the Secretario del Ayuntamiento, Culiacan, where further information can be obtained. This city has a population of 12,000, and is the capital of the State of Sinaloa.

Tenders will be recived up to 2:30 of Dec. 30 for the supply and delivery at the Commonwealth of Australia Departmental Stores, *Sydney, N.S.W.*, of telegraph, telephone and electric light material. Specifications, conditions and tender forms can be seen and obtained from the General Post Offices of Sydney, Melbourne, Brisbane, Hobart, Adelaide and Perth, and samples may be seen at the four first-mentioned offices.

TENDERS RECEIVED AND ACCEPTED.

Canterbury Town Council received the following tenders for the supply of 2,200yds. of 0·4 sq. in. twin concentric cable :—

Siemens Bros.&Co.(*accepted*)	£1,290	W. T. Glover & Co.	£1,334
E. F. Heath.....	2,000	Callender's Co.	1,331
Union Cable Co.....	1,699	W. F. Dennis & Co.	1,320
St. Helens Cable Co.	1,495	British Insulated and Helsby Cables (Ltd.)	1,308
Johnson and Phillips.....	1,453	Land and Sea Cable Works (Cöln-Nippes, Germany)..	1,283
W. T. Henley's Co.....	1,395		
Burley and Strange	1,384		
Western Electric Co.	1,372		

Newcastle-under-Lyme Council have accepted the following tenders :—

Andrews Limited, two gas engines	£788	0	0
Ditto ropes, iron floor plates and driving pulleys	90	0	0
Electric Construction Co., two dynamos	385	0	0
Crompton & Co., switchboard	345	17	0
Electrical Power Storage Co., storage battery	255	10	0

Cable Accessories Limited, house service fuse boxes.

J. S. Roberts (Ltd.), 600yds. 6in. socket pipes, £5s. 1s. 3d. per ton, and specials at £9. 7s. 6d. per ton.

Hammersmith (London) Borough Council have received the following tenders for motor-generators :—

Witting, Eborall & Co. (*accepted*) .....£615 or	£691	Johnson & Phillips ..£790 or	£850
Lancashire Dynamo & Motor Co. .....£778, £832 or	971	Electric Construction Co.....	809
Bruce Peebles & Co.	890	Geipel and Lange....£664 or	750
General Electric Co.....	870	Fuller-Wenstrom Co.....	730
		F. A. Glover & Co.....	700

The British Westinghouse Co. have secured a contract for the equipment of all the Glasgow tramcars (nearly 700) with their magnetic brake. This order has followed upon exacting experiments extending over nearly two years on 100 cars. The number of these magnetic brakes sold in the United Kingdom is 1,300.

The Hart Accumulator Co. (Ltd), Marshgate-lane, Stratford, London, E., have received an order from the War Office for a storage battery of 54 cells for Shoeburyness.

Magnetic brakes are to be mounted on the new electric tramcars now being built by the British Electric Car Co. for Batley, these brake equipments having been recently ordered from the British Westinghouse Co.

Walthamstow District Council have placed an order with the Electrical Co. for the supply of 350 ½-ampere Nernst lamps at £1,200, the company agreeing to renew all filaments failing under 400 hours for six months.

Lanchester Joint Hospital Board has accepted the offer of Bowes and Partners to supply electricity for lighting the Infectious Hospital at Tanfield at 4½d. per unit, with an annual rental of £35 for the mains.

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King's Norton and Northfield District Council have accepted the tender of R. W. Blackwell & Co. for overhead construction work of Pershore-road electric tramway at £2,718, subject to the material being of British manufacture.

Cambridge Town Council have accepted the offer of the National Telephone Co. for maintaining the Corporation fire alarm system at £35 per annum.

The British Westinghouse Co. are supplying for the new tramway system at Pietermaritzburg, S. Africa, six complete electric tramcar equipments of standard Westinghouse pattern, each including two No. 90 series-parallel controllers, two No. 200 (35 H.P.) motors, and the usual auxiliary apparatus.

East Cowes Council are considering an offer by the Isle of Wight Electric Light and Power Co. to supply and erect lamp-posts at £1. 18s. 6d. each.

Rochdale Guardians have accepted the tender of W. T. Henley's Company for the alteration and extension of the switchboard at Dearnley Workhouse, and for the supply of cables.

Mander Bros., Wolverhampton, have placed an order with the British Westinghouse Company for a three-cylinder vertica type producer gas engine coupled to a 100kw. electric generator.

Boston Council have accepted the tender of J. Bakewell & Co. for wiring the new municipal buildings at £473. 15s. 6d. The tenders varied from £494 to £576.

Radcliffe Council have accepted the tender of Callender's Co. for the supply of cables, &c., at £5,350. 2s. 2d.

Bury (Lancs.) Town Council have accepted the tender of the British Thomson-Houston Co. for electric motors for hiring out.

Gillingham District Council have accepted the tender of Hayward-Tyler & Co. for pumps at £546. 13s. 6d.

BUSINESS NOTICES.

Mr. T. L. Miller, M.Inst.C.E., M.I.Mech.E., M.I.E.E., has arranged with Mr. C. H. Wordingham, on his acceptance of the post of electrical engineer-in-chief to the Navy, to take over that gentleman's consulting practice at Manchester, and is arranging to complete for Mr. Wordingham a large number of unfinished works. Mr. Miller is taking over Mr. Wordingham's offices at 19, Brazennose-street, Manchester, and will continue to practice at that address as well as at 7, Tower-buildings, N., Water-street, Liverpool; and 61, Old Broad-street, London, E.C. (under the style of Miller and Collins). Mr. Miller has taken into partnership Mr. H. W. Wilson, for a considerable time engineer to the Lancashire branch of the British Thomson-Houston Co. The combined practices will in future be carried on in the name of T. L. Miller and Wilson.

Mr. C. H. Wordingham announces that, in consequence of his having accepted the offer made to him by the Admiralty of the position of electrical engineer-in-chief to the Navy, he has disposed of his consulting practice to Mr. Thos. L. Miller.

Mr. H. Smethurst informs us that, having terminated his engagement with Messrs. Wheatley Kirk, Price & Co. of London after 18 years' service as chief of the staff, he has commenced business on his own account, as auctioneer and valuer to the iron, steel, electrical engineering and allied trades, under the style of H. Smethurst & Co., at 37, Ommaney-road, New Cross, London, S.E. Mr. Smethurst's business career commenced as a pupil of Wm. Galloway, jun., of Manchester. He was afterwards draughtsman and assistant to Mr. R. H. Radford of Sheffield, and subsequently he filled the position of science and art master at Sheffield under the Science and Art Department; obtained a first-class certificate in iron manufacture from the City and Guilds of London; was appointed chief draughtsman and demonstrator to the Institution of Mechanical Engineers, London; and is the author of a Paper on "Iron Manufacture," read before the Junior Institution of Engineers.

The Consolidated Supply Co., general merchants and importers of electric pocket lamps, torches, house lanterns, &c., have removed from 9, London-street, Fenchurch-street, to 78, Queen Victoria-street, London, E.C., where additional accommodation will enable the company to make a larger show of their electric and other novelties.

Mr. Gerald Hooghwinkel, M.I.E.E., informs us that he has resigned his position as assistant chief engineer to the Brush Electrical Engineering Co. to establish himself in consulting practice at Dacre House, 20-22, Victoria-street, London, S.W. Mr. Hooghwinkel will devote himself specially to electric mining and traction work.

BANKRUPTCIES, LIQUIDATIONS, &c.

Mr. F. E. Wright, 19, St. Dunstan's-hill, Great Tower-street, E.C., has been appointed trustee in the bankruptcy of Ferdinand Fanta, electrical engineer, 4 and 5, Warwick-court, Holborn, London, W.C.

The first meeting of creditors of Thomas Williams, electrical engineer, 54, Bridge-street, Llandaff (late of Cardiff), was held last week. The gross liabilities are £13,019. 1s. 4d.; expected to rank, £1,653. 5s. 4d. Estimated assets, £1,913. 19s. 1d. The Official Receiver remains as trustee.

The Desolle Electro-Plating Co. (Ltd.) is being wound-up voluntarily. Mr. J. J. B. Arter, Norwich Union-chambers, Birmingham, is liquidator.

The Yorkshire Electric Power Syndicate (Ltd.), 4, South-parade, Leeds, is being wound-up voluntarily.

A meeting of the Mangano Electric Process (Ltd.) is to be held on Nov. 16 at 15, George-street, London, E.C., to receive an account of the winding-up.

A meeting of the Highland Water Power Syndicate (Ltd.) will be held on Nov. 17 at 11, Cornhill, London, E.C., to receive an account of the winding-up.

Sales by Auction.—Messrs. Wheatley Kirk, Price & Co. have been instructed by the Newcastle-on-Tyne Electric Supply Co. (who are concentrating their plant in one generating station) to sell by auction, on Thursday, the 29th inst., their central station at Pandon Dene, and the entire contents. The plant includes five Lancashire boilers, economisers, two 560kw. Belliss-Holmes direct-coupled sets, 700 I.H.P. compound horizontal Robey engine, three 300kw. Mordey alternators, two 150kw. ditto, one 100kw. motor-generator, one 25kw. ditto, eight vertical engines, 124 Brush transformers, 133 B.T.-H. ditto, nine motor-generators, numerous dynamos, small motors, pumps, &c.; also 230 meters, 30 arc lamps, 150 Cardew earthing devices, instruments, switches, lamps, switchboards, &c. Catalogues (gratis) of the auctioneers, 46, Watling street, London, E.C., and Albert-square, Manchester.

Messrs. Wheatley Kirk, Price & Co. have also been instructed to sell by public auction, on Nov. 4, 5 and 6, piecemeal, the entire contents of the celebrated Castle Works, Northfleet, Kent. The catalogue will include a number of slide-surface and screw-cutting lathes, automatic screw machines, turret and chasing lathes, profiling and slotting machines, shapers, drilling, grinding and milling machines, polishing lathes, screwing and turning machines, a Lancashire boiler, one 150 H.P. Westinghouse steam engine, 9 H.P. Tangye gas engine, complete plating plant, &c. The entire contents (including the loose tools) are, with a few unimportant exceptions, practically new, and are in perfect condition and by the best-known American and English makers. Catalogues may be obtained (price 6d.) of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester. See also advertisement.

Messrs. Wheatley Kirk, Price & Co. have also been favoured with instructions from the liquidator of Heaton and Smith, Ltd. (Mr. J. P. Garnett) to offer for sale by auction, as a going concern, in one lot, at the Albion Hotel, Piccadilly, Manchester, on Tuesday, Nov. 3, at 2:30 for 3 o'clock, the valuable works premises of the company, including offices, stores, machine shop and galleries. Further particulars are given in an advertisement. Failing the sale of the whole, the land, buildings and motive power will be offered as an alternative lot, the purchaser having the option of taking over the plant, tools, &c., at valuation. Particulars will be supplied (gratis) on application to Messrs. David Smith, Garnett & Co., 22, Booth-street, Manchester; Messrs. Parkinson, Slack and Needham, solicitors, 10, York-street, Manchester; or the Auctioneers, Albert Chambers, Albert-square, Manchester, and 46, Watling-street, London, E.C.

Plant for Sale—Two Westinghouse motors (7½ H.P. and 5 H.P.), with starting switches, &c., and a Worthington pump are advertised for sale in another column.

The National Electric Supply Co., Preston, have for sale a Belliss-Westminster set. See advertisement.

A 3 H.P. B.T.-H. electric motor, shafting, pulleys, &c., is advertised for sale by Mr. Sardy, 8, Snow-hill, London, E.C.

Paper Insulated Cable.—Messrs. Johnson and Phillips' Electric Cable Works point out that there is at the present time a large quantity of wood pulp and other inferior makes of paper being offered for use in electrical work, and they forward us a sample of the standard electric "pure Manila" paper which is used on I. and P. cables made to Post Office and other standard specifications. The paper appears to be of good texture and extremely tough, and it would evidently not break in the taping machine, even when laid on at a fast speed and with an extremely short lay. If its insulating properties are on a par with its mechanical properties, it is evidently a first-class material for the manufacture of electric light and power cables, as well as for telephone cables. So much Manila paper comes from the United States nowadays that we trust this brand is of English manufacture.

Robey-Saurer Oil Engine.—We illustrate below a new type of oil engine manufactured under the Saurer patents, and guaranteed by Messrs. Robey & Co. of Lincoln. Messrs. Drake and Gorham, 66, Victoria-street, Westminster, London, are sole agents for these engines, the special features of which are the ease with which the piston can be taken out and replaced, and the arrangement by means of which the water jacket surrounding the cylinder can be cleared of all scale. This is claimed to meet the difficulties frequently

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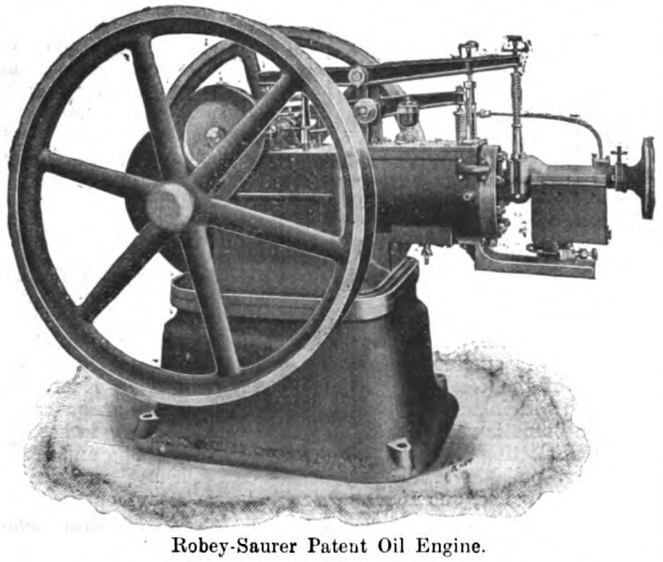
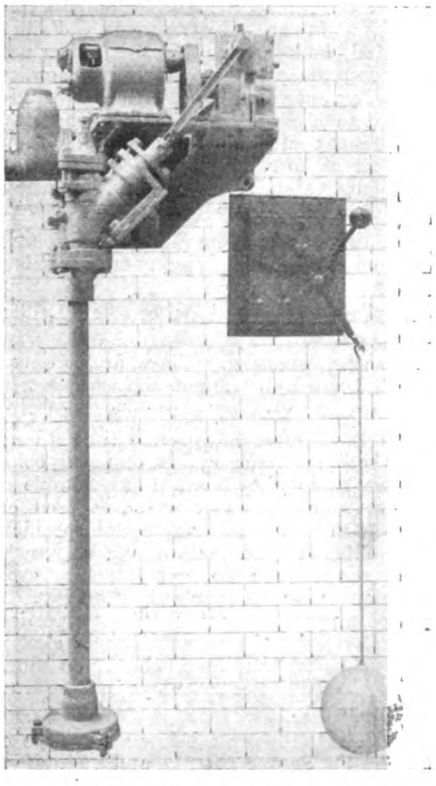
met in the use of this type of engine where a bad quality water has to be used. The engine is provided with larger bearings than any engine at present on the market. The lever for actuating the valves in the engine up to the 14 H.P. size are all above the engine, and are so placed as to be easy of inspection at any time, an advantage which users of the smaller sizes of such engines will appreciate. The arrangements for pumping petroleum to the vaporiser are of a special type, and an automatic lamp of extreme simplicity has been provided to keep the vaporiser and the ignition tube hot at the same time, ensuring that the engine shall run equally well with any proportion of its load up to the maximum. It is further claimed for the Saurer engine that its steadiness of running renders it specially suitable for use in electric lighting work. There is also supplied a



Robey-Saurer Patent Oil Engine.

combination of the engine coupled direct to a dynamo on the same base, forming a compact unit of plant taking up but little space. Several years' experience with the engines have, Messrs. Drake and Gorham state, realised the highest expectations both as regards its economy and reliability.

Draw-pit Pumps (Electrically Operated).—For dealing with accumulations of water in cable draw-pits and manholes, and for ordinary domestic use, the British Thomson - Houston Co. have introduced a small combined motor and pump of double-throw, single-acting plunger type, of 7½ gallons capacity per minute, and suitable for heads up to 55ft. The pump is driven by a ¼ H.P. motor through double reduction gearing. The first reduction consists of cast-iron machine - cut spur gearing enclosed with a cast - iron guard. The second reduction is obtained by worm and worm-wheel running in oil and provided with a ball thrust bearing. The motor is automatically controlled by the rise and fall of the water in the pit raising and lowering a copper ball float connected by a rod to a fall-over switch, giving a quick make-and-break action. The makers ask that inquirers for this class of apparatus shall state the nature of the circuit; if continuous current, the voltage; or, if alternating, the voltage, frequency and phase.



B.T.-H Electrically-operated Draw-pit Pump.

Catalogues.—A new edition of the Electrical Co.'s pamphlet on the Nernst lamp is now ready, and contains information regarding every type of these lamps now on the market, and useful hints concerning their treatment. Copies of the pamphlet can be obtained from the company's offices, 122-124, Charing Cross-road, London, W.C. It may be added that alternating-current burners for the "Luna" type of Nernst lamps will shortly be on the market.

A new list of cable accessories and jointing materials has been issued by Messrs. Siemens Bros. & Co.

The Howard Conduit Co. are issuing a card illustrating an example of their troughing, showing a bend which it is claimed can be made with no other troughing on the market.

The Birmingham Electrical Fittings Co. have a new sheet list ready of main switches, fuses, &c.

The British Westinghouse Company have ready a new circular (No. 1,045) dealing with apparatus for the protection of electrical circuits from the effects of lightning or other static discharges.

Hyde Electrical Mfg. Co., Hyde, Manchester, have ready a new catalogue of standardised direct-current motors. In these machines special attention has been devoted to the ventilation of the field coils and armature, ventilating ducts being provided through the poles and external casing in line with suitably shaped fans mounted in a corresponding duct in the armature core. Illustrations and a general description of the machines are included in the list.

The Keighley Electrical Engineering Co. have ready a new list of motors, dynamos and motor starters. Several of these machines are illustrated, and a full specification of "Keighley" plant is given.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Oct. 14 to 20, with the ports of destination:—

Africa—Alexandria, £168 (telegraph material); Cape Town, £1,531; Chinde, £35; Delagoa Bay, £2,122 (including £1,902 telegraph material); Durban, £796 (including £190 telegraph material). *Argentina*—Rosario, £774 (telegraph material). *Australasia*—Adelaide, £39; Fremantle, £79; Gisborne, £24; Melbourne, £187; Otago, £609; Perth, £96; Sydney, £3,111 (including £1,110 telegraph material); Wellington, £1,163. *Channel Islands*, £502. *China*—Shanghai, £167; Tientsin, £284. *France*—Boulogne, £55; Paris, £238. *Holland*—Amsterdam, £30; Rotterdam, £45 (telegraph wire). *Hong Kong*, £27. *India*—Bombay, £500; Calcutta, £741; Madras, £126. *Portugal*—Lisbon, £54. *Straits Settlements*—Singapore, £53. *Sweden*—Stockholm, £160 (telegraph wire). *West Indies*—Trinidad, £18. Total £13,725, against £14,838 in the corresponding date last year (Oct. 15 to 21).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

June 27, 1903.

14,211 VERITYS LIMITED and E. J. SELBY. Switch and circuit-breaker.
14,223 W. J. BURTON. Winchester. Electro-pneumatic action for organs.
14,231 J. W. BOWLEY. Manchester. Arc lamps.
14,247 HANS VON KRAMER. Glasgow. Resistances.
14,269 E. G. PULFORD. Liverpool. Electrical signalling systems.*
14,286 C. M. DORMAN and R. G. SMITH. Salford. Covers for electrical apparatus.*
14,295 EDISON ORE-MILLING SYNDICATE. Electromagnets for electromagnetic separators. (T. A. Edison, U.S.)
14,299 H. BRAUN. Telegraph apparatus.
14,300 G. RARP. Electrical alarm apparatus.
14,304 J. B. JARVIS. Sparking plugs for electric ignition.
14,309 G. E. DUTERTRE and M. F. A. NODET. Birminghan. Electric oven.
14,318 H. W. BUTLER. Regulating supply of current in mains.
14,363 H. H. LAKE. Telephone call recording systems. (Automatic Telephone Meter Co., U.S.)
14,373 SIEMENS BROS. & Co. and L. M. G. FERREIRA. Illumination of signals by incandescent lamps.*
14,375 C. M. JACOBS and A. H. NICHOLSON. Switches for selective signalling apparatus.

June 29, 1903.

14,380 H. W. VAN RADEN and C. B. ROBINSON. Coventry. Contact-breakers for induction coils.
14,476 J. L. DAVIES. Arc lamps.

June 30, 1903.

14,500 H. SMITHSON and E. R. SHARPE. Manchester. Overhead equipment.
14,520 J. L. ALBIEZ, Jun. Glasgow. Switches.*

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14,523 P. MANSON. Leigh. Ship's telegraph alarum.*
14,539 BRITISH WESTINGHOUSE ELECTRIC AND MFG. CO. Armature coils. (Westinghouse Electric and Mfg. Co., U.S.)
14,541 G. SCHAULI and W. LOEWENSTEIN. Galvanic dry cells.
14,542 D. L. LINDQUIST. Controlling devices for electric motors.*
14,550 J. F. MASON and H. KREMNITZ. Lifeguards for electric vehicles.
14,551 A. SUNDH. Electric controllers.*
14,555 D. L. LINDQUIST. Controlling devices for electric motors.*
14,558 D. L. LINDQUIST. Electromagnets.*
14,561 H. P. BALL. Automatic circuit-breakers.*
14,562 H. P. BALL. Circuit-breakers.*
14,563 H. P. BALL. Switches.*
14,566 H. J. HADDAN. Electrically-driven centrifugal engines. (American Tool and Machinery Co., U.S.)*
14,575 P. KLEBER. Holders for incandescent lamps.*
14,597 E. A. CAROLAN. Machines for making bases for electric lamps. (G.E. Co., U.S.)
14,598 E. A. CAROLAN. Electric motor-driven machine tools. (G.E. Co., U.S.)
14,601 and 14,602 P. DU BOIS. Coin mechanism for electricity meters.
14,605 G. B. BOWELL and PEARSON FIRE ALARM. Thermostats.*

July 1, 1903.

14,610 F. HAMER. Hayes. A dynamo-electric generator for the production of high-voltage continuous currents without commutation.
14,654 H. JONE. Converting energy of fuel into electric energy.
14,655 H. JONE. Regenerative voltaic cells and mode of operating.
14,656 H. JONE. Heating voltaic cells and restoring the battery products thereof to original state.
14,671 R. C. W. WOOD and G. CLIFTON. Electrical shot-firing or like apparatus.
14,697 SIEMENS BROS. & Co. Manufacture of frames for dynamo-electric machines. (Siemens and Halske A.G., Germany.)

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

19,366 HITCH. Cable conductors.
19,573 LAKE (G.E. Co., U.S.). Contact shoes for electric railways.
19,579 BECKMANN. Detection of short circuits in batteries.
20,323 CODD. Switches.
20,444 WOLSELEY TOOL AND MOTOR CO. and AUSTIN. Sparking plugs.
20,556 WATERMAN. Electromagnetic valve controlling apparatus.
20,656 ADDENBROOKE and ROBINSON. Switches and connections for testing circuits.
21,213 PATTERSON and DARRAH. Lighting miners' and other lamps by electricity.
21,267 ZAY. Secret electrical interrupter.
21,301 KAY and KAY. Telegraphic apparatus for engines on shipboard.
21,302 CHALMERS. Electric lampholders.
21,488 COOK, COOK and PARTINGTON. Trolley heads to guide live wire into groove of pulley when changing direction of car.
22,809 SOLOMON and SHEPPARD. Using Nernst light in optical or magic lanterns.
22,957 SCHULZ. Construction of switches.
23,114 NIBLETT. Storage and other batteries.
23,115 NIBLETT. Current meters for use with batteries.
23,151 LAKE. Battery installation for submarine boats.
23,560 BUSHELL. Trolley gear for electric traction.

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Co. (Ltd.).

The sixty-fourth ordinary general meeting was held on Wednesday, Mr. CHARLES W. PARISH presiding.

The SECRETARY (Mr. James Scott) having read the notice convening the meeting and the auditors' certificate,

The CHAIRMAN said: Gentlemen, it has given us great pleasure to be able to set before you such satisfactory accounts for the half-year's working from January to June, 1903, which show a better result than we have been accustomed to for some time. The actual traffic receipts amount to £17,244, while for the corresponding half-year of 1902 they were shown in the accounts as £12,784, but this amount was afterwards increased by the payment we received in respect of our claim from the West India and Panama Company, so the comparison can only be taken as a satisfactory indication that our revenue has improved. This is due partly to the encouraging manner in which the Republic of Cuba is gradually settling down under the new government. President Palma is a man of high ability and rectitude, and there seems every hope that he will initiate a more peaceful and a more prosperous era than existed under the old régime. We hear of new industries being started; in the western part of the island land is being cultivated to grow fruit and early vegetables; tobacco and sugar plantations are being enlarged, and there is every hope that the ruins of war and former revolutions will give way to a speedy development of the natural riches of the island, which in time must undoubtedly add to our business. I should, however, explain that, as regards the traffic of last half-year, we have somewhat benefited from interruptions which have befallen the French company's cables. It appears that even cable companies, which have their property deep down in the seas, come under the old adage that "It is an ill wind which blows nobody any good." Following the other items of the revenue account, you will notice that beyond the £17,244 traffic receipts there is £2,076 interest on investments and cash balances, and £5 for transfer fees, giving a total of £19,325 to deal with. Our working expenses amount to £6,066, and after placing £5,000 to the reserve fund and providing £3,000 for the preference dividend, we are able to propose a dividend on the ordinary shares at the rate of 5 per cent. per annum, with a further bonus of 2s. per share, which together are equal to 3½ per cent. for the six months. I am glad we are able to contribute £5,000 to the reserve, for, as I have before explained, this fund is partly a depreciation fund, and as time goes on and our cables grow older it is of the greatest importance that our business should be fortified to meet all possible emergencies. You will see we still have to hold up the £8,174 of our claim against the United States Government for the damage done to our cables during the Spanish-American War. I do hope we may soon have it settled, but nothing can be done until the matter again comes before Congress, which will not be for two or three months at the earliest. It does seem extraordinary that such a small claim should require so long for settlement, especially in view of the favourable recommendation of President McKinley to Congress in 1900. As regards the subsidy due from Cuba in respect of the coast cables, I am disappointed that we have not yet received it; it is about £2,000 a year, and the arrears cover the period from January, 1899, so that altogether about £9,000 is due to us. Our agent is continually negotiating with the Government, and expects a favourable settlement, and I should also say that His Majesty's representative has been instructed by the Foreign Office to assist us in every way. I have good reason to believe that the matter has been carefully laid before the President and I hope that before long we may receive some satisfactory news. I now move the adoption of the report and accounts.

Mr. GEORGE KEITH seconded the resolution.

Mr. J. P. HOOPER: Have you any idea of the amount of depreciation on our investments of £132,000?

The CHAIRMAN: We have got £6,641 as a reserve against depreciation, and, taking to-day's quotations, which are exceptional, there would appear to be a total deficit on the balance of some £10,000. That is the difference, but I hope before we meet again the value of Consols and other gilt-edged securities will have gone up.

The resolution was carried unanimously.

Resolutions were then carried approving the dividends and bonus, and re-electing Mr. Robert Kaye Gray a director.

Mr. T. SMITH asked if there was any likelikood of Marconi's Wireless Telegraph Co. competing with them to do them any damage.

The CHAIRMAN: I do not think it will do us much harm yet awhile, at any rate.

The auditors were then re-appointed, and a cordial vote of thanks to the chairman, the directors and the staff at home and abroad terminated the proceedings.

Drake and Gorham (Ltd.).

The second annual meeting was held on Tuesday, under the presidency of Mr. BERNARD M. DRAKE.

The SECRETARY (Mr. A. C. Reid) having read the notice convening the meeting and the auditors' certificate and report,

The Chairman referred to the following report of the directors for the 12 months ended June 30. After payment of all charges, including bonuses to staff, there is a net profit of £16,327. 6s. 3d., which with £3,245. 18s. 4d. brought forward, makes £19,573. 4s. 7d. It is proposed to pay a dividend of 8 per cent per annum, absorbing £10,000, and to carry forward £9,573. 4s. 7d. Subject to a resolution being approved by the shareholders, the directors propose to place £7,000 to reserve. During the 12 months the turnover has been considerably larger than in the previous year, and the increase in the number of houses and factories fitted with the Drake and Gorham standardised system of electric lighting and power has been amply maintained. The departments concerned with the sale of electrical apparatus to the trade continue to expand, and fresh agencies are constantly being arranged to take the place of those which may lapse by time or by agreement. Mr. R. Percy Sellon has retired from the board.

The CHAIRMAN, after referring to the satisfactory result of the year's trading, as shown by the net profit, said it was satisfactory to note that the percentage of general charges to turnover had been reduced. The item in the balance-sheet of sundry debtors was somewhat large, but a considerable part of that sum had been collected since the accounts were prepared. The amount expended on work in hand at June 30 was less than in the previous year, but the orders received up to Aug. 31 in the current year showed an increase over the corresponding period in 1902. During the year they have carried out contracts of considerable magnitude for Lord Tankerville, Lord Crewe, Lord Mansfield, Lord Amherst of Hackney, Lord Burnham, Lady Augusta Mostyn, Sir Edward Colebrooke, Sir William Boord, Capt. Burns-Hartopp, Mr. Pandeli Ralli, Mr. J. P. Cross and many others, and have fitted with electric light and power several factories, including Ten Acres Mill, Manchester, with about 2,500 lights, acknowledged to be one of the finest examples of factory lighting and power transmission in the district. At present they had in hand numerous contracts of a similar character to those previously mentioned. The advantage of standardising sets so that every individual part was the result of experience obtained elsewhere, and the cheapening of electric light, which has been possible owing to the production of large quantities of these sets, might be regarded as essential factors in the company's success.

The report and accounts were then approved and the dividends recommended therein adopted. At the subsequent extraordinary meeting the resolution submitted by the directors was approved, and £7,000 of the amount carried forward was ordered to be placed to reserve.

A cordial vote of thanks to the chairman terminated the proceedings.

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BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—The directors' report for year ended June 30 states that the gross receipts showed an increase over the preceding year of $95,717, and net earnings (after charging renewals) an increase of $39,172. After providing for renewals maintenance (£10,446), bonus to employés (£1,494), writing off preliminary and issuing expenses (£1,000), and adding £1,594 to capital amortisation fund, the net profit was £37,864. After providing for debenture interest and preference dividends, the directors propose a dividend on the deferred ordinary stock at the rate of 3 per cent., making 5 per cent. for year (tax free). £1,000 is transferred to contingency fund and £3,000 to reserve. The carry forward is £1,098.

BRITISH COLUMBIA TELEPHONES (LTD.)—The report for the year ended June 30 was presented at the meeting on Wednesday. The expenditure for improvements and extensions during year was £7,334, and the purchase of plant of the Columbia Telephone and Telegraph Co. involved a further £7,668. A new switchboard is being installed in the Victoria exchange on the central battery system, necessitating the purchase of new instruments for all subscribers there, involving a total expenditure of at least £15,000. The Provincial Legislature has passed an act enabling the company to lay a cable connecting the mainland and Vancouver Island, the cost of the cable and land-lines being estimated at £35,000. Owing to past heavy but necessary expenditure, the directors regret they are unable to pay any dividend on the ordinary shares. A reorganisation scheme, transferring the head office to British Columbia and increasing the debenture issue, was submitted and approved. The balance from last year's account was £322, and the directors have transferred from reserve £4,500, making £4,822. Out of that have been paid expenses of English office (£146), income tax (£376), bank interest (£164), debenture interest to June 30 last (£1,271) and preference dividend (£1,694), leaving £1,170 to provide for directors' fees and to carry forward.

KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION (LTD.)—The chairman (Mr. Roger W. Wallace, K.C.) stated at the meeting on Tuesday that, notwithstanding the prevailing depression, the industry of Kalgoorlie had been maintained, and prospects were promising. The company's franchise would last as long as mining in Kalgoorlie would last. The work done by their manager (Mr. Crocker) had been eminently satisfactory. The plant was one of the best, and perhaps the only thing they had been agreeably disappointed in had been the supply of water at Kalgoorlie. It had been much better than anybody anticipated. They sent out an excellent condensing plant that had worked well. They could have sold the whole of their electricity very readily, but that supply would not have been to their company a remunerative supply if they had taken all contracts offered to them, because the company's object was to get contracts which would run as far as possible over the whole 24 hours in the day. Hoisting machinery and machinery of that description gave a load for a comparatively small number of hours, and they refused such applications, and should go on picking them out until they got their whole supply taken up on the most remunerative basis. The work done during the period of the accounts was only preliminary work; since then they had got a large number of other customers, and they were getting additions from day to day. Their customers included the Kalgoorlie Electric Tramways Co. and several gold mining companies. Up to July the number of units supplied was 153,745, and that would go on increasing. He expected to be in a position to pay a dividend next year. Before, however, they could pay a dividend it would be necessary to write off, or to place to capital account, the sums expended in preliminary work. Their plant had been erected more cheaply than any other plant he had ever known, and he had had a good deal of experience in electrical matters. The engineers (J. G. White & Co.) were large shareholders in the company, and therefore interested in doing the work in the cheapes manner possible. He did not believe there was any other tramway com-t pany at work in the world that had been stopped on so few occasions on account of loss of power.

MONTE VIDEO TELEPHONE CO. (LTD.)—The directors' report for the year ended July 31 shows a net profit of £12,224. 8s. 1d., after providing for all working expenses. Adding £1,064. 3s. 10d. from last year, the available balance is £13,288. 11s. 11d. From this it is proposed to transfer £5,000 to reserve, and the directors recommend, after payment of the 5 per cent. preference dividend, a dividend at the rate of 3 per cent. per annum on the ordinary shares. £1,783. 11s. 11d. is to be carried forward. The company has acquired, as from June 12, 1903, the rights, privileges and properties of the undertaking known as La Hispano Uruguaya, comprising a system of telephone lines and exchanges outside the city and province of Monte Video, which materially enlarges the territory occupied by the company.

TRAFFORD PARK ESTATES (LTD.)—At the meeting on Wednesday the chairman (Col. Paget Mosley) said that since the last meeting they had constructed a portion of the tramways nearly 3 miles in length, which served the greater part of the area within the Stretford district. The tramways were opened in July, and were working satisfactorily. They had endeavoured to obtain, through the West Manchester Light Railways, a junction with the tramlines in Trafford-road, which the Stretford authority had leased to Manchester Corporation. Those lines ran within 10yds. of their own road, and the Stretford Council could, if they cared, give them the right to join up. The junction was badly wanted by Manchester and Salford Corporations and by the company, and would unquestionably be of great public benefit by providing for the running of electric tramcars direct into and through the park from all parts of Manchester and Salford. Powers to effect this junction would form part of their application to Parliament. It was impossible to estimate the true value of the electric tramways and light railways to an estate like theirs, particularly when it was seen how simple it would be to couple them up with existing systems outside their areas.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—The report of the meeting held on Thursday last (officially supplied) states that the chairman (Mr. C. T. Yerkes) submitted the first report, which showed that the company had up to June 30 last received £6,519,672 cash, and had spent £5,600,222, leaving £919,450. £6,999,931. 10s. 4d. of profit sharing notes had been negotiated, and it was from those notes and also from the sale of securities received from the different companies with whom they had contracts, that they were realising the funds to carry on the work of construction. After those notes were negotiated, the total amount of capital required was then assured, and he congratulated the shareholders on the fact that the company would not want for funds to finish its work. The power house, being the most important part of the work, had received their fullest attention. It would be the largest of its kind in existence, and with the exception that more time had been taken in its construction than anticipated, the whole work was most satisfactory. It had been the desire of the management to purchase in this country everything pertaining to construction, and while they had accomplished that to a great extent, still there had been some material which had come from Germany, owing to the fact that it could be produced there much cheaper than in England. Owing to the favourable conditions prevailing, their expenditure had been considerably within the estimates. They were aware that the Metropolitan District Railway would be the first plant to operate with electricity, and the construction going on there was progressing rapidly. The line which they were working to South Harrow had been of great service to them, for it discovered to them some defects in mechanism, and also showed what it would be to their advantage to adopt. The experiments they had tried in regard to safety devices had been exhaustive. They had decided that nothing inflammable in the way of construction should go into their tunnels. It was a fact that the use of electricity meant fire if not properly guarded, and the only way to prevent it was to have nothing which the electric current came in contact with that was inflammable. A fire could easily be prevented if proper care were taken. The platforms in their tube stations would be made entirely of cement, while those of the District road which were now wood would be taken out and cement substituted. The wooden stairways would also be removed and iron ones put in. Their rolling stock would be of a pattern of their own, and the construction would be most carefully looked after. Everything would be done to give the public perfect confidence in using underground railways, which would be made as safe, if not safer, than those on the surface. The underground work on the Baker Street and Waterloo line, between Baker-street and Waterloo, is now practically finished, and attention was being given to the completion of that line, as it was desirable that they had it ready simultaneously with the District railway. They expected to make a connection between the two lines at Charing Cross, District station. The Baker Street and Waterloo Co. had decided to extend its lines from Waterloo station to the Elephant and Castle, and the work there was being pushed forward rapidly, while the extension from Baker-street to Edgware-road was about to be commenced. When the latter was finished, the line would be still further carried on to Paddington. The Great Northern, Piccadily and Brompton, and the Charing Cross, Euston and Hampstead lines were making good progress. Their acquisition of the London United Tramways had been a great advantage to their system and they intended to connect directly both the Great Northern, Piccadilly and Brompton and the District Railways with that tramway, so that passengers might have an almost uninterrupted passage from Bow, and from Finsbury Park to Hampton Court.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BLAKE-MORSCHER ELECTRICAL ORE SEPARATOR SYNDICATE (LTD).—Reg. Oct. 6, capital £10,000 in £200 shares, to adopt an agreement with H. C. Callahan, to investigate the validity of patents and efficiency of process and mechanism therein referred to, to promote a company for acquiring all or any of the property and liabilities of this company or otherwise, and to carry on the business indicated by the title. First directors H. C. Callahan, E. A. Weinberg, J. E. Scantlebury and T. L. M. Llewellyn. Reg. office, 20, Copthall-avenue, London, E C.

CHICHESTER AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Reg. Oct. 12, capital £20,000 in £1 shares, to carry on in the United Kingdom and elsewhere the business of suppliers of electricity, carriers of passengers and goods, electrical engineers, electricians, engineers, manufacturers of and dealers in railway, tramway, electric, magnetic or other apparatus, &c. The subscribers are C. H. Dade, G. J. Somerville, electrical engineer, G. R. Hulme, electrical engineer, C. L. Robertson, H. S. Day and A. B. Gridley. Reg. office, Donington House, Norfolk-street, London, W.C.

GENT & CO. (LTD.)—Reg. Oct. 13, capital £50,000 in £1 shares (20,000 preference), to acquire and carry on business of manufacturing electricians, electrical engineers, wire and cable manufacturers, wire coverers, &c., carried on by A. W. Staveley and I. H. Parsons at Leicester as Gent & Co. and the Midland Electrical Wire Co., and to carry on the said business and that of telephone, water supply and mechanical engineers, manufacturers of speaking and pneumatic tubes, workmen's and watch-

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men's check clocks, tool makers, metal workers, manufacturers of rolling stock, &c. Among the seven subscribers are A. W. Staveley, electrical engineer, I. H. Parsons, electrical engineer, W. Levi, electricity works manager, and J. N. Derbyshire, C.A. First directors, A. W. Staveley, I. H. Parsons and W. Levi.

HEMSWORTH ELECTRICITY SUPPLY CO. (LTD.)—Reg. Oct. 7, capital £6,000 in £1 shares, to acquire from the Rev. C. Leteux and G. Hodgson the benefit of a contract entered into by them with R. J. Nicholson, and to carry on the business of electrical and mechanical engineers, suppliers of electricity, &c. First directors, Rev. C. Leteux, J. Gomersall, C. E. Turner, R. J. Nicholson (managing), and two others. Reg. office, 5, Bank-street, Hemsworth, near Wakefield.

PISCICELLI ELECTRIC POST PARENT SYNDICATE (LTD.)—Reg. in Guernsey Oct. 17, capital £150,000 in 60,000 £6 per cent. preference and 90,000 ordinary shares of £1 each, to acquire and turn to account an invention of Count R. T. Piscicelli, Naples, for an aerial electric post, with patent rights for same, and to carry on the business incidental thereto. First directors, Count R. T. Piscicelli (permanent) and Duc de Morny, Comte de Pradere, H. S. Saunders and W. Digby (till 1905). Count R. T. Piscicelli is also technical director and constructional engineer.

MORTGAGES AND CHARGES.

ANLGO-PORTUGUESE TELEPHONE CO. (LTD.)—Lien reg. Sept. 23, for £3,000 8 per cent. second debentures, part of £40,000; amount previously issued, £17,600. No trustees. Charged on undertaking and all property, but subject to first debentures for £10,000.

BATH ELECTRIC TRAMWAYS (LTD.)—Deed of further charge, reg. Sept. 22, for £15,000 and interest, supplemental to two charges, dated July 14, 1893, and Aug. 29, 1893. Holder, Union of London and Smiths Bank. Secured on balance of call of 2s. 6d. per share, due Sept. 17, 1903, remaining unpaid on preference and preferred ordinary shares.

BRIGHT'S LIGHT AND POWER LIMITED.—A fifth mortgage debenture for £500, dated Oct. 8, 1903, charged on all company's concessions, freehold and leasehold works and plant in England and elsewhere and (as floating security) its other assets and undertaking in England and elsewhere, including uncalled capital (subject to first, second, third and fourth debentures, securing in the aggregate £12,000), has been registered. Holder, C. Owles.

CONNOLLY BROTHERS (LTD.)—Issue on Oct. 1 of £4,650 debentures, part of series created Feb. 12, 1900, to secure £30,000, charged on company's undertaking and property, present and future, including uncalled capital. Trustees, J. B. Lloyd and J. W. Davidson. Previous issue of same series, £24,950.

EDMUNDSON'S ELECTRICITY CORPORATION (LTD.)—Acknowledgment of indebtedness, dated Sept. 28, securing £100,000 debenture stock (supplemental to trust deed dated July 10, 1899, and to three acknowledgments of indebtedness dated respectively April 27, 1900, Aug. 1, 1901, and Nov. 14, 1902, securing debenture stock to an amount not exceeding three-fifths of paid-up capital for time being) has been registered. Property charged: First mortgage debentures of Winchester Electric Light and Power Co., Wycombe (Borough) Electric Light and Power, Salisbury Electric Light and Supply Co., Ventnor Electric Light and Power Co., Bromley (Kent) Electric Light and Power Co., Woolwich District Electric Light Co., Chislehurst Electric Supply Co., Newmarket Electric Light Co., Alderley and Wilmslow Electric Supply Co., and the corporation's undertaking and other assets, present and future. Trustees, J. Bailey and J. R. Wigham. Debenture stock previously issued, £200,000.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Oct. 9 of £2,300 debentures, part of series created June 3, 1896, to secure not more than two-thirds of subscribed and paid-up capital for time being, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £28,250.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 27⅞d. per oz. (Oct. 22). Consols 88⅜—88½ for money, 88⅜—88½ for account; 2½ per cent. 88½—88¼ (Oct. 22). Consols Pay Day Nov. 5; Stocks and Shares Continuation Days, Oct. 27 and Nov. 10; Ticket Days, Oct. 28 and Nov. 11; Pay Days, Oct. 29 and Nov. 12; Mining Share Carry-over Days, Oct. 26 and Nov. 9.

CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)—The directors have decided to pay an interim dividend of 5s. per share (at the rate of 10 per cent. per annum) on the ordinary shares.

ELECTRICITY IN MINING.—At the meeting of Lake View Consols (Ltd.) on Tuesday the chairman (Mr. F. A. Govett) said they proposed to completely reorganise their power plant. The preliminary recommendations from the managers had been given in the directors' report, and the work had been authorised. They had sent out their recommendations, which had been carefully drawn by their electrical advisers (Mr. Killingworth Hedges and Mr. Weekes).

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—A dividend is announced of 3s. per share on the preference and 2s. per share on the ordinary shares, payable Oct. 31.

METALLIC SEAMLESS TUBE CO. (LTD.)—The directors' report for the past year states that the net profit was £1,596. Dividends of 6 per cent. on the preference and 5 per cent. on the ordinary shares are proposed, leaving £372 to be carried forward.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)—The directors have declared an interim dividend of 3 per cent. on the ordinary shares, tax free. Transfer books are closed from 22nd to 31st inst. inclusive.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LTD.)—During first nine months of 1903 the company sold 2,788,400 units of electric current, against 645,000 units for the corresponding period last year. The gross revenue was £27,065, against £13,436.

STOCK EXCHANGE NOTICE.—The committee have been asked to appoint a special settling day in and to grant a quotation to £200,000 5 per cent. first mortgage debenture stock of the *Auckland Electric Tramways Co. (Ltd.)*.

WESTERN TELEGRAPH CO. (LTD.)—The directors, after transferring £35,000 to general reserve and £2,000 to maintenance ship's reserve, recommend a final dividend of 3s. per share, making, with previous distributions, a total of 6 per cent. for the year ended June 30, 1903, and a bonus of 2s. per share (both tax free), payable Nov. 5. The transfer register will be closed from Oct. 27 to Nov. 4 inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Oct. 17	1,212	+ 287	20	26,082	+ 8,827
Ayr Corporation	,, 10	217	- 3	21	8,061	+ 52
Barnsley	,, 9	182	...	40½	7,347	...
Birkenhead	,, 18	1,091	+ 96	...	...	...
*Birmingham Tramways	,, 17	5,133	- 97	15	78,216	+ 2,519
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 15	535	+ 28	§28	34,484	- 230
Blackpool and Fleetwood	,, 17	317	+ 11	16	18,721	- 140
Bolton Corporation	,, 18	1,803	+ 4,231	29	54,747	+ 7,149
Bournemouth Corporation	,, 14	1,000	...	29	31,939	...
*Bradford Corporation	,, 18	3,757	+ 394	29	112,389	+ 16,515
Brighton Corporation	,, 13	894	+ 92	47	41,872	+ 6,074
Brisbane Tramways	Sept. 2	2,218	- 77	9	21,388	+ 169
*Bristol Trams & Carriage	Oct. 16	5,048	+ 242	21	114,284	+ 12,784
*Buenos Ayres & Belgrano	Sept. 20	3,237	+ 265	‡22	87,914	+ 2,964
Burnley Corporation	Oct. 17	805	+ 87	29	31,256	+ 4,930
Burton Corporation	,, 15	361	...	...	...	...
Calcutta Tramways Co.	,, 17	R32,684	+R5,208	16	R519,808	+R100,900
Camborne-Redruth	,, 19	117	...	50	5,791	...
Cardiff Corporation	,, 17	1,962	+ 410	29	58,308	+ 16,957
Carlisle Tramways Co.	,, 17	492	+ 9	¶41	8,073	+ 576
Central London Railway	,, 17	6,443	- 528	16	97,583	- 5,024
Chatham and Dist. Lt. Rys.	,, 15	570	+ 39	41	22,372	...
City & South London Rly.	,, 18	2,761	- 512	16	40,084	- 5,814
Cork Electric Trams Co.	,, 15	492	- 191	31	21,982	- 2,872
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 9	512	+ 144	40½	18,491	+ 811
Dover Corporation	,, 17	208	+ 4	†29	7,280	+ 137
Dublin & Lucan Railway	,, 18	116	+ 7	16	2,281	+ 168
Dublin Southern District	,, 16	869	+ 33	¶15	18,590	+ 7,378
Dublin United	,, 16	4,024	- 70	¶15	64,070	
Dudley—Stourbridge	,, 9	841	+ 94	40½	34,169	+ 8,379
Dundee Corporation	,, 14	939	+ 58	...	...	...
East Ham Council	,, 17	589	+ 96	†29	20,103	+ 6,019
Gateshead & Dist. Trams	,, 9	1,027	+ 154	40½	35,200	+ 4,862
Glasgow Corporation	,, 17	14,082	+ 1,391	20	274,527	+ 30,110
Gravesend—Northfleet	,, 9	276	+ 65	40½	9,905	+ 945
Greenock & Port Glasgow	,, 9	515	+ 13	40½	22,365	+ 1,705
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 9	283	+ 65	40½	11,083	+ 567
Hull Corporation	,, 17	2,559	+ 64	†29	54,393	+ 2,644
Ilkeston Corporation	...	...	...	...	...	...
Isle of Thanet Co.	,, 17	395	- 33	16	19,526	- 956
Kidderminster & District	,, 9	120	- 1	40½	5,354	+ 185
Kirkcaldy Corporation	,, 14	156	...	33	5,906	...
Lanarkshire Trams Co.	,, 15	625	...	§9	8,154	...
Leeds Corporation	,, 17	5,138	+ 73	29	164,631	+ 10,191
*Liverpool Corporation	,, 10	10,474	+ 601	41	413,847	+ 13,756
Liverpool Overhead Rly.	,, 18	1,594	+ 74	16	27,133	+ 1,833
*London County Council	,, 10	10,556	+ 8,233	†28	281,595	+ 48,020
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 17	11,455	+ 6,146	18	217,094	+ 116,867
Mersey Railway	,, 17	1,317	+ 275	16	21,255	+ 4,000
Merthyr	,, 9	212	+ 19	40½	8,065	- 206
Middleton	,, 9	280	+ 42	40½	13,275	+ 1,653
Newcastle-on-Tyne Corp.	,, 17	3,498	+ 380	16	55,749	- 5,892
Newport (Mon.)	,, 17	462	+ 181	3	1,390	+ 557
*Oldham, Ashton & Hyde	,, 9	571	+ 18	40½	23,261	+ 1,543
Perth (W. A.) Elec. Trams.	,, 16	1,131	+ 139	§11	47,354	+ 4,783
Peterborough	,, 9	244	...	37	6,125	...
Poole and District	,, 9	298	+ 56	40½	12,646	+ 1,904
Portsmouth Corporation	,, 17	1,472	+ 54	...	...	...
*Potteries	,, 9	1,738	+ 112	40½	63,456	+ 3,418
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 9	60	- 7	40½	6,544	+ 1,612
Salford Corporation	,, 19	3,973	+ 1,059	29	111,565	+ 34,089
*Sheerness	,, 7	73	...	26	2,460	...
Sheffield Corporation	,, 18	4,841	+ 723	16	75,314	+ 5,643
*Southampton Corporat'n	,, 15	974	- 16	...	...	...
Southend Corporation	,, 14	247	+ 30	28	10,696	+ 1,706
Southport Tramways	,, 9	820	+ 89	40½	13,083	+ 2,399
S. Staffordshire Trams.	,, 9	927	+ 194	40½	36,505	+ 5,463
*Sunderland Corporation	,, 18	1,125	+ 45	29	87,431	+ 1,909
*Swansea Trams	,, 9	517	+ 56	40½	21,214	+ 1,773
Taunton Trams	,, 9	56	...	40½	2,525	- 196
Tynemouth and District	,, 9	279	- 19	40½	13,285	+ 863
Tyneside Trams Co.	,, 11	294	+ 79	41	13,521	...
Wallasey District Council	,, 17	657	+ 65	†29	21,475	+ 2,725
Weston-super-Mare	,, 7	62	- 11	40	5,364	- 482
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 9	393	+ 92	40½	15,935	+ 7,271
Wrexham	,, 9	131	...	27	3,967	...
Yorkshire Woollen District	,, 9	479	...	33½	12,228	...

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed. Oct. 21.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS, WEEK TO OCT. 21 Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅜—4⅝	5 8 1	April, Oct	4 5/16	4½
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
10	10/0	Barcelona Tramways Ord.	7½—8½	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4 —4½	5 11 1	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —102	4 9 6	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼—10½	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	108 —110	3 12 8	Feb, Aug	..	..
St.	..	British Columbia Elec. Rlwy. Def. Ord.	83 —86	..	..	..	..
St.	5%	Do. Pref. Ord. Stock	92 —95	5 8 1	..	..	..
10	4/2½	Do. 5% Cum. Perp. Pref.	10 —10¼	4 15 3	..	..	..
4	4½%	† Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	..	..
10	10/0	British Electric Traction Ord.	11⅜—12⅛	6 10 8	..	12½	11⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 4 3	Feb, Aug	11 5/16	11¼
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	120⅜	..
5	..	Buenos Ayres and Belgrano Ord.	2⅜—2⅝	..	..	2½	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5 —5⅛	5 9 1	..	..	..
5	3/0	Do. "B"	4½—5	6 0 0	..	4⅝	..
St.	5%	Do. 5 per Cent. Debs.	107 —110	4 12 1	..	107½	107½
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	99 —102	4 18 9	..	..	..
5	2 6	Calcutta Tramways	6⅝—7	4 12 10	..	6 1/16	6⅝
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —109	4 3 3	..	..	..
1	1/2½	Cape Electric Tramways Shares	2½—2⅝	6 6 4	..	2½	2 3/16
St.	4%	Central London Ordinary Stock	94 — 97	4 2 11	June, Dec	95½	94
St.	4%	Do. 4 per Cent. Pref. Stock	99 —102	3 18 10	..	102	101¾
St.	4%	Do. Deferred Stock	99 —102	4 0 0	..	..	..
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 10	..	..	..
5	2/6	†City of Birmingham Trams.5% Cm. Prf.	5 —5⅛	4 10 11	..	..	..
100	4%	† Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 5	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	51 —53	5 17 10	Feb, Aug	56	50
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	127 —130	3 17 3	Feb, Aug	..	..
St.	5%	Do. (1896)	126 —129	3 17 9	..	..	..
St.	5%	Do. (1901)	122 —127	3 19 7	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	115 —118	3 7 10	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	102 —105	4 16 10	..	105⅜	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 —13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	3¾—4½	6 13 4	..	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 —98	5 2 0	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7⅞—8½	3 10 7	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9½—10	..	..	..	..
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 3 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3⅞—4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 3	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4⅜—5	2 10 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼—10⅝	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11½—12	4 3 4	..	11 13/16	11 11/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 8	..	..	..
St.	..	Mersey Con. Ord. Stock	7 —10	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	9 —12	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	..	..	..	..	..
1	..	Do. 5% Cum. Pref.	7/16—5/8	..	..	..	..
100	0/6	Montreal St. Rly. St'g 5% Mrt. Dbs.(1908)	¼—½	4 8 11	..	1	..
100	5%	Do. Sterling 4½% Debs. (1922)	102 —104	4 16 2	..	..	..
5	..	New General Traction Ord.	105 —107	4 4 1	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½—¾	..	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	2—3	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	99 —102	4 18 0	..	101	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	..	9⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	8½—9½	5 5 3	Feb, Aug	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	104 —107	4 6 10	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..
St.	3½%	Waterloo and City Ord.	..	..	Jan, July	..	..
		TELEGRAPHS.	93 —96	3 7 11	June, Dec	93	..
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	100½	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	70 —80	..	..	..	..
St.	15/0	†Anglo-American	45 —48	6 5 0	F,My,Ag,N	..	..
St.	30/0	† Do. Preferred	90 —92	6 10 8	F,My,Ag,N	91½	90⅜
St.	1/0	Do. Deferred	7½—7⅝	0 12 11	F,My Ag,N	7 9/16	7½
100	32	Commercial Cable Capital Stock	145 —155	5 9 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	Jn Ap,Jy,O	..	..
10	9,0	Cuba Submarine Ord.	7½—8½	7 13 0	Feb, Aug	8½	..
10	10/0	Do. Preference 10 per Cent.	16½—17½	5 14 3	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	96⅞—102⅞	4 9 0	Jan, July	..	..
20	3/0	†Direct United States Cable	10½—10⅝	6 0 11	Ja,Ap,Jy,O	10⅝	10⅝
100	4½%	Direct West India Cable 4½% Rg. Db.(rd.)	99 —102	4 8 10	Jn, Dec	..	..
St.	26/0	†Eastern Ordinary	123 —128	5 9 5	Ja,Ap,Jy,O	126	124
St.	17/6	† Do. 3½ per Cent. Pref. Stock	89 —92	3 16 1	Ja Ap,Jy,O	89⅝	89½
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 —109	3 14 4	May, Nov	107½	106½
10	2/6	†Eastern Extension	11½—12	5 16 8	Ja,Ap,Jy,O	11 15/16	11⅝
St.	4%	Do. 4 per Cent. Deb. Stock	104 —107	3 15 0	Feb,Aug	104	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 18 10	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅞—103⅞	3 18 3	May, Nov	100	..
10	5/0	Great Northern of Copenhagen	22½—23½	5 6 5	Jan, July	..	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	99 —102	4 8 4	June, Dec	..	..
25	37/6	Indo-European	37 —40	6 5 0	May, Nov	..	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel. 4% Guar. Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..
2½	..	West Coast of America	1/16—3/16	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	3/16—¼	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	6½	..
10	..	Do. 6 per Cent. 2nd Pref.	3½—4½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	100 —103	4 18 9	Jan, July	..	..
10	3/0	Western Telegraph	12 —12½	5 12 0	Mr,Jn,O,D	12 1/16	12½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 8	..	100	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅜—5⅛	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	8⅜—9⅛	4 6 6	Ja Ap Jy O	9	8⅜
10	3/0	Do. 6 per Cent. Pref.	12⅜—13⅛	4 10 7	Ja Ap,Jy,O	13⅛	..
8	4/0	Reuter's	6⅞—7⅛	5 6 8	April, Oct	..	..
100	6%	†Submarine Cables Trust (Cert.)	114 —119	5 0 10	April, Oct	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed. Oct. 21	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS, WEEK TO OCT. 21 Highest.	Lowest.
		TELEPHONES.					
£	6 0	Chili Telephone (fully paid)	4½—5½	5 14 3	August	..	..
St.	6%	National Co. Pref. Stock	90 —101	5 19 6	..	100	99½
St.	5%	Do. Def. Stock	72 —74	6 10 2	..	73⅜	72
10	6,0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	13 1/16	13⅛
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	4⅜—5½	4 17 7	Feb, Aug	5 1/16	5
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	93 —95	3 14 3	June, Dec	94	93
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 —104	3 17 5	..	103	102½
1	0/8½	Oriental	⅞—1	6 0 0	April, Oct	..	..
5	4'0	United River Plate	5½—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜—5½	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 – 107	4 13 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝—¾	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	116 —119	3 15 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 —11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 3	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	102 —105	4 6 4	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—10⅞	4 3 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10 —10½	3 6 8	Mar, Sept	10⅜	..
5	3'6	Calcutta Electric Supply Ord.	7 —8	4 1 3	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 – 110	3 13 2	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	9 —9½	5 5 3	Feb, Aug	9⅜	9¼
5	2/3	Do. 4½ per Cent. Pref.	5½—5⅝	3 18 3	Feb, Aug	5⅝	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	4 15/16	..
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 16 2	..	105½	..
5	2 0	Chelsea Electric Supply Ord.	5½—6	4 3 4	March	5⅝	5⅝
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 —111	4 1 6	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10 —10½	7 2 10	Feb, Aug	10⅜	10¼
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 —127	3 18 11	Jn, Dec	125	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 9 5	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7½—8½	4 14 2	..	7⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	11 11/16	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 2 11	..	108⅛	107
St.	..	Do. Second Deb. Stock Prov. Certs.	100 —103	..	..	101½	..
5	2 0	Folkestone Electricity Supply Co. Ord.	6 —6½	4 10 11	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
5	3 6	†Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10½—11½	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
3	..	London Electric Supply Ord.	1⅞—2⅛	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	5⅛—5⅜	5 4 4	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	100 —102	3 18 5	Mr,Jn,S,D	101½	..
10	8 0	Metropolitan Electric Sup. Ord.	17½—18¾	4 3 9	April, Oct	..	..
5		Do. 4½ per Cent. Cum. Pref.	3½—3⅝	..	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 8	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 10 0	..	..	..
10	6,0	Notting Hill Electric Ord.	12½—13½	4 8 11	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..
5	2 6	Oxford Electric Ord.	5½—6½	4 15 8	March	..	..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 9	..	99½	..
1	..	Rand Electric	3/16—1/2	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	98 —100	4 10 3	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½—15½	4 13 7	Feb, Aug	15½	14½
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 2	..	99	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3 —3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
£	1/9	South London Electric Supply Ord.	3½—4	4 7 6	..	3⅞	3 13/16
5	2,6	Urban Electric Supply Ord.	4½—5½	4 17 7	..	..	..
5	2,6	Do. 5% Cum. Pref.	4½—5	5 0 0	..	4 15/16	..
5	6/6	Westminster Electric Supply Ord.	12⅝—13½	4 16 4	Mar, Sept	13	12⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—½	6 13 4	..	..	..
1	7½d.	Aron Electric Meter 6% Cum. Pref.	⅜—½	..	Mar, Sept	..	..
5	4,0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5½—5⅝	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	103 —106	4 4 11	..	..	..
St.	4½%	British Thom'n-Houst'n 4½% 1st Mt. Db.	104 —106	4 4 11	..	104	..
5	3/0	British Westinghouse 6% Pref.	5⅜—5⅝	5 6 8	..	5⅝	5⅝
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	100 —102	3 18 5	..	101½	100⅝
½	..	Brush Electrical Engineering	¾—1½	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1⅝	6 17 2	Mar, Sept	1⅝	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	85 —90	5 0 5	Jan, July	..	..
5	10,0	Callender's Cable Construction Ord.	11½—12½	8 0 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5⅝	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	106 —110	4 1 10	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	¾—1	6 0 0	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	89 —94	4 16 9	..	..	..
1	0 7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March	..	..
8	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 —2½	5 19 10	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	100%—104%	4 16 10	Jan, July	..	..
5	..	Edison & Swan United("A"Sh.) (£3 pd.)	½	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1½—2½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 5 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6½—6¾	5 3 8	H'lf-yearly	6¾	6¾
5	3/0	Do. 6 per Cent. Cum. Pref.	6¼—6¾	4 8 11	..	6 1/16	6 1/16
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 —108	4 4 1	..	..	..
2	1/2½	Electric Construction Co.	1½—1⅝	6 17 2	Jan, July	1 11/16	1⅝
2	2 9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	2⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 3	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅜—½	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10½	4 17 7	..	10⅜	9 15/16
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 —99	4 0 10	..	..	..
5	6,0	Henley's Telegraph Works Ord.	14 —15	6 13 4	Feb, Aug	14⅜	14
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	5,0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	18½	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 8	Mar, July	35	34
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 —103	3 17 8	Jan, July	..	..
5	3/0	†Willans and Robinson Ord.	5½—6½	5 0 0	Apr, Oct	..	..
5	3/0	† Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	Apr, Oct	6 1/16	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 10	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

WE publish in another column of this issue the result of further deliberations by the Engineering Standards Committee, which, in this instance, relates to electrical pressures and frequencies. In the early days of the electrical industry authorities differed considerably as to what pressures and frequencies should be employed, but times have changed, and with them ideas, so that there is now more or less unanimity amongst engineers regarding these points. It is, therefore, fairly safe to say that the limit of standardisation in this direction has already been reached. No recommendation is yet made for standard alternating-current voltages, but it would clearly be advantageous to make these the same as the continuous-current pressures, as the manufacture of lamps and various fittings would be simplified and cheapened thereby. To add $220\sqrt{3}$ as a standard motor voltage for the benefit of those who believe in four-core three-phase distribution should not be necessary. We are surprised to read that sanction of the Board of Trade has been gained to the proposal of 500 volts as one of the standards for continuous-current lighting supply. As matter of fact, 480 volts is the maximum "declared pressure" sanctioned for consumers' premises in the more recent systems. The standard frequencies are those put forward by the Institution of Electrical Engineers a few years ago. It may be noted, however, that it is not always advisable to adopt these in particular cases, although they are certainly good standard practice for general use. For instance, we believe that frequencies of 30 and 60 $\sim$ per second frequently make the design of turbine-driven sets easier. It will be seen that the frequency of the large Shawinigan generator described in this issue is 30 $\sim$ per second, and this figure has also been adopted for the Westinghouse steam turbo sets which will be employed for the Metropolitan-District Railway.

ON Friday last the Physical Society began a new era, under revised Articles of Association, by meeting at its old home, the physical lecture theatre of the Royal College of Science. There was only a moderate attendance, which seems to indicate that the change of abode may have in that respect but little effect. The advantages of the migration from Burlington House to South Kensington may be summed up in the statement that now all the resources of a great laboratory are available for the experimental illustration of Papers; a gain which was, as the president remarked, emphasised at Friday's meeting by Dr. WATSON'S demonstration of the loops of potential in a Lecher wire system contained in part in a huge vacuum tube. The new Articles of Association provide that in future the usual fortnightly meetings shall be held on Fridays at 5 p.m. and 8 p.m. alternately.

POPLAR may get into difficulties with its electric lighting undertaking if it is not careful. This London Borough Council has had its electricity works in operation since 1900, and its generating station is at present practically fully loaded. The borough electrical engineer, Mr. A. BLACKMAN, submitted a scheme for extensions a short time ago, but it was voted too expensive, and was therefore not adopted. Now, however, Mr. BLACKMAN has pointed out that, if any appreciable additions are made to the present connections, the plant would be too overloaded during the approaching winter to give an efficient supply. Consequently, instructions have been issued that certain applications for current be refused, and that others be only accepted on the understanding that the customers would undertake not to take any current during certain hours in the months of heaviest load. Doubtless the Council is paying due attention to the geographical position of the consumers to whom it refuses

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supply. Under the Electric Lighting Acts a consumer within 50 yards of a distributing main may require the Council to "give and continue" a supply to his premises. The penalty for default on the part of the electric light undertakers is £2 per unsupplied consumer per day, the total penalty not to exceed £50 per day.

THE much-discussed question of refuse destructors once more obtrudes itself in the form of a joint report drawn out by the surveyor and electrical engineer of Hammersmith. This report deals with the subject in a very exhaustive manner and emphasises the opinions repeatedly put forward in these columns. The figures relating to six London municipal electricity supply stations, three working with and three without destructors, are very interesting. It is shown that the extra cost of the capital due to the installation of destructors considerably over-balances the saving in fuel costs. But this does not take into account the inconvenience to the electric light undertaking due to irregularity of steam pressure and supply, to say nothing of the intolerable smell and dust. If combined destructor and electricity works are really as successful as their advocates claim them to be, surely the various supply companies would be only too anxious to adopt them. The local authorities could then get rid of their refuse at very little expense, while the supply companies would destroy it free of charge in return for steam generated. But, unfortunately, supply companies are chiefly concerned with money-making, and are not yet convinced that such combined stations have a tendency in this direction.

WE publish in this issue Col. VON DONOP'S report on the enquiry into the accident which occurred at Ramsgate, on the Isle of Thanet Light Railways, last August, resulting in personal injuries to over 30 passengers. This accident is typical of a rather large number of runaway car accidents, but the facts are so clear, and the remedy so obvious, that the lesson should be taken well to heart and applied. It was shown that the brakes and sanding gear were in good order, and—properly applied—adequate for safe working on the gradient of Bellevue-road. But no track brake was provided for regular use on the severe gradients—the so-called track-brake fitted on the cars being, in fact, a scotch intended and used to prevent a car standing on a gradient from running backwards. It could not be used regularly in descending.

THE true function of a track brake is to prevent a car from attaining a dangerous speed, and to that end it should be applied at the top of every severe gradient and only released at the bottom, stopping, re-starting, and control of speed while descending the hill being performed by manipulation of controller and hand brake in the usual way. Under these conditions the driver has nothing unusual to do, and his operations become automatic, whilst the car cannot get beyond a safe and controllable speed. Reliance on "emergency" safeguards is very risky; the little-used device is likely to be stiff, or in bad adjustment; the unfamiliar action does not occur to the man faced by sudden danger, and with but a few seconds in which to do anything. The car driver normally has both hands and both feet allocated to specific duties—controller, hand-brake, gong and sand-gear; it is hard to see how he can utilise any "emergency" device when he is probably using all the others. So long as the railway companies ordered their drivers to make all service stops with the hand brake and use the continuous brakes on emergencies only, accidents from brake failures or omission to use brakes in time were frequent, but the general use of continucus brakes for every stop keeps both brakes and men in order, and such accidents have become rare. The application of the lesson to tramway practice should not need enforcement by any more accidents of the Ramsgate type.

FIFTEEN years ago the advantages of paralleling alternators were hardly fully realised, and the feat of synchronising two such machines was considered somewhat in the nature of an interesting scientific experiment. Then no one ventured to run two machines of different makes and sizes in parallel as the everyday practice of an electricity works, and if two similar alternators driven by similar engines ran smoothly together it was thought by the user to be a case of good luck rather than good design. This has all been changed now, and it is the exception if alternators in the same works are not all coupled to the same 'bus bars. Ninety-nine central station engineers out of every hundred, and forty-nine consulting engineers out of every fifty, will agree that any alternator will run sweetly in parallel with any other, provided that the machines are at the same voltage and frequency, are "well-designed," and are driven by engines with a cyclic irregularity of not more than one-third of one per cent. Whether this figure of 1/300 emanates from America or was "made in Germany," or whether it was first defined on an English professor's black-board or an English consultant's slide-rule, has already been forgotten, but one in three hundred has now become part of the electrical engineer's tradition; it is to be found in all his engine specifications, and is even making its way into his numerous text-books and swollen pocket-books of the "Wisdom While You Wait" order. True, the advent of gas engines will require another change, whether it may be the adoption of "compensated" alternators or merely the selection of another numerical criterion has still to be seen; but for steam engine practice, to the average mind thinking of average alternators, one in three hundred is synonymous with parallel running.

THIS faith in one in three hundred is fated, however, to undergo severe trials on some occasions. It happens incidentally that a pair of British-Swiss, British-American, British-German or British-British alternators, coupled to truly British engines which are built to the one in three hundred specification, show a disinclination to run kindly in parallel. An impetuous young engineer, whose experience extends to perhaps half-a-score of alternators, bravely asserts that such machines, if driven by slow-speed engines, will not run properly in parallel; he ignores the hundreds of machines that do so, and ignores also the one in three hundred article of the electrical engineer's faith. The impetuous young engineer, confident that the alternators under his charge show tendencies to "hunt"—a thing which no respectable alternators

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driven by respectable one in three hundred engines should do—refuses to be silenced or over-awed, and a critical situation is evolved. Such situations do arise, and we have a right to ask our high priests of the chalk and blackboard, or of the drawing-board and slide-rule, for the why and wherefore of their one in three hundred article of faith. And, moreover, we have a right to ask them whether one in three hundred of the engines supplied to the one in three hundred specification is tested to see if its cyclic irregularity does not exceed this figure. And, if it is tested, how is the test performed with accuracy?

THE most recent case in which paralleled alternators have given disappointing results is at Fulham, where British-made alternators of Swiss design driven by all-British engines refuse to keep in phase. One may reasonably expect that from such instances some further light will be thrown on the parallel running of alternators from actual practical experience. It is, therefore, discouraging to read in the report, printed in another column of this issue, that the experts who have been called in "do not think that any blame can be attached to the engine or dynamo makers, or to anyone else, as regards the trouble; in the present state of knowledge 'hunting' is rather a misfortune than an avoidable evil. . . ."

Institution of Electrical Engineers.—The annual dinner of the Institution of Electrical Engineers will take place on Wednesday, December 9th, in the Grand Hall of the Hotel Cecil, at 7 p.m. for 7.30 p.m.

The Nobel Prize.—It is announced that this year it is proposed to award the Nobel physics prize to Signor Marconi, the chemistry prize to Prof. Arrhenius, and the medicine prize to Prof. Finsen. Each prize is worth about £8,000.

High-speed Electric Railway.—As a consequence of the recent high-speed trials in Germany, it is reported that the Prussian Government are negotiating for the practical application of the experiments in the form of an electric railway between Hamburg and Berlin. It is said that a speed of 131 miles per hour has now been attained.

Chancellorship of Oxford University.—Viscount Goschen and Lord Rosebery have been nominated for the Chancellorship of the Oxford University, rendered vacant by the death of the Marquis of Salisbury. The election will take place between noon and 4 p.m. to-morrow (Saturday).

Indian Electricity Act, 1903.—Messrs. Thacker, Spink & Co. of Calcutta will shortly publish a commentary on the Indian Electricity Act, 1903, containing the revised rules, licence forms, &c., under the act, with notes, entitled "Electrical Legislation in India." The price will be Rs.6, or 8s.

Matriculation Directory.—This publication, issued by the University Tutorial Press, forms an extremely useful guide to candidates reading for the Matriculation Examination of the University of London. It contains a copy of the questions set at the September examination, together with model solutions thereto.

Moseley Educational Commission.—The Moseley Educational Commission, particulars of which were given in our issue of August 21st, were entertained last week by President Roosevelt at Washington, when a number of prominent American educational authorities were present. In a short speech the President of the United States expressed the opinion that both the United States and Great Britain had a great deal to learn from each other.

Persian Telegraphs.—A Reuter telegram from Teheran states that the Central Persian telegraph line from Kashan to the Perso-Baluchistan frontier was, on October 19th, completed as far as Kerman. The line is being constructed by the British Government in accordance with the Convention of August, 1901, and consists of three wires carried on iron posts. When completed its total length will be 900 miles, and of these 430 have still to be constructed to take it to the Baluchistan frontier.

Royal Meteorological Society.—The Council of the Royal Meteorological Society have designated Hofrath Dr. Julius Hann of Vienna as the recipient of the Symons gold medal in recognition of the valuable work which he has done in connection with meteorological science. This medal, which is awarded biennially, was founded in memory of the late Mr. G. J. Symons, F.R.S., the distinguished meteorologist and originator of the British Rainfall Organisation. The medal will be presented at the annual meeting of the Society on January 20, 1904.

Glasgow Technical College Scientific Society.—The twelfth session of the Glasgow Technical College Scientific Society opened on the 17th inst. with the delivery of the presidential address by Mr. R. D. Munro. The list of Papers this year is not of such a uniform electrical nature as was the case last session, but the following may be mentioned:—"The Evolution of a Technical College," by Prof. A. McLay; "Some Remarks on the Willans Engine," by J. H. Pocock; "Steam Turbine Machinery," by A. A. Wynne. A number of visits to works has also been arranged.

Liverpool Engineering Society.—The first meeting of the coming session of this Society will be held on Wednesday next, November 4th, at the Royal Institution, Liverpool, when Mr. T. L. Miller, the president, will deliver his inaugural address. Fortnightly meetings have been arranged and the list of Papers includes the following:—"Voltage Regulation in Alternating Current Plants," by H. S. Meyer; "Induction Motors," by Prof. E. W. Marchant; "Fuel Economy from the Chemical Point of View," by J. B. C. Kershaw; "Electric Transmission from Water Powers," by E. K. Scott.

Engineering Standards Committee.—The Government of India has made a grant of £1,000 to the Engineering Standards Committee in consideration of special work done for the Indian railways. The manufacturers of locomotives for India conferred with the four consulting engineers of the Indian Government, Sir Alex. Rendle & Co., Sir John Wolfe Barry, Messrs. Hawkshaw and Dobson and Sir George Bruce and White, the result being a favourable report which it is said will save the Indian Government a great deal of money in the future supply of locomotives to the State railways.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Guadeloupe—Martinique	May 9, 1902 ..	—
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Nagasaki—Fusan	Oct. 19, 1903 ..	Oct. 26, 1903
Trinidad—Demerara	Oct. 23, 1903 ..	—

Personal.—Prof. H. S. Hele Shaw, F.R.S., of Liverpool University, has been appointed, through the Colonial Office, organiser of technical education in the Transvaal and Orange River Colony. The appointment is a temporary one, and Prof. Hele Shaw, who has been granted leave of absence by the Liverpool University Council until September next, will take into account not only the immediate organisation of technical education, but the future university requirements of the colonies named.

The committee of the National Physical Laboratory has appointed Mr. W. A. Caspari, B.Sc., Ph.D., to the post of junior assistant in the chemical department.

London Electrical Contractors' Association.—The series of monthly meetings which have been arranged by the London Electrical Contractors' Association commences on Tuesday, when Mr. W. R. Rawlings will read a Paper on "A Model Specification for Contractors' Use." For the first Tuesdays in December and January respectively the following Papers have been arranged: "Are we Tradesmen," with a Few Notes and Suggestions on Etiquette for Contractors, by Mr. F. B. Joseph·

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"The Necessity for the Standardisation of Wiring Rules," by R. B. Johnson. The annual dinner has been fixed for April 13th in the King's Hall of the Holborn Restaurant.

Australian Federal Patents.—Writing to *The Times* on Monday, the secretary of the Chartered Institute of Patent Agents states that from cablegrams which have reached his Council, it would appear that a bill providing for the grant of letters patent under the Australian Federation has passed the Legislature, although not without certain important modifications. Working of patented inventions within the territory of the Federation will not be obligatory, but there is provision for the grant of compulsory licences, as under the existing British law. The act is not likely to come into force within the next six months, but pending the preparation and issue of rules of practice, applications may be filed and priority thereby secured.

Westminster City Council and Electric Supply.—At a meeting of the Westminster City Council on Thursday last week, it was decided to memorialise the Board of Trade with regard to the prices charged by the various electric supply companies within its area. It was also decided to agree to the use of 2,000 volts in certain trunk mains of the Charing Cross and Strand Electricity Supply Corporation, but to inform the Board of Trade that the Council should have further powers as to the breaking up of streets by electric supply and other companies. Further, it was suggested that all electric supply companies should be bound by statute to supply current for light or power to public buildings and for public lighting at rates not greater than the lowest rates charged to any of their consumers.

London Chamber of Commerce.—Last Wednesday the new premises of the London Chamber of Commerce, situated in Oxford-court, Cannon-street, were officially opened by Lord Brassey, the president, and representatives of the Council. The area on all floors in the new and airy building amounts to 15,000 sq. ft., only 6,750 sq. ft. of which, however, are at present being utilised by the Chamber of Commerce for its own purposes, the remainder being sub let. Electric light has been provided throughout, one-half of the circuits being supplied from the Charing Cross and Strand Electricity Supply Corporation's mains, the other from the City of London Electric Lighting Co.'s mains. In all, about 150 incandescent lamps have been installed, mostly of 16 c.p., and a few of 32 c.p. Each of the two lighting circuits is quite independent of the other, and no means have been provided for changing over the circuits from one supply system to the other.

Wireless Telegraph Notes.—We are informed that a demonstration of the De Forest wireless telegraph system will shortly take place between Holyhead and Dublin, and that it is the intention of those interested in Great Britain to incorporate the British Empire De Forest Co. upon the completion of the tests. ——Mr. Marconi is reported in *The Times* as having taken passage in the battleship "Duncan" on a cruise in the Mediterranean with a view to experimenting in setting up communication with Gibraltar. The apparatus carried on the "Duncan" differs somewhat from the regulation service equipment. Twenty wires run from the masthead to the instrument room, whereas generally there are only two. The distribution of the fittings on the "Duncan" is also different. ——The system of wireless telegraphy to be employed by the Western of France and the London, Brighton and South Coast Railways between Newhaven and Dieppe is that invented by M. Octave Rochefort, a French engineer.

Speed of Electric Tramcars.—Some time ago four summonses were taken out by Mr. Moffat Ford against various drivers in the employ of the London United Tramways Co. for exceeding the legal speed limit of 10 miles an hour. At the hearing of the case, the defendant company contended that none of their cars, except one, were capable of exceeding that limit. At the instance of the magistrate at the West London Police Court, this question was to have been finally settled by a number of Board of Trade trials last Wednesday morning. At the appointed time both parties were present at the place of the trials, but as Col. Crompton, who acted as electrical expert for Mr. Moffat Ford, was not allowed by the officials conducting the tests to board the car in order to check the conditions of the trials, the prosecuting party drove away. Some car-speeds were, however, taken by Mr. C. W. Brown, official timekeeper of the N.C.U., over 1 furlong. At a speed of 10 miles per hour this distance would be covered in 45 seconds; Mr. Brown informed us that the times taken were respectively 35⅕ and 37⅘ seconds for two runs of the same car. The final hearing of the case is to take place before Mr. Rose, at the West London Police Court, at 2 p.m. to-morrow (Saturday).

Osmium Lamps.—Since the information given in *The Electrician*, Vol. L., p. 544, concerning these lamps, further improvements in the direction of economy of power consumption and length of useful life have apparently been made. The range of voltages for which the lamps may be used has been increased, and lamps for 55 volts are now supplied by the Austrian Gasglühlicht and Elektricitäts-gesellschaft of Vienna. From a report of tests made by Dr. W. Wedding, professor at the Technical College of Berlin, and dated June 13, 1903, it seems that two groups, consisting of six 37-volt lamps each, were submitted early in January to Dr. Wedding, and were connected by him in series across a 220-volt supply. In group I., for the first 3,132 hours, the average life of the six lamps was 2,853 hours, and the average candle-power fell from 30·1 to 23·7, the mean consumption per candle-power rising from 1·46 to 1·78. After 520 hours the first lamp collapsed, and after 3,724 and 3,940 hours respectively two others gave way, the remaining three still burning after 3,973 hours. With regard to group II., consisting of six 25 c.p. lamps, the report gives the average life as 1,479 hours, the candle-power dropping in 2,198 hours from 25·1 to 19·9, and the energy consumption increasing from 1·37 to 1·75 watts per candle power. According to an illustration sent to us by the Gasglühlicht Company, the filament of the lamps is made up of two loops which are held apart by insulating stays attached to the interior of the glass bulb.

Automatic Telephone Exchanges.—The *Australian Mining Standard* states that the plans of the automatic telephone exchange boards which are being installed in America have been reported upon by Mr. H. V. Jenvey, the chief electrician of the Victorian Postal Department. He states that no proof has been furnished that they are in practical use with satisfactory results. Mr. Jenvey is not aware of the alleged success of the new board, and for all he knows the Chicago exchange may prove a disastrous failure. The cost of the present Hawthorn exchange was about £1,750. It is estimated that an automatic board to suit 500 subscribers would cost £3,500. The Windsor exchange, with 5,000 subscribers, would cost £30,000 under present conditions, while to instal the new multiple board there would involve an outlay of £40,750. Mr. Jenvey, therefore, arrives at the general conclusion that the initial expense of this modern invention would be about double that of the ordinary board. After setting out the first relative cost of the two systems, Mr. Jenvey suggests that if it is decided to try the new board, the inventors should guarantee its efficiency. Mr. R. T. Scott, secretary to the central administration, in commenting upon the report, suggests that the department should not accept any responsibility in respect to the board until its merits have been debated by a board of experts. If, however, the local agents care to establish a board in some suitable exchange in order to demonstrate its advantages, he thinks that the department should agree to this being done.

The Junior Institution of Engineers.—The annual general meeting of this Institution was held at the Westminster Palace Hotel on October 24th, the principal business consisting of the reception of the council's report and accounts and the election of officers for the ensuing year. The report stated that the total membership was now 746. Mr. R. W. Newman had been awarded the Institution premium for his Paper on "The Effect of Design on Methods of Construction from a Contractor's Point of View." It was shown by the accounts that £300 had been invested, and that the income had been £156 more than the expenditure. Officers for the ensuing year are as follows:—Chairman, S. Cutler, jun.; Vice-Chairman, Adam

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Hunter; Hon. Librarian, H. T. Gould; Hon. Auditors, H. N. Gray and H. B. Vorley; Members of Council, J. N. Boot, W. H. De Ritter, A. H. Huddart and J. H. Pearson; Provincial Members of Council, V. H. Chabot, T. D. Evans, E. King, W. E. Lilly, F. S. Pilling and E. W. Porter. The programme of Papers for the new session was announced: November 20th, "Fires on Shipboard," by Mr. G. Canning. December 4th, "Gas Engines," by Prof. D. S. Capper. January 22nd, Mr. Moulton's Presidential Address. February 5th, "Producer Gas Power for Ice Factories," by Mr. Hal Williams. March 4th, "Electric Storage Batteries," by Mr. G. C. Allingham. April 8th, "Heating and Ventilation of Factories," by Mr. K. Gray. May 6th, "The Design of a Dry Dock," by Mr. A. W. Young.

The Midland Institute.—On Friday evening last week, Mr. J. H. Choate, the American Ambassador, as President of the Midland Institute, Birmingham, delivered his Inaugural Address. A numerous company was present, including Sir Oliver Lodge. Prior to his address, Mr. Choate distributed the prizes for last session. The chief topic of his speech was the life of Benjamin Franklin, of Philadelphia. Besides standing second only to Washington in the list of patriots, who on both sides of the Atlantic stood for those fundamental principles of English liberty which culminated in the independence of the United States, Franklin had enlarged the boundaries of human knowledge by discovering laws and facts of Nature unknown before, and applying them to the use and service of man; this latter alone entitled him to lasting fame. In giving a brief biographical sketch of Franklin's life, it was pointed out that although he invented many things, not one was patented for personal advantage, his reason being that "as we enjoyed great advantages from the inventions of others, we should be glad to give the world the benefit of our own." Of these numerous inventions, those in electricity placed him in the very front rank. Another great trait of Franklin's was his Imperialism. Although an American, he loved neither America nor England, and it was only his failure to successfully unite the two as an Empire that resulted in his returning to America in 1775 to throw in his lot with his countrymen before the War of Independence began. Sir Oliver Lodge, in seconding a vote of thanks to the president, which was proposed by the Lord Mayor of Birmingham, urged the necessity for greater attention to technical education. Everyone knew that there were two nations already in advance of us in this respect. Reference was also made to Franklin's work in connection with electricity.

Underground Concrete Conduit.—A demonstration took place on Wednesday, at the partially erected Metropolitan Railway power station at Neasden, of a new system of underground concrete conduit construction. Iron pipes, about 4ft. in length, were coated with a one to four mixture of paraffin wax and graphite to a thickness of about ¼in. These were then screwed together to form one piece of any desired length, and after being placed in position they were firmly embedded in concrete. This concluded one-half of the demonstration and visitors were then shown the remainder. Certain pipes had already been treated, as described above, some days before and the concrete, therefore, had time to dry and become firmly set. Steam was then passed through the pipes, and owing to the low melting point of the paraffin wax mixture it was possible to withdraw the pipes, leaving a layer of mixture on the inside of the concrete conduit. This layer, it is claimed, acts as an excellent lubricant and enables cables to be drawn in with great ease and minimum abrasion. The cost, we are informed, is from 1s. to 1s. 3d. per yard run of conduit. The process was certainly being worked under difficulties at Neasden, but even under the most favourable conditions it is still open to considerable improvement. Steam had to be applied twice to pipes of about 5yds. or 6yds. in length as cooling took place so rapidly that the wax solidified and prevented the withdrawal of the pipe until steam was passed through a second time. This being the case with short lengths, it is not difficult to imagine what would happen in the case of pipes 125yds. in length, which the promoters of the system claim to be able to work. For the conduits in the works themselves, as at Neasden, the system may prove suitable, but for long lines of cables its application will certainly be attended with difficulties. The principal advantage is said to be due to the fact that the conduit, when completed, is absolutely seamless, manholes being placed at intervals of about 150yds. Herr Otto Wilhelmi is the inventor, and Messrs. Berry, Skinner & Co. are introducing the system in this country.

The Royal Commission on London Traffic.—The sub-committee of the Royal Commission on London Traffic which visited the United States with the object of inquiring into means of locomotion and transport there, has now returned to this country, after an absence of five weeks. A correspondent of *The Times* on Monday gave an account of the doings of the sub-committee whilst in the United States. New York, Boston, Washington and Philadelphia were visited, besides which Mr. Lynden Macassey, the secretary to the Royal Commission, visited a number of other places, including Chicago, Detroit, Cleveland and Albany. Full information was placed before the Commissioners as to the constitution and functions of the New York and Boston Rapid Transit Commissions, although this ground has already been covered more or less in the evidence which Col. Yorke of the Board of Trade gave at the earlier sittings of the Commission in London. A number of schemes are in hand, or contemplation, in New York for the conversion of steam lines to electric traction, and for the building of electrically-operated subway and elevated railways, and in connection with the majority of these the plans, specifications and data were placed at the disposal of the sub-committee. The same may be said of Boston and the other places visited. In Boston the whole of the street communications, including railways, elevated railways and a subway, belong or are leased to one company, the subway having been constructed by the Boston Rapid Transit Commission. As in New York, the officials of the company and Transit Commission attended and gave every assistance to the Commissioners. In Philadelphia, the Philadelphia Rapid Transit Co. has recently acquired and consolidated all the previously existing separate undertakings, and, with a view to the reduction of the congestion in the central portions of the city, a subway is under construction similar to those in New York and Boston. In Chicago the whole of the street communications are under reorganisation at the hands of Mr. Bion J. Arnold. As we have already announced, it is expected that the Royal Commission will resume taking evidence in London on Friday, November 6th.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, October 31st.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read: "The Evolution of a Technical College," by Prof. A. McLay.

MONDAY, November 2nd.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF CHEMICAL INDUSTRY: LONDON SECTION.

8 p.m. Meeting in the Rooms of the Chemical Society, Burlington House, W. Among the Papers to be read is the following: "On the Application of the X-Rays to the Examination of Safety Fuses."

TUESDAY, November 3rd.

LONDON ELECTRICAL CONTRACTORS' ASSOCIATION.

8 p.m. Meeting at Restaurant Frascati, Oxford-street, W. Paper to be read: "A Model Specification for Contractors' Use," by W. R. Rawlings.

INSTITUTION OF CIVIL ENGINEERS.

8 *p.m.* Ordinary Meeting, when Sir William H. White, F.R.S., will deliver his Inaugural Address.

WEDNESDAY, November 4th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

7 p.m. Second Annual Dinner in the Grand Hotel, Charing Cross, Glasgow.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. Meeting at the Royal Institution, Liverpool, when the Presidential Address will be delivered by Mr. T. L. Miller.

THURSDAY, November 5th.

RÖNTGEN SOCIETY.

8:30 p.m. Meeting at 20, Hanover-square, W. The President, the Right Hon. Lord Blythswood, will deliver his Inaugural Address.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Physiological Effect of Zinc Ions.—S. Leduc has found a marked effect of an electro-deposition of zinc upon the growth of hair. He applied two electrodes of 10 sq. cm. surface to the ends of a space 10cm. by 6cm. on the shaven skin of a rabbit, contact being made by means of hydrophil cotton impregnated with a 1 per cent. solution of zinc chloride. He passed a current of 10 milliamperes for 40 minutes. At the end of that time nothing was seen at the cathode, but at the anode there were a number of small white circles, showing that the zinc had penetrated into the skin. In about eight days these circles peeled off. The zinc having been introduced on July 10th, the hair on the place of application of the anode showed a decided growth on the 20th, the hair on that place growing much faster than that on the other shaven surface. On August 3rd the hairs were 5mm. or 6mm. long, and on August 10th 10mm. long, whereas on the other parts of the shaven surface, including that under the cathode, the growth was insensible. The surface where the zinc had been introduced was marked out by a thick fleece of grey hair on a buff background. A similar introduction of chlorine, and, in another experiment, of potassium, exerted no action on the growth of hair.

[S. LEDUC, *Arch. d'Électr. Méd.*, October 15, 1903.]

Combined Coherers.—A. Turpain combined a number of coherers in parallel attached to the same antenna, and found that they preserved their relative sensibilities whether in open or closed circuit, but that the sensibility of each was much less in an open than in a closed circuit. The order of sensibility may be rapidly determined by producing waves which just make the most sensitive coherer respond, and then cutting out that coherer while increasing the strength of the waves until the last coherer is cut out in the same manner. The author also connected several coherers in series, and again determined their relative sensibility by exposing them to the same wave-train, and then measuring for each coherer separately the amount of cohesion as indicated by its conductivity. In this case the order of sensitiveness of the various coherers changes with the connection, since the coherer which is directly attached to the antenna has a greatly-increased sensibility. The author has adapted these results to the measurement and automatic registration of thunderstorms, and also to the construction of very sensitive detectors, both for wireless telegraphy and Hertzian wire-wave telegraphy, but he gives no details of these applications.

[A. TURPAIN, *Comptes Rendus*, October 12, 1903.]

Theory of Colloidal Solutions.—J. Perrin supposes that every colloidal solution is made up of granules, invisible in the microscope, but much more bulky than the molecules, since they diffuse light considerably, and charged electrically, since they follow the lines of force in an electric field. The difficulty in the way of this conception lies in understanding why the larger granules do not absorb the smaller ones as in rain clouds, how the granules can grow and diminish reversibly with the temperature, and how, at a certain limit, an irreversible coagulation can set in, especially under the influence of polyvalent ions. To account for the stable equilibrium, the author supposes that the surface tension and cohesion which lead to the formation of granules are counteracted by the electrification which acts in a dissociating sense, and that at a certain point these two opposing forces are in equilibrium. The author traces the development of a granule from the first conglomeration of atoms to the time when it contains two similar electrons which tend to produce a "segmentation" of the granule by their mutual repulsion. When the granule becomes very large, or when poly-valent ions are present, the chances are overwhelmingly in favour of an equal quantity of both electricities, in which case the granule becomes an electric doublet, and there is nothing to counteract the tendency to coagulate.

[J. PERRIN, *Comptes Rendus*, October 12, 1903.]

Electricity Direct from Coal.—R. Lorenz gives a capital summary of the present state of the problem of directly converting the chemical energy of burning carbon into electricity. The slow combustion involved in an electrolytic process such as is exemplified in an ordinary voltaic cell suffers under three disadvantages—viz., the slowness of the reaction between C and O at ordinary temperatures, the impurity of the carbon, which gives rise to complicated hydrocarbons in solution, and the necessity of using the highly-priced conducting forms of carbon instead of ordinary coal. These circumstances led to the adoption of a gaseous "electrode" consisting of carbon monoxide, as in the cells of Bucherer and Borchers. In these, however, the currents obtained cannot be proved to result from the further oxidation of the CO. Indeed, the existence of CO ions has yet to be demonstrated. Another and more indirect way of utilising the energy of carbon is that suggested by Nernst, in which carbon is used for regenerating other cells, such as Daniell's cell, by the reduction of the zinc sulphate. Another method proposed by Nernst is to heat an accumulator having a negative temperature coefficient until its E.M.F. disappears and then let it cool. Dolezalek has, indeed, obtained an E.M.F. of 0·6 volt between two lead accumulators having a difference of temperature of 90deg. The problem is theoretically soluble, but will require much detailed work for its final solution.

[R. LORENZ, *Mitt. Phys. Ges. Zürich*, No. 5, 1903.]

Alkaline Accumulators.—The chief advantage of alkaline accumulators is that, apart from water, no constituent of the electrolyte enters into the reaction, and the liquid can, therefore, be much curtailed and the weight reduced. The oxidation of Cu_2O into CuO in an electrolyte of KHO and water takes place by the simple transference of oxygen from one electrode to the other through the medium of water, which disappears at one electrode and re-appears at the other. O. Schmidt points out that any metal whose oxides are insoluble in alkalies is suitable for alkaline accumulators. Such are the ordinary metals—cadmium, iron, nickel, copper, mercury and silver. Zinc oxides are soluble in alkalies, but not in alkaline silicates, aluminates or carbonates. Accumulators consisting of two electrodes of the same metal are most advantageous, since self-discharge by the accidental deposition of one metal upon the other is avoided. The difficulties encountered are mainly mechanical, and concern the mounting of the oxide in the shape of cohesive and yet porous masses. The oxide has to be prepared beforehand, as in Edison's nickel-iron accumulator, and contained in small metallic boxes closely packed. The oxide is utilised to a greater extent the nobler the metal. In silver the utilisation reaches 100 per cent. The yield of Edison's accumulator is now 25 watt-hours per kilogramme, but the efficiency is less than that of the lead accumulators, and the price is higher.

[O. SCHMIDT, *Mitt. Phys. Ges. Zürich*, No. 5, 1903.]

American Electric Railway Accidents.—The number of fatalities caused by railways in America is in striking contrast to that of Great Britain. Steam railways are, however, not the only offenders, for it is stated by *Engineering News* of New York that the electric railway accidents in Chicago during September numbered 126, and 144 persons were injured in these accidents. During that month 35 persons were killed by being run over on the steam railways within the city, 14 were killed by the electric cars and one was killed by a cable car. The worst accident of the month occurred at 6:30 p.m. on September 30th, when an electric car crowded with people returning from the Harlem race track was struck by a Wisconsin Central Railway train at the 52nd-street grade crossing of the Illinois Central Railroad (over which the Wisconsin Central Railway enters Chicago). The car was running at high speed, and did not slow up for the crossing, nor did the conductor go ahead to look out for trains. Six persons were killed and 11 injured. On the same day an electric car was derailed while passing off the Lake-street bridge, owing to the bridge tender starting to open the bridge before the car was clear of the structure. The car was partially crushed by one of the trusses before the bridge was stopped, but nobody was injured.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 10.)

So far radium has only been found in minerals containing uranium, and very few of these appear to contain a sufficient quantity to repay extraction. Not all pitchblendes are equally rich in the element; for example, the Cornish pitchblende, although it contains a high percentage of uranium, possesses such a low activity (1·6 compared to 8·3 for the Johanngeorgenstadt ore) that it is doubtful if it contains radium at all. Practically the last-mentioned ore and that from Joachimsthal provide the whole of the available supply. A method for the accurate estimation of radium in ores will be given later, after its properties have been more closely studied. The quantity obtainable even from the best ores is excessively small. Mme. Curie states that from 2 tons of residues from the Joachimsthal ore she obtained a few hundredths of a gramme of the pure chloride and a few tenths of a gramme of considerably less active material. Giesel, who has probably prepared the largest quantities of concentrated radium compounds, obtains about 0·25 gramme of pure radium bromide from 1 ton of residues.

The following method of treatment of the residues from the Joachimsthal ores has been worked out by Debierne and is taken from Mme. Curie's thesis:—To extract the uranium, the ore is roasted with sodium carbonate, lixiviated with warm water and then with dilute sulphuric acid, when the uranium passes into solution. The insoluble part consists of the sulphates of lead and calcium, alumina, silica and iron oxide together with greater or less quantities of nearly all the metals. These residues possess an activity four and a-half times that of uranium, and constitute the raw material used for the extraction of radium. The insoluble sulphates are converted into carbonates by boiling with a concentrated solution of carbonate of soda, and the soluble sodium sulphate produced is removed by repeated washing. The residue is treated with hydrochloric acid, which dissolves most of it, including the polonium and actinium, but the radium remains undissolved. It is washed with water, again boiled with concentrated sodium carbonate, which completes the transformation of the sulphates into carbonates, again thoroughly washed and treated with dilute hydrochloric acid free from sulphuric acid. Polonium and actinium are still present in the solution, from which the radium and barium are removed by precipitating with sulphuric acid. From 1 ton of residues 10kg. to 20kg. of crude sulphates are thus obtained of activity about 60 times that of uranium, which contain calcium, lead, iron and a trace of actinium. The sulphates are transformed into chlorides as before, and the solution treated with sulphuretted hydrogen, filtered, oxidised with chlorine and precipitated with ammonia. The activity of the precipitated hydrates and oxides is due to actinium. The filtrate is precipitated with sodium carbonate, and the precipitate washed and converted into chlorides, evaporated to dryness, and the chlorides washed with concentrated hydrochloric acid, which removes calcium. The purified chlorides of barium and radium thus obtained possess an activity of about 60. Eight kilos are obtained from 1 ton of residues. At this stage the material leaves the factory, and is now fractionated in the laboratory. Mme. Curie's system was based upon the fact that if the mixed chlorides are dissolved in water, raised to the boiling point, and allowed to cool, the small part that crystallises out is five times more active than the part left in solution. By successive repetitions of this process the mixture is divided into two parts—the one consisting of the great bulk of the material, which may be obtained only one-tenth as active as uranium, the other consisting of continuously diminishing quantities of preparations with correspondingly increasing activity. As the fractionation advances it is convenient to dissolve in water containing gradually increasing quantities of hydrochloric acid. The salts are less soluble in the latter than in water, and larger quantities of solution are obtained. When the proportion of radium increases to a certain point, the crystals of mixed barium and radium chloride become coloured after a few hours, the colour disappearing when the crystals are re-dissolved. A maximum coloration is reached when the radium present is of a certain concentration, and then again diminishes as the preparation becomes more concentrated. This serves as a check on the progress of the fractionation.

Giesel (*Berichte der Deutschen Chemischen Gesellschaft*, 1902, p. 3,609) has improved upon the method by using the bromide instead of the chloride for fractionation. He states that eight crystallisations suffice to remove the easier soluble barium bromide, leaving the radium bromide approximately pure. But it is probable that to approach the purity ultimately attained by Mme. Curie with her method very many more fractionations would be required. Giesel discovered the beautiful carmine red flame coloration produced by salts of radium, which serves as a useful control over the progress of fractionation. In this respect radium shows its relationship to the other alkaline-earths, which all yield fine flame colorations.

The atomic weight of radium has been determined by Mme. Curie with the preparations obtained during the progress of the fractionations. The method employed was to precipitate the chlorine in a known weight of the chloride with silver nitrate, and to weigh the silver chloride obtained. Besides being extremely accurate and applicable to very small quantities of material, the method possesses the advantage of retaining the radium in the soluble form, as nitrate, after the performance of the operation.

The atomic weight of preparations of activity 230 and 600 times as active as uranium was indistinguishable from that of barium—viz., 137. With a preparation of activity 3,500 the number 140 was obtained, showing a small but distinct difference. Another sample of activity 7,500 gave the number 145·8, while two samples of very high activity, each of the order of one million times that of uranium, gave 173·8 and 225 respectively. In the latter the barium could only just be detected spectroscopically. A mean of three determinations of the purest sample prepared also gave the number 225.

It may be noted that the radio-activity of pure radium salts is generally taken to be of the order of a million times that of uranium, but the exact value is unknown. This is because it is experimentally impossible to directly compare together activities which are so widely different. An absolute measure in electrical units of the radio-activity of pure radium salts has not yet been published, although its accomplishment presents no insuperable difficulty.

The value 225 for its atomic weight places radium as being the third heaviest element known, the two heavier being the other radio-elements—thorium 232 and uranium 238. It is surely not merely a coincidence that the three elements distinguished by their radio-activity should possess the three heaviest atomic weights. Except in this respect they are chemically very dissimilar, radium being divalent like barium, thorium tetravalent like tin, and uranium hexavalent like tungsten. On the other hand, these elements, which they most resemble, show no trace of radio activity.

That pure radium compounds show numerous unique and astonishing properties is well known. The most remarkable of these may be here briefly mentioned. First, of course, is the ceaseless emission of rays, some of which can penetrate metal screens several inches in thickness in sufficient intensity to illuminate a platino-cyanide screen on the far side. The greater part of the radiation has recently been shown by Rutherford to consist of the projection of atoms of matter with a speed of about 20,000 miles a second, a velocity which matter has never before been known to attain. In addition, there occurs simultaneously a continuous production of a radio-active emanation or gas, the absolute amount of which is so small that it has not yet been directly perceived. Yet this invisible quantity of gas possesses enough energy to give astonishing indications of its existence. The quantity of emanation obtainable from a few milligrammes of radium salt will keep a phosphorescent mineral like willemite continuously luminous for several days or even weeks, to a sufficient extent to be visible even in a

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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brightly-lighted room. Radium continuously generates electricity and heat, the latter to the extent of 100 gramme-calories per gramme per hour, as shown by MM. Curie and Laborde (*Comptes Rendus*, 136, p. 673, 1903). In aqueous solution it continuously generates hydrogen and oxygen, as first shown by Giesel (*Ber.*, 1903, p. 347), to the extent of about 10 cubic cm. per gramme per day. These gases contain also helium (Sir W. Ramsay and F. Soddy, *Nature*, August 13, 1903, p. 354), and the growth of the helium spectrum can be observed from day to day in a sealed vacuum tube originally containing no helium but charged with the radium emanation. At this stage, however, two points must be emphasised. In spite of these properties the radio-activity of radium appears in no essential point different from that of uranium and thorium. It is merely a matter of the phenomena in the former case being exhibited to an extraordinarily greater degree than in the latter case. Secondly, radium comports itself, so far as atomic weight, spectrum, chemical properties, &c., are concerned, as a strictly normal element, and occupies a vacant place in the periodic law as the heaviest member of the alkaline-earth group. There is thus a double nature to the radio-elements according as their ordinary material properties or their radio-active properties are considered. We shall see later that it is probable that the same set of atoms is not concerned in the two cases, the ordinary material properties being caused by what may be called the normal atoms, which are in overwhelming numerical majority, while the radio-active properties are caused by a very minute fraction of the total in a very critical and unusual state.

Polonium.—Besides radium there is strong evidence that there exists in pitchblende two other new radio-active bodies, polonium and actinium, and although neither of these has yet been obtained in sufficient quantity to give a spectrum reaction or any other evidence of their presence, except their radio-activity, the peculiar nature of the latter in each case leaves little doubt that each is a specific new form of matter, whose ultimate separation may be confidently expected. In the fractionation of pitchblende by M. and Mme. Curie, the polonium appeared in the second group of metals precipitated from acid solution by hydrogen sulphide. It resembles bismuth in analytical properties, and separates with the latter. But it can be concentrated by special methods even from the bismuth, which shows that it is chemically distinct. Mme. Curie describes three methods: (1) By sub-liming the active sulphide in vacuo, the active part being the more volatile tends to deposit on the cooler parts of the tube. (2) By fractional precipitation of the solution of the nitrates with water it is found that the basic nitrate precipitated is more active than the fraction which remains dissolved. (3) By precipitation of the chlorides in strong hydrochloric acid solution with hydrogen sulphide the fraction precipitated as sulphide is again the more active.

So far Mme. Curie has not succeeded in obtaining her preparations free from bismuth. Its radio-activity is peculiar in two respects: (1) It comprises only α or non-penetrating rays, the penetrating β-rays being completely absent. In this respect it is sharply distinguished from the other radio-active substances, uranium, thorium, radium and actinium. (2) Its radio-activity is not permanent, but decays slowly with the lapse of time, falling to half its original value at the expiration of about nine months. The discussion of this important point, which throws a great light on the nature of polonium, and why it has so far been impossible to separate it as a distinct element, must be reserved until the numerous other cases of temporary activity which are now known have been considered.

Recently Marckwald (*Berichte der Deutschen Chemischen Gesellschaft*, 1902, p. 2,285) has shown that polonium may be easily separated from pitchblende residues which contain it by immersing a polished plate of bismuth in the solution. The whole of the active substance is deposited in highly concentrated form on the plate, while the solution is left inactive. The deposit, which is metallic, can be easily detached, and weighs but a few milligrammes, which, however, when dissolved still shows the reactions of bismuth. In a later communication (*ibid.*, p. 4,239) the same investigator has shown that the metallic deposit more nearly resembles tellurium than bismuth in its chemical nature, and he has proposed the name *radio-tellurium* for his preparation, believing it to be distinct from Mme. Curie's polonium. He finds that it is precipitated out of its solutions by stannous chloride as a black precipitate, and recommends this method as giving far purer preparations than that first employed. The activity of these is far higher than the earlier products, but the weight obtained is correspondingly smaller. But he states that the activity, unlike that of Mme. Curie's preparations, is constant, and does not diminish with the lapse of time. In a still later communication (*ibid.*, 1903, p. 2,662) Marckwald gives some very interesting details of the actual amount of the new substance present in pitchblende. 2,000kg. of the latter yielded 6kg. of bismuth oxychloride, which gave 1·5 grammes of the tellurium-like precipitate with stannous chloride. He now finds that this is almost entirely ordinary inactive tellurium, which he separates from the active product by precipitating the chloride with hydrazin hydrochloride in not too acid solution. The active substance remains in the filtrate, and after precipitating with stannous chloride was found to weigh 4 milligrammes! Even so, the author does not consider it proved to be a homogeneous substance. He states that from $\frac{1}{100}$th milligramme of this preparation he has obtained sufficient light, by means of the phosphorescence produced by the rays in a preparation of zinc sulphide, to be plainly visible to an audience of several hundred people.

Marckwald insists throughout that his substance is not the same as that discovered by Mme. Curie. He bases this conclusion on certain differences of chemical behaviour between the two bodies, and also on the statement that the activity of his preparation does not decay with time. The latter, if proved, would undoubtedly decide the point in his favour, but no measurements are given of the alleged constancy of activity, and in the short time the substances have been prepared it is possible the slow diminution has been overlooked, especially when it is remembered that the accurate determination of the radio-activity of these intensely active preparations is a very difficult task, which necessitates many precautions. Against the view that radio-tellurium is distinct from polonium, is the entire similarity of the radiations emitted, which we have seen are unique in being entirely composed of α-rays.

The chemical differences exhibited by polonium and radio-tellurium respectively could easily be accounted for. For, as Sir William Crookes has pointed out (*Proc.* Roy. Soc., 1900, Vol. LXVI., p. 409), the analytical behaviour of a substance present in minute amount bears no relation to the true chemical nature of the same substance when obtained by itself. Since Marckwald admits that only 4 milligrammes of radio-tellurium was obtained from 6kg. of bismuth salts, it seems too early to base any argument on the analytical behaviour of the new substance, which might have been completely different had the bismuth salt happened to contain no tellurium. For the present it is best to consider the preparations of Curie and Marckwald to be essentially the same, until the constancy of the radio-activity of the latter's preparation has been substantiated.

On the view that polonium is a new element, this work of Marckwald establishes a record in the achievements of chemical analysis. Before it, the separation of xenon from the atmosphere by Sir William Ramsay and Dr. Travers, one part of the former in between 10 and 100 millions of the latter, was probably the best example of the possibilities of modern methods in the detection and separation of minute quantities of new elements as they exist in Nature. But in Marckwald's separations the proportion of the new substance in pitchblende is certainly less than this, and may be estimated at one five hundred millionth part of the whole.

Actinium.—Little has been published about this substance, and the only investigator who has examined it is Debierne, who discovered it in the ammonium hydrate group in the analysis of pitchblende (*Comptes Rendus*, 1899, 129, p. 593; 1900, 130, p. 906; 1903, 136, pp. 446 and 767). The element most nearly allied to actinium in its analytical behaviour was first stated to be titanium and subsequently thorium. In fact, the preparations were shown by a spectroscopic examination by M. Demarçay to consist chiefly of thorium. Like radium, it gives penetrating rays deviable in a magnetic field, and also a

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characteristic emanation capable of producing temporary activity upon objects in the neighbourhood, but being distinguished from that of radium and thorium by a more rapid rate of decay than either of the others. On these latterly discovered facts its chief claim to be considered a new radio-active substance rests.

Giesel (*Chemical News*, 1903, p. 97) has also described a substance which appears to be identical with Debierne's actinium. He calls his body "The Emanation Substance from Pitchblende," because it is characterised by great power of giving the Rutherford emanation. Both Debierne and Giesel have suggested that the new body is the cause of the radio-activity of thorium, but this seems unlikely. It resembles thorium and the rare earths in its analytical reactions, being precipitated from its solutions by hydrogen peroxide and by oxalic acid. But Giesel has obtained it free from thorium and nearly free from cerium and didymium, and finds the substance to consist mainly of lanthanum. This preparation was about one-thousandth as active as pure radium salts. The close resemblance between certain very curious and unique properties of the emanation from both Debierne's actinium and Giesel's emanation-substance (these properties being discovered independently by the two observers for their respective preparations) show that the source of the radio-activity is almost certainly the same substance in the two cases. These special properties of the actinium emanation will be considered later, for it possesses the highest interest in the peculiarities it exhibits.

Five radio-active substances, possessing apparently permanent and characteristic radio-activity are thus known—uranium, thorium, radium, polonium and actinium, although the permanence of the last two over a term of years is doubtful. These bodies present many peculiarities among themselves in the kind of radio-activity they exhibit (compare Rutherford and Miss Brooks, *Phil. Mag.*, VI. 4, p. 1, 1902), so that it is impossible that the radio-activity of any two or more of them can be caused by the presence, possibly in minute quantity, of the same substance.

These peculiarities can be grouped mainly under two heads. The first of these is the character of the rays and their penetrability. Three types of rays, known as the α, β and γ rays, arranged in the ascending order of their power to penetrate matter, are recognised, and, although the rays of any one kind differ slightly among themselves in penetrating power for different radio-active substances, this is always of the same order for the same type of ray and of a completely different order for different types of rays.

The second distinctive feature which serves to differentiate radio-active substances is their power to produce, besides rays, radio-active gases, not necessarily in visible quantities, but possessing *sufficient radio-activity* to be easily detectable. This property was discovered for thorium by Prof. Rutherford, who gave the name "Emanation" to the radio-active gas produced from thorium. Uranium and polonium do not, while thorium, radium and actinium do, possess this property. The respective emanations of the last three are distinguished from one another by the time their activity lasts, the activity of the radium emanation lasting several weeks, that of the thorium emanation only a few minutes, and that of the actinium emanation being even shorter lived. With the power of a radio-active element to produce a radio-active emanation is bound up its power to impart radio-activity to objects in the neighbourhood. Rutherford discovered this property for the thorium emanation, and designated it the excited activity. M. and Mme. Curie discovered it simultaneously for the element radium (the emanation of radium was not then known), and called it the induced activity, As both terms are misleading in light of present knowledge, I shall apply the term "Imparted radio-activity" to this phenomenon in these articles. In the preceding table a list is given of the radio-active substances and the characteristics of their radio-activity with respect to the features just enumerated.

Substance.	α-rays.	β-rays.	γ-rays.	Radio-active emanation.	Imparts activity to surrounding objects.
Uranium	Yes.	Yes.	Yes.	No.	No.
Thorium	Yes.	Yes.	Yes.	Yes.	Yes.
Radium	Yes.	Yes.	Yes.	Yes.	Yes.
Polonium ..	Yes.	No.	No.	No.	No.
Actinium	?	Yes.	?	Yes.	Yes.

One other possibility may be mentioned which is not in disagreement with these facts. The radio-activity of the feebly active elements uranium and thorium may not be a specific property of these elements, but may be due to specific new elements in each case which have not yet been recognised, but which are contained in all uranium and thorium preparations to an invariable extent. Two observers (Brauner, *Trans.* Chem. Soc., 1898, Vol. LXXIII., p. 951 ; Baskerville, *Journ.* Am. Chem. Soc., 1901, Vol. XXIII., p. 761), have obtained evidence of a new element of heavier atomic weight, associated with thorium in its compounds, and the latter believes that pure thorium compounds are not radio-active. Quite recently, Hoffman and Zerban (*Berichte der Deutschen Chemischen Gesellschaft*, 1903, p. 3,093) state that the thorium prepared from gadolinite is not radio-active. Before these results can be accepted, more details as to the method of testing and the time since preparation of the specimens employed must be made known. For both Becquerel (*Comptes Rendus*, 1902, 134, p. 208), and Sir William Crookes (*Proc.* Roy. Soc., 1900, Vol. LXVI., p. 409), considered that they had separated the radio-activity from uranium, although we know now that this result was only partially true (compare *Trans.* Chem. Soc., 1902, Vol. LXXXI., p. 860).

(To be continued.)

THE NEW GAIETY THEATRE.

The newest specimen of the theatre builder's art is, doubtless, the finest in the metropolis, and probably in the whole country. The interior exhibits an entire lack of anything approaching display, but everything is good and serviceable. This is particularly the case with the electric light fittings, which have been specially designed and made for the purpose. We are informed that they were not at all expensive.

Current is obtained from three distinct sources, two of which are interchangeable. The main supply cables enter the building through a basement under the Strand. This compartment is absolutely fireproof, and is isolated from the theatre proper by means of an iron door. Entering at this point are two pairs of cables belonging to the Metropolitan Electric Supply Co., one pair coming from the Sardinia-street station and the other from Willesden. By means of a change-over switch, having a capacity of 1,000 amperes, it is possible to obtain current from either source ; but under normal conditions the mains from Sardinia-street will be employed, those from Willesden being held in reserve. There are many other points at which cables enter the building, but this is the chief. From the change-over switch four 0·5 sq. in. cables are taken to the stage switchboard, all coloured lamps being supplied by one pair and all white lamps by the other. Coming in at the same point there is also a three-wire service from Sardinia-street for stage arc projectors only. These cables, after passing through a switch and being fused in the usual manner, run to two distribution boards under the stage, one on the prompt side and the other on the O.P. side. From these leads are run to the 24 arc sockets.

Adjoining the room into which the Metropolitan Company's mains run is another compartment, also fireproof, and enclosed by an iron door. Here a two-wire 200-volt service from the Charing Cross Company's mains enters. Current supplied by this company is used entirely for the "police" lights and for the central chandelier, which carries about 150 lamps. The "police" lights take the place of the oil or gas used in older theatres, and in order to dispense with these agents it was necessary to instal an entirely separate system from the ordinary lighting, supplied from an independent source. Altogether there are from 400 to 500 "police" lamps within the

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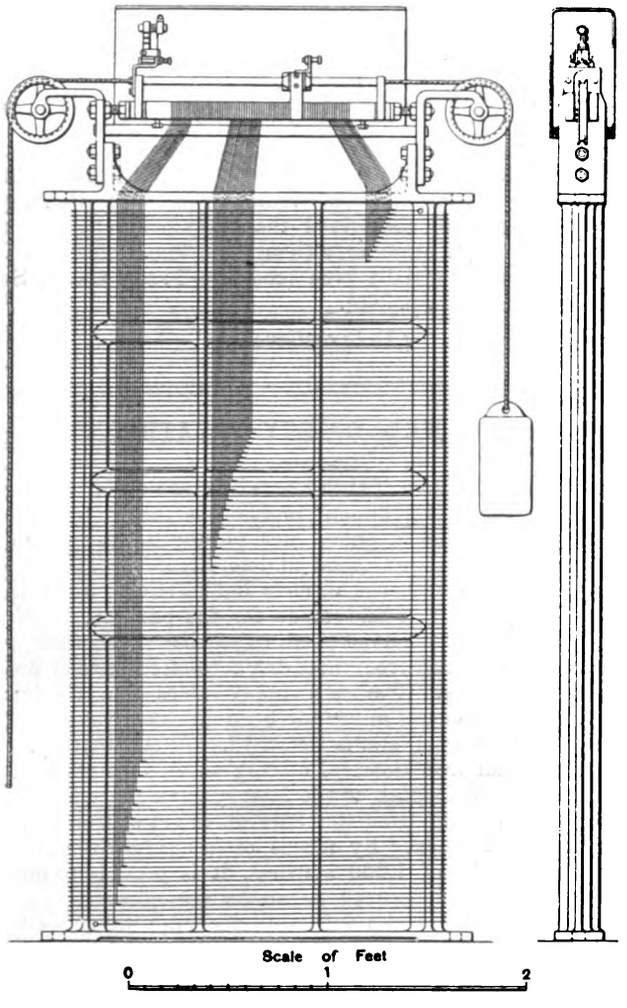
building, including those on the central chandelier. The total number of lamps in the building is 4,703, exclusive of arcs, for which 240 amperes is required.

The intake for the dressing rooms, offices and motors is situated on the opposite side of the theatre to those described above, the Metropolitan Company's mains being employed as usual, and eight separate circuits are taken from the distribution board. It is interesting to observe here that no less than 40 H.P. in motors is installed, much of this being for ventilating fans. In addition to fans, however, there is a 5 H.P. motor operating the passenger lift for the offices, as well as a Keighley 4 H.P. motor which drives the pump for the vacuum carpet cleaner.

The stage switchboard is a very fine one, consisting of polished slate panels, measuring over all 12ft. 6in. long by 6ft. 6in. high. It is situated on the O.P. side, about 10ft. above the stage. On the extreme right are four main switches



RHEOSTAT AT GAIETY THEATRE.

fitted with carbon breaks. These control, respectively, the auditorium lights, and white, red and blue lamps on the stage. At the top of the board are three pilot lamps which indicate whether switches on smaller boards situated in other parts of the building are opened or closed. All lights on the stage, as well as the majority of those in the auditorium, are controlled by the stage board, but those lamps under the circles and in the corridors, &c., are, under a County Council regulation, controlled by the smaller boards. Only one of the two wires is taken through the stage board, the return being connected through fuses to a separate distribution board. Hence, it is impossible to get a short circuit on the board itself, as it only controls one pole. In connection with stage lighting, it is frequently necessary to put out every light with the exception of a few in the float or a particular batten. This has constituted a difficulty hitherto, and has usually been effected by switching off individual circuits separately. In the Gaiety this difficulty has been overcome in the following manner:—In series with each circuit switch is a two-way switch, one pole of which is connected to the ordinary 'bus bar controlled by the main switch, the other pole being connected to a 'bus bar attached to the live side of the main switch. Hence, it is possible to make any circuit fitted with this device independent of the main switch. The whole board controls 3,000 lamps, and has a capacity of 1,000 amperes.

Of course, it is necessary to have a regulating device in every theatre, but that employed at the Gaiety is the first of its kind ever used in this country. It hails from Germany and is a product of the Allgemeine Elektricitäts Gesellschaft. It is customary to employ liquid resistances in theatre work, and 24 of these are in use at the Gaiety, but in addition to these there are also 33 wire resistances wound on asbestos-covered iron frames. It is also the rule to place all resistances under the stage, but the rheostats in this particular case are situated in a separate chamber above the switchboard. The regulator which controls the resistances is fixed opposite to the switchboard, so that the operator is enabled to observe the exact effect upon the lamps, as he has them in view the whole time. Each regulator lever possesses a coupling device, so that it may be connected—in whatever position it may be at the time and independently of the other levers—to its respective shaft. Every three levers, arranged vertically one above the other, control, separately, the three colours of the same batten. If several levers in connection with the same colour are to be simultaneously operated, they are all coupled to their shaft, and common regulation is then performed by the hand wheel at the end of the shaft. By actuating this hand wheel, all the levers which are coupled to the shaft are quickly rotated, so that an instantaneous lighting up or darkening is obtained. If this change of light intensity is required to be performed gradually, the hand wheel is mechanically connected by means of worm gearing to another wheel, and the moving of this will have the effect of slowly increasing or diminishing the light. The coupling of the worm-wheel device is performed by a single movement, and in its construction care has been taken to avoid any play. Since at the time of coupling the various levers to the shaft, the former may not be all in the same position, an arrangement has been fitted which uncouples the levers as soon as they arrive in their end positions. The hand wheel may, therefore, be rotated until all the levers are in their end positions. Each lever is fitted with a graduated dial, so that once a certain illumination has been experimentally found, it may afterwards always be reproduced by referring to the dials. We illustrate, herewith, one of the wire resistances. It will be seen that connections are taken from the winding at various positions, and attached to contacts at the top. These contacts when built up form a solid bar of alternate slices of copper and insulation, which presents the appearance of a developed commutator. Along the bar runs a rubbing "jockey," which is worked to and fro by the regulator lever and a counterweight. A very ingenious device is provided to prevent damage to the last contact by sparking. Before the jockey gets to the end of the bar it causes the circuit to be broken through a tiny spring switch with carbon contacts. This switch closes again automatically when the jockey is drawn back by the counterweight.

Underneath the stage is a chamber containing the latest liquid resistances manufactured by the General Electric Co. All cables are brought from the roof, so that it is impossible for liquid to be spilled upon them. There is also, under the stage, a distribution board for the float alone. Not more than three lamps are on any one fuse and these three are not adjacent, but alternate lamps. The result is that if a fuse should blow the diminution of light is scarcely perceptible as it does not all occur at one spot.

A novel feature in connection with the arrangement of the battens is that they may be inclined at any angle so as to light either the front or back of the scene. In theatre lighting practice the cables feeding the battens have hitherto been a fruitful source of trouble when moving large pieces of canvas. Instead of these cables running in a horizontal direction from the flies to the end of the batten, at the Gaiety they are dropped from the gridiron far above to the centre of the batten and are long enough to reach to the stage if desired.

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A 16-way Berliner telephone system is also installed, as well as a return signal system of electric bells, no less than 40 points being controlled from the prompt corner. By means of small red, white and blue electric lamps inaudible signals may also be conveyed from this spot to various parts of the house and stage. Another departure from standard practice is the erection of separate lighting flies, below the ordinary flies, so that the men attending to the light do not come into contact with those whose business it is to look after the scenery.

No less than 30 men were employed on the installation for eight months; 25 miles of lighting cable have been put in, and the total cost, without telephones and bells, was £5,500. Many yards of pipe with draw wires are embedded in the walls of the building, so that if extensions are required, no walls or floors will have to be damaged. Other precautions in this respect have also been taken by inserting inspection boxes in the pipe work at convenient intervals.

Mr. Thomas J. Digby has acted as consulting engineer, and has introduced a great many new features as a result of his inspection of Continental theatres made last year. He considers that the electrical equipment of English theatres is much inferior to that of the French, German and Italian theatres. Messrs. Roger Dawson (Ltd.) were contractors for the lighting, Messrs. G. E. Taylor & Co., for the bells and telephones, and all the switch gear was supplied by Messrs. F. E. Moy.

SOME NEW DICK-KERR DYNAMOS.

Last Friday we were invited to join a small party visiting Messrs. Dick, Kerr & Co.'s works at Preston, especially with a view to inspecting some of the large machines which this firm has recently completed. The works show at present no sign of the depression which is now affecting the electrical industry; there may be a scarcity of orders for the future, but, at any rate for the present, the enormous quantities of machinery and plant about the works in various stages of completion are convincing signs of strenuous activity. The works are even being extended, and a fine large and well-lighted shop is being added, into which will be transferred the manufacture of induction motors and some other lines of smaller plant which are just reaching standardisation. As these works were fully described in *The Electrician* a few years ago (Vol. XLV., p. 314), we will confine our attention in this article to some of the large machines referred to above.

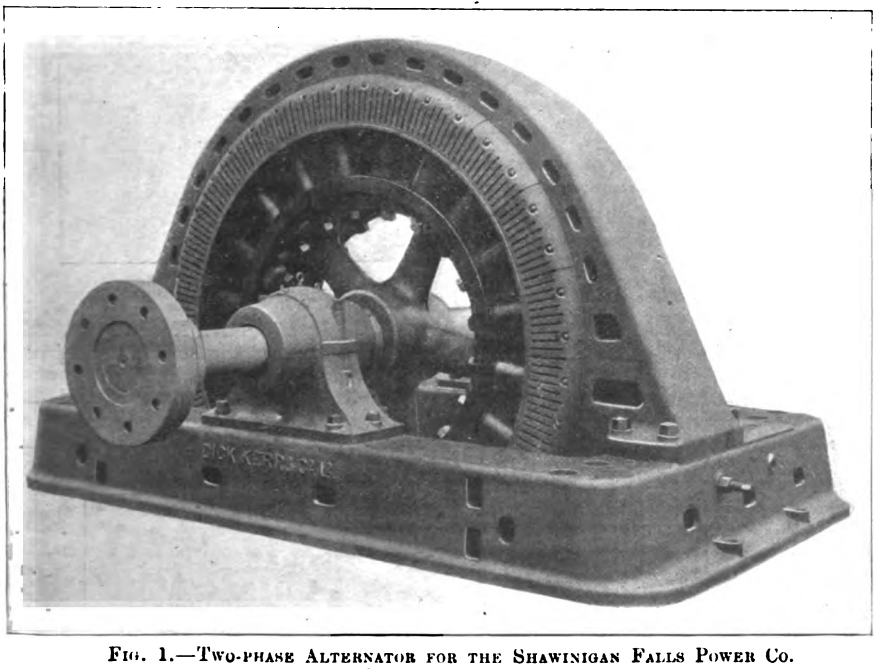

Fig. 1.—Two-phase Alternator for the Shawinigan Falls Power Co. 3,750kw., 2,200 volts, 30 ~.

The most interesting of these is a 3,750kw. two phase alternator, destined for the Shawinigan Falls Power Co., in Canada. Although it is the machine of the largest capacity yet built in Europe, its dimensions are by no means the greatest, owing to the fact that it is to run at a comparatively high speed (180 revs. per min.) Fig. 1 is a general view of the machine, and we may add that its height above the floor line is 10ft. 9in., the external diameter of the stator 14ft. 10in. and of the field magnets 10ft. 5¼in. The voltage of the machine is 2,200, and the frequency 30 ~ per sec. The magnet wheel has 20 poles with laminated pole-shoes. The latter are bolted together at the ends, but these bolts are insulated from the laminations and do not serve as *amortisseurs*. Should such damping coils be found necessary, however, wires for the purpose could be clamped under the bolts, but it is improbable that there would be any difficulty in parallel running with turbine drive and at so high a speed. The winding of the armature is by means of flat strip, there being one coil per pole per phase. The turbines for driving the machine are being made by Messrs. Escher, Wyss & Co.

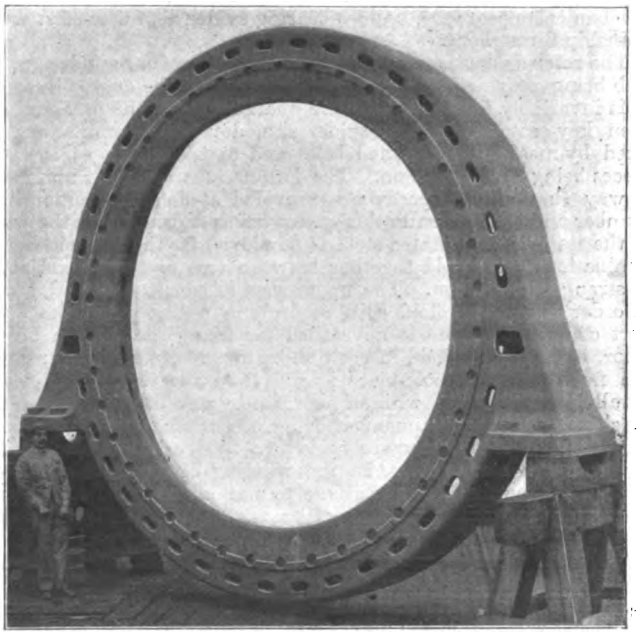

Fig. 2.—Stator of one of the 1,500kw. Three-phase Alternators for the London County Council Tramways.

Among the other machines being built at Messrs. Dick, Kerr & Co.'s works were two fine 1,500kw. three-phase alternators for the new Greenwich power house which will supply the London County Council tramways. The stator of one of these machines is shown in Fig. 2. For the same customer Messrs. Dick, Kerr & Co. have in hand 12 motor-generators of 300kw. capacity and three of 50kw. capacity. It will be remembered that the machines at the temporary power house near Loughborough Junction, were Ferranti—Dick-Kerr sets, and Ferranti engines with Dick, Kerr dynamos are also being put in at the second temporary generating station in the London Electric Supply Corporation's yard at Deptford. Eight 500kw. motor-generators on order for the Metropolitan Electric Supply Co. add further emphasis to the fact that "rotaries" are by no means standard machines in this country.

A fine machine which we saw under test in the shops was a 1,500kw. three-phase alternator which is to go to the power house of the Lancashire and Yorkshire Railway Co., for driving electrically the section of the line between Liverpool and Southport. The sub-station machinery and motors for this line were also in hand in various parts of the works. The alternator is a slow-speed machine, and it will be driven by a Yates and Thom engine, the voltage being 6,600 and the frequency 25 ∽ per sec. The effect of speed on the dimensions of machines was particularly brought home by a comparison between this 1,500kw. alternator and the 3,750kw. machine for Shawinigan, whose external dimensions were considerably less, and probably also the total weight of metal in the Shawinigan machine was also far smaller than that in the 1,500kw. slow-speed alternator. Another fast-speed machine, of 600kw. output, was a two-phaser destined for Fulham, where it will doubtless help to a solution of the difficulties at present vexing the spirit of the resident engineer. Other machines were being manufactured for Canada, Australia and South Africa, and in the former country, it

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may be mentioned, English machinery has a 30 per cent. preference over machinery made in the United States which is heavily taxed.

Messrs. Dick, Kerr & Co. have given us the following general particulars as to the design and construction of their standard alternators. We may add, however, that the machines, which are constructed to the designs of Mr. A. P. Zani, are of strong and mechanical appearance, besides bearing evidence of first-class workmanship throughout.

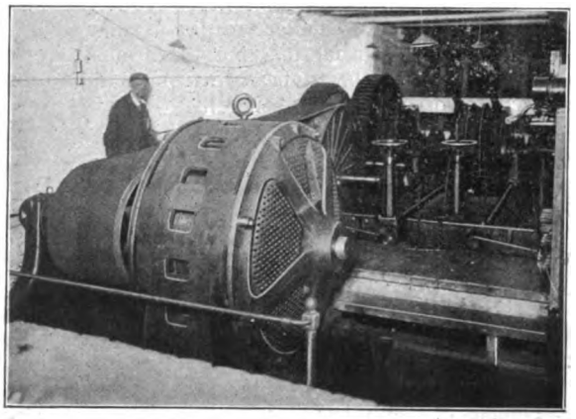
The rotor spider is made of cast iron, and of strong design, the hub being provided with a flange for bolting the engine flywheel. It is invariably pressed on to the shaft by hydraulic pressure, and then key-seated. On the spider rim, dovetailed laminations are fixed by means of machined bolts and cast-iron flanges, the pole-pieces being then bolted on. The laminations are built up in such a way that ample spaces are provided at defined positions, the number and size of ventilating spaces being dependent on the width of the stator. Laminated steel is employed for the pole-pieces, the laminations being held together between two cast-steel end-plates of strong construction. The upper part is constructed of T shape, in order to hold the field coils securely in position, and the lower part of the pole-piece is dovetailed for fixing on the rim of the rotor, it being then held in position by means of keys. To remove the field coils, the pole-piece is slid from the dovetailed groove parallel to the shaft without disturbing any other part of the machine, such an arrangement being of extreme convenience, not only when it is necessary to remove a field coil, but also for the removal of a stator coil. In the winding of the field coils it is obviously a mechanical advantage to use edge-wound strip; and, whenever the excitation voltage permits, the field coils are wound with a single layer of copper strip wound edgewise and insulated between the turns by means of specially prepared fibrous material. When the edgewise strip winding is employed, the external surface of the windings is left practically bare, being protected merely by insulating varnish, which allows a rapid radiation of heat.

The stator frame, even in the largest type, is div.ded into two parts only. The lower half is provided with feet, which rest upon the foundation bedplate. In the machines of larger size, the lower part of the underframe is provided with a special screw for vertical and horizontal centering of the stator relatively to the rotating field. The frame is made of high grade cast iron, and is designed to allow complete ventilation of the laminations and at the same time to secure rigidity. The soft iron laminations forming the core are held in position in the frame by means of retaining machined bolts. Separate coils of considerable rigidity and a well-defined mechanical shape are employed. The coils are former-wound, embeddied in rectangular slots, and held in position by wooden wedges, and they can be easily and quickly replaced. The coils are protected outside the laminations by means of a perforated cast-iron shield, cast in sections, bolted to the frame and easily removable.

Before leaving Preston we found time to pay a brief visit to the Electric Railway and Tramway Carriage Works, which we found were almost as busy as Messrs. Dick, Kerr & Co.'s own works. Among the interesting cars we saw was a delightfully broad and airy one for Buenos Ayres, in which city there are no Board of Trade regulations as to maximum width. This car had cross seats, and the windows could be pushed away into the frame so that the car could serve either as an open or closed one. The company has, on the other hand, evidently given early consideration to the recent Board of Trade suggestions with regard to tramcar design. It will be remembered that objection was taken to the reversed stairway type on account of the fact that the stairway slightly restricts the motorman's view. An endeavour to lessen this defect has been made by perforating the back of one of the steps on the stairway.

A LARGE POLYPHASE HAULING PLANT.

An interesting example of the applications of electricity to mining is that of the Bolsover Colliery, near Chesterfield, where, we are informed, a 200 H.P. endless rope hauling plant, operated by a polyphase induction motor of this output, is doing good service. The hauling plant is fixed in a chamber 360yds. below ground level, where it is supplied with three-phase current at 440 volts by 0·35 sq. in. paper-insulated armoured cable. The motor is coupled to the hauling gear by a 22in. cotton belt, running normally at a speed of 5,000ft. per minute. A constant motor speed of 580 revs. per min. is maintained, and this gives a haulage rate of 194ft. per minute. Three hundred and fifty waggons at present comprise the load, with a constant number of 20 empties, the incline varying between 1 in 22 and 1 in 40. The motor, of the Westinghouse induction type, is controlled from a marble panel switchboard fitted with voltmeter, circuit-breakers and starting switch. The latter operates in conjunction with two auto-transformers which lower the line voltage for starting, the full pressure being applied when the switch is thrown to the running position. The plant is in constant operation for 16 hours a day. Electrical energy is derived from a



200 H.P. WESTINGHOUSE POLYPHASE INDUCTION MOTOR.

250 H.P. Westinghouse steam alternator and exciter, furnishing polyphase current at 440 volts, this unit being on the pit bank.

CONVERTED WORTHINGTON PUMPS.

Mr. Hollamby, chief engineer of the De Keyser's Royal Hotel, sends us particulars of two pumps converted for electric driving. Previously the pumps—which are used for feeding the boilers and for producing the vacuum in the heating system of the hotel respectively—were running for some years as ordinary steam-driven pumps. It is said that several other pumps in use in the City have been similarly converted, and apparently with success,

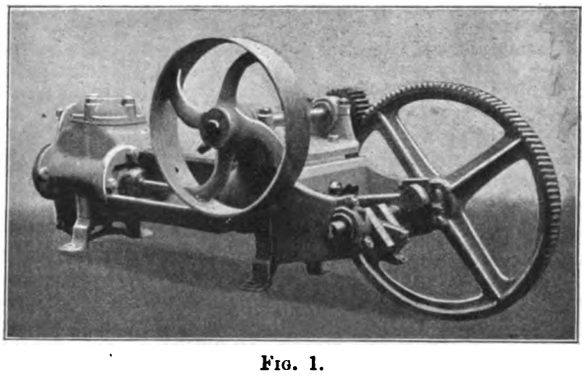


FIG. 1.

since the Southern Motor and Engineering Co., Kennington, who undertook the alterations, have applied for a patent covering the new arrangement. Referring to the illustrations, the larger pump (Fig. 1) is a 4½in. by 2⅞in. by 4in. wet vacuum pump, and the smaller one (Fig. 2) is a 3in. by 1⅞in. by 3in. feed-pump. A bracket carrying the crankshaft is bolted to the cylinder ends in

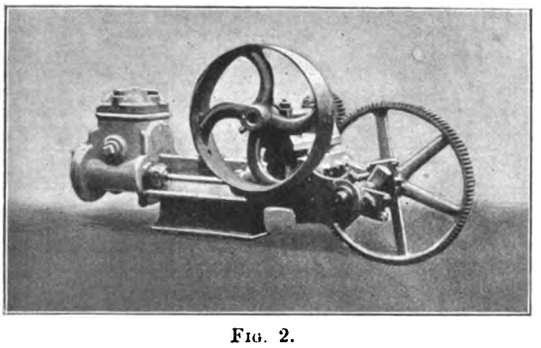


FIG. 2.

place of the usual cylinder cover. Another bracket, bolted in place on the steam chest, carries the countershaft. Both shafts are connected by a spur-wheel gearing as shown. The steam piston is replaced by a solid piston, from the front face of which two lugs project, which carry the pin for the connecting rod. Similarly, as is the case with a gas engine, the piston also performs the duty of a crosshead. The cranks are set at 90deg.

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ELECTRIC LIGHTING OF THE PORTRANE ASYLUM.

The following brief description of what is the largest private electric light and power installation in Ireland will doubtless interest some of our readers. The Portrane Asylum, which is the building in question, accommodates some 1,200 patients in eight blocks, and includes workshops, storerooms, a Roman Catholic and a Protestant chapel. Covered corridors, beneath which are built subways (Fig. 3) containing cables, water and steam piping, interconnect the different blocks.

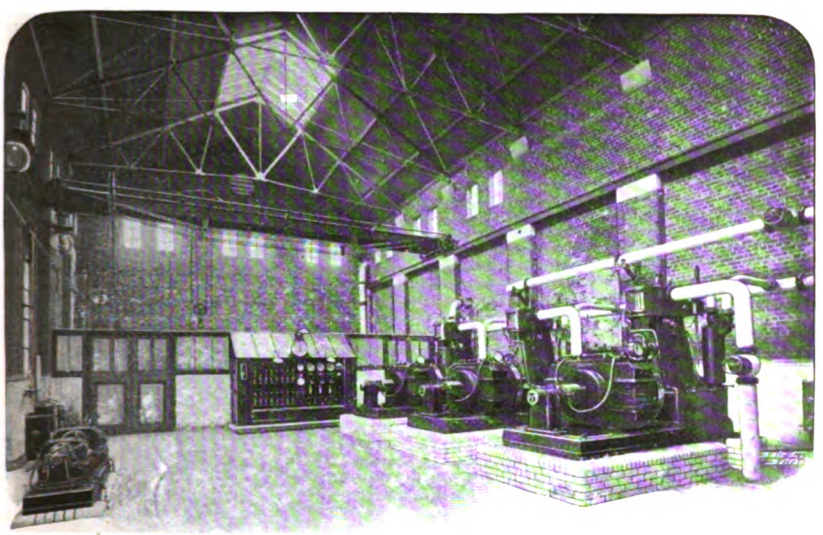

Fig. 1.—Engine Room.

The engine room, a lofty building, as will be seen from Fig. 1, contains three high-speed 120 H.P. Belliss engines, directly coupled to which are 80kw. 205-volt dynamos. Two sets are sufficient to scope with the normal demand, the third acting as reserve.. Lead-covered cables convey the current from the switchboard to the mains in the subways, these mains being arranged on the ring

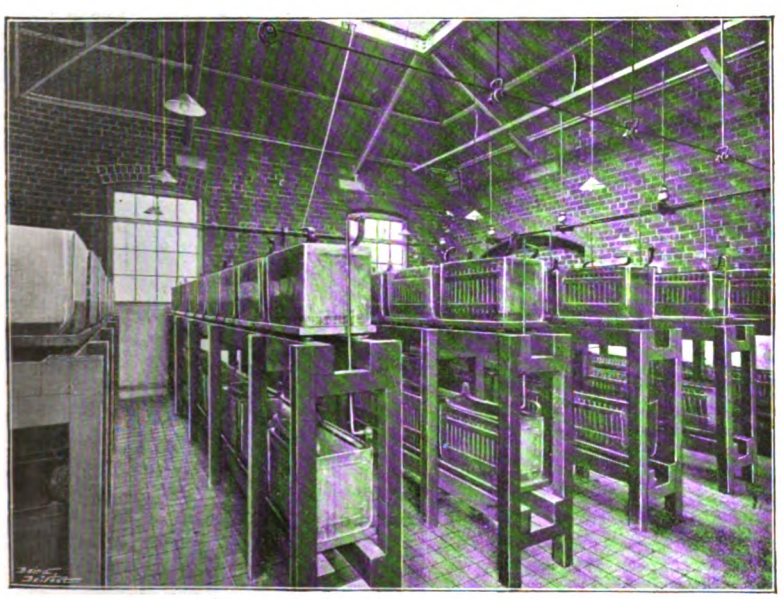

Fig. 2.—Storage Battery Room.

principle. Adjacent to the engine room is the storage battery compartment (see Fig. 2), the accumulator capacity being sufficient to provide for three hours' electrical energy for nearly 1,000 8 c.p. lamps. A motor-driven booster serves to charge the battery.

Numerous electric motors are distributed over the buildings. Four motors, for instance, ranging in power from 7 H.P. to 30 H.P., are installed in the laundry, the ventilation in this place being carried out by four electrically-driven 36in. fans. A 4 H.P. motor drives a centrifugal blower which circulates hot air through the drying rooms. Each of the patients' blocks is ventilated by means of one or more electrically-driven fans erected in the lofts. The bakery and the workshops, too, are provided with electric motors.

Incandescent lamps, as a rule, have been used for lighting interiors, an exception being the dining and recreation hall, which is fitted also with arc lamps. The grounds and roads surrounding the buildings are lighted by arc lamps.

A telephone system connects the various blocks, and a small exchange, dealing with 15 lines and attended to by the porter, has been installed. A fire-alarm installation, consisting of 16 indicators and bells and a large number of pushes erected in different parts of the buildings, is a feature of the electrical equipment. On the glass cover being broken and a push pressed, all 16 bells start ringing and an indicator flag drops at each station, notifying where the alarm has been given. A separate telephone line connects the asylum with the waterworks at Broadmeadow, 5½ miles distant. The whole electrical installation has been carried out by Messrs. W. Coates & Son of Belfast and Dublin.

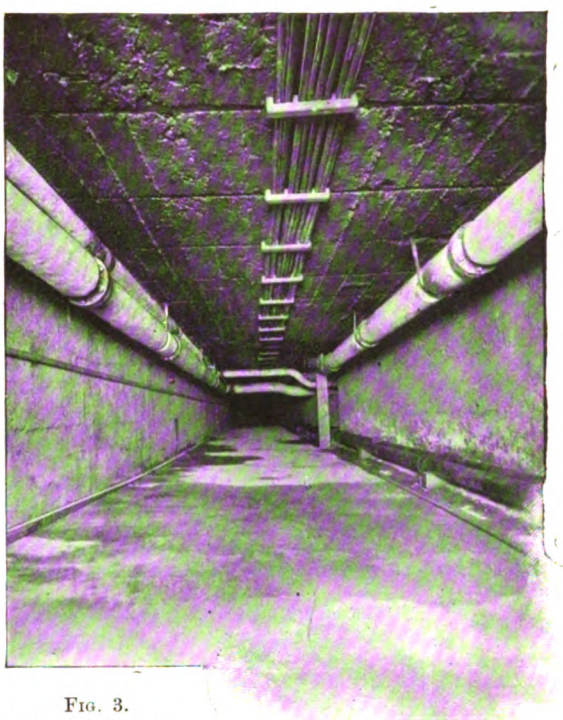

Fig. 3.
View of Subway.

THE RICHARDS-EVERSHED SHIPS' TELEGRAPH.

In *The Electrician*, Vol. LI., p. 806, there appeared a detailed description of the electrical fitting of two of the latest American war ships, and this showed the extensive use to which electrical methods of communications are put on board these vessels. Much of the signalling is done by placing a series of lamps behind a number of translucent signals, and illuminating the lamp corresponding to the signal which it is desired to give. This method is rather primitive, and entails running a separate wire for every signal: it also has the disadvantage that it is difficult to see in a bright light. It may not be out of place to give a brief description of the Richards-Evershed system of electrical ships' telegraphs, which can be adapted to various uses where a limited number of signals is required and which has been in use in the British navy for many years for the purpose of indicating to the officer in charge of the ship the angle to which the helm has been put over. To this description we propose to add an account of one of the latest and most extensive adaptations of the system which is to be installed on the two Chilian battleships now being built in this country.

The Richards-Evershed system was brought to the notice of the Admiralty in the year 1893, and was used in that year on board H.M.S. "Howe" and "Narcissus" as a reply to the mechanical

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steering telegraphs. The system was found so successful, that after lengthy trials the Admiralty placed an order for a complete system of steering telegraphs and helm indicators, which was fitted on H.M.S. "Royal Sovereign" in the early part of the year 1896, and it was in the following year that the Richards-Evershed helm

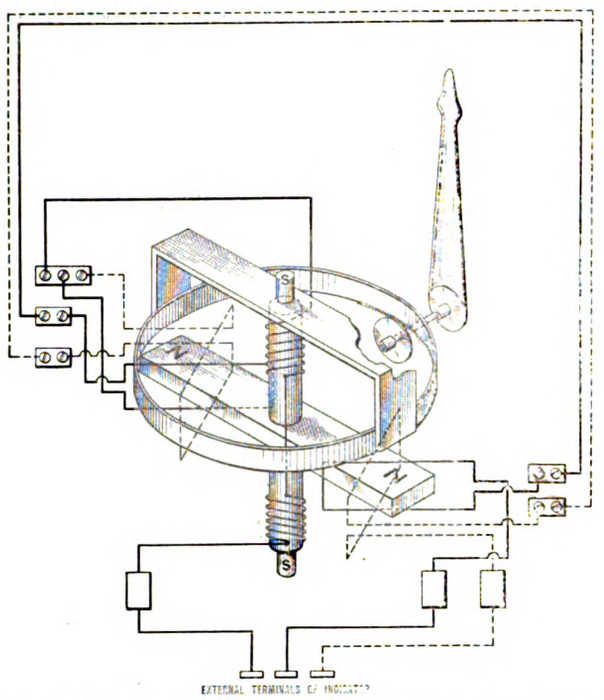

FIG. 1.—PERSPECTIVE DIAGRAM OF MECHANISM AND CONNECTIONS OF INDICATOR AS SEEN FROM BACK OF CASE.

indicator was adopted as a standard pattern and fitted to all first-class battleships and cruisers. The system consists essentially of an indicator constructed on the ohmmeter principle, in which the position of a needle is determined by the ratio of the currents in two coils placed at right angles to one another, while the transmitter

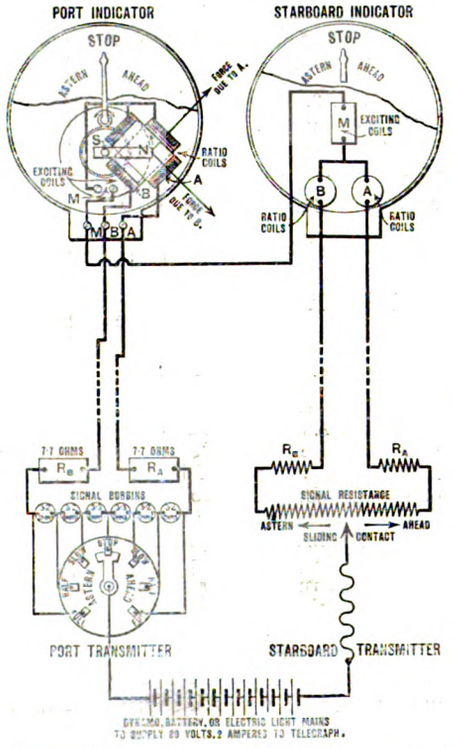

FIG. 1A.—DIAGRAM OF CONNECTIONS FOR REPLY ENGINE-ROOM TELEGRAPHS.

consists essentially of a series of resistances provided with contacts over which a switch can be moved. If one of the ohmmeter coils be connected to one end of this series of resistances and the second to the other end, while the current is led in through the movable switch and taken out at the other end of the ratio coils, which are joined together, it follows that the position of the needle in the ohmmeter coils will depend upon the position of the switch. The arrangement can be clearly seen in Figs. 1 and 1A, which gives a per-

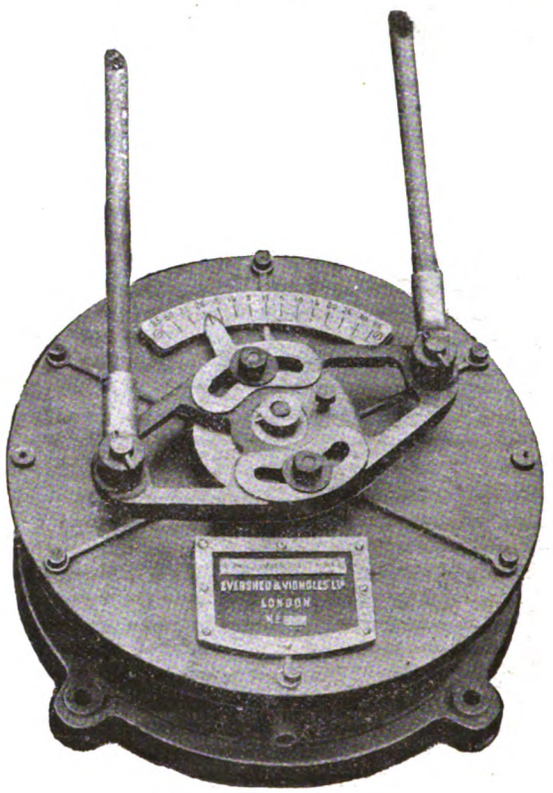

FIG. 2.—HELM INDICATOR.

FIG. 3.—INDICATOR ON DECK PEDESTAL. FIG. 4.—HAND TRANSMITTER.

spective sketch of the needle index and gear connecting them, together with a diagram of the connections of the coils by which the needle is magnetised and by which its position is determined.

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In the helm indicator (Fig. 2) the transmitter contains the resistances and a switch arm, the latter being moved by two parallel coupling rods by which it is attached to the rudder stock. The position of the switch automatically determines, in the manner described above, the position of the needle of the indicator, and any one of several indicators can be switched into circuit with the transmitter. In this manner it is possible for the officer navigating the ship to obtain automatic signals from the helm either on the bridge, in the conning tower or at any other steering station to which it may be desired to make connection. It will be noticed from the diagram of connections that in no case is it necessary to use more than three wires, and it is customary to use three-core cable having three wires covered in distinctive colours so as to facilitate the operation of connecting up on board.

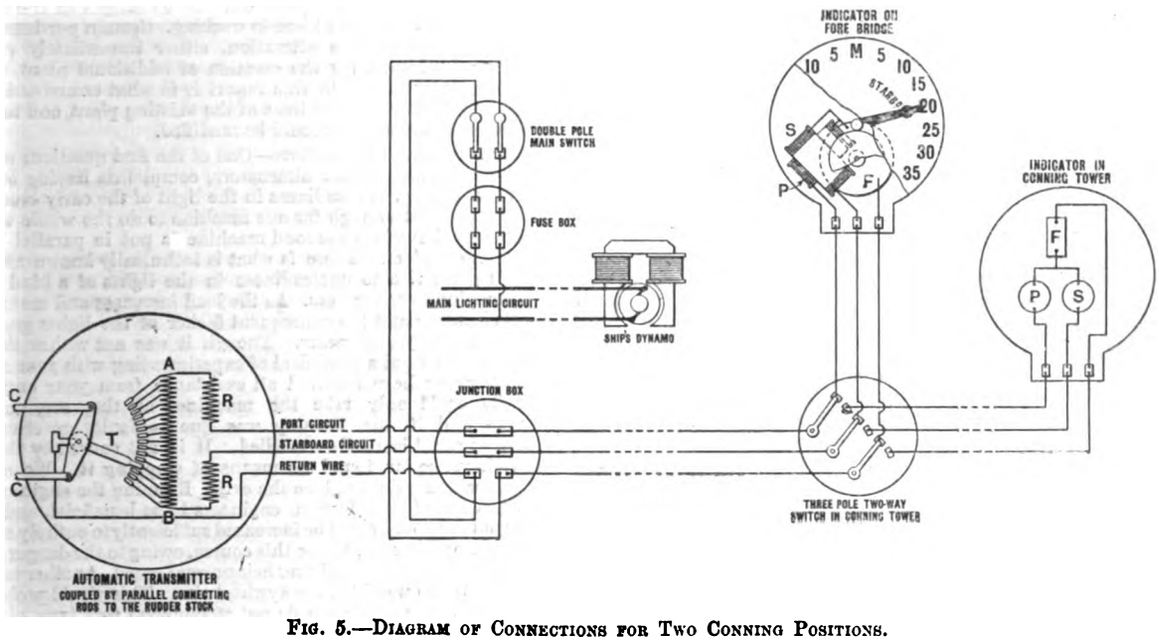

FIG. 5.—DIAGRAM OF CONNECTIONS FOR TWO CONNING POSITIONS.
A B, Sub-divided Resistance. T, Contact Arm. R R, Series Resistances. P S, Port and Starboard Ratio Coils. F, Magnet Exciting Coils.

The transmitter is illustrated in diagram by Fig. 5, which shows the arrangements adopted for the adjustment of the switch relatively to the position of the coupling rods, so as to secure that it is in register with the helm. Fig. 8 shows the indicator fixed on a deck pedestal. The whole apparatus is made in the most substantial manner, and every portion is absolutely watertight; it is largely owing to these precautions that the success of the system is due. Precisely the same system can be used for sending any limited number of signals, and in the Japanese battleship "Mikasa" as well as in the Chilian battleships "Libertad" and "Constitucion," a second application of the system is made, the apparatus being installed also as a steering telegraph. The object of a steering telegraph is to enable the ship to be steered from either the conning or steering positions without bringing into use the mechanical shafting (or the water pipes of the telemotor, if that system is in use) which connects the steering position directly to the steering engines.

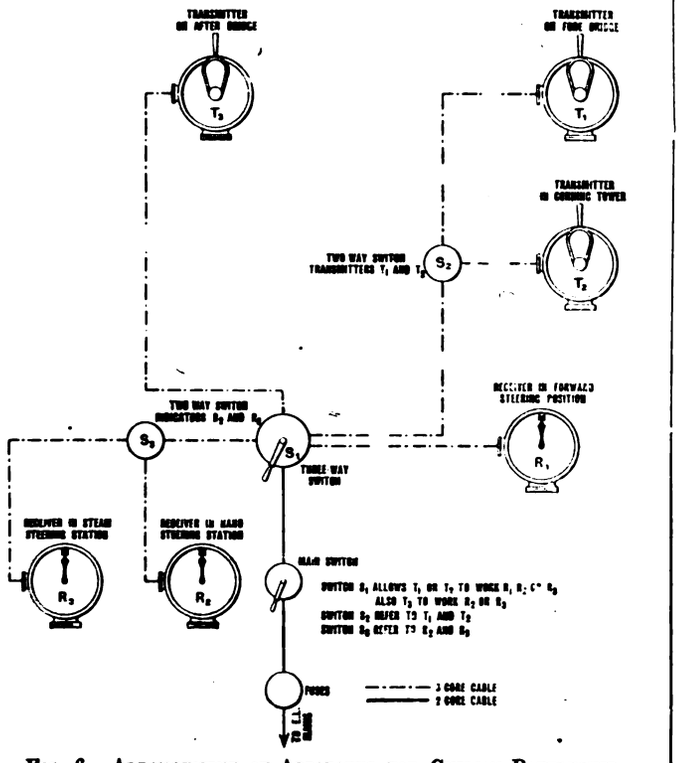

FIG. 6.—ARRANGEMENT OF APPARATUS FOR CHILIAN BATTLESHIP "CONSTITUCION."

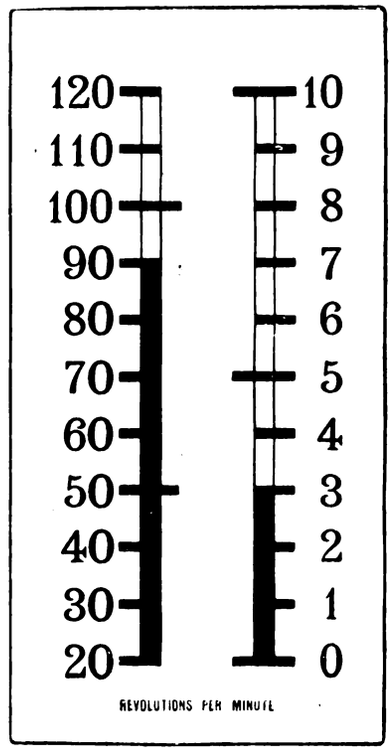

FIG. 7.—REVOLUTION TELEGRAPH: DIAL FOR RECEIVER. (1/3th full size.)

These mechanical or hydraulic connections may easily be put out of gear in action, and should a single rod be bent or a single pipe leak, it may be impossible to effect the steering from the conning position. The steering telegraph enables the ship to be worked from the conning position, while the actual steering is done below the armoured deck. Since all communication is effected by means of a single four-core cable, it is clear that damage in action is much less likely than in the case of the shafting or the telemotor. Each

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of the conning or steering positions, therefore (for example, the fore bridge, the aft bridge and the conning tower), is provided with a steering telegraph transmitter which is worked by hand by the officer controlling the ship, who, instead of using the steering wheel, puts the telegraph over to the required degree of helm movement. The signal is transmitted to an indicator in each of the steering positions below deck, for instance, to the forward steering position, the steam steering position close to the steering engines, or the hand steering wheel. When the man at the steering position executes the order conveyed in the above manner, the automatic helm indicator signals to the officer in charge the angle to which the helm has been put over, and he is thus made aware that his order has been received and obeyed.

The diagram of connections (Fig. 6) shows the arrangement adopted to carry out the above scheme in the Chilian battleships. The hand transmitter is shown in Fig. 4; it has its figures painted on opal glass and illuminated from the interior of the instrument, while immediately below the handle is an adjustable switch for varying the degree of illumination. The order is received on an indicator precisely similar to that of the helm indicator, shown in Fig. 3. Means are provided for illuminating the dial of this instrument also, and a switch for varying the degree of illumination is shown on the right-hand side of the indicator. Another application of the Richards-Evershed system has been made in a revolutions telegraph for the purpose of signalling from the officer in charge to the engine room the number of revolutions at which the engines are to be run, and by an ingenious arrangement two indicators are made to signal any number from 20 to 129. This instrument was not adopted by the British Admiralty, but a Continental government has tried the system and recently placed a repeat order with the makers. Fig. 7 shows the dial of the instrument, in which each column of figures represents a separate indicator giving 10 signals. The height of the black column on the left-hand side indicates the numbers of tens, and that on the right column the number of units, and the rising and falling of the black line is effected very simply by means of a relay, which moves a flag, one half of which is painted black and the other white. All the flags below a certain critical value (determined by the position of the switch) will be moved over to one side, while those above that value will be moved over to the other side: those below the value will show black, those above white; and the instrument is read in the same way as a thermometer. It will be noticed that this system of reading enables over 100 signals to be given on one dial, and each with the most absolute precision; such a result could never be obtained by means of an ordinary index.

Messrs. Evershed and Vignoles, who make these instruments at their new Chiswick works, have for some time made a special study of electrical communication on board ship.

THE FULHAM DISPUTE.

In November, 1902, Mr. R. L. Ferguson, the electrical engineer to the Fulham (London) Borough Council, resigned his position on being appointed to a similar post at Hastings. At the end of January, 1903, Mr. A. J. Fuller, then borough electrical engineer at Ayr, was selected to succeed Mr. Ferguson, and in due time took up his duties. This gentleman, both prior and subsequent to his appointment, stated to the Electric Lighting committee that he would not be responsible for the running of the 300kw. steam alternators, and that within two years he might possibly have to "scrap" them. This resulted in a protest by Mr. F. H. Medhurst, the consulting engineer to the Fulham Borough Council, against the appointment of Mr. Fuller as borough electrical engineer (*The Electrician*, Vol. L., p. 669). Mr. Fuller, however, maintained the attitude he had taken up, and at a special meeting of the Borough Council, on February 11th, the following resolution was carried by 14 votes to 11: "That the president of the Institution of Electrical Engineers (then Mr. James Swinburne) be requested to prepare a report, or to nominate some person to report, to the Council—(1) as to the adaptability and suitability of the whole of the plant at the electric lighting station; (2) as to the design and construction of the station generally; (3) as to whether the whole of the capital had been expended in the best manner and to the best advantage of the Council." Eventually Messrs. Swinburne, Cooper and Baillie inspected the plant with a view to reporting upon the first two items. This report has now been presented to the Council, and is set out below:—

In pursuance of the instructions we received, we have made numerous visits to the Fulham electricity works, and have carefully examined the working of the plant, and in this we have given especial attention to the point specifically mentioned—namely, the parallel running of the alternators. As regards the design and arrangement of the station, it would probably be of little use for us to discuss such questions as whether it would have been better to have adopted direct current or alternating current in place of the existing two-phase system, or other broad questions of design. These are very largely matters of opinion, and it would be as useless as it is easy to criticise what has been done, and, in the light of later experience, to point out where changes in the design would have led to greater convenience in working. Certain portions of the plant do, we consider, require alteration, either immediately or when the increasing load calls for the erection of additional plant, and what we have mainly considered in this report is to what extent additional plant should be laid down on the lines of the existing plant, and to what extent the present arrangement should be modified.

Alternate-Current Generators.—One of the first questions we considered was the behaviour of the alternators, complaints having been received from consumers of unsteadiness in the light of the early evening. When the load is light enough for one machine to do the whole work there is no difficulty, but when a second machine is put in parallel the running is far from perfect. There is what is technically known as "hunting," and this gives rise to unsteadiness in the lights of a kind that may be very annoying to consumers. As the load increases and more light comes on, this hunting and the consequent flicker of the lights goes down, and finally practically disappears. Though it was not within the reference, we have carried out a good deal of experimenting with your machines, in which work we have received all assistance from your engineers. We naturally could only take the machines as they are, and examined them to find if the hunting was due to faulty governors or other cause that could be easily remedied. It is not caused by the governors, and we have, so far, found no means of stopping it. We could several methods which might reduce the evil. Running the engines at a higher speed has been found by your engineers to be beneficial, and we have no doubt that the speed could be increased sufficiently to entirely stop hunting. We could not, however, advise this course, owing to the danger attendant in running engines at much above their normal speed. Another method would be to modify the weight of the flywheel rim. This would probably remedy the evil, but here, again, we do not recommend this form of experiment. A third method would be to fit what are known as "amortisseurs" on the pole-pieces of the alternator. This would certainly diminish the hunting, but might not be sufficient to stop it altogether. We shall be happy to go on with these experiments if desired, but we do not think it necessary, as the matter will soon be of little importance. In the first place your engineers have studied the regulation of these engines, and work the parallelling with such care, that the hunting is reduced to a minimum and only lasts a short time each evening. In addition to this, you have now a Belliss set which is practically ready for running; and your customers are rapidly increasing in number. The day load can then be run by one of the small engines, until it is full up. This will be pretty early, that is to say, before it is very dark. Then the Belliss set will be started, and will take the whole load, until it is fully loaded. Then the smaller engines will be added one by one as needed. We think this will overcome the difficulty and prevent any further complaint. In any case, we would advise that the working of the station with the Belliss set be tried before entering on any costly alterations to the alternators, which after all, might not quite eliminate flickering in the lights. As to extensions of the engine room, at present you are putting in a Belliss set which is practically finished. At the rate you are developing, you will soon have to consider further extensions. As a station increases in size, the size of its engines should increase too, and it is quite possible it may pay you better rather to replace one of the smaller horizontal steam dynamos with a large vertical set which takes the same or less room, than to go to the expense of enlarging the buildings and making more foundations. This suggestion, which is due to your engineer, Mr. Fuller, will demand a careful estimate, which can only be made at the time, when you have settled what extension to make. We do not think any blame can be attached to the engine or dynamo makers, or to anyone else as regards the trouble; in the present state of knowledge, "hunting" is rather a misfortune than an avoidable evil, and certainly credit is due to your staff for the care with which they have minimised the evil.

Dust Destructors.—We have nothing to say against the dust destructors; quite the reverse. We are putting in the same type elsewhere, and consider your plant thoroughly efficient, but we do not think the arrangement of the destructors in the boiler house good. While the station is young the destructors are especially economical, but the station will increase far faster than the refuse to be burned. The boiler house should not, therefore, be sacrificed for the destructors in any way. The present state of affairs in the boiler house is far from satisfactory, the intolerable atmosphere of dust and smoke from the destructors being injurious both to health and to machinery in the boiler house. The best arrangement would be to have the destructors walled off from the boiler house and to be as open as possible, and, in making extensions in the boiler plant, it will have to be carefully considered whether the advantage of such an arrangement would not warrant the expense either of shifting some of the boilers and destructor cells, or of discarding some of the present boilers. If this be not done, we would suggest the less drastic but less perfect remedy of furnishing the cell doors with hoods leading into a flue with up-draught produced either naturally by connection with the main flue or by a fan. This system is used by Messrs. Horsfall in connection with their destructors, and gives satisfactory results. The expense of fitting would be, of course, far less than that of shifting the position of boilers and cells.

Economisers.—The economisers have given rise to trouble from a rapid deterioration of their tubes. This is probably due to the action of the gases from the dust destructors, and is, we think, unavoidable. We

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gather that the cost of renewal of the tubes would be so great as to annul the advantages of the economisers. Under these conditions, we think it will be best to cease using economisers in the flues from the destructors. The economisers need not be idle, however, as before long the increasing load will require the use of boilers which are purely coal-fed and they can then be fixed in the flues from these boilers.

Feed Pumps.—These, we consider, require attention in the immediate future. There are at present only two steam pumps, which are used simultaneously. If one were under repair or broke down the other would be hard pressed, and might, in turn, break down and cause a complete stoppage of the station. Further, the pumps are located in an inconvenient position, being too far from the boilers, the attendants of which have to regulate them. On the other hand, we fear that pumps in the boiler house with its present atmosphere of dust might give trouble. We would recommend replacing the existing pumps by others of a more suitable type rather than adding to those now installed. The new pumps should be fixed in the boiler-house if the dust question be dealt with in time, and, if not, in the most convenient position available which is free from dust.

Circulating Pumps.—There are at present four small centrifugal pumps, and, in view of their consumption of energy, we think they might be with advantage replaced by one large pump and a spare.

Well Pump.—We believe it would lead to more economical running if this were replaced by a steam pump more suited to the work. There is, however, no immediate need to alter either this or the circulating pumps.

Condensers.—These appear to be most satisfactory, with the one trouble that the water taken from the river carries with it a considerable quantity of fine sand, which entails continual work for its removal from the tanks. This trouble could be avoided by replacing the present Körting condensers by a surface condenser in the river, which could be of comparatively small size. We think it very questionable, however, whether this would be worth doing. It would be a matter of calculation between the cost of labour in cleaning out the sand and the capital cost of the new condenser. As to the engines, we would recommend the adoption of safety governors. The present governors have dashpots, which have to be regulated to secure as good parallel running as possible. This makes the engine system unstable at very light loads, and the safety or run-away gear has had to be detached, as it was apt to act without occasion. The result is that an engine might, under certain circumstances, run away and burst its flywheel, a most serious matter. This should be attended to at once. It is not that it is in the least likely an accident will occur, but that it is possible, and such an accident would probably be a very serious affair if it did occur.

Superheaters.—At present there are no superheaters in your station, and the steam is sometimes rather wet. As the load is small and the dust destructors provide a large part of it, there was no reason why superheaters should have been included in the original design. In the near future, however, we would recommend the adoption of superheaters in connection with purely coal fed boilers.

We consider that the original design of the station is, broadly, good, and quite satisfactory and reflects credit on those concerned with it. Our report deals essentially with details of improvements that can be carried out in extending, with present knowledge and experience.

RAMSGATE ELECTRIC CAR COLLISION.

Lieut.-Col. Von Donop, R.E., has made a report to the Board of Trade on the accident which occurred at Ramsgate on August 12th last, from which we extract the essential portions below :—

In this case while a tramcar which was travelling from Margate to Ramsgate was descending Bellevue-road, Ramsgate, the driver lost control of it, and it came into collision with a car which was travelling in the opposite direction. Bellevue-road, Ramsgate, where this accident occurred, is about a ¼ mile in length, and for a car running from Margate to Ramsgate the gradient of it is a falling one throughout its entire length. The Margate end of Bellevue-road commences at Thanet-road, and for the first 120yds. of its length the gradient is one of 1 in 30. At this point Albion-road crosses Bellevue-road, and at this crossing the gradient changes to one of 1 in 12, which continues for a length of 90yds. to a point where Victoria-road crosses it. The gradient then changes again to one of 1 in 30, which continues down to the end of Bellevue-road, where there is a sharp curve leading into the Plains of Waterloo. The gradient of the road, therefore, is generally one of 1 in 30 with a length of 90yds. in the middle of it of 1 in 12. There are two lines of rails laid along this road, but near the bottom of the road there is a short portion—20yds. in length—where the lines are placed so close together that two cars cannot pass each other; the lines of rails do not actually cross each other, so they are what is known as single-double lines. This single-double portion commences about 150yds. below Victoria-road, and it was on this portion that the accident occurred. A speed of 6 miles an hour is authorised down Bellevue-road, with the exception of the steep portion between Albion-road and Victoria-road, over which it is restricted to 4 miles an hour. The two cars concerned in this collision were similar ones; they were double-decked bogie cars; they were each fitted with hand brake, rheostatic brake and a somewhat unusual form of track brake. It was raining slightly at the time of the accident, and had been doing so for a short time previously; the rails, consequently, were wet, and they are said to have been in a greasy condition.

Driver Collins' evidence was to the effect that he had his car well under control until he had nearly reached the bottom of the steep gradient, when the car seemed to shoot away, and he lost control of it. He stated that he applied all his brakes and reversed his current, but without any effect; he accordingly released all his brakes and shouted to the conductor to apply the brakes at his end of the car, but the conductor was unable to do so before the collision occurred. The car was, therefore, at the time of the collision running freely down a gradient of 1 in 30. Collins attributed his losing control of the car to the fact of the rails being greasy and to his sanding arrangements having suddenly failed to act. As it had only just commenced to rain, Collins should have been prepared for greasy rails, and as regards the alleged failure of the sanding arrangements, Collins admits that they were acting efficiently up to the moment before the runaway occurred. The sand-hopper was examined after the accident, there was still sand in it, and the valve which released the sand was found to be working correctly. As regards the fact of the reversed current having had no effect in stopping the car, the trolley had at that time left the wire. But the apparent failure of the brakes is not so readily explained. The hand brake and the rheostatic brakes in use on these cars are of the usual type, but the track brake is of a novel design. It consists of two steel skates one of which is fixed in front of one of the large wheels at either end of the car. The two skates work independently of each other, each being applied from the platform at that end of the car near which it is fixed. When released the skate is pressed by a spring between the wheel and the track, the spring tending to force the skate under the wheel and thus bring the weight carried by that wheel on to the skate. This brake was primarily designed to prevent cars from running back. With this object the conductor at the rear end of a car releases the skate at his end before commencing to ascend a steep gradient, the skate accordingly slides in behind the big wheel, and, if that wheel should commence to revolve in a backward direction, the weight would immediately come on to the skate and the speed would be at once checked. But it is further claimed for this brake that it is equally effective in preventing cars from running away in the forward direction. In this case the brake has to be applied by the driver. The skate slides in in front of one of the big wheels at the leading end of the car, and, if that wheel be revolving in the forward direction, the weight immediately comes on the skate and the speed of the car is at once considerably checked. But an undoubted defect connected with this brake is that it is impracticable to apply it on the level before commencing to descend a steep gradient. For, when once it is applied, the wheel skids; it is not, therefore, available for easing a car down a steep gradient, as is done with the usual form of slipper brake, and it is never used in that manner. As far as forward running is concerned, it is only available as an emergency brake to check the speed of the car when it has got out of the control of the other brakes. It is admitted, therefore, that the car which ran away on this occasion started to descend the 1 in 12 gradient without any slipper brake being applied to it. It is probable that the driver's loss of control was primarily due to his running too fast down this portion, and then to his applying the hand and rheostatic brakes injudiciously, thereby causing the wheels to skid. Collins seems then to have entirely lost his head, and finally, as he was unable to check the car with the hand and rheostatic brakes, he removed both brakes, allowing his car to run free, and shouted to the conductor to apply the brakes at the rear end of the car; before, however, the conductor was able to do this the collision occurred.

Collins states that after shouting to the conductor he reversed his current and applied his track brake, but that that brake also failed to have any effect. It appears to have been in good order, and, if Collins' statement is correct, the wheels of the car were revolving quite freely at the time at which he tried it, so that there was nothing to prevent its coming into action at once. It is difficult, therefore, to understand why it should have had no effect at all, and I am inclined to think that Collins never thought of applying it on this occasion. It was, however, specially with the view of preventing drivers from losing control of their cars that Major Pringle, in his report of October 12, 1901, recommended the provision of slipper brakes, so that these might be applied before commencing to descend steep gradients. The 40 four-wheel cars belonging to the company have, it is stated, all been equipped with slipper brakes, which can be used in that manner, and since this was done there have, it is understood, been no cases of runaways with those cars. But the brakes fitted to the 20 eight-wheel cars belonging to the company cannot be so applied, and it is to this defect that this accident must also be attributed. The company point out that the provision of such brakes is a matter of great difficulty, on account of the arrangement of the wheels on these eight-wheel cars. This may be so, but the problem must be faced, or the use of these cars be discontinued.

Production of Mercury.—According to the *Western Electrician* the production of quicksilver in the United States amounted in 1902 to 2,635,500lb. and was valued at $1,500,412. In 1901 the production was 361,386lb., valued at $1,382,305. This shows a very marked decrease in price. The three greatest quicksilver producing states are California, Texas and Oregon. California is the largest producer, with Texas next, while in 1902 Oregon produced none, due to development work going on at the principal mines. Quicksilver is obtained principally from cinnabar (Hg_2S), and under ordinary circumstances can be produced in California at a cost of $35 a flask of 76½lb., or about 46 cents a pound.

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WILDE v. THOMPSON.

This extraordinary libel action was brought to a conclusion on Monday. It will be remembered that Dr. Henry Wilde brought an action to restrain Prof. Silvanus P. Thompson from referring, in books of which he is the author, to certain electrical machinery as being "dynamo-electric machinery," Dr. Wilde himself claiming the distinction of being the inventor of the dynamo and dynamo-electric machinery, and objecting to the invention being accredited to anyone but himself. A dynamo may perhaps be most accurately described as a machine by means of which mechanical energy is converted into electrical energy, or vice versa. But in 1831 Faraday invented and constructed such a machine, and statements in Prof. Thompson's books to this effect were held by Dr. Wilde to be damaging to his reputation. Dr. Wilde further alleged, in his statement of claim, that Prof. Thompson had arranged with him what should be inserted in defendant's books, and demanded that no mention of his name whatever should appear in these books except in the terms of a proof which had received Dr. Wilde's approval. The books in question are Dr. Thompson's famous "Dynamo-electric Machinery" and the "Life of Faraday."

Naturally, the action caused considerable delay to forthcoming editions of the former book, as the printers and publishers were also cited as defendants, and Dr. Thompson immediately took steps to make this delay as brief as possible. He brought a motion before Mr. Justice Buckley, in the Chancery Division, to strike out the statement of claim as frivolous and vexatious. The hearing of this motion commenced on Thursday, March 12, 1903, and judgment was delivered on the following day. In the meantime, however, proceedings against Messrs. Clowes & Co. and Messrs. E. and F. N. Spon, to restrain them from printing and publishing the book, were withdrawn, Dr. Thompson being cited as sole defendant. Mr. Justice Buckley's judgment was extremely scathing, his opening remark being to the effect that he found difficulty in delivering judgment with becoming gravity. He considered that he could not put the judgment upon a higher level than "sticking up a couple of dummies to knock them down again." He failed to find any libel in the words complained of, and was very emphatic on the point that although Prof. Thompson submitted proofs to Dr. Wilde there was no contract. His lordship made an order striking out the statement of claim, and dismissing the action with costs. Mr. Fletcher Moulton, counsel for Dr. Wilde, asked for leave to appeal, and this was granted, the judge remarking, however, that there ought to be peace between the parties.

In spite of these remarks, however, Dr. Wilde went a step further by taking the case to the Appeal Court, and there, as stated above, the matter was settled on Monday. The Appeal Court judges took the same view as that taken by Mr. Justice

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BUCKLEY, and dismissed the appeal with costs. Here also some very pertinent remarks were delivered from the Bench. Counsel for the appellant confessed to being unable to find any authorities to quote except one which was hardly relevant to the case under issue. Lord Justice VAUGHAN WILLIAMS disposed at once of the alleged breach of contract by saying that it was impossible to have a bargain unless both parties were bound to something. In giving judgment, he also said that there was nothing to justify the claim that the word "dynamo" was to be appropriated exclusively to a description of the machine which Dr. WILDE says he invented. Judgment was delivered without even hearing any arguments from Prof. THOMPSON'S counsel; but there was a suggestion made by counsel for the appellant to the effect that the appeal might be taken higher.

It is greatly to be regretted that Dr. WILDE has seen fit to prosecute his claims to scientific distinction in the law courts. His reputation as a scientist was and always will be high—nothing could detract from that. He has rendered real and valuable service to the electrical industry by his researches in the field of electrical science, for which every member of this great and growing industry respects him. But it is absurd for him to lay claim to a universal reputation of being "the inventor of the dynamo," as well as to say that FARADAY never used an electromagnet but only permanent magnets of steel, while his (Dr. WILDE'S) great invention consisted in substituting an electromagnet. Without doubt, he was the inventor of a dynamo, and he applied the use of a dynamo to new processes, but it does not detract in the least from his reputation to say that other persons have also invented dynamos. Even, however, if Prof. THOMPSON did not give him all the credit he deserved, that is no reason why he should bring an action for libel. As Lord Justice ROMER remarked: "If every person who wrote a book on any particular matter was to be subjected to an action for libel because he did not give the fullest merit claimed by every inventor upon that subject, nobody would ever be able to write a history of science. . . . . The Courts would be inundated with libel actions under such circumstances."

We have it on good authority that Dr. WILDE has been threatening, with a similar action, the Trustees of the Oxford University Press because of the article entitled "Dynamo-electric Machine" in Dr. MURRAY'S new Oxford Dictionary, and the Editors of the "Encyclopædia Britannica" because of HAWKINS' article on the Dynamo. We trust that, as Dr. WILDE'S claims have been practically laughed out of court by four of His Majesty's most eminent judges, he will now cease his crusade.

SOME NOTES ON STEAM TURBO-GENERATING PLANTS.

The following is an abstract of the discussion which took place at the Leeds Local Section of the Institution of Electrical Engineers on October 22nd, in connection with Mr. J. Wilkinson's Paper, "Some Notes on Steam Turbo-Electric Generating Plants." The Paper was published in our last issue.

Mr. WILSON HARTNELL asked for more information on the points in the Willans and Robinson turbine which differed from the Parsons. Mr. Robinson, he said, had told him in the course of conversation that he thought the time for reciprocating engines for electrical work was slowly coming to an end. One point he might mention, was driving at a uniform speed. In a certain town some 50 H.P. motors driving direct had given trouble, owing to the pinions wearing as much on the back as on the front side. To get the same low consumption of steam with a reciprocating engine as with a turbine, the very greatest pains in every direction would have to be taken.

Mr. HOLIDAY said that he had been using Parsons turbines at a colliery since 1895. They had now several of these, from 150kw. to 300kw. A little difficulty was first experienced with the very varying loads, due to the armature connections breaking off at the commutator. This was owing to insufficient flexibility, but was overcome, and since then the trouble had not recurred. He mentioned that Messrs. Parsons had fitted an automatic brush-rocking gear, worked by steam taken from the first row of blades. As the steam pressure on the first blade was always proportional to the load, the position of the brushes was shifted in accordance with the load. This had been running for 18 months, and caused no trouble whatever. The speaker concluded by relating a curious fact—namely, that there was 1 megohm of resistance between the steel spindle of the turbine and the frame of the bearings in which it was running, the film of oil on the bearings being sufficient to insulate the shaft.

Mr. S. D. SCHOFIELD referred to the inexpensive foundations required for steam turbines, and to the advantage that the machine itself, in the smaller sizes, could be moved to suit the pipe work, condensers, &c. Some 12 months ago he had occasion to borrow a 120kw. turbine from Messrs. Parsons until they could deliver one of a larger size, and to save expense of special pipes he borrowed a number of scrap 12in. cast-iron pipes, bolted them together the best way they would fit, and then set the machine to suit them. With reference to the suggestion that in the Curtis turbine the condenser could not be driven from the shaft, he would suggest that a separate motor-driven condensing plant was better, as he found that even driving the force pumps at times spoilt the governing of the machines. In the older type of the Parsons, both pump and governor were driven from one vertical shaft, and on two machines slight hunting of the governors occurred due to the reciprocating motion of the pump, causing them to slow up owing to the back-lash of the gearing. With regard to the claim that no expensive cylinder oil was necessary, he said, however, that an expensive lubricating oil was necessary. On two occasions he had had trouble with oil, once due to the water and oil combining, and the second time to impurities in the oil attacking the cast-iron reservoir and choking up the oil passages. He had found it a good thing to draw off a few gallons of oil each day, putting it into the filter and making up the deficiency with filtered oil. He had tried one machine with steam superheated over 600deg. and had not had the slightest trouble with the blades. Tests on a 200kw. machine worked out as follows:—

Date of test.	Steam pressure.	Superheat Deg. F.	Vacuum.	Load in kw.	Speed.	Lb. of steam per kw.
8/1/03	150	56	26·5	½-load.	3,000	26·6
	150	56	26·5	full-load.	3,000	22·23
	150	166	26·5	½-load.	3,000	24·41
	150	181	26·5	full-load.	3,000	20·39

Note.—Excluding power for air and circulating pumps.
Decrease of steam consumption for higher superheat = 8·3 per cent.

Mr. STONEY said that with respect to the economy of space both Parsons and Curtis turbines were exactly the same, whilst the Curtis was double the height. He asked how such a small vertical clearance as about 0·02in. was obtained with the Curtis turbine.

Mr. JACKSON said that the Curtis turbine was in no way an infringement of the Parsons patent. The footnote to Table I. said that in order to get the steam consumption one should multiply by 10 and divide by 6, but he would suggest that the figure be increased to 7, otherwise it put the efficiency of the generator rather too low. The friction with the Curtis turbine was, he said, so small that they could turn the governor balls round by hand. The Curtis people would shortly deliver a continuous-current turbo-dynamo in which, he thought, they had overcome certain difficulties peculiar to that type.

Mr. W. J. A. LONDON, referring to the De Laval steam turbine, in which there is only 2mm. clearance between the exhaust end of the nozzle and the wheel, said that he had always understood that steam issuing from a properly constructed nozzle flowed in a parallel stream for a considerable distance, and that a clearance of 20mm. or so could be allowed without decreasing the efficiency. To bring out the point of parallel running still more, he would like to mention the instance of the Parsons-Brown, Boveri turbo-generator of 3,000kw. installed at Frankfort. This machine was started up and put into parallel with a slow-speed machine without the slightest difficulty and without assistance from the turbine expert. He referred to the difficulty of dismantling a vertical turbine, and thought that it was a very much more difficult thing to dismantle a vertical turbine than it would be to dismantle the same machine built on a horizontal plane. Referring to the Westinghouse turbine, he said that the new machine was a modified combination of the De Laval and Parsons type, steam entering at the centre of the cylinder and issuing both ways through a series of stationary and revolving nozzles, the low-pressure expansion being taken care of by Parsons blades. The Westinghouse people had recently guaranteed on a 1,800kw. machine with a steam pressure of 180lb. sq. in., vacuum 27½in., and superheat of 150deg., 16·4lb. per kilowatt-hour. The overall length of the 5,500kw. turbine for the London Underground Railway would only be about 40ft., which compared favourably with any slow-speed horizontal reciprocating steam engine. The total weight of the combined plant was about 200 tons, being about one-third of the 3,500kw. Sulzer-Kolben plant. He failed to see how any additional ventilation was obtained in the Curtis turbine, because with the generator being placed directly above and the steam entering at the top, one would think there would be a great deal of radiation, and that the hot gases from the turbine would arise and heat up the generator to a greater extent than in the horizontal machine. With reference to oil economy, he gave the following results, which were obtained per day's run of 24 hours whilst he was with a Continental firm, the machines being of 1,000kw. output;—Reciprocating engine plant; 4 gallons engine oil,

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4 gallons cylinder oil, 4 gallons filtered oil. Steam turbine: 0·8 gallon engine oil, 0·4 gallon cylinder oil. Assuming a station of 10 units of 1,000kw. reciprocating plant, and taking an average price for oil and assuming the machines to be giving two-thirds of their output all the year round, the oil bill for the year would come out about £2,300, whereas that of a turbine station would only be about £300.

Mr. A. B. MOUNTAIN said that the figures they had had given them showed what excellent results could be obtained providing the superheat was very high, but what was the difference in the coal bill? They knew a certain amount of coal had to be burnt to produce superheat, and he thought it was unfair for the author to compare the Sulzer plant with the Parsons plant, because in the one case he had a plant with saturated steam and in the other case one with 100deg. superheat; and, again, in one case there was 4in. more vacuum than in the other. He thought that the Curtis turbine would have a larger diameter than the Parsons. The other day he had a steam leakage through a space some hundredths of an inch wide, and he was astounded at the amount of steam passing through that little space. It was obvious that if the diameter were increased the leakage past the edge was also increased.

Mr. SAMUELSON said that by superheating 100deg. the steam consumption was reduced 1lb. Previous speakers had alluded to the fact that you could not superheat without some expense. They might assume the consumption to be 19lb. and the efficiency to be improved 10 per cent. Four-tenths had been added in heat, and more coal had had to be put on the fire, but 2 per cent. more was obtained from the superheated steam. The qualities which this steam had gave another 2 per cent., because when steam went through the machine and was wet, the friction was very much greater than when the steam was dry. Thus nearly 6 per cent. represented the total gain. He then gave some tests on a 500kw. British Thomson-Houston turbine, the steam pressure being 150lb., superheat 150deg. and vacuum 28½in. to 30in. The full load consumption was 18·75lb. of steam, half-load 20½lb. and quarter-load 22½lb. The turbine, he said, was under-rated, as it was really a 750kw. machine and could be run up to 900kw. For 50deg. of superheat they had obtained 9½ per cent. and for 100deg. 14 per cent. improvement in steam consumption. There had been no occasion to take the machine to pieces since it was erected, but to do so it would only be necessary to lift the generator up a couple of inches or so. The weight of a 1,500kw. machine was 60 tons and of a 3,000kw. 130 tons. He also added that the blades on the wheels were cut from the solid, so that they would stand any amount of superheat.

Mr. BARKER said that Cambridge electricity works, of which he had been resident engineer, was the second turbine station in this country. It had been a continued success, although the coal costs were rather high. The output was comparatively small; the station was 2 miles away from the centre of the town and the load-factor was low. The coal cost per unit sold was 0·66d., and would have been 0·5d. if continuons direct current had been employed.

Mr. WILKINSON, in reply, said that he did not agree with the view of some speakers that the days of the reciprocating engine, so far as electric power stations were concerned, were numbered, as notwithstanding the assurances which had been given that all the objections named as to the fitness of steam turbines for driving continuous-current generators had been surmounted, there was no doubt that the future of continuous-current generation lay with the slower reciprocating engine, until a type of turbine was perfected to run economically at speeds not exceeding 500 per minute. Automatic rocking gear for the brushes of continuous-current generators operated by a piston in a steam cylinder connected to the turbine side of the throttle valve governor had been named, but this was a makeshift device, and did not get over the difficulty of excessive wear and tear on the commutators and collecting brushes. He regretted that they had had no definite information given them as to the effect of high superheat, and he would suggest that it would be highly interesting and useful if they could have a Paper dealing with the economies of superheat, both with reference to steam turbines and reciprocating engines, setting forth exactly at what point the advantages of superheating were nullified by the increased consumption of fuel to produce such superheat. It had been suggested that it was unfair to compare the steam consumption of the Sulzer-Kolben plant with the Parsons plant, inasmuch as the results in the latter were obtained by superheating 100deg. with a 4in. better vacuum. It would be interesting to know why advantage was not taken in the Sulzer engine of the increased economy obtainable by superheating. Possibly it was not easy to improve the vacuum on the reciprocating plant, whereas one of the advantages of turbines was that no air was drawn into the condenser. A fertile cause of low vacuums in reciprocating plants was air leakage at the low pressure piston rod and valve packings; in such cases he found it of great advantage to water-seal the packings at the low-pressure end, especially in the case of engines with metallic packings. Recently, in a 600 H.P. plant, he had obtained by this means 2½in. increased vacuum in the condenser.

THE ENGINEERING STANDARDS COMMITTEE.

The standardisation of electrical pressures and frequencies was the first portion of the important work entrusted to the Sub-Committee on Generators, Motors and Transformers by the Electrical Plant Committee. The names of those constituting the sub-committee were given in *The Electrician*, Vol. LI., p. 439.

At an early stage in their deliberations the sub-committee decided that the most advantageous method of approaching this problem, beset as it is with so many difficulties, would be from the point of view of those most affected—namely, the users of lamps and of motors for power purposes. It was, therefore, agreed that the standard pressures to be suggested should be measured at the consumers' terminals, as settled by Act of 1899. At the present time there exist many different pressures declared by the various lighting and power authorities. In view of the great desirability of obviating this unsatisfactory state of affairs it was deemed advisable to suggest the minimum number of standard pressures which would best meet present commercial requirements, and at the same time utilise to the fullest extent the consumers' existing appliances. After careful consideration it became evident to the sub-committee that the direct-current pressures of 110, 220, 440 and 500 volts would best meet the requirements, because carcases built for these standard pressures could be utilised for pressures 10 per cent. above or below the suggested standards, without any alteration whatever in the castings or mechanical components, by merely altering the windings and excitation. It is to be hoped that now these direct-current pressures have been fixed as standards by the committee, they will in future be universally adopted by the engineers advising corporations and others distributing electrical energy. In course of time the benefits to the electrical industry at large, which will certainly follow the adoption of these standard pressures, must become more and more apparent. A circular was drafted embodying the suggestions of the sub-committee, and this was submitted, first, to the manufacturers for their consideration, and, secondly, to the leading consulting engineers and users of motors. The information so courteously placed at the disposal of the sub-committee by the consulting engineers and manufacturers was most carefully weighed and considered by the sub-committee, and certain definite conclusions were arrived at, the circular being sent, in the first instance, to the manufacturers, as they were the people most directly interested. Replies were received from all the leading firms, who expressed themselves unanimously in favour of the recommendations of the sub-committee. The consulting engineers similarly gave their adherence to the proposals of the sub-committee.

Before coming to their final decision the sub-committee on generators, motors and transformers conferred with the sub-committee on electrical tramways, of which A. P. Trotter, Esq., is chairman, and a joint meeting took place with the result that the pressure of 500 volts, which most concerned the latter sub-committee, was agreed to, and in addition to the pressures already agreed to, 600 volts was decided upon as the standard pressure for electrical railways. The question of the adoption of standard frequencies, although of equal importance with that of standard pressures, was not surrounded with the same difficulties. It was, however, deemed advisable to fix upon the standard frequencies at the earliest possible stage of the work, as no progress could be made in the standardisation of prime movers for driving alternate-current machinery until such time as the frequencies had been settled upon. On this question there appeared to be a great preponderance in favour of frequencies of 25 and 50. The only point upon which any serious difference of opinion appeared to exist was the advisability of the adoption of a third frequency of 40 or 42, to enable rotary converters to be used to the fullest advantage. All the arguments in favour of this third frequency were fully discussed, but after carefully weighing the pros and cons the sub-committee decided not to recommend the adoption of more than two frequencies—namely, 25 and 50. The recommendations of the sub-committee were then submitted to the Electrical Plant committee, the Publication committee, the Main committee and the Board of Trade for their approval. This having been obtained, it was deemed advisable, in the interest of the electrical industry of the country, that the findings on the questions of direct-current pressures and frequencies should be published at an early date, without waiting for the completion of the entire report to be issued at a later date. The following are the resolutions on standard direct-current pressures and standard frequencies:—

1. That the standard direct current pressures, measured at the consumers' terminals, be: 110, 220, 440, 500 volts.

2. That the standard direct-current pressures, measured at the terminals of the motors, be: For tramways 500 volts. For railways 600 volts.

3. That 25 periods per second be the standard frequency for:

(*a*) Systems involving conversion to direct current by means of rotary converters. (*b*) Large power schemes over long distances. (*c*) Three-phase railway work, where motor gearing and the inductive drop on the track rail have to be considered.

4. That 50 periods per second be the standard frequency for: (*a*) Mixed power and lighting on town supply mains. (*b*) Ordinary factory power plant. (*c*) All medium size power plant where rotary converters are not employed.

REPORT ON REFUSE DESTRUCTORS.

At the request of the Joint Committee of the Hammersmith Borough Council Electricity and Lighting and Cartage Committees, the following Report has been drawn out by Mr. H. Mair, the borough surveyor, and Mr. G. C. Bell, the borough electrical engineer:—

Mr. Chairman and Gentlemen,—In accordance with your instructions, we herewith beg to report upon the question of a refuse destructor for the Borough of Hammersmith. It is perhaps unnecessary to explain, in the first instance, that the primary object of refuse destruction is the disposal, in a sanitary manner, and rendering innocuous, all waste materials collected from the private-house dustbins and trade refuse. If at the same time not only can this object be realised, but some useful product obtained by so doing, without any corresponding disadvantages or drawbacks, the cost can be materially reduced and the financial aspect of the question becomes more favourable. It is our duty to lay

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before you the *pros* and *cons* of this question from these points of view. In the first place, there is no doubt whatever that a proper system of refuse destruction is the most sanitary method of dealing with the house-bin refuse collected from large communities, as it can be dealt with close at hand, thus avoiding the risks and cost of transit to the dust-shoots, which must of necessity be some distance from the large centres of population. The question of cost, however, is to a very large extent the ruling factor, and as the available shoots near at hand are gradually filled up, this simple method of dealing with the matter becomes more and more expensive, although from a sanitary point of view it does not materially affect the persons whose refuse is carted away. Dust destructors, therefore, really affect the community at large, and if the cost of dealing with our refuse by means of a dust destructor is heavier than by sending it away, we are paying this extra money simply for a more ideal state of affairs.

At the present time the disposal of refuse is receiving the very serious consideration of the authorities throughout the whole of the kingdom, and up to the present time about 160 towns in Great Britain and Ireland have adopted some form of destructor. A large number of these, however (nearly one-third), have been erected quite recently, so the actual cost of dealing with refuse in this manner cannot be accurately ascertained with a modern form of destructor. It must also be borne in mind that many of these towns have no other possible method of dealing with their refuse. As, however, some municipalities have been carrying out experiments in this direction for a number of years, it will not be difficult to arrive at a figure which will give the approximate costs, and be suitable for basing our estimates upon. The perfect dust destructor has not yet been designed, and should be a combination of the following points, but there are some very good approaches to it on the market.

1. Perfect cremation of the refuse, so that there can be no offensive nuisance from partly-burned gases.

2. Must be capable of dealing with the refuse immediately it is delivered, so that it is not necessary to store same, as it quickly becomes offensive under these conditions.

3. No nuisance to the surrounding neighbourhood through fine dust or grit being distributed from the chimney stack.

4. The furnace temperature should be so great that the residue is melted and forms hard clinker, which then becomes a useful by-product.

None of these points should be sacrificed in order that the refuse should be used instead of coal for any useful purpose, and if these points can be fully met and any surplus heat used for generating steam, then this steam may and should be used for driving the necessary machinery required in the destruction of the refuse, and we believe that there would be very little, if any, heat available for any other useful purpose. It would, perhaps, be as well to examine the conditions which prevail at Hammersmith, and ascertain the cost of erecting and working a destructor, and also see if any useful purpose could be served by the apparatus after its true functions have been carried out. The actual amount of dust bin and house refuse dealt with last year was, approximately, 28,000 tons, but as the population of the borough is continually increasing, any destructor erected should be capable of dealing with 30,000 to 35,000 tons per annum, which, taking 300 working days in the year, will give an average of about 100 tons daily. The cost of the necessary dust destructor, as well as tipping floors, boilers, dust catcher, buildings and chimney would be about £18,000, to which must be added the cost of the land. The area required would be approximately 1 acre, as provision must be made for a necessary inclined approach road, stores and other buildings. This may be estimated at £2,500. The London County Council would lend this sum, to be repaid within 50 years, on which we should have to pay interest at the rate of 3½ per cent. per annum, so the capital charges for interest and sinking fund on the land would amount to £93. 10s. per annum. The amount, £18,000, to be borrowed for the buildings and machinery, we may take it, would have to be repaid within 30 years, and interest at the rate of 3½ per cent. per annum, so these capital charges for interest and sinking fund would amount to £915 per annum. In provincial towns where destructors are at work it is found that 1s. per ton is the average cost for labour only at dust destructors combined with electricity works, but this is increased to 1s. 8d. per ton if the London installations are included, so we may infer that the cost for labour here will be at least 1s. 8d. per ton, which must be added to the above figures. A further amount must also be included for depreciation, which we believe will ultimately prove to be a very heavy item, and it is not safe to estimate this at less than another 5 per cent. on the whole cost of the plant in addition to the sinking fund previously mentioned, which will amount to another £900.

When the refuse has been tipped into the destructor cell this is not the end, as there is a very heavy residue to be dealt with which varies from 25 per cent. to nearly 50 per cent. of the total quantity placed in the cell. This must be disposed of in some manner or other as rapidly as it is made, and where building operations are in active progress or a large number of new roads and streets are being made up in the district it might be disposed of, but in our case, where sand is abundant and the number of new roads to be made is extremely small, we believe there would be difficulty in disposing of, approximately, 10,000 tons of clinker without barging away. These items may be briefly summarised thus:—

Cost of land, £2,500 for 50 years at 3½ per cent.	£93 10
Buildings, £18,000 for 30 years at 3½ per cent. (£600 sinking fund, £315 interest)	915 0
30,000 tons of refuse at 1s. 8d.	2,500 0
Add 5 per cent. for depreciation	900 0
10,000 tons of refuse at 2s. 7d.	1,291 0
	£5,699 10

The cost of barging away dust at the present time is 2s. 7d. per ton, which, at 30,000 tons per annum, equals £3,875, showing an increase of £1,824 per annum. Of course, it is possible to use the hard clinker for manufacturing artificial stones for paving, but the plant necessary to do this—*i.e.*, mills, crushers, hydraulic press, &c., would cost a further £2,000 before we could deal with this clinker satisfactorily and economically. Taking it for granted that we should be able to get rid of the whole of the clinker, the question arises as to whether any surplus steam which the destructor would generate could be used for any useful purpose. This entirely depends upon the amount of steam and the steadiness at which the supply can be maintained, as, of course, an intermittent supply would not be of any use from a commercial point of view. Mr. Goodrich, in a Paper on refuse destructors, recently stated that out of 160 towns in Great Britain and Ireland whose authorities have adopted dust destructors, 45 are combined with electricity works, 26 are combined with sewage works, whilst the remaining 89 towns use their destructors for destruction only, and do not attempt to make anything else out of same. This question is one turning upon the calorific value of the refuse, and the position which Hammersmith occupies does not justify one in looking for a very high calorific value for the following reason. It is not the centre of any very large industrial activity, so that the amount of trade refuse is absolutely a negligeable quantity; it is not the centre of a rich residential district, so that the amount of combustible material in the house dust bins is reduced by the residents to the lowest possible denomination. An examination of the refuse tipped will bear this out, and, in fact, we are afraid that in order to obtain a sufficiently high temperature to ensure perfect cremation of the gases it would, perhaps be necessary to add a little coal to the refuse to obtain this result. If we are fortunate enough to burn the refuse without the aid of coal, then the surplus heat, after driving the necessary plant for producing the forced draught, lighting the building, driving any artificial stone machinery, &c., will be such a negligeable quantity that it is not safe to allow any credit for this in making out the estimates. Taking the average cost per ton as shown above, we arrive at a total cost of 3s. 9½d., which, we think, is a fair estimate, and may be taken as the average cost. The actual ascertained cost at Fulham is 3s. 7d. per ton, before, however, allowing a sufficient sum for depreciation and working a more expensive plant suitable for assisting the electric light works.

Upon examination of the annual returns of six London municipal electric light stations, three of these having the assistance of destructors and three with coal only, the following comparison shows the value of a dust destructor:—

Capital expenditure per kilowatt of non-destructor stations £80
do. do. destructor stations .. £118

The working costs of non-destructor stations is 0·2d. per unit higher than the destructor stations, which upon 5,774,644 units (their total output) represents £4,895. The extra cost of the capital involved to effect that saving is apparently, at 5 per cent.—£7,395—showing a net loss of £2,500 per annum as the cost of combining dust destructors and electric light stations. Turning again to the Fulham result, the resident engineer reports that the value of the fuel saved by using dust was £2,260 per annum, which, however, we find would be turned into a loss of about £200 if a proper amount were set aside for the depreciation of the special plant. We have arrived at the following conclusions:—

1. That barging away is more economical at the present time.

2. That the refuse has not sufficient calorific value to justify the combination of a dust destructor with the electricity works.

3. That there is every probability that the cost of cremation of refuse will greatly decrease, whereas the cost of barging is more likely to increase. A time will come when the destructor will be necessary, and it would be good policy to obtain the necessary ground at once, having easy facilities for transport, thereby reducing the cartage.

DEPRECIATION AND SINKING FUNDS IN MUNICIPAL UNDERTAKINGS.*

BY FREDERIC WALMSLEY, F.S.A.A.

The question of depreciation of assets, in relation to sinking funds, has been, for some considerable time back, exciting an increasing amount of discussion and interest in financial circles generally, and in municipal quarters in particular. Doubtless the whole question has been brought into greater prominence by the extraordinary growth of so-called municipal trading, and the consequential large increase in the amount of capital embarked by corporations generally in gas, water, electricity, tramways, markets and similar undertakings. The universal and continued demand for money by corporations and other authorities, at a time when money is scarce and consequently dear, has also accentuated the interest and concern of financial circles in the whole question, and in its treatment generally by corporations. Now, it is not our province to discuss the ethics, or propriety, or policy of municipal corporations engaging in commercial enterprises; indeed, we may even say that it is, by common consent, too late in the day to do so; but, having regard to the fact that a debt of something over £300,000,000 sterling has been created by corporate bodies in this kingdom, I think, as accountants, we may very profitably consider the whole question from the aspect of the present and future incidence of its burden on the whole community.

* Paper read before the Conference of Incorporated Accountants at Liverpool.

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Sinking Fund.

Firstly, as to a sinking fund. What does it mean, and for what was it introduced? It may be defined as a reserve, or fund, created by corporations out of profits of undertakings, or by contribution from the rates, or both, for the specific purpose of redemption of loan or debt. The contribution is paid annually, and its amount is fixed or regulated by the period or term of years for which the money is borrowed. This term is fixed either by Parliament, where expenditure is authorised by an Act, or by the Local Government Board, where the authority for the expenditure is conferred by sanction or order. The annual payment to sinking fund is also regulated by the rate of interest on the investment of the fund, the object being to fix such a sum annually as, together with the accumulations of interest, will suffice to meet the repayment of the loan at the end of the period. This is arrived at by a calculation by means of fixed interest tables, usually upon the assumption that the investment will return 3 per cent. The *modus operandi* by which this is worked out, it is not necessary for me to go into.

Sinking funds were originally introduced by Pitt, for the redemption of the national debt, during those great and prolonged wars at the close of the 18th and beginning of the 19th centuries, the object being to relieve that period, to some extent, of repayment of a debt which was incurred for national security and for exceptional purposes, and the benefits of which would accrue to the future as well as the present. Since then the principle has been embodied by Parliament, the Local Government Board and other authorities controlling public expenditure, in all acts and powers given to local authorities for the spending of money on capital account, in order to prevent the creation of permanent debt, by providing that immediately the money is borrowed and expended, the contributions towards its redemption must be commenced, and thus, whilst the capital is rendered a non-permanent financial load upon the ratepayers, its repayment is thus equitably distributed between those who conceive and carry out the work and the next generation, which enters into and enjoys their labours.

The authorities have acted thus wisely for two reasons: Firstly, the uncertainty as to what future additional burdens of capital expenditure a given community may have to incur. Secondly, the uncertainty as to the rateable value and prosperity of that community in the future, and its continued ability to bear its burdens.

In this connection, it is interesting to consider the enormous growth of capital expenditure, and to look back for the last 30 years over a period of municipal activity and enterprise without a parallel in our history. For this purpose I have extracted figures from the best sources available, showing the progress under the three heads of Population, Rateable Value and Municipal Debt.

Statement showing the Growth of Local Government Expenditure in England and Wales during the last 30 Years.

—	1872.	1882.	1892.	1901.
Population	23,000,000	26,055,000	29,002,525	32,617,001
Rateable value..	£107,398,242	£139,636,307	£155,896,383	£186,563,738
Loans outst'ding	69,461,087	144,335,238	207,524,093	293,864,224
Debt per head of population ..	£3 0 4	£5 10 8	£7 3 1	£9 0 8
Debt per £ of rateable value.	0 12 7	0 19 4	1 6 7	1 13 6
Rateable value..	4 13 4	5 7 2	5 7 6	5 14 5

If this is the growth during the last 30 years, what is to be the position in the future, with a continuation of this ratio of increase? And are we quite sure that the country and its people will be able comfortably to bear burdens such as this generation is building up for them? We must remember that the security and credit of local government is based chiefly on rateable value, and, no doubt, to some extent also, it is influenced by the wisdom and prudence of the corporate bodies who are responsible for the administration. With regard to the first factor, it is plainly indicated in the figures I have submitted to you that the debt is fast, too fast, outrunning the rateable value, and is there not a fear that, consequently, municipal security is to some extent being shaken? Doubtless it will be said that if the debt grows, the assets (valuable assets, it may be) grow also; that to some extent modifies the situation, but, in my judgement, the spending of the nation, imperially and locally, is gradually becoming a serious menace to our national financial stability, and calls for the urgent attention, not only of all those concerned in municipal life and work, but of every citizen of the empire. The other factor affecting credit is the prudence of every-day corporate administration—that just, efficient and equitable control which demands the fair distribution of the financial burden between the present and the future. The Irishman who said, "What care I for posterity; it never did anything for me," is, after all, a type of some who argue, "Never pay to-day what you can put off till to-morrow, next year or the next generation." But what of the ability of the next generation to bear the burdens that are being laid up? Is there any certainty that rateable value will continue to increase in the same ratio as hitherto? None. On the contrary, there are places in our own country where, from decay of local industry and other causes, affairs have either become stationary or begun to decline.

Under these circumstances of doubt as to the future, justice and prudence alike dictate a policy of decision (1) that no permanent debt shall be possible in respect of any assets now created and (2) that as a principle all capital shall be repaid by sinking fund, concurrently with the creation of ample reserve for replacement of worn out or obsolete assets of the undertaking, so that, in other words, there shall be no re-borrowing or permanent continuation of capital debt in respect of an old undertaking. Reading the report of the proceedings at the recent joint Select Parliamentary Committee on Municipal Trading, it is evident that there was in their minds some concern and doubt as to the adequacy of depreciation reserves, and we find them embodying this view in their recommendation of regulations for future audit of corporation accounts. In setting forth the various matters upon which the auditors are to satisfy themselves, and to certify, we have the following in clause 18: "Auditors should be required to express an opinion upon the necessity of reserve funds, of amounts set aside to meet depreciation and obsolescence of plant in addition to the statutory sinking funds, and of the adequacy of such amounts."

It may be urged that such a system would place too heavy a burden on the present-day ratepayers, and I quite agree that there is something in this; but I believe that this should be met by a revision of the general conditions and terms under which the sinking fund periods are settled by the Local Government Board. At present they seem to be fixed without, in many cases, due regard to the life of the undertaking, and frequently without regard to the usefulness or liability to obsolescence of the institution affected. Therefore, I would urge that, as a general rule, renewals and depreciation being provided for out of revenue, longer periods for the repayment of capital should be allowed. That the present system of regulating sinking funds is inequitable, unjust and inconsistent must be the opinion of all conversant with municipal affairs, and not only have frequent representations been made to the authorities on the subject, but it is a constant "bone of contention" in applications to Parliament or on Local Government inquiries.

Take, for instance, waterworks and water supply undertakings, which frequently involve the acquisition of large areas of land, which must, in most cases, increase in value. Or, take again, public parks and public improvements, including street widenings in cities and towns. The probability of increase in value is even greater in these cases than in waterworks, and yet it is impossible for such works to get a longer sinking fund period than 50 or, at the most, 60 years. But as these institutions are clearly for the benefit of the community for all time, with no risk of obsolescence, with practically no wear and tear, the maximum period in all such cases should be materially increased. A case in which I was recently concerned vividly demonstrates the present system (or want of it) which is practised by the Local Government Board. An omnibus application for borrowing powers included the rebuilding of bridges and the re-formation or re-paving of some main roads in a large town, which were, therefore, subject to heavy traffic. Only 30 years was granted for such permanent structures as bridges, and 23 years for the roads.

Depreciation.

Coming, secondly, to the question of depreciation in its relation to sinking funds, let us first inquire into the real definition of the term, and what its object is. Depreciation is a provision, or reserve, created out of or charged against revenue, for the purpose of reinstatement or entire renewal of assets when the occasion arrives, the object being that the accumulation of depreciation, as a fund, shall be sufficient in the future to replace the worn-out assets without recourse to re-borrowing. It will, therefore, be observed how necessary it is to fix the annual percentage or contribution at such a figure as will, beyond all doubt, cover the life or duration of useful service of the asset in question.

In dealing with the question of depreciation, we are led to the much-vexed question, which has been freely discussed of late—viz., to what extent, if any, does sinking fund provide depreciation. I should like at this point to take the opportunity of acknowledging the able evidence given by the president of our society—Mr. Wilson—before the Joint Select Committee on Municipal Trading. It may appear that I differ from him on this question, and I do to this extent, that whereas he expressed the opinion before the committee that the sinking funds put upon all municipalities by Parliament operated sufficiently well to render the question of depreciation a secondary matter, I, on the other hand, advocate that the sinking funds should be put upon a sounder basis, and the subject of depreciation dealt with separately. In my judgment, the two are in origin, principle and object absolutely separate and distinct. The sinking fund, as already defined, is a contribution towards and in repayment of capital borrowed, whilst depreciation is a fund for the preservation and restoration of assets so as to prevent the raising of further capital for the maintenance and continuance of the status quo.

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If these definitions are correct, as I believe most strongly, we shall see the importance of keeping the two things separate in the accounts and balance-sheets of corporations. All capital expenditure should be charged to capital, so long as it is for extension purposes; and so long as it is, beyond all doubt, in its nature adding to the power of production or of service it is capital, and must be so charged. If it is expenditure in substitution or renewal or repair it must go against revenue. Whether sinking fund should be assisted by payment out of depreciation fund, as some urge, is another question, which I will return to later; but even if such a course were taken, the two accounts—sinking fund and depreciation—should be kept separate and distinct, so that at any time hereafter the position of the total capital expenditure and the total depreciation fund shall be clearly shown. I think this condition is of growing importance to corporation finance, because no factor is so essential to the credit of a corporation as the soundness of its financial position, and this can only be attained and maintained by such a treatment as I have indicated, showing the cost, history and present valuation in the books of every asset.

Having dealt with the definition and treatment of depreciation in the books, we now come to the amount of depreciation to be charged. This will be a fixed annual charge or percentage, and should preferably be based on the original cost, or total accumulated cost as shown by the capital account of the asset, so that the annual burden will be continued until the asset value is entirely recouped. Thus the annual charge will be based on the actual estimated life of the asset, and should be well over the estimate, for safety. In fixing this rate of depreciation, the nature of the asset should be taken into account, and the division of the corporation assets into three classes or grades will perhaps facilitate a more just and sound treatment.

Classification of Corporation Assets for Depreciation Purposes.

Class 1.—Non-profit undertakings, such as streets, roads, parks, &c.

Class 2.—Trading and other undertakings, of long or permanent duration, such as waterworks, docks, cemeteries, sewage-works, &c.

Class 3.—Trading undertakings of less permanency and certainty and with assets of a greater wasting nature, such as markets, gas, electric lighting, tramways, &c.

Dealing with Class 1.—These being maintained out of revenue, and being institutions of a permanent character, free from all risk of obsolescence, the rate of depreciation, if any, need only be trifling.

Class 2.—Trading concerns of this description which, in their administration and scheme of charges to consumers, admit of profit making, should be subject to more liberal depreciation.

Class 3.—Being wholly trading concerns, and usually making large profits, in most cases for relief of rates, and being industries subject to more rapid depreciation from a variety of causes, such as the march of invention and discovery, these should be considered as of a much less permanent character, and in all cases liberal depreciation should be provided. There ought to be no difficulty in these cases, for the corporation committees of management of trading concerns, under class 3, enjoying a monopoly of supply of its product, can, and should, levy such charges for gas, electricity and tramways as will admit of the most liberal depreciation.

So far as I can learn, I fear that, generally, the depreciation of trading undertakings is not at present adequate, and therefore not in the best interests nor for the permanent credit of municipal administration. This conclusion is borne out by some figures, quoted in a recent able Paper by Prof. Turner, of Glasgow University, read at the British Association Meeting at Southport—figures taken from Sir William Fowler's report submitted to Parliament last December—from which it appears that, out of a total expenditure of £9,443,741 on tramway undertakings in England and Wales up to 1902, the average annual depreciation fund was £50,307, or only slightly over ½ per cent. Taking the whole of the municipal undertakings together, the depreciation fund is even much less, for I find it quoted, in a valuable contribution on this subject by Councillor Alex. Murray, of Glasgow (whom we had the pleasure of having with us at our last autumnal conference), that it appears, from a return obtained in 1899, the average annual contribution to repairs or depreciation funds, in respect of the debts on productive undertakings in England, over an average of five years, only amounted to $\frac{1}{16}$th of 1 per cent. per annum. I am informed that in America there are numbers of tramway undertakings which find it absolutely impossible to make a profit, in consequence of the large heaping-up of capital, owing to obsolesence and the rapid march of improvement, so that it is imperative, if such undertakings are to succeed, that a full and ample renewal and depreciation fund should be built up to provide against the necessity for further capital requirements.

Coming, now, to the last, and probably the most controversial question, which I lightly touched on earlier—viz., should sinking fund be paid out of depreciation? I believe not, for they involve two separate and distinct principles, and there should be no confusion of the two, either in administration or in book-keeping. I am clearly of opinion that sinking fund should be separately treated and separately charged, as previously indicated; but, no doubt, it will be urged that, with the scheme of depreciation in addition, a double burden will fall on the present generation in the case of some undertakings, as compared with the system now in force in most corporations. That there will be an additional burden in some cases there is no doubt, but is it more than the present generation ought to bear? Let us take our minds back to the circumstances associated with the original undertakings, which, doubtless, brought the necessity for borrowing powers into existence. These would, probably, be works such as sewerage, parks, waterworks, roadways, &c., which were in existence before the days of electrical developments, tramways or even gas works. In all these cases but little provision for depreciation will be required, not by reason of any different method of treatment, but because the assets in question do not depreciate, and are not liable to obsolescence or supersession. In fact, at the termination of the period of repayment, the undertakings will become the property of the local authority, free from debt, and, as in the case of parks and waterworks, possibly with an increment of value.

This, I believe, was originally the ideal and the intention in all undertakings, and why should it not apply to those of later days? As an evidence of this view of the matter I would point out that in some of the tramway acts and other municipal powers of a more recent date clauses have been inserted providing for a depreciation fund, and the report of the Select Committee on Local Loans Repayment, to my mind, indicates, or, at least, favours this contention. If I am right in this, then it must inevitably follow that where the works are of a wasting character, hazardous in their nature and liable to more or less rapid depreciation, care must be taken to build up a depreciation reserve out of the earnings of the undertaking, to obviate the necessity of re-borrowing. Opponents of this view argue that there should be a continuity of re-borrowing, to provide for the periodical replacement of worn-out plant. Under these circumstances there must of necessity be perpetual debt, more or less, in connection with the undertakings. This, I contend, is contrary in letter and spirit, to the intention of Parliament, is financially unsound and unjust to those who come after us.

I am addressing gentlemen some of whom have had considerable experience in corporation accounting as professional auditors and accountants, and we have also a considerable number of members who, as borough accountants and treasurers, are closely identified with the municipalities, and in whose hands lies, to a great extent, the destiny of corporation finance with all its far-reaching consequences to the community. In the last 10 years a large increase has been noticeable in local rates generally, which, in many cases, have risen to 8s., 9s. and occasionally even 10s. in the £. Again, the new Education Act has added considerably to the burden of local and imperial taxation, and additional sewage and sanitary works and other requirements will in the near future materially increase the demands upon the ratepayers. With these growing charges, and with the certainty that the ever-increasing needs of the public and the civic problems that will inevitably hereafter have to be solved will continue to be a serious addition to ratepaying responsibilities, are we quite sure that the prospective burden, as here indicated, is one that will be comfortably borne in the future? I think it is very doubtful, and it is for these reasons that I urge that the present generation, who have incurred £300,000,000 of local debt, should feel their responsibility more, and not only bear a fair share of its repayment upon the lines which I have advocated, but should resolutely make up their minds to exercise greater control in the future over capital expenditure generally.

What is the Solution?

Then, gentlemen, what is the solution of the present divergence of practice? It is obvious, at the outset, that uniformity of treatment of both sinking fund and depreciation, in all corporations and local authorities alike, should be the basis of reform of procedure. The enormous growth of investment in corporation funds demands, in justice to the investor, that the funds of these great concerns, so closely identified with the comfort and life of the 40 millions of subjects in the British Isles, should be administered on the soundest lines, commercially and financially. If this uniformity is a step in the right direction, how is it to be brought about, and what are the means to the end?

You will remember that the Joint Committee on Municipal Trading recommended that the Local Government Department should invite our own Society, the Institute of Chartered Accountants, and the Institute of Municipal Treasurers and Accountants in England and Wales, and the Society of Accountants in Edinburgh and the Scottish Institute Branch of our Society in Glasgow to confer and report as to whether it would be possible to prescribe a standard form of keeping accounts for all municipal or other local authorities, having regard to the varying conditions existing in different districts. I am of opinion that a further invitation should be addressed to these bodies, requesting them to examine into the whole question of the treatment of sinking funds and capital repayments, and also to investigate the nature of the various assets, and settle the rates of depreciation to be uniformly reserved by all corporations and local authorities in respect of the various assets. I have made no reference to the Irish bodies of

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accountants, not because I wish to exclude them, but simply on account of the fact that the recent enquiry did not extend to Ireland. From a professional point of view, if the matter is to be satisfactorily settled, Ireland should be consulted as well as England and Scotland.

Having thus settled a universal practice, it would then be beyond the power of cheese-paring councillors on the one hand or extravagant councillors on the other to do either injustice to present or future ratepayers, and another advantage would accrue, in my opinion, in the creation of added market value and credit to corporation investments by the common knowledge that all the assets everywhere were under the same sound system of writing down on terms settled by experts and decreed by law. This could be further secured by an obligation on the auditors to report to the Local Government Board annually that the statutory sinking funds and depreciation regulations had been duly complied with.

RECAPITULATION.

To recapitulate, my suggestions are :—

1. Depreciation should be charged in all undertakings liable to waste, obsolescence or supersession on terms quite sufficient to recoup or renew the assets when required, without recourse at any time to re-borrowing, repairs being charged direct to revenue year by year, so as to maintain the assets in efficient condition.

2. Longer periods should be allowed for the repayment of loans, especially in undertakings of a permanent character, where there is no risk of obsolescence.

3. Sinking fund should be charged separately without regard to depreciation.

4. All these matters should be settled by conference, as previously explained, so as to establish a uniform treatment of depreciation and sinking fund in the accounts of all corporations.

As many of you know, I have long taken a deep interest in corporation finance and its many problems, and consequently I have appreciated to the full this opportunity of laying before you my views on this important question. I am aware that I may find myself in conflict with some of those present at this conference, but as I have endeavoured to deal with the problem on the broad lines of justice and prudence, and, as I believe, in the direction of sound finance and just administration, which, after all, are the best guarantees of public confidence in public affairs, I court your frankest criticism. It is a question that appeals, perhaps, more to the municipal branch of our profession than to the one in which most of us "live and move and have our being." But as an interchange of views upon a matter of such universal interest is calculated to bring both branches into closer union in work and in sympathy, if my somewhat scattered treatment of the subject has tended to create a livelier interest on the part of the society in municipal accountancy, then I am amply compensated.

CORRESPONDENCE.

THE INVENTION OF "DYNAMO."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It has been suggested to me that I should write something to throw light on the circumstances under which Dr. Wilde brought his astounding action for libel against me, and so avail myself of an opportunity of clearing up some points which, owing to the form of the defence, could not come out in the trial. The charges made in the statement of claim may be briefly summarised as two :—

1. That it is a libel on Dr. Wilde to use the term "dynamo-electric machine" or "dynamo" for any machine of earlier date than that of Dr. Wilde's machines of 1863-1865, or to any later machine, unless constructed upon some "principle" alleged to have been discovered by him, and which when stripped of pedantic terms appears, see paragraph 6 of statement of claim (in *The Electrician*, Vol. L., p. 869) to mean the method of "the separately-excited dynamo." This principle Dr. Wilde claims as his, and denounces my having attributed it to Faraday.

2. The second point is: That he (Dr. Wilde) had made an agreement with me which bound me to describe his machines in some particular way, which he sets forth, and in which I was to declare that "this name" (of dynamo-electric machine) "was first given to the machine invented by Wilde"; or, again, that this term having been originated in 1867, "its first application was to the machine invented by Dr. Henry Wilde, F.R.S., 1863-1865." The statement of claim besought the Court to compel me to make these assertions, and to restrain me from making any mention of the plaintiff and his inventions, in my book on "Dynamo-electric Machinery," or in any new edition thereof, "or otherwise than in accordance with the said agreed proof or agreement."

I may very briefly deal with the first point. The term "dynamo-electric machine" appears to have had two independent origins—one in Germany, one in England. From information which has become available during th progress of this case, it is now clear that Dr. Werner Siemens and his brother, Sir William Siemens, were using the term in 1866-7, in private correspondence between themselves, to denote a *self-exciting machine*, such as Werner Siemens described before the Berlin Academy on January 17, 1867. On that occasion he publicly described his machine as a "dynamoelektrische machine" (see Werner von Siemens, "Technische Werke," II., p. 476; or *Sitzber.* Berl. Akad., November 18, 1880, p. 949), though the name does not appear in the Paper as printed (*Sitzber.* Berl. Akad., January 17, 1867, p. 55). Siemens continued to use the same name, publicly, as other published documents of 1867 show, to denote a *self-exciting machine* as distinguished from the older machines, whether separately-excited or with steel magnets, which older types of machines he regarded as merely magneto-electric machines. The English origin of the term was later. It occurs in an obscure Paper by Charles Brooke, entitled "Remarks on the Nature of Electric Energy, and on the Means by which it is Transmitted," in the *Proceedings* of the Royal Society of March 21, 1867, Vol. XV., p. 409. On this page Brooke not only gives his definition of this term but discusses the principle upon which it is etymologically formed. The passage is instructive :—

> The writer has elsewhere applied ("Elements of Natural Philosophy," p. 550, *note*) a definite and intelligible meaning to the construction of those compound terms which must be constantly employed in relation to the conversions of energy. This may be accomplished by taking the first section of the term to mean the *acting cause*, the second the *resulting effect*; thus a dynamo-electric machine will be one in which dynamic energy is employed to produce an electric current; and an electro-dynamic engine, one in which a current is employed to evolve dynamic energy.

According to this the first definition of the term *dynamo-electric machine* on its first appearance in the English language, the term would include *all* machines in which mechanical movement is used to generate a current. It therefore includes not only all machines now called by that name, including all the primitive magneto-electric machines from the days of Faraday downwards, but also all influence machines, and even all frictional machines. It is in this wider sense, but with the exclusion by common consent of all the electrostatic class, that the term has been used by Hopkinson, Hawkins and other writers. I so used it in my Cantor lectures of 1883; and for the past 20 years, though I have tried several varying phraseologies for its definition, I have so used the term. It is a generic term, and does not connote any man's special form. All English authorities, so far as I am aware, may be ranged under one or other of two groups—those who use the term generically, as defined by Brooke, and those who use the term in the narrow sense to mean self-exciting machines only, as defined by Siemens. What Dr. Wilde has in effect sought by this action is to deter all writers by fear of pains and penalties from using the word in *either* of these senses, and to force them to use it only in a new and totally unheard-of sense to mean only those machines which embody or depend upon some principle supposed to have been discovered by him, and embodied in his machines. The most strange thing about the whole business is that throughout the patent specifications which he took out, and the Papers he read to scientific societies, Dr. Wilde never called his machine a dynamo at all, but described it variously as a "magneto-electric machine" (Specification 3,006 of 1863, Specification 2,762 of 1865, and *Electrical Review*, November 22, 1884, p. 422), or "electro-magnetic machine," or as a "generator of dynamic electricity," an "electro-generating machine," or "electro-magnetic induction machine" (Specification 5,677 of 1882). Yet, when in my "Life of Faraday," p. 259, I call it Wilde's "new magneto-electric machine," this is declared by Dr. Wilde to be a false and malicious libel, meaning thereby "that the plaintiff was not, but some other person was, the inventor of the Dynamo-electric Machine"!

As to the allegation that I had entered into some agreement or contract to insert into my new edition the statement that "this name was first given to the machine invented by Wilde," the facts are briefly these:—Dr. Wilde, for whom, as my senior by some quarter of a century and a pioneer in the commercial applications of the dynamo, I had always entertained a great respect, had several times complained personally to me, on

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casual meetings, that I had not done justice to his inventions. I had assured him that I had not the least intention to do him an injustice, and that whenever I should be preparing a new edition I would look into the matter. Accordingly, of my own motion, on April 12, 1902, when the first galley-slips came in, I sent him, as an act of courtesy, a piece of the proofs, that he might see for himself whether I had succeeded in my effort. His reply was a solicitor's letter threatening proceedings! To cut short any account of the correspondence and the interview which followed, let me say that I succeeded, after much difficulty, in getting him himself to prepare me a version, which his solicitors sent me on June 16, 1902, as a type-written document. Looking through this, I saw it contained references to Brooke and other authorities, and as I had then no reason to question the accuracy of the statements, I accepted them *in bona fide*, as statements given by one scientific man to another, and I gummed one copy into my galley-slips to go back to the printers. Before sending off these slips it occurred to me to go to the library of the Royal Society to verify the references. To my utter amazement I discovered that the originals did not bear out the statements furnished to me. I found that the first machine to which the name dynamo-electric machine was applied by Brooke was *not* the machine of Dr. Wilde. On the contrary, the first machine to which Brooke applied the name was the influence machine of Holtz; and, further, so far from applying that name to Wilde's machine, he cited Wilde's machine along with that of Ladd and two others not as dynamo-electric machines, but as "cognate (*sic*) machines," differing from the dynamo-electric machine of Holtz in that, in these other four, "there is an intervening conversion of dynamic into magnetic energy." I was therefore in the position of having accepted, as true, statements which on enquiry proved to be false. I am certain that Dr. Wilde believed them to be true: any other supposition would be inconsistent with Dr. Wilde's whole conception of his claim to be the inventor of the dynamo. On my pointing out to Dr. Wilde that the passages which he had thus furnished to me were untenable, he himself sent me, on July 12, 1902, some new versions. Yet in this libel suit his lawyers have set up this old discarded version, admitted, even by Dr. Wilde, to be untenable; and his counsel have argued (unsuccessfully) that though there was no consideration alleged, there existed a contract under which I was compelled to insert these inaccurate and misleading statements. Need I say more. No self-respecting man could have consented to insert in his book, as though they were true, statements which he had found to be false, even though furnished to him by a respected and aged inventor who supposed them to be true. I preferred the worry and the waste of time and money inseparable from a Chancery suit, knowing full well that, even when I should have succeeded in my defence from this monstrous attack, the English law could award me no damages to compensate me for the inevitable loss. My heartiest recognition is due to my counsel, Mr. Buckmaster, K.C., and Mr. Gray, for the admirable way in which they have conducted my defence.—Yours, &c.,

London, Oct. 27. SILVANUS P. THOMPSON.

COMPENSATED AND COMPOUNDED ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I wish to reply to the criticisms of Mr. Meyer on the subject of commutated alternating-current machinery (see pp. 803 and 1,038 of *The Electrician* of September 4th and October 16th). My interference is quite justified, since, as impartial readers of *The Electrician* certainly recollect, I have never ceased to claim complete priority of invention of the commutated machinery under discussion.

Mr. Meyer is mistaken in comparing the compensated motor to an ordinary induction motor. On the contrary, the compensated motor should be compared to the synchronous motor, over which it has the following advantages:—

1. Unity power-factor obtained automatically at all loads.
2. The rotor may be made much lighter (less copper and iron) in the compensated motor, and this without risk of its getting out of step under serious overloads.
3. The compensated motor is not subject to hunting.

Synchronous motors are often used at present in large sizes. The compensated motor will, in consequence of these advantages, be substituted for the synchronous motor in all installations.

Mr. Meyer questions the advisability of building commutated alternating-current generators with a large number of poles, and I am quite of his opinion, believing that this type of generator is suited only to the construction of high-speed machines with few poles. I know that my compounded commutator type of high-speed alternator is a cheaper machine than the present type of machines with separate exciters. In fact, with my type of alternator the commutator and connections of the exciter are simply transferred to the rotor of the alternator, where they take the place of the collector rings.

The advantages of compounded alternators (economic construction and automatic regulation of voltage) are to-day universally recognised. No other type of compounded alternator or automatic voltage regulator can give as close and reliable a voltage regulation as my compounded commutator type of alternator, especially as in my machines the stator reaction is annihilated in magnitude, in direction and in form. The voltage regulation is, therefore, instantaneous, and is obtained for each phase separately, thereby compensating for all dissymmetric loads on the circuit of any power factor whatsoever. The copper on the rotor of my machines does not sensibly exceed in weight the copper on the stator, which condition corresponds to the best possible economy.

The commutated alternating-current machinery forming the subject-matter of my patents is not intended to bring about a revolution in electrical construction, as may be inferred from the large publicity given to the subject by others, but I am convinced that my machines are superior to the present type of high-speed alternating-current generators.—Yours, &c.,

Paris, Oct. 22. M. LATOUR.

N.B.—Mr. Meyer should know that the compensated motor under discussion, with or without short-circuited rotor windings, corresponds in fact to the Wilson motor (*see* British patent 18,525 of 1888) when operated at approximately synchronous speed, as is necessary to satisfy the conditions of commutation.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To conclude from my side the present discussion on the question of compensated and compounded generators, and in answer to the letters of Messrs. Heyland and Fynn in your issue of October 23rd, kindly publish the following remarks:—

With regard to Mr. Heyland's letter, I was fully aware at the time of writing my notes on the compensation and compounding of alternating-current generators, that such machines are being built, and that some have even been tested, but what I contest is the claim of commercial superiority or even equality with the standard revolving field type of modern design, special cases excepted. If my suppositions are fallacious, it is for Mr. Heyland to prove this. However, it would seem that this would be difficult—at least, if the rest of my suppositions is only nearly as correct as that referring to the comparative first cost of the two types of machines.

With regard to Mr. Fynn's remarks: I can assure him that the compounding arrangement referred to in my article is radically different from that mentioned by him. The use of a relay which, by means of magnetic clutches, acts mechanically on the rheostat of the exciter field, is indeed an old scheme; its drawback is the considerable time lag and its consequences.

Referring again to the new B.T.-H device, I give below some additional information, which I trust will be sufficient to convince Mr. Fynn of the novelty of the scheme.

A constant resistance is put into the field circuit of the exciter, so that the voltage of the latter is reduced to about 40 per cent. of its normal value. In parallel with this resistance is a circuit containing a contact device which short-circuits and open-circuits the exciter resistance in rapid succession, thereby changing the exciting current to a more or less pulsating current. The frequency of the make and break of this circuit is controlled by the voltage and the current of the generator, and varies from about 1 to 20 per second. The smallest drop in the voltage will cause the rheostat to be short-

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circuited for a longer period, thus raising at once the voltage of the exciter and the main generator. The rapidity of action and reaction is such as to keep the voltage practically constant for all such changes in load, power-factor and speed of the engine as are experienced in modern plant.

Further details and test results I must defer for the present.—Yours, &c., H. S. MEYER.

Rugby, Oct. 26.

THE QUESTION OF THE HOUR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As a firm believer in Free Trade—where we can get it—I should like to ask why it is that so many followers of Cobden give all the credit for our material progress to the comparative absence of import duties on our part, without so much as a glance at other contributory causes. Surely they lay themselves open to effective rejoinder and do their cause harm. After all, to the statement that our prosperity is due to "Free Trade" it is a good reply that we should have done better with modified Protection, since both statements are mere matters of opinion.

In your last issue "H. C. D." cites submarine cable enterprise as an instructive instance "among our innumerable industries which have attained world wide pre-eminence under Free Trade." It can, however, hardly be contradicted that, after British scientific discovery and our large foreign trade, the main factor (there are very many others) which made our wide-spread cable communication possible was the existence all over the world of British stepping-stones in the shape of ports under our control. Let me mention the landing places on the eastward route:—Gibraltar, Malta, Egypt, Aden, Bombay, Madras, Penang, Singapore (omitting Java), Australia and New Zealand. So that we are able to lay cables—none of which exceed 2,150 miles in length—to the Antipodes without touching at more than one foreign spot, and even that may be considered neutral. Contrast this with the position of, say, France. When she wanted a national line to Madagascar it was seriously proposed to lay a continuous cable from her possessions in West Africa round the Cape and up to her great Island Colony—a distance of about 4,500 miles. But perhaps the genius of our forefathers for annexing strategic points was due to Free Trade!

Another reason why cable enterprise is perhaps the very worst illustration that could have been chosen for the purpose of the present controversy is that no country can impose duties on conductors lying at the bottom of the high seas, while so anxious were our Colonies and foreign countries to secure cable communication that they did not even levy duties on the shore ends within the 3 mile limit! If it had been possible for them to put a 25 per cent. duty on cables as on machinery would our position have been what it is? Cable enterprise is, no doubt, a unique instance of what our export trade, with all our other advantages, might be if we had real Free Trade—*i.e.*, if our Colonies and foreign nations did not impose duties against our products; but it should be contrasted, not compared, with the manufacture of machinery under present conditions for home use and export. Forty years ago capital for the cable network could not have been raised abroad, now our trade rivals both can and do lay long cables, thanks to their accumulated capital largely due to profit on exports to our free market.

Notwithstanding the denial by Mr. Sayers of any parallelism between commerce and war, ought we not, as Free Traders, to fight with tariffs for as near an approach to foreign free trade as we can now get, just as General Grant said he would have peace if he had to fight for it. Suppose, as an illustration, both we and the United States agreed to put only 10 per cent. on machinery, would trade not be more free, especially for us, than with the United States imposing 20 per cent. and we nothing? Recognising that your columns are not a proper place for a general discussion on the subject of the hour, I have compressed the argument as much as possible. By the way, I hope to goodness no fiscal Oliver Twist will ask for all the connecting links.—Yours, &c., G. R. N.

London, Oct. 24.

INSULATING PAPER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to your note on Insulating Paper in *The Electrician*, October 23rd, p. 31, in which you refer to the large amount of Manila paper which comes from the United States nowadays, you touch on a subject which ought to be a real grievance to our English paper makers, but which, however, only serves to furnish another instance of the apathy of the British manufacturer in face of competition from abroad. From the point of view of the cable maker (who is the chief user of Manila paper for insulating purposes) such a state of things is also to be deplored, inasmuch as, in my experience of insulating paper, extending over seven or eight years, very little of the alleged Manila paper from the land of wooden nutmegs has any appreciable proportion of Manila fibre in it. The greater part of the many dozens of samples I have analysed I have found to be as full of wood as the nutmegs. Straw is also very largely used by our cousins across the pond, and I have found some of the alleged Manila papers to consist of it solely.

I suppose it is hardly necessary to point out the utter unsuitability of such "Manila" paper for cable or other insulating work, viewed either from a chemical or an electrical standpoint, or that the strength and appearance of a paper before impregnation or drying form no criterion of its behaviour or efficiency when doing its insulating duty under the pressure of volts and the disturbing scurry and surging of capacity currents, hysteresis watts and things. The strength, so much admired, diminishes very appreciably when heated during drying or impregnation. Residual chemicals (which are practically inevitable in papers of the wood or straw class, owing to the drastic chemical treatment necessary in their preparation) retained by the fibres lay waiting to become the sport of leakage current or to quarrel with the insulating compound, and so on. To the cable works' chemist such papers are, or should be, taboo. This granted, what becomes of all the "American Manila" paper? Surely it is not sent here for "dumping" purposes only. Perhaps we should not press the question.

I am bound to admit, however, that, backward as English paper manufacturers are in providing a decent pure Manila paper, they can make it uniformly and of good quality when they have been educated to the requirements and precautions to be observed in the manufacture. But as my firm, Messrs. W. T. Glover & Co., know well, it is by no means easy to get the average paper maker to depart from the methods of his forefathers, nor is it cheap to acquire and maintain a satisfactory standard of purity and excellence. But it can be done, and if engineers would insist on having their "Manila" papers free from wood pulps of any kind or from fibres of the straw and esparto class, it would not only tend to greater efficiency and durability, but would "Support home industries" into the bargain.—Yours, &c. C. BEAVER.

Manchester, Oct. 28.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Tube, Train, Tram and Car; or Up-to-date Locomotion." By A. H. Beaven. With an introduction by Llewellyn Preece. (London: G. Routledge & Sons.) 6s.

"Notes on Material, Construction and Design of Land Boilers." By Edward G. Hiller. Published by the National Boiler & General Insurance Co. (Manchester: Taylor, Garnett, Evans & Co., Ltd.) 1s.

"Fowler's Mechanical Engineer's Pocket-book for 1904." Edited by William H. Fowler. (Manchester: Scientific Publishing Co.) 1s. 6d. net.

"Cours d'Électricité." By H. Pellat. Vol. II. (Paris: Gauthier-Villars.) 18fr.

"Proceedings of the Cambridge Philosophical Society." Vol. XII., Part III. (Easter Term, 1903). (London: C. J. Clay & Sons.) 2s. 6d.

"The Matriculation Directory" (No. 35, September, 1903): with Lists of Text-books for use under the New Regulations of the University of London. (Cambridge and London: University Correspondence College.)

"Designing Ironwork." Second Series. Part IV. General Data on a Fireproof Floor. By Henry Adams. (London: The Author.) 2s.

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LEGAL INTELLIGENCE.

Wilde v. Thompson.

This was an appeal from a judgment by Mr. Justice Buckley in the Chancery Division on March 13, 1903, and was heard before Lords Justices Vaughan Williams, Romer and Stirling, on Monday. A full report of the previous action appeared in *The Electrician*, Vol. L., pp. 869 and 911. Mr. Thomas Terrell, K.C., and Mr. Clarkson now appeared for Dr. Henry Wilde, F.R.S., and Mr. Buckmaster, K.C., and Mr. Gray represented Dr. Silvanus P. Thompson, F.R.S. The original judgment struck out the statement of claim in an action pending between Dr. Wilde and Dr. Thompson as showing no cause for proceedings and that it was vexatious. The appeal was for this finding to be set aside, and for the action to be allowed to go before a judge and jury.

Mr. TERRELL, K.C., said the point raised was substantially one of libel. Supposing a man had a big reputation for certain actions; was it depriving him of that reputation to state that somebody else did that same thing before him? It was this which was alleged in the first six paragraphs of the statement of claim (see *The Electrician*, March 13, p. 869). Particular statements concerning a man of no reputation might be no libel in that instance, but the same statements with reference to a man of undoubted reputation might be a very great libel. Dr. Wilde was the inventor of what was known as the "dynamo electric machine" or "dynamo," and he was very jealous of that reputation, and maintained that by attributing this invention, as the defendant had done, to Faraday, he was being deprived of that reputation. That amounted to libel. However, he could find no authorities to quote except one which was, he confessed, some way off the present case. In this case a book by a certain author was republished by the publishers edited by another man, who made mistakes. The original author claimed and recovered damages. There was also another point in the statement—viz., breach of contract. The plaintiff had complained of certain passages in Dr. Thompson's book on "Dynamo Electric Machinery," with the result that the defendant had agreed to omit or modify these in the new edition of that work, but he now declined to do so. He maintained that this was an agreement within the law of contract.

Lord Justice ROMER: What is the consideration?

Mr. TERRELL replied that there was the mutual consideration of a settled agreement. There had been a claim made by the plaintiff as to certain passages in the book, and upon that claim being asserted it had been settled by an agreement to withdraw or modify these statements. That he held to be good consideration. It did not matter whether the original claim was well founded or not. An agreed modification had been settled.

Lord Justice VAUGHAN WILLIAMS said there was no consideration. It was impossible to have a bargain unless both parties were bound to something.

Mr. TERRELL said the consideration was in paragraph 7 of the statement of claim.

Lord Justice ROMER: That is simply a friendly action on the part of the defendant.

Mr. TERRELL: In the absence of any authority on this point I cannot put the case any higher.

Lord Justice VAUGHAN WILLIAMS: The statement of claim does not amount to the statement which you allege in your second paragraph.

Mr. TERRELL argued that it was true consideration. It was not what the particular statements meant in their natural sense. One must take into consideration the circumstances existing at the time they were written. Therefore, the plaintiff had the right to assert that the words had a certain meaning, and under the circumstances the case ought to come before a jury.

Lord Justice ROMER said there were many persons in this world who thought they were discoverers of important matters. If every person who wrote a book on any particular matter was to be subjected to an action for libel because he did not give the fullest merit claimed by every inventor upon that subject, nobody would ever be able to write a history of science. No two inventors were ever agreed as to the extent of their invention, and if this state of things existed it would be terrible. The courts would be inundated with libel actions under such circumstances.

Mr. TERRELL, continuing his case for the plaintiff, read the judgment of Mr. Justice Buckley appealed against, and argued that in this too narrow a view of the meaning of the term "libel" had been taken. In his opinion it was an actionable wrong to deprive a man of his reputation. It was reducing his position below the level it had the right to occupy.

Lord Justice VAUGHAN WILLIAMS: On the question of libel, there is no libel in the statements complained of in paragraph 5.

Lord Justice STIRLING said that if a search was made of all Faraday's researches and laboratory experiments he had no doubt that a number of ideas would be found which had since been discovered and patented by others. This was because Faraday had not published them, and he did not see how a discovery by one man could prevent another man from independently discovering the same thing.

Mr. TERRELL replied that it was not the discovery of the electromagnet, but the principle of applying it to working.

Lord Justice ROMER: Do you mean that Faraday never used an electromagnet?

Mr. TERRELL: Yes. That is what the plaintiff alleges.

Lord Justice ROMER: A separately excited dynamo was used by Faraday.

Mr. TERRELL: The plaintiff alleges that he himself invented this.

Lord Justice ROMER: I cannot agree to this.

Mr. TERRELL, in conclusion, submitted that Dr. Wilde had been deprived of his reputation and that there was sufficient consideration between the two parties as to the insertion of the modified passages in the book.

Mr. CLARKSON, also for Dr. Wilde, said that the gist of the complaint was that Dr. Wilde claimed to be the inventor of the dynamo, and Dr. Thompson had stated in his book that it had been invented prior to 1866, when Dr. Wilde made the invention. This brought the plaintiff into ridicule or contempt, for his great reputation was taken away from him by the dissemination of such statements which claimed that he was not entitled to this reputation. Of course, if the case went for trial by a jury and he failed to prove that he had acquired this reputation then his action would fail.

Lord Justice VAUGHAN WILLIAMS pointed out that contempt or ridicule was not complained of in the statement of claim. The complaint was that the plaintiff was deprived of the credit of being the inventor of the separately excited dynamo. Dr. Wilde may have invented the large power generator of dynamic electricity, but somebody else might have invented another not nearly so good beforehand.

Mr. CLARKSON said that the statements complained of were tantamount to saying that the dynamic electric machine was a thing known before the invention of Dr. Wilde.

Lord Justice STIRLING: There was never an invention made upon which some reference to an obscure prior invention was not made by some writer.

Lord Justice ROMER said that the words in the book did not use the term "dynamo" as applying specifically to Wilde's machine. The word was applied generally. On the face of it this was so. What was the use of going to trial upon a point which could not be proved and succeeded in? He could not make out why the plaintiff wished to go to trial. What reasonable hope was there of success? Dr. Wilde's reputation had not been damaged in any way whatever.

This concluded the case for Dr. Wilde, and without hearing any arguments from counsel for Dr. Thompson,

Lord Justice VAUGHAN WILLIAMS said: The decision of Mr. Justice Buckley must be upheld. Speaking for myself, in coming to this conclusion I must not be supposed in any way to be affirming such a proposition that you cannot libel anyone by denying his title to a reputation which he may have obtained as an inventor or as a man of science. It seems to me that it is not at all necessary to come to such a conclusion in order to support the judgment of Mr. Justice Buckley. Nor, as I understand it, is it at all necessary to support that judgment to say that to publish such things of an inventor or of a man with a reputation as a scientist necessarily falls outside the old definition of defamation as being something which is calculated to bring him into hatred, contempt or ridicule. I support this judgment of Mr. Justice Buckley upon the terms of which Mr. Justice Buckley puts it. The statement of claim states that Wilde is the first discoverer of the principle of the indefinite increase of magneto-electric forces from quantities indefinitely small, but that part of the statement of claim which deals with the injury which he suggests he has suffered does not in any way say that there is anything in defendant's book which is not consistent with that portion of the statement of claim I have just read. In fact, the statement of claim goes on to say that the plaintiff invented a new and powerful generator of dynamic electricity in which his said discovery was embodied and practically applied by him with marked success in the direction of the electric searchlight and to the electro-deposition of metals from their solutions, and that it has also been since applied to other important purposes. Well, now, as far as we have got, there is nothing in the passages of the book set forth in the statement of claim which is inconsistent with the definition of the statement of claim of the plaintiff. But the real point of the statement of claim is that the plaintiff goes on and says that his invention was subsequently designated by the term "dynamo electric machine" or "dynamo" by way of distinguishing the said machine from the magneto-electric machines which generate electricity through the agency of ordinary permanent magnets, and which in no way embody or depend upon the plaintiff's discovery of the said principle. But the word "dynamo" was not appropriated exclusively to a description of the machine which the plaintiff says he invented. There is nothing to justify the statement that it was appropriated exclusively to his machine. Under these circumstances it seems to me that Mr. Justice Buckley was perfectly right in the conclusion that he came to. If the plaintiff thinks he can improve upon his statement of claim as set forth, there is nothing to prevent him making an application to be allowed to make such an amendment, but I do not suppose that really it would be possible to do so. I do not doubt that the statement of claim as it stands goes to the very limit of which the plaintiff hopes to be able to prove. With regard to the hardship which it is alleged is being done to the plaintiff, because his reputation as a scientific inventor might be damaged, although we know that inventors are a very thin-skinned, excitable class, I cannot understand even an inventor supposing that there is one word in defendant's book which in the slightest degree can injure his reputation. On the contrary, if you take the passages set out as a whole, they seem to me to recognise to the fullest degree the scientific reputation of the plaintiff. With regard to the action of the supposed breach of contract, all I can say is, that there is no statement in the statement of claim bringing it within the law of contract. There is no suggestion that there was anything to sue or intention to sue. It seems to be a mere conversation in which Dr. Silvanus Thompson expressed, for the sake of peace, an intention to do that which he ultimately found he could not, according to his view, properly do. There was no agreement here which in the slightest degree would have prevented the plaintiff from bringing this action. Under these circumstances, Mr. Justice Buckley was right, and this statement of claim ought to be struck out as not disclosing any cause of action, and so long as that order stands it is perfectly right that this action should be dismissed.

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Lords Justices Romer and Stirling concurred.

Mr. TERRELL asked leave for the plaintiff to be allowed to consider his position with a view to a possible amendment of his statement of claim.

Lord Justice VAUGHAN WILLIAMS said he only made this suggestion in case there might have been some slip in the present statement of claim.

Lord Justice ROMER said that surely the plaintiff could not wish to continue the matter.

Mr. TERRELL replied that he would not have made the application had it not been for the remark made by Lord Justice Vaughan Williams.

Mr. BUCKMASTER, K.C., for the defendant: I ask that the appeal be dismissed, with costs.

Lord Justice VAUGHAN WILLIAMS: Yes.

Greenhouse v. South Lancashire Electric Traction and Power Co.

In the Chancery of Lancashire, Manchester, on Monday, this case came before the Vice-Chancellor (Sir S. Hall) on a motion by the plaintiff, a debenture-holder.

Mr. GRANT, for plaintiff, said his client claimed that a declaration that extraordinary resolutions of the debenture-holders recently passed were not within the provisions of an indenture dated Jan. 28, 1901, and he asked for an injunction to restrain defendant company from giving effect to the resolutions and for the appointment of a receiver and manager. The point was whether a majority were able to carry, as against a minority, a resolution which reduced the present first debenture-holders to the position of second debenture-holders, by giving the company power to issue debentures to the amount of £600,000 and place them in front of the present debentures.

Mr. HUGHES, K.C., for the company, suggested the motion be postponed if an early trial of the action could be arranged, the company undertaking to keep matters in statu quo meanwhile, and

The Vice-Chancellor fixed Nov. 16, at Liverpool, for the trial of the action.

Forster v. Barker.

At West Hartlepool County Court on Friday, the Rev. M. Forster sued defendant, a local plumber and ironmonger, for £40. 19s. 10d., damages caused by alleged defective work done and materials supplied in the erection of an overhead wire for conveying electric current from Wingate Colliery to the Roman Catholic schools at Wingate, and for breach of warranty and guarantee in respect thereof.

Evidence was given that the wire broke on two occasions, and in a gale between March 13 and 14, 11 spans came down.

Mr. THOS. BROWNLESS, electrician, said the wire used was very soft, the joints were not properly made, and the insulators were not proper for outside use.

For the defence, it was submitted that the work was reasonably and properly carried out, and that proper materials were provided.

Mr. H. F. FRIEDRICHS, borough electrical engineer, said the wire might have been hard drawn, and become heated through in consequence of fusing. The insulators were such as were used in one or two works connected with the Corporation's mains, and they answered their purpose. The joints might have been soldered; he considered these were not proper for outside work.

Mr. GEO. H. PRESCOTT, electrician, considered the insulators were sufficient for the work. The joints would have been better had they been soldered.

The Judge did not think plaintiff had established his case, though he could not help thinking that it might have been established. He must find for defendant, with costs.

In Re Geo. F. Milnes & Co. (Ltd).

On Tuesday, before Mr. Justice Buckley, an order for the voluntary winding-up of this company, under the supervision of the Court, was made, the receiver in the debenture-holders' action being appointed as additional liquidator.

Electric Tramways Construction and Maintenance Co. (Ltd.).

On Tuesday Mr. Justice Buckley heard a petition by E. Horton and others for the winding up of the company.

Mr. KIRBY, for petitioners, now asked that the petition be dismissed on terms arranged with the company, and his lordship assented.

In re Reuter's Telegram Co. (Ltd.)

Mr. Justice Buckley, on Tuesday, heard a petition by the company seeking additional powers. The company was established in 1865 to take over the telegraphic business of Mr. Julius Reuter, and in 1891 the Court sanctioned an extension of the objects to telephonic and advertising business.

His Lordship now sanctioned extension of the company's objects to the collection and remittance of money, &c., by telegraph, telephone, &c., and to make advances on merchandise and mercantile documents, particularly in connection with the despatch or carriage thereof between different countries or places.

John Pickering & Sons v. Urban Electric Supply Co. (Ltd)

Mr. MAUGHAN mentioned this action (relating to the laying of a cable which plaintiffs alleged was an infringement of their rights) to Mr. Justice Farwell on Monday, stating that an order had been agreed to between the parties which would stop further proceedings.

His lordship sanctioned arrangement.

Andrew v. Failsworth Industrial Co-operative Society.

At Oldham County Court, on Wednesday, Mary Andrew claimed (under the Workmen's Compensation Act) £300 from the Failsworth Industrial Co-operative Society in respect of the death of her late husband.

Mr. FRIPP, for the applicant, said her husband was a bricklayer employed by respondents. On Aug. 14 he was struck by lightning whilst at work and killed, and he submitted it was an accident within the Workmen's Compensation Act. His theory was that the lightning was attracted by the steel girders, and he suggested that the presence of the girders ought to have been taken into consideration in relation to the claim. He argued that death took place from a natural cause "incidental to the nature of the employment," and that a man on the top of a building was more liable to be struck by lightning than a man protected by the presence of non-conducting materials.

Mr. CHAPMAN, for respondents, submitted that it was not an accident within the meaning of the act, as it did not arise out of the employment.

Judge BRADBURY said if evidence were forthcoming to satisfy him that there was an appreciably greater risk owing to the man being where he was at the time of the stroke he would say the Society was liable, and he adjourned the case for scientific evidence.

Verey & Co. v. Saunders.

At Dover County Court last week plaintiffs sought to recover from defendants, an electrical engineer, £11s. 8s. for goods supplied. Both parties had had business relations for some time.

Mr. VEREY stated that he offered to let defendant have goods for the wiring of the Buckland Church School at 70 per cent. less than trade price so that defendant might be able to reduce his tenders for the wiring of the school. It was not true that these were a gift to defendant.

Eventually, judgment was given for plaintiff for £15. 2s. 6d. and costs.

Re Elmore's Trust (Ltd.).

On Tuesday Mr. Justice Buckley had before him a petition for the compulsory winding-up of this trust, but no one appeared in support of the petition, and it was dismissed.

Legal Causes.

The following causes with an electrical interest have been set down for hearing at the Royal Courts of Justice during the present Michaelmas Sittings:—

COURT OF APPEAL.

CHANCERY DIVISION.—*General Appeals.*

National Telephone Co. (Ltd.) *v.* Corporation of Hull. (Appeal of plaintiffs from order of Mr. Justice Buckley, June 17, 1903.)

Patent Exploitation (Ltd.) *v.* American Electrical Novelty, &c., Co. (Ltd.). (Appeal of plaintiffs from order of Mr. Justice Buckley, June 24, 1903.)

KING'S BENCH DIVISION.

New Trial Paper.

British Mannesmann Tube Co. *v.* Tonks Limited. (Application of plaintiffs for judgment or new trial on appeal from verdict and judgment, March 25, 1903, at trial before Mr. Justice Bruce.)

Interlocutory List.

The Metropolitan Electric Supply Co. (Ltd.) *v.* Lundy and another. (Appeal of defendants from order of Mr. Justice Walton, Sept. 1 1903.)

CHANCERY DIVISION.

Before Mr. Justice Kekewich.—Causes for Trial with Witnesses.

Jandus Arc Lamp and Electric Co. (Ltd.) *v.* Arc Lamp Limited. (Action.)

Before Mr. Justice Buckley.—Further Consideration.

In *re* Easton, Anderson and Goolden (Ltd.). Wilson *v.* the Company.

British Pioneer Electric Light and Power Co. of India (Ltd.) *v.* Bingham. (Further consideration by original action.)

Bingham *v.* British Pioneer Electric Light and Power Co. of India (Ltd.). (Further consideration by counterclaim.)

Companies Winding-up Petitions.

Electric Tramways Construction and Maintenance Co. (Ltd.). (Petition of E. Horton and others.)

French Electric Lighting Boards (Ltd.). (Petition of Electric Lighting Boards (Ltd.) and its receiver.)

Desolle Electro-Plating Co. (Ltd.) (Petition of Wm. Canning & Co.)

KING'S BENCH DIVISION.

Special Jury Actions.

Electric Tramways Construction, &c., Co. (Ltd.) (Contract.)

Common Jury Actions.

Tamplin and Makovski (Ltd.) *v.* Piccadilly Motor Co. (Money paid.)

Non-jury Actions.

London Scottish Engraving Co. (Ltd.) *v.* Consolidated Telephone Construction and Mfg. Co. (Work.)

Tramways in Canada.—The Dominion Parliament have passed a measure safeguarding the rights of municipalities and provinces to grant charters exclusively for the construction of local railway lines. This is directed against certain tramway corporations, which, not liking the terms demanded by municipalities for franchises, have sought to secure them direct from the Federal authorities.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Rotherham Education committee invite applications for the position of lecturer in engineering (including geometry and mathematics) in the Technical Institute. Salary £120. Particulars from the director of Higher Education (Mr. C. H. Burkhardt, M.Sc.), Town Hall, Rotherham, to whom applications by Nov. 10. See advertisement.

There is a vacancy for an improver at the Barnsley electricity works. Applications to borough electrical engineer, Mr. E. A. Barker. See advertisement.

There is a vacancy for an improver at municipal electricity works during laying of mains, erection of plant, &c. See advertisement.

A test-room assistant is required by Messrs. Crompton & Co. (Ltd.) Chelmsford. See advertisement.

King's Norton and Northfield Urban District Council require a clerk of works to superintend the erection of overhead equipment and laying of mains for about 3½ miles of electric tramway. Applications to Mr. Edwin Docker, 10, Newhall-street, Birmingham, by Nov. 2.

Mr. H. D. Wilkinson, M.I.E.E., has been selected to deliver lectures on wiring and technical mathematics at the South-Western Polytechnic, Manresa-road, Chelsea, London, S.W.

Mr. Charles Burgess, of the electricity works, Derby, has been appointed clerk to the Kirkaldy (N.B.) electricity works.

Mr. R. Dinmack, of Thomas Parker (Ltd.), has been appointed mains draughtsman to the Newport (Mon.) electricity and tramways department.

Mr. G. F. Kenyon, of Frizinghall, Bradford, has been appointed (out of 102 applicants) assistant electrical engineer at Shipley Council's electricity works.

Mr. G. C. Law, engineer-in-charge at Bermondsey, has been appointed assistant electrical engineer at the electricity works of Barnes District Council.

Mr. H. E. Brown has been appointed second distributing assistant at the Poplar (London) electricity works.

Mr. J. W. Kenyon, B.Sc., late assistant lecturer at Hull Municipal Technical School, has been appointed lecturer in physics at the Swindon and North Wilts Technical School.

EDUCATIONAL NOTICE.

Technical Instruction in Ceylon.—The Technical College at Colombo is a Government institution established in 1893 and reorganised in 1897. It forms the regular channel for admission into the post and telegraphs, public works, railway and survey departments of the Government. At the college there are departments for civil, mechanical and electrical engineering, telegraphy, &c. 165 students were enrolled in 1902.

Accrington.—The local tramways company have offered to equip the tramways electrically, provided the company be not disturbed for seven years from the commencement of the use of electric traction.

Altrincham.—A plebiscite of ratepayers on the question whether the Council should obtain electric tramway powers has resulted in 1,311 affirmative and 1,098 negative votes.

Arbroath.—The protracted negotiations for the transfer of the Council's electric lighting order have culminated in the acceptance of the proposals of the Empire Electric Light and Power Co.

Asylum Lighting.—Amongst other improvements at the Cumberland and Westmoreland Asylum which have been approved by the Lunacy Commissioners and the Secretary of State is an electric light installation estimated to cost £8,000.

Belfast.—Consumers of electricity for lighting, who take over 25,000 units per annum are in future to be allowed a 5 per cent. discount.

Birmingham.—An arrangement has been arrived at for the erection by Birmingham Corporation of electrical plant at the destructor works at Saltley, to generate the electric energy required by the Birmingham, Tame and Rea District Drainage Board.

Bolivia.—Particulars, catalogues, prices, &c., of alternating and direct-current electric generators and motors, transformers and rotary converters, switchboards and measuring instruments, overhead trolley lines and fittings, third-rail insulators, plastic and copper bonds, screw jacks and lifting tackle, contractors' plant and tools, turbines, and general railway stores are required by the Director of Public Works for the Government of Bolivia, Mr. D. Clive Sheppard, who is also general manager of the Guaqui-La Paz Railway. Communications for Mr. Sheppard should be sent by registered post either via New York or via Panama and Mollendo.

Bolton.—The Council have applied to the Board of Trade for sanction to generate and transmit electric current at extra high pressure.

Bradford.—The report of the Tramways committee states that during the past year the total length of tramway route has increased from 39 to 45 miles. The car mileage has increased by 1,719,896 miles, and the receipts by £68,964. There are 206 cars, 187 of which are in service. Various extensions were opened for traffic during the year, and the alterations in fares and conditions made in January have been successful.

The total number of car-miles run during the year ended Aug. 31 was 4,353,139, compared with 2,633,241 in 1902, the receipts were £183,648, against £114,664, and the average receipts per mile 10·12d., against 10·45d. The number of accidents for the same period was 1,168, none of which were fatal. Calculated upon the mileage, the proportion of accidents was less than in the previous 12 months. The life-guard fixed to the cars had proved of great value in preventing serious accidents. In 64 cases pedestrians were knocked down by the car and picked up by the life-guard. In no case was serious injury inflicted. 44,000,000 passengers were carried during the 12 months. The staff (exclusive of general manager) consists of 901 persons, compared with 826 in 1902. During the year a commencement was made with the construction of the Barkerend-road tramway and with several junction lines necessary to form a central terminus at the Town Hall. Including the Saltaire line, the total lengths of lines now worked by the Corporation and open for public traffic are: Single line, 14 miles 250yds.; double line, 31 miles 1,699yds.; length of route, 45 miles 927yds.; length reduced to single track, 78 miles 128yds.

Brent.—A meeting of ratepayers is to be called to discuss a scheme for the erection of electricity works.

Bristol.—The Electrical committee have adopted the recommendations of the Wiring sub-committee that "free" wiring be done through local contractors, and that a percentage of the cost of installation (to be fixed after sanction of the loan by the Local Government Board) be charged as rental; that if the hire-purchase system is preferred the consumer shall pay 10 per cent. of the cost on signing the agreement, and 12 quarterly instalments of 8½ per cent. of the cost, with interest at 4 per cent. per annum on the principal outstanding; or that the instalments may be extended so as to cover any period up to five years. Regulations for letting motors on hire have been approved.

Buenos Ayres.—The directors of the City of Buenos Ayres Tramways Co. have protested formally to the Municipal Council as to the attitude of that body to the company's application for a modification of their concession, in order that electric traction might be adopted:—

The company's lines are 216km. in length, of which 60 are held under a concession for an indefinite period, without any obligation of surrender, and 156 for 99 years. The company desire to adopt electric traction on all their lines, and solicits from the Municipal Council permission to make the conversion, asking for a new concession for the whole system for 99 years, similar to that previously granted to the Anglo-Argentine and Buenos Ayres and Belgrano Companies. The manner in which this proposal has been met is the cause of the protest which has been made.

Calne.—The proposed application of the Southern District Electricity Co. for a provisional electric lighting order is being considered by a committee.

Camberwell (London).—At the last meeting of the Borough Council an application of the County of London Company for leave to fix a transformer box in Burbage-road was granted, subject to any disturbance of the footway or roadway being made good to the satisfaction of the borough engineer, and to the company giving an undertaking that, should the site or any portion thereof or the works connected therewith be required at any time for public purposes, the company would pay the cost of removal or of any alterations. On Wednesday a letter was received from the company's solicitor, stating that his clients could not accept the Council's conditions, and unless these were withdrawn there would be no alternative but to submit the matter to the Board of Trade. After discussion the town clerk was authorised to support the conditions before the Board.

Canary Islands.—An application is before the Spanish Government authorities for a concession for an electric tramway from the port of La Luz to Sardina.

Cheltenham.—Friction has arisen between the Corporation and the Cheltenham Light Railway Co. in regard to certain proposed extensions. The trouble is as to the material to be employed in paving the route of the company's lines.

Chesham.—The Council are negotiating with the Empire Electric Light and Power Co. for a supply of electrical energy for the waterworks pumping station.

Dublin.—An application was made last week to the Judicial Committee of the Irish Privy Council by the Dublin United Tramways Co. for an order to extend by three years the time for completing certain portions of their tramways. After hearing counsel

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for the applicants and for Rathmines District Council, who opposed, an extension of two years from the present time was granted.

Dumfries.—The Corporation have received an offer from Messrs. Frank Suter & Co. to construct and equip (with the co-operation of W. T. Glover & Co., the British Westinghouse Co. and the Tudor Accumulator Co.) electricity works for the town on payment of £16,300 capital expenditure by the Council, interest and sinking fund to be paid by the contractors, who will also divide equally any profit with the Corporation.

It is proposed that any loss shall be borne by the contractors who, however, stipulate for reimbursement in subsequent successful years. The Council are to have the right of taking over the undertaking at any time upon one year's notice. It is proposed that the charges for current shall be 5½d. per unit for private lighting and 2½d. for public lighting and for power purposes.

East Barnet.—The District Council recently called in a second electrical engineer (Mr. F. J. Warden-Stevens) to report upon electric lighting, and in his report he confirms Mr. Adams' recommendation to retain the electric lighting order, but, instead of erecting municipal works, to take current in bulk from the North Metropolitan Electrical Power Distribution Co. and to lay down their own distribution system. Mr. Warden-Stevens' scheme would involve a capital expenditure of £14,821.

Eastbourne.—At a special meeting of the Council on Monday the chairman of the Electric Light committee (Councillor Maude) said he was not satisfied with the municipal motor buses, and he did not advise any increase in their number until it was ascertained whether those already running were successful, and if they were not he did not see anything before the Council but the adoption of a system of tramways.

Electric Lighting Notice.—Formal Notice is given in the *London Gazette* that Barry District Council intend to apply for a provisional electric lighting order to amend their 1901 order by extending the period within which mains are to be laid in certain streets, and to authorise the transfer of the Council's powers to a company.

Electric Power for New Zealand.—Mr. Allo, the consulting engineer recently called in by the Government to report on the proposal to utilise the Haku Falls (New Zealand), states that 39,000 H.P. could be obtained and distributed even in a dry season, and (allowing for probable increase) he estimates that the railways of the North Island (which now use 4,000 H.P. in steam power) could be worked by 9,000 H.P., and 30,000 would remain for general industrial purposes. He estimates that steam power costs from £7 to £7. 10s. per horse-power per annum, and that electrical power under the proposed scheme could be supplied at from £4 to £5 per horse-power.

Electric Railway Scheme.—The guarantors of the Bristol, London and Southern Counties Railway met on Monday to consider an alternative scheme for this project, one of the chief innovations being a proposal to work the line between Bristol and Trowbridge electrically. The work of surveying, &c, cannot be completed in time to introduce a bill next session, and the matter will, therefore, be postponed for 12 months.

Ely.—The Southern District Electricity Co., who are applying for an electric lighting order, have informed the Council that they propose to form a local company to carry out the provisions of the order, and to charge the Council 4d. per unit for current for public lighting and 2½d. for power, the charges to private consumers being 6d. for lighting and 3d. for power. The Council is to have the right to purchase at one year's notice.

Erdington.—Last week the Tramways committee considered the detailed specification and drawings for the construction of the first portion (about 6 miles) of the electric tramway system prepared by the joint engineers (Messrs. Robert Green and H. H. Humphries), who were instructed to obtain the approval of the Board of Trade and to advertise for tenders.

Fire.—A fire broke out on Tuesday night at the Bureau of Posts Telegraphs and Telephones, Amsterdam, causing considerable damage. It was reported on Wednesday morning that telegraphic communication would probably not be interrupted, but there was a possibility of a serious interruption of the international telephonic service.

Gibraltar.—Electricity supply was established here in 1898. The demand for current has led to considerable developments. The total plant capacity has been increased from the original 20,000 8 c.p. lamp equivalent to 23,333. There is a scheme in operation for letting motors on hire and for house wiring on a rental basis. The price per unit at Gibraltar for lighting is 6d. and 7d., and for power 3d.

Gillingham (Dorset).—Messrs. Parry, Ross and Richards, who propose, with the acquiescence of the Parish Council, to form a company for the supply of electricity in the district, have been authorised to prepare a detailed scheme, with estimates, &c., for submission to the Council.

Gold Coast.—Some time ago the Imperial Government loaned the Gold Coast authorities £25,000 for the purpose of extending the telegraph lines to Gambaga, but as the work has not been carried out the amount has been repaid.

Gloucester.—The City Council decided on Wednesday to advertise for a manager for their electric tramways at a commencing salary of £300, rising to £450 per annum.

Grays (Essex).—The accounts of the electricity department for the half-year ended Sept. 30 show expenses £621, against £546 last year. The revenue was £980, against £737. Gross profits were £359, against £191. During the half-year 696 8 c.p. lamps have been connected, representing 22 additional consumers.

Hastings.—The work of construction of the electric tramways will be commenced in February, and it is anticipated that the principal routes will be in operation before the end of next year.

Hornsey.—A statement was made in our last issue, on the authority of our local correspondent, that a loss of £2,000 had been made on the first year's working on the Hornsey District Council's electricity undertaking. This is entirely erroneous, as the station has only been running for about six months. Mr. Norman Staniland, the resident electrical engineer, naturally prefers to see the result of the first year's working before the undertaking is condemned as unprofitable. We find that the sum of £2,000 was mentioned in the course of the discussion on the electricity estimates, and this is probably the source of our correspondent's report.

Huddersfield.—The Council are applying for a provisional order to extend the electric lighting mains to Golcar..

Ilford.—The Electric Lighting committee advise abolition of electricity meter rentals.

Italy.—It is estimated that the water-power available on the River Poschiavosee at Graubunden is equal to 20,000 H.P., and the *Frankfurter Zeitung* states that a combination of British and Swiss capitalists has been formed to carry out the scheme proposed by the Lombardi Company for the establishment of new hydro-electric works at Graubunden.

Kettering.—The Council have decided (by the casting vote of the chairman) to promote a bill to authorise the council to borrow moneys for wiring premises, and for the supply of electric fittings and motors on hire.

Kirkcaldy.—The Council are applying for Parliamentary powers for doubling portions of their tramway system and for laying a new double-track line to Dysart.

Lichfield.—The City Council have retained Messrs. F. H. Medhurst and Lloyd as consulting engineers in connection with the application for an electric lighting order for Lichfield Rural District.

Light Railway.—Owing to omission to give formal notice to landowners the Light Railway Commissioners have postponed the inquiry into the Central Wilts. light railway scheme.

London County Council.—At Tuesday's meeting it was agreed to continue the arrangement with the National Telephone Co. for the supply and operation of certain telephone lines at the central offices for another year.

London County Council Tramways.—Poplar Council are recommended by their General Purposes committee not to consent to the adoption of the overhead trolley system on the Bow-road section of the London County Council tramways.

The Council Council have made to Lewisham Borough Council a similar proposal to those to those recently submitted to other Metropolitan Councils—viz., that they should contribute one-third of the cost of road widenings necessitated by the proposed electric tramways. The Borough Council, who previously offered one-sixth, have agreed to agreed to reconsider the matter.

Wandsworth Council have under consideration a similar proposal involving an expenditure by the Borough Council of £65,000. This extension will complete the lines from the London bridges to the terminus of the Croydon tramways.

It was agreed by the County Council on Tuesday to allow an expenditure up to £2,500 in connection with the preparation of the plans, &c., for the reconstruction of existing and the construction of new authorised tramways on the south side of the Thames.

It is anticipated that the electric tramways from the Thames bridges to New Cross will be opened for traffic early in January.

Maidstone.—The Electricity committee reported to the Urban Council last week that a writ had been issued against the Council by Mr. Henry Payne to recover damages alleged to have been caused to his property by the fusing of an electric service main. Appearance had been entered, and the town clerk was instructed to defend.

Manchester.—The report of the Electricity committee presented at the Council meeting on Wednesday referred to the resignation of the city electrical engineer (Mr. G. F. Metzger), and in moving its adoption the chairman (Mr. Howarth) moved the deletion of the following words from the clause which announced the resignation

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of Mr. Metzger: "On the ground of his inability to work in unison with the deputy chairman."

Mr. Howarth gave the following outline of the incidents leading up to Mr. Metzger's resignation. In January last (Mr. Howarth said) Halifax Electricity committee wrote to the town clerk asking if he would allow the engineer to advise Halifax in connection with certain works in progress in that town. That letter came before the committee, who found that Mr. Metzger was appointed subject to a condition that he should devote his whole time to the duties of the position, and the town clerk of Halifax was informed that Mr. Metzger could not advise that Corporation. He saw no necessity to consult Mr. Metzger on the matter, but he subsequently explained to him that the Corporation could not allow its officials to do outside work. Burslem Council subsequently approached Mr. Metzger personally, and he undertook the revision of their scheme, and received for that work 50 guineas. When Mr. Metzger was asked for an explanation by the committee, he said he had received the sanction of the chairman, but Mr. Howarth denied that that was so. Mr. Metzger wrote to him, and the impression left on his mind was that someone merely wished to consult him on a technical point, and he did not feel justified in refusing permission for that. It appeared that Mr. Metzger had accepted the task of arbitrating between the Trafford Park Power Supply (Ltd). and the Allgemeine Elektricitäts Gesellschaft of Berlin, and as the latter company were doing a large amount of work for Manchester Electricity committee, the action of the chief engineer placed the committee in an invidious position. The matter was discussed by the committee, and a good deal of personal feeling was manifested. Ultimately Mr. Metzger tendered his resignation. It was accepted by the committee, and the words which he asked to have deleted were inadvertently inserted in the minutes. Mr. Howarth concluded by saying that Mr. Metzger had been in the service of the Manchester electricity department for two years and nine months, and during that period he (Mr. Metzger) had applied himself to the work very earnestly and very successfully.

Mr. Burgon seconded the resolution, which was passed without further discussion.

Mansfield.—The exhibition of electric light fittings, &c., organised by the Electricity committee and the borough electrical engineer (Mr. Hewlett) was opened on Tuesday.

Marylebone (London).—A special meeting of the Borough Council was held last evening to take into consideration and determine upon the expediency of promoting next session a bill for amending the Electric Lighting Order Confirmation (No. 1) Act, 1901, and the Marylebone Electric Ligthing Order, 1901.

The matter was brought forward as a motion by Mr. Councillor E. R. Debenham, chairman of the Electric Supply committee, that it was expedient to promote such a bill, comprising the objects and purposes set out in the draft submitted to the last meeting of the Council (see *The Electrician*, Oct. 23, p. 28. Mr. Debenham referred to the steps which had been taken in applying to the London County Council, the Board of Trade and the Local Government Board, to enable them to carry out the terms of the arbitrator's award, and said the whole difficulty would seem to have arisen through the omission of a special clause in the Council's act making the Council the electric lighting authority. Such a clause had been included in the first place by their legal representatives, but this particular clause was strongly opposed by the Metropolitan Comthis clause, and to prevent postponement by the throwing out of the bill pany, who contended that the Council was given ample powers without it was ultimately agreed that the clause be omitted. Owing to pressure of time, it was now necessary that the Council should at this meeting agree to the preliminary steps being taken for the promotion of the bill, for it would have to be held over till next session. If they did not proceed in this way they could not go to the Court and ask for a suspension of sequestration on the ground that the Council were doing all in their power to carry out the terms of the award. The draft of the bill would be placed before the new Council, and after that it would have to go before the ratepayers. It was proposed by the bill to spread the repayment of the loan over a period of 42 years; to spread the possible loss on the first year's working over a number of years; to change the system of charging so that all consumers are charged at the same rate, so as to encourage the small consumer; and to alter the system of supply to the higher voltage. The change-over was necessary, as, although it involved an outlay of some £25,000, if the old system of supply was continued it might involve the Council in an expenditure of perhaps £100,000 for new mains. It was announced in the local press that the Metropolitan Company were offering free wiring to the poorer inhabitants of Marylebone, and what the company offered in this direction the Council were bound to carry out. He could see no objection to this, as it would enable the very class they desired to encourage to become customers. On the question of compromise, which was suggested by some, he said if the Council were to approach the company with any prospect of success they must first of all place themselve in a position to compromise. At present, with the judgment of the High Court hanging over their heads, the position was disastrous.

A lengthy discussion followed, but ultimately the motion was carried on a division by 43 votes to 6.

The town clerk was directed to take all necessary preliminary steps in connection with the promotion of the bill.

Milford-on-Sea (Hants).—The electricity works of the Milford-on-Sea Electric Supply Co. were inaugurated last week. The contractors for the erection and equipment of the station were Messrs. Christy Bros. and Middleton.

Motor Omnibuses in Western Australia.—What is claimed to be the first public electric omnibus service in Australia was recently started between Perth and Victoria Park. If the service proves successful it will also be adopted in and between Perth and Fremantle.

New South Wales Tramways.—The revenue of the tramways for the September quarter was £185,840, compared with £166,900 last year, and the expenditure £159,239 against £143,528.

Newcastle-on-Tyne.—The Council have referred back a recommendation of the Tramways committee to connect the Chillingham and Heaton tramway routes at an estimated cost of £6,800.

Northfleet.—*Important Sale of Plant and Machinery.*—A sale by auction of more than usual interest is that which is announced by Messrs. Wheatley Kirk, Price & Co. to take place at the Castle Works, Northfleet, Kent, on Wednesday, Thursday and Friday next, Nov. 4, 5 and 6, commencing each day at 10 for 11 a.m. We have before us the catalogue of this sale, which testifies to the importance of the group of machinery to come under the auctioneer's hammer by illustrating a number of the machines. It is not, of course, always possible, from the point of view of cost, to present a catalogue in this excellent and time-saving form, but we think it safe to say that the well-established practice of Messrs. Wheatley Kirk, Price & Co. of illustrating many of the chief items in their larger sales is a departure on the right lines. A large proportion of the plant to be sold is almost new, and offers tempting opportunities for buyers of steam and gas engines, electric lighting, electro-plating and electric testing plant, boilers, pumps, shafting, lathes, milling, drilling and shaping machines, power-stamping and power-drop presses, screwing and tapping machines, tube-cutting and polishing machines, surface grinding machines, &c. The engines, boilers and machines, are by the best British and American makers, and the unique assemblage of plant presents features of particular interest to machinery buyers and users. Catalogues can be obtained (price 6d.) of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester, or at the place of sale.

Patent Amendment.—Prof. Blondel, 41, Avenue de la Bourdonnais, Paris, seeks to amend the specification of Letters Patent No. 6,061 of 1903 (1902 under International Convention) for "Improvements in Electrodes for Electric Arc Lamps." Particulars of the proposed amendment are set out in the *Illustrated Official Journal* (Patents) of Oct. 28, and notice of opposition must be received within one calendar month from that date.

Penrith.—The Council have before them an estimate for erecting municipal electricity works which puts the initial capital outlay at £7,507 and the annual expenses at £700, plus £450 for interest and sinking fund. Offers have also been received from three companies for establishing supply, and the Electric Lighting sub-committee have recommended for acceptance one offer by which the Council would provide the capital, the company paying interest and sinking fund charges and receiving a premium of 5 per cent. on the capital expenditure if the works are taken over by the Council within 10 years.

Personal.—Mr. Albert Higgins, A.M.I.E.E., M.I.M.E., who is retiring from the managership of the electrical department of Strode & Co. after 20 years' service to become a partner in another firm, was recently entertained at a complimentary dinner and presented with an illuminated address by Messrs. Strode & Co.'s employés.

Mr. R. G. Mercer, A.M.I.E.E., who has been with the British Insulated and Helsby Cables (Ltd.), Prescot, for the last five years as outdoor superintendent, has been appointed manager to Psychiloid Limited, Electrical Insulating Works, Sheffield.

The Huddersfield staff of the National Telephone Co. have made a presentation to Mr. H. W. Aspinall, who is leaving to become manager at Portsmouth.

Pitlochry (N.B.)—A scheme for erecting electricity works, involving the utilisation of the water power of the River Tummell in the generation of current, has been drawn up, and inquiries are being made as to the probable demand for current. The price of gas in the district is 7s. 6d. per 1,000.

Portsmouth.—The accounts of the electric lighting department were presented to the Council on Tuesday, and their adoption was moved by the chairman of the Electric Lighting commitee (Ald. Ellis). The accounts were abstracted in our issue of Aug. 28.

The borough auditors had reported that the sinking fund and interest paid during the past year had not been properly done, but Ald. Ellis said that he had nothing to do with interest and sinking fund. The committee had to manufacture, sell and deliver electricity and hand the proceeds to the Finance committee. The Electric Lighting committee had so many applications for current that the staff was inadequate to cope with them. A general complaint was that people were not joined up fast enough. The report was adopted.

The committee recommended the sinking of a well at the station at an estimated cost of £762, but with the condition that, in the event of water not being found, the contractors should remove the tubes and apparatus, and the charge in that case would be about £500. The recommendrtion was agreed to.

The Corporation have applied for sanction to a loan of £24,000 to provide for extensions of the electric lighting during the next three years.

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Proposed Anthracite Coal Trust.—The promoters of the South Wales Anthracite Amalgamation Syndicate, who have for about 12 months been negotiating with (it is stated) 90 per cent. of the mine owners of the Welsh anthracite coalfield, announce that they have arrived at an agreement with owners of mines representing about two-fifths of the total output of the anthracite collieries, and are hopeful of arriving at an agreement with an appreciable number of those still being negotiated with. The proved coal in the mines acquired represents over 90,000,000 tons, and the annual output is approximately a million tons.

Rangoon.—We learn that fresh tenders are to be invited by the Municipality from the four firms and others who recently submitted proposals for the construction and equipment of electricity works. None of the tenders originally submitted was accepted.

Railway Station Lighting.—The Caledonian Railway Co. have made arrangements for the electric lighting of the Dundee West station, including the goods yards, sidings, &c. Current will be taken from Dundee Corporation.

Risca.—A special meeting of the Council has been called to consider the question of applying for a provisional order. The Empire Electric Light and Power Co. has already notified its intention of applying for an order.

St. Pancras (London).—*Correction.*—In our issue of Sept. 18, p. 906, we referred to the past year's profits of the Borough Council's undertaking, giving the figure as £7,220. The net profit made for the year to March, 1903, was, however, the much larger sum of £16,818.

The Council have sanctioned the erection of an arc lamp in the courtyard of the new working-class dwellings in Goldington-street, and also the provision of meters in connection with the wiring of the buildings now proceeding. Further mains extensions have been authorised.

The London County Council offer to lend the Borough Council £23,960 for electric lighting extensions at 3¾ per cent., but the Prudential Assurance Co. offer to loan the same sum at £3. 12s. 6d. per cent. The matter has, therefore, been referred to the Finance committee.

Saffron Walden.—The Council will apply for a provisional electric lighting order.

Salford.—The Corporation have been recommended by the Electricity committee to apply for sanction to a loan of £10,000 for purchasing electric motors to let out on hire.

Sheffield.—The Tramways committee recommend the Corporation: To cease insuring against claims for compensation by third parties and themselves undertake to meet these risks, but suggest, with a view to limiting the liability, that notice be given that from Dec. 5 next, as passengers are being carried at less than the maximum authorised charges, they will only be carried on the express condition that the liability of the Corporation is limited to an amount not exceeding £25 for any accident to any one person.

On the presentation of the Tramway committee's minutes at the Corporation meeting on Wednesday a short discussion arose round an item of £501. 6s. 9d. for repairs of tramlines and track during August, and in reply

The chairman of the committee (Ald. Clegg) admitted the amount was unusually large, and that the position was not satisfactory. They were making an inquiry into the matter, to see if any alteration could be made. There was some difficulty, because a question might arise between the Highway and Tramways committees in regard to the appointment of a man to look after the repair of the track only. The difficulty was as to dual control. The charges for repairs were, however, getting serious. There had also been considerable difference of opinion as to the best destination indicator that should be placed on the cars.

South Shields.—To encourage the development of the town as a pleasure resort the Parks committee recommend the extension and improvement of roads adjacent to the sea and the lighting of same by arc lamps.

Speed of Electric Tramcars.—A conference of West Midd'esex local authorities was held at the Board of Trade offices on Tuesday as to framing of bye-laws governing the service of the London United Electric Tramways Sir Herbert Jekyll presided. Mr. Balfour Browne, K.C., and Mr. Clifton Robinson represented the company, and Twickenham, Chiswick, Brentford, Hanwell, Teddington, Hampton and Hampton Wick District Councils were also represented.

The president said that in many instances the drafts submitted by the authorities exceeded the model code of the Board and there must be uniformity. That particularly applied to the speed of electric cars. Some districts wanted the cars to run above the Board's standard, others below, but all these matters would have to be subject to the Board of Trade, who quite recognised that the code as it applied to horse-drawn traction was quite inapplicable to electric running, and the question of tramway speeds was now under consideration. He advised that the existing conditions be left unchanged, and the Board would communicate with the local authorities when the new speed limits had been fixed. Brentford Council have asked for a speed indicator on each car, but that was impracticable. The suggestion, also from Brentford, that each car should be disinfected once a month to the satisfaction of the local authority was *ultra vires*, and the suggestion from the same Council that each conductor should produce the bye-laws when called upon was already governed by Board of Trade regulation. Mr. Clifton Robinson said his company would give a bonus of £500 to a designer of a reliable speed indicator. Mr. Balfour Browne questioned the power of the councils to make bye-laws, but Sir H. Jekyll declined to entertain a legal argument on this point at the present stage.

Some time ago Dundee Corporation applied to the Board of Trade for permission to increase the speed of the cars on some of their electric tramway routes, and an official inspection of the system took place last week.

Stepney (London).—On Wednesday the Council sanctioned mains extensions (estimated cost £2,845), arc lighting (£1,670) and incandescent electric lighting extensions with modern Nernst lamps (£250).

Telephone Extensions in Fifeshire.—The Post Office telephone system is to be extended to Largo, Colinsburgh, Elie, St. Monans, Pittenweem, Anstruther and Cellardyke. This extension is to be made in consequence of requisitions from the local authorities of the districts concerned. A minimum of eight subscribers in each place had to be guaranteed. The terms of subscription on a three-years' agreement and an unlimited local service is £7. 10s. per annum, or an annual rent of £3 and a minimum message rate of £1. 10s.

Thornbury.—In order to keep out companies, the District Council will apply for a provisional electric lighting order.

Trunk Telephonic Communication.—In consequence of the representations of the Bristol Chamber of Commerce as to the present inadequate trunk service between London and Bristol, the Postal Telegraph Department propose to erect a fifth telephone trunk line between Bristol and London.

Village Lighting.—Hamanford (Wales) District Council have asked Mr. H. Coles to report on electric lighting.

Wireless Telegraph Notes.—An order for the installation of wireless telegraph apparatus on 10 ships of the U.S. navy has been received by Die Gesellschaft für Drahtlose Telegraphie, Berlin. This when completed will bring the total number of the equipments on the "telefunken" system installed on American battleships up to 60. The 10 new installations referred to are to be forwarded directly to East Asia. At present the company is busy in equipping the German signal-ships in the North Sea with their system so as to enable these vessels to communicate with the coast stations of the German navy. Sweden, it is stated, possesses 20 installations of the same kind in connection with its navy, and since the recent naval manœuvres have proved the reliability of the system, further orders are awaited.

Wisbech.—A consulting engineer is to be appointed to prepare a report on electricity supply.

Wolverhampton.—A meeting of the Council will be held this (Friday) afternoon to consider the promotion of a bill for powers to extend the municipal tramways.

Workhouse Lighting.—The Guardians of St. Olave's (London, S.E.) have decided to adopt electric lighting at their workhouse.

Wrexham.—Extensions of the electric light cables, estimated to cost £4,500, have been authorised.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

The directors of the *Midland Railway Co.* invite tenders for stores for 12 months from Jan. 1, 1904. The company's requirements include telegraph instruments, stay rods, bolts, insulators, &c., telegraph and signal wire, indiarubber goods, varnish, steel castings and files, copper and brass tubes, &c. Patterns and samples will be ready for inspection at the General Stores department, Derby, after Nov. 2. Forms of tender from the stores superintendent, Mr. Alfred Derry. Tenders (addressed General Stores committee, Midland Railway, Derby), by 9 a.m. Nov. 10. An advertisement contains further particulars.

Leeds Lighting committee invite tenders for the supply and erection of about 45 tons of steel or wrought-iron and cast-iron pipes and valves, oil extractors, &c. Conditions and specifications from the manager of the electric lighting department (Mr. Harold Dickinson), 1, Whitehall-road. Tenders to the town clerk (Mr. W. J. Jeeves), Town Hall, Leeds, by Nov. 13. See advertisement.

Swindon Corporation invite tenders for the supply, delivery and erection of steel poles, overhead line section-boxes, arc lamps and accessories. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey and Sillar), 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, London,

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S.W., and may be obtained from the latter office only. An advertisement gives further particulars. Tenders to the town clerk (Mr. Robert Hilton), Town Hall, Swindon, by Nov. 16.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)*, invite tenders for wiring for various installations of Oatway automatic fire alarms for direct communication with the fire brigade headquarters at Glasgow, Aberdeen and Partick. Some information is given in an advertisement; other particulars from the managing director, 49, Queen-street, Glasgow. Tenders by Nov. 7.

Bermondsey (London) Borough Council invite tenders for low-tension triple-concentric feeder cables, arc circuit and pilot cables and sundry connection boxes; also cast-iron arc lamp standards and accessories, arc and incandescent lamps, switchboxes and sundry fittings for same. Tenders to the town clerk (Mr. Frederick Ryall) by noon Nov. 9.

Chichester Waterworks department require tenders for electrical water level indicators and recorder, and telephones between their waterworks, pumping station, reservoir, sewage works and city surveyor's office. Tenders by Nov. 6.

London County Council invite tenders for supply and erection of (*a*) engine, dynamo, switchboard, &c., and (*b*) electric wiring, mains and fittings required for the installation of the electric light at the Abbey Mills pumping station. Tenders by 10 a.m. Nov. 3.

Kilmarnock Corporation invite tenders for three Lancashire boilers, engines and dynamos, overhead travelling crane, storage battery and switchboard. Tenders to town clerk (Mr. W. Middlemas) by Nov. 18.

Beckenham Urban District Council invite tenders for the electric wiring of houses in their district under a "free" wiring scheme. Tenders to the clerk (Mr. F. Stevens) by 4 p.m. Nov. 9.

Chorley Corporation invite tenders for the transfer of their electric lighting order, 1896. Further particulars from the town clerk (Mr. Jno. Mills), Town Hall, Chorley, to whom tenders.

Wakefield Corporation require a 400kw. two-phase generator (engine, alternator, exciter and accessories). Tenders by Nov. 7.

Wednesbury Corporation invite tenders by noon Nov. 20 for wiring and fitting up various public buildings for the electric light.

Manchester Paving committee invite tenders by Nov. 5 for laying underground telephone pipes,

Blackpool Electricity and Tramways committee invite tenders for a new 450kw. traction set. Tenders to chairman by Nov. 14.

Radcliffe District Council invite tenders for lighting and traction switchboard and accessories and rail bonds. Tenders by Nov. 14.

Dundee Council invite tenders for tar boiler, pitch compound and wood troughing for their electricity department. Tenders by Nov. 7.

Plymouth Corporation invite tenders for wiring the borough asylum. Tenders by Nov. 14.

Tenders will be received up to 2:30 of Dec. 30 for the supply and delivery at the Commonwealth of Australia Departmental Stores, *Sydney, N.S.W.*, of telegraph, telephone and electric light material. Specifications, conditions and tender forms can be seen and obtained from the General Post Offices of Sydney, Melbourne, Brisbane, Hobart, Adelaide and Perth, and samples may be seen at the four first-mentioned offices.

The *Ceylon* Government is prepared to consider proposals from contractors for the supply of electrical energy to the offices, buildings and premises of the Government within the municipality of Colombo for a term of years commencing about Aug. 1, 1905. A memorandum is published in the Government *Gazette* for Oct. 2 setting out the terms of the agreement to be entered into, the price to be charged for current, system and pressure, contract terms and list of the buildings to which current is to be supplied. Proposals to the Colonial Secretary, Colombo, Ceylon, not later than Dec. 1. A copy of the *Gazette* can be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

Tenders are invited for the concession for lighting the town of *Culiacan*, Mexico, by electricity. Proposals will be received by letter until Dec. 31, by the Secretario del Ayuntamiento, Culiacan, who will supply further information. The city has a population of 12,000, and is the capital of the State of Sinaloa.

TENDERS RECEIVED AND ACCEPTED.

Bradford Corporation have placed an order with Mr. J. Best for constructing the permanent way of the tramways from Pateley Bridge to Lofthouse at £20,300, and from Lofthouse to Augram Reservoir at £5,385.

Swindon Town Council have accepted the tender of Messrs. E. Wood & Co. (at £500) for reconstructing lifting bridge and swing bridge and providing new footbridge over the Wilts. and Berks. canal at Swindon, in connection with the Council's electric tramways.

The Central South African Railways (before the termination of the war known as the Imperial Military Railways of the Transvaal and Orange River Colonies) have placed contracts for the equipment of the lines in the Orange River Colony with the Tyer electric tablet signalling system, at an outlay of over £49,000.

Devonport Corporation received the following tenders for a negative booster:—

Brush Company (*accepted*)	82% guar. eff.	£327
Elec. Construction Co.	80%	465
Brit. Schuckert Company	76%	455
Lister Elec. Mfg. Co.	76%	433
Mather and Platt	75%	425
Laurence, Scott & Co.	75%	420
Lancs. Dynamo and Motor Co.	78%	410
Brit. Westinghouse Co.	79%	597
Thomas Parker (Ltd.)	77·5%	393
Mavor and Coulson	79%	391
Rhodes Elec. Mfg. Co.	77%	390
Johnson and Phillips	81%	375
Keighley Eng. Co.	80·5%	347
Bruce, Peebles & Co.	79%	341
Industrial Eng. Co.	72%	338
Siemens Bros. & Co.	72·25%	332
Crompton & Co.	73%	313
Walker and Hodget's	80%	310
British Elec. Plant Co.	70%	310

Among the recent orders received by the British Schuckert Electric Co. are:—

For Paisley Corporation: Extensions to tramway switchboard, consisting of nine panels with instruments and switchgear; also a negative booster set of 27kw. capacity to work in connection with return-current feeders.

For Dunlop Rubber Co. (through Messrs. Willans and Robinson, who are supplying the engine): A 275kw. direct-current generator, 250 volts, 340 revs. per min. This machine will operate in conjunction with the existing plant of the Dunlop Company, the whole of which, including generators, motors, &c., was installed by the British Schuckert Electric Co.

For Lurgan Weaving Co., Belfast: An 88½kw. combined direct-current generator, 220 volts, and Allen steam engine, together with ejector condensing plant complete.

An order (as sub-contractors to Messrs. Crompton & Co.) has been placed with Messrs. Rowland Carr & Co. for 40 arc lamp columns and accessories for Hackney.

An order has been placed with the National Rail and Tramway Appliances Co. by the Sheffield Corporation for 75 car sets of National life-guards at £5. 5s. each.

Southend Town Council have accepted the tender of Crompton & Co. for electrical instruments for the electricity works at £163.

Messrs. Rowland Carr & Co. have obtained a further order from the New Century Arc Lamp Co. for 40 arc lamp columns for Stepney.

Blackpool Corporation have accepted the tender of Crompton & Co. for the supply of arc-lamp carbons for the ensuing year.

Bristol Town Council have accepted the tender of Mr. D. McNaughton (agent for M. Fabius Henrion) for arc lamp carbons.

Bolton Council have accepted the tender of E. Green & Sons for economisers at the electricity works.

Brighton Council are recommended to place an order with Dick, Kerr & Co. for 20 new tramcars at £10.200.

Farnworth (Lancs.) District Council have accepted the tender of Mr. Walter Kellett for wiring the infectious diseases hospital.

Messrs. Rowland Carr & Co. have secured the contract for the steel troughing in connection with the electrification of the Underground Railways.

Messrs. Pritchetts and Gold have received an order from West Ham Corporation for an electric motor car for the use of the borough electrical engineer.

BUSINESS NOTICES

The address of the Melbourne house of W. T. Henley's Telegraph Works Co. (Ltd.) has been altered from Cromwell-buildings to 380-382, Bourke-street, Melbourne.

The offices of the London Chamber of Commerce have been removed to Oxford-court, Cannon-street, E.C.

Messrs. H. Cecil Hodges & Co. notify that they have established works at Millwall and offices at 52, Queen Victoria-street, London, E.C., where the business of manufacturers of electrical apparatus will be carried on. Mr. J. Gray, 19, Waterloo-street, Glasgow, has been appointed sole agent for Scotland, and Messrs. Dixon & Co., Imperial Buildings, Westgate-road, Newcastle, for Newcastle and the Tyne district. The company's telegraphic address is "Ammeter London," telephone 8041 Bank.

Mr. H. Willoughby Lance, who has been engaged at the Islington (London) electricity works for seven years, and who has acted as senior mains electrician for the latter three years, has acquired the electrical contracting business lately carried on by Mr. Edward Leach at 9, Tudno-street, Llandudno. Mr. Lance was, prior to his engagement at Islington, in the service of the Brush Company and the General Electric Co., and is district agent for the Brush Company's incandescent lamp and North Wales representative for Messrs. Fielding and Platt's gas and oil engines and hydraulic machinery.

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BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against the Yorkshire Electric Power Syndicate (Ltd.) must be sent by Nov. 21 to Mr. J. W. Close, 7, Greek-street, Leeds.

Claims against Harry South & Co. (Ltd.) must be sent to Mr. H. H. Hilton, 7, Lothbury, London, E.C., by Nov. 7.

In the matter of Ferranti Limited an approximate balance-sheet has been issued by the joint receivers and managers (Messrs. A. W. Tait and Arthur Whittaker) up to Sept. 2 last. The statement is accompanied by the announcement that "the value placed upon the assets is that shown by the books of the company, it being deemed unnecessary at this juncture to incur the expense of obtaining independent valuations":—

Approximate Balance-sheet at Sept. 2, 1903.

Liabilities.	£	s.	d.	Assets.	£	s.	d.
Capital Issued:				Leasehold land, buildings, plant and machinery and fixtures	153,800	9	10
Six per cent. cumulative pref. shares £120,000				Goodwill and patent rights	48,800	0	0
Ord. shares 100,000				Investments — *Less* loans secured thereon	25,312	11	0
	220,000	0	0	Expenditure on patents, concessions, experimental work and debenture issue	15,311	19	7
Five per cent. first mortgage deb. stock	100,000	0	0	Expenditure on work in hand	26,004	3	5
Loans from bankers	37,498	4	7	Stock in hand	26,719	0	9
Sundry creditors	56,099	1	4	Sundry debtors and debit balances	99,806	12	6
				Cash at bank and in hand	2,318	4	6
				Deficit	15,524	4	4
	£413,597	5	11		£413,597	5	11

Amongst the securities held by the bankers for their advance is a second mortgage of £30,000 on the assets of the undertaking, and £17,482 of book debts. Included in "sundry creditors" was an amount of £617. 18s. 8d. for wages, and this, being preferential, has been paid by the receivers and managers. The deficit shown arises (so far as Messrs. Tait and Whittaker are able to ascertain) from the works not having dealt with a sufficiently large output in proportion to the heavy standing charges, and also from faults of a technical character in the construction and design of certain of the company's manufactures. The works are capable of dealing with a considerably increased output. The difficulties of manufacture have now, in a large measure, been overcome, and the management of the various deparments is in the hands of a highly-trained and efficient staff. The sums expended on patents, concessions and experimental work, &c., have made demands upon the resources of the company in excess to its working capital, and, certain arrangements intended to overcome temporary embarrassment not having been carried through, the appointment of receivers and managers became imperative on behalf of the first mortgage debenture-holders, with the sanction of the company. It is hoped that with the improvements which have been and are being effected in the company's manufactures, and the economies which will be secured in the administration of its affairs, the business may be again made profitable and successful. In that case, a scheme for reconstruction will be submitted for the approval of the Court. The receivers and managers ask that no steps be taken by creditors likely to hamper them in the process of bringing the company into a satisfactory position. All necessary information is offered to the creditors on any point which may require explanation. In the meantime, orders for materials required during the continuance of the receivership are, as far as possible, to be placed with firms having already business relations with the company.

Sales by Auction.—Messrs. Wheatley Kirk, Price & Co. have been instructed to sell by public auction, on Nov. 4, 5 and 6, piecemeal, the entire contents of the celebrated Castle Works, Northfleet, Kent. The catalogue includes a number of slide-surface and screw-cutting lathes, automatic screw machines, turret and chasing lathes, profiling and slotting machines, shapers, drilling, grinding and milling machines, polishing lathes, screwing and turning machines, a Lancashire boiler, one 150 H.P. Westinghouse steam engine, 9 H.P. Tangye gas engine, complete plating plant, &c. The entire contents (including the loose tools) are, with a few unimportant exceptions, practically new, and are in perfect condition and by the best-known American and English makers. Catalogues (price 6d.) from the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester. See also advertisement.

Messrs. Wheatley Kirk, Price & Co. have also been favoured with instructions from the liquidator of Heaton and Smith, Ltd. (Mr. J. P. Garnett) to offer for sale by auction, as a going concern, in one lot, at the Albion Hotel, Piccadilly, Manchester, on Tuesday, Nov. 3, at 2:30 for 3 o'clock, the valuable works premises of the company, including offices, stores, machine shop and galleries. Further particulars are given in an advertisement. Failing the sale of the whole, the land, buildings and motive power will be offered as an alternative lot, the purchaser having the option of taking over the plant, tools, &c., at valuation. Particulars will be supplied (gratis) on application to Messrs. David Smith, Garnett & Co., 22, Booth-street, Manchester; Messrs. Parkinson, Slack and Needham, solicitors, 10, York-street, Manchester; or the Auctioneers, Albert Chambers, Albert-square, Manchester, and 46, Watling-street, London, E.C.

Plant for Sale.—Blackpool Electricity and Tramways committee invite offers for some electrical plant, which can be seen running at the electricity works. Particulars from the borough electrical and tramway manager (Mr. Charles Furness), West Caroline-street, Blackpool. See also advertisement.

Two Westinghouse motors (7½ H.P. and 5 H.P.), with starting switches, &c., and a Worthington pump are advertised for sale in another column.

Sale of Old Post Office Stores.—Tenders are invited for the purchase of about 45 tons of gutta percha, 100 tons of copper and a quantity of other metals, indiarubber-covered copper wire, glow lamp tops, &c. Forms of tender from the controller of stores (G.P.O.), 17-19, Bedford-street, London, W.C. Tenders by 10 a.m., Nov. 11. See advertisement.

Workshops and Factories to Let, &c.—A small foundry, in good position adjoining G.W.R. main line and close to three docks, is advertised to be let or sold. Applications to Mr. G. Mercer, New-road, Llanelly.

Messrs. Geo. W. Dawes & Co., auctioneers, 11, Basinghall-street, E.C., have large factories to let in London and suburbs, and also in Birmingham, Derby, Cheltenham, Colchester and other leading towns.

Handy light worshops, suitable for electricians, &c. (with power if desired), are advertised to be let in another column. Apply, 401½, Wandsworth-road, London, S.W.

Dynamo Wanted.—Messrs. S. Dixon & Son (Ltd.), Bow-lane, Leeds, want a 60-ampere 135-volt second-hand dynamo.

Fault Localising Device.—Messrs. Oliver & Co., of Woolwich, have introduced a novel electrical device, which they have termed "Phielashok." It is intended for locating faults in connections in arc lamp circuits, but may be used on other circuits. The Phielashok takes the form of a flat pocket pencil-case, and owes its introduction to the high pressure now generally adopted. There is an outer metal case, and an inner slide portion specially prepared of very low electrical conductivity. This slide portion is capped with metal. In making the test the degree of shock is regulated by the distance the slide portion is drawn out from the case. It can be used up to 1,000 volt circuits, or even higher, and can be applied to a large number of testing uses.

Gilbert Arc Lamps.—A new illustrated list of Gilbert arc lamps has just been issued by the Gilbert Arc Lamp Co., Chingford, Essex. In this list the various types of lamps, lamp gear and accessories manufactured by the company are illustrated and described. A lengthy list of towns, docks, railway stations, &c., where these arc lamps are installed is given, and shows great variety of the lighting work efficiently done.

Electric Driving for Printing Machinery.—A formidable and interesting list of printing firms who have introduced electric driving into their works is issued by Messrs. J. H. Holmes & Co. of Newcastle-on-Tyne and Soho-square, London. This list comprises over 100 of the principal letterpress and lithographic printing undertakings, type foundries, bookbinderies, printing machine manufacturers and newspaper printing plants in the kingdom, and includes the driving of all classes of printing machinery, from the "Hoe" and "Victory" rotary giants to the miniature platen. Of this branch of electrical engineering work Messrs. J. H. Holmes & Co. have secured a large share for their make of the Lundell continuous-current electric motor; 27 of these machines are installed at the Bank of England, aggregating over 60 H.P., and a printing firm at Carlisle have no less than 102 electric motors of a total of 418 B.H.P. The "Holmes-Clatworthy" system of printing machine equipment is being applied in the principal printing offices of the country. The apparatus consists of a main and auxiliary motor geared direct to the main shaft of the printing press, and a controller with a single handle for starting, "inching" round (during making ready, changing set-offs, and similar operations), and for speed regulation and stopping. For the convenience of the machine minder, and as a labour-saving adjunct, stop-pushes are fitted at convenient positions about the machine to effect an instant stop when required. The facilities offered to the minder and the layer-on by the provision of electric driving are becoming very fully appreciated, and are, in fact, amongst the chief advantages of electric motor driving. The economy of working by electricity has long been clearly demonstrated, and as the older steam and gas motors become depreciated, electric motors will, undoubtedly come into universal use for driving this class of machinery. As there are hundreds of thousands of printing machines running in all parts of the world to which electric driving can be applied, there is a very promising outlook for the "Holmes-Clatworthy" system of printing machine equipment.

Messrs. Bergtheil and Young have also issued a pamphlet dealing with special printing press equipments. This firm calls attention to the advances made in this class of motor work, and urges that the

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large number of heavy printing presses now driven efficiently and economically by electricity proves the suitability of their motors for this work. The list of daily, weekly, monthly, and other papers and magazines printed on rotary and other presses electrically driven by printing press equipments supplied by Messrs. Bergtheil and Young is a formidable one, and the method of showing these by means of the front pages and titles is effective.

Catalogues.—The Western Electrical Co., 171, Queen Victoria-street, E.C., and North Woolwich, London, E., have published a catalogue specially devoted to telephone installations for electric traction systems, and it is claimed for the special type of telephone equipments manufactured by the company that, to meet the requirements of the tramway service, special attention has been given to reducing the quantity of apparatus required to a minimum without sacrificing efficiency. In the use of this apparatus a microtelephone, plug, and spring jack only are required, no induction coil or batteries being necessary. In the accompanying illustrations, Fig. 1 shows a folding pocket microtelephone quarter actual size. The transmitter and receiver fold over to a length over-all of 6in. Fig. 2 shows a tramway wall switchboard designed for use in conjunction with the telephone instrument at the generating station, and is the type of board employed when the telephone system extends over several different routes.

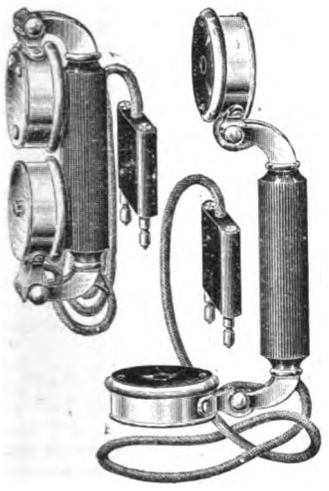

FIG. 1.—Pocket Microtelephone, ¼ full size.

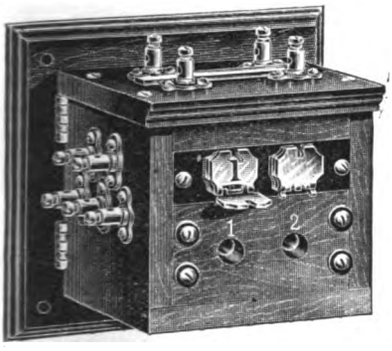

FIG. 2.—Wall Switchboard.

Mr. A. P. Lundberg, 477-487, Liverpool-road, London, N., has ready a new list of special types of electric light fittings and accessories for which his firm is noted. It is not necessary at this time of day to particularise Mr. Lundberg's manufactures, but we may say that the catalogue just issued contains numerous items of electric lighting details which bring Mr. Lundberg's manufactures right up to modern requirements. The demand for these goods is a constantly increasing one, a proof that the market for a well-designed and well-made article is always a steady and usually an improving one.

The Electrical Fittings Co. have ready a supplementary catalogue of serviceable and artistic fittings in polished brass, oxidised copper and oxidised silver. The company's showrooms at 38, Conduit-street, London, W., have an excellent display of these goods installed for buyers' convenience.

We have called attention from time to time to the sectional catalogues issued by Messrs. Holden and Brooke of Manchester. We have now to acknowledge the receipt of this firm's complete catalogue, comprising 220 pages and nearly 200 illustrations of all kinds of steam plant specialities. The catalogue is indispensable to steam users.

Psychiloid (Ltd.), Love-street, Sheffield have ready a new price list of Psychiloid insulating materials. It is claimed that this material has been submitted to the severest tests with satisfactory results, and is now being used by many electrical firms as a substitute for vulcanite, ebonite, &c. Psychiloid has great rigidity and strength, and is insoluble in all ordinary solvents. The list before us includes prices for sheets (round and square), tubing, insulating handles and hand wheels, commutator rings, pushes and washers, &c. Psychiloid sheets are made from $\frac{1}{16}$in. to 1½in. in thickness. The material is easily drilled, punched, sawn or worked in a lathe.

Baker's Patent Appliances Co., Scarborough, have issued a new catalogue of oil separators, which contains new facts concerning this apparatus, and also designs for several varieties which have been constructed to meet special requirements of existing engines where limited space is at disposal. The company claim that engineers who experience trouble with grease in their boilers will find the information given in the new list of service.

From the Metallic Seamless Tube Co. (Ltd.), Wiggin-street, Birmingham, a neat catalogue of metallic steel conduit and accessories for electric wiring is to hand. The company claim that they have invented and fully protected a device which gives, at little extra cost, a perfect metallic connection, besides being easier to instal than the screw systems. This is known as the Bayliss patent grip system, which, it is urged, enables a much lighter gauge conduit to be used at a considerable saving in cost; abolishes the use of screwing tackle, ensuring the work being carried out more quickly and easily, and prevents the revolving of tubes, twisting of wires, and damaging of insulation. Examples of this system are illustrated, as well as a large variety of bends, tees, clips, crosses, crampets, saddles, blocks, nipples, connection, branch and junction boxes, &c. The metallic steel conduits are supplied, with the exception of the welded type, in two gauges, light and heavy, and full particulars of the wiring capacity of these are set out.

Four pamphlets, Nos. 155, 156, 157 and 158, are published by the British Thomson-Houston Co., dealing respectively with "Induction Motors," "Enclosed Arc Lamps," "Oil Switches," and "Overhead Trolleys." All the lists are fully illustrated, and in the arc lamp list there are some excellent illustrations of interior illumination by B.T.-H. lamps.

Messrs. H. Cecil Hodges & Co., 52, Queen Victoria-street, London, E.C., have ready a new pamphlet list of electrical testing and measuring instruments, switchboards, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Oct. 21 to 27, with the ports of destination:—

Africa—Alexandria, £55; Beira, £261 (including £99 telegraph material); Cape Town, £4,153 (including £951 telegraph material); Chinde, £59; Delagoa Bay, £7,321; Durban, £1,153 (including £198 telegraph material); East London, £1,803; Port Elizabeth, £1,306; Port Said, £777; Tripoli, £202 (telegraph material). *Argentina*—Buenos Ayres, £1,535. *Australasia*—Auckland, £75; Fremantle, £313; Launceston, £95; Melbourne, £440; Perth, £337; Sydney, £2,510 (including £90 telegraph material); Wellington, £2,554 (including £2,423 telegraph material). *Brazil*—Bahia, £9,618 (telegraph material); Rio Janeiro, £84. *Canada*—Kingston (Ont.), £30; Montreal, £24; Toronto, £85. *China*—Shanghai, £403. *Columbia*—Santos, £14. *Denmark*—Copenhagen, £52 (telegraph cable). *Germany*—Hamburg, £250 (telegraph material). *Holland*—Amsterdam, £60. *Hong Kong*, £399. *India*—Bombay, £130; Calcutta, £1,290 (including £770 telegraph material); Madras, £272. *Japan*—Nagasaki, 1 knot telegraph cable; Yokohama, £641. *Mauritius*, £30 (telegraph material). *Mexico*—Vera Cruz, £2,433. *Portugal*—Lisbon, £380; Oporto, £111. *Russia*—Kure, £97; St. Petersburg, £59 (telegraph wire). *Straits Settlements*—Penang, £59; Singapore, £824 (including £776 telegraph material). *Sweden*—Gothenburg, £15. *United States*—New York, £22. *West Indies*—St. Lucia, £22. Total £35,353, against £7,404 in the corresponding week last year (Oct. 22 to 28).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 2, 1903.

14,721 C. H. JONES. Liverpool. Holders for incandescent lamps.
14,728 J. C. FULLER. Primary batteries.
14,731 P. R. J. WILLIS. Kingston-on-Thames. Electrolytic separation of copper and nickel from mattes or ores. (C. S. Shields, Canada)
14,754 C. C. REGNART. Cricklewood. Electric lamp.*
14,770 W. E. BURNAND. Sheffield. Electric motors or dynamos.

July 3, 1903.

14,814 S. G. BROUNGER and W. G. HAYWOOD. Rheostat applicable as regulator motor-starting switch.
14,823 H. E. STARRETT. Metal anodes.*
14,828 A. B. TUBINI. Apparatus for signalling through space.
14,837 J. REID. Flash-light signalling apparatus.

July 4, 1903.

14,877 A. ECKSTEIN and W. WHITE. Manchester. Mounting electrical fittings on or in metal bases, frames and cases.
14,883 R. KLEMM and F. REISS. Electric motors.*
14,908 E. E. PRESTWICH and E. C. LEA. Electric contacts.

July 6, 1903.

14,913 E. J. MURPHY and A. TOWNSEND. Arc lamps.
14,920 H. M. HOBART. Automatic exchanges and operating same. (F. Merk, Germany.)
14,923 E. ADAMS-RANDALL (trading as E. von Hoffmann). Apparatus for electro-mechanical massage.

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SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

23,949 ECKSTEIN and COATES. Electrical influence machines.
24,101 CAROLAN (G.E. Co., U.S.). Transforming electric energy.
24,172 GALLOWAY. Conduit system of electric traction.
24,236 BROUN. Obtaining metallic sulphides in electric furnaces.
24,330 ELMORE. Electric currents for electrolysis.
24,644 BURLEIGH. Field magnets of dynamo-electric machines.
24,711 CAROLAN (G.E. Co., U.S.). Magnet coil spools.
25,442 IMHOFF and UNITED ALKALI CO. Secondary electrodes for electrolytic apparatus.
27,672 ROBERTSON. Engine-room telegraphs.
28,523 HADDAN (Soc. Française de l'Accumulateur Tudor). Accumulators.

1903.

5,811 MILLER. Manufacture of induction coils.
7,191 RAYNER (Wilhelmi). Protection of underground cables and conduits.
7,737 TUNBRIDGE. Terminals for secondary batteries.
8,488 REMY and REMY. Magneto-electric generators.
9,316 BLONDEL. Arc lamps. (Rights under Patents, &c., Act, 1901, not granted.)
11,738 LAKE (Elektrisk Bureau). Telephone switchboards.
12,683 COPE. Conduit systems for electric tramways and railways.
12,801 COMPAGNIE ANONYME CONTINENTALE POUR LA FABRICATION DES COMPTEURS A GAZ ET AUTRES APPAREILS. Electric meters. (Date applied for, Oct. 4, 1902.)
13,983 SPLITDORF. Induction coils. (Date applied for, April 8, 1903,)
14,888 KLEMM and REISS. Electric motors.
14,940 NEUBERG. Indicating excess of specified speeds on dynamos, motor cars, &c.
15,338 ROOS. Magneto-electric ignition apparatus.
15,929 JONES, JONES and SEDWELL. Vehicle for conveying cable drums.

COMPANIES' MEETINGS AND REPORTS.

Monte Video Telephone Co. (Ltd.).

The annual general meeting was held yesterday, Mr. FRANK WILLIAMS JONES presiding.

The Secretary (Mr. E. M. Reiss) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said the past year had been one of continued progress, and the prospects of the company for the future were very satisfactory. An especially favourable feature had been the acquisition, after long negotiation, of the system of camp lines known as La Hispano Uruguaya, with which for a number of years they had had a working arrangement. This had given them 14 small exchanges, and added over 300 subscribers. The property had been acquired upon a fair basis, and afforded an additional assurance in regard to their business in Monte Video, with which all of these exchanges were in speaking connection. General improvement was manifest in Uruquay, particularly in and about Monte Video, and it was hoped that a settled condition of affairs throughout the Republic had been reached. In their liabilities the item of sundry creditors stood at an unusually high figure, as it included the balance due on account of the purchase of La Hispano Uruguaya, the payment for which extended over two more years. Depreciation (£8,000) remained the same, but reserve (£26,500) had been increased by £5,000 and would now be increased a further £5,000. The assets showed a capital expenditure for the year of £14,499, mainly on account of the acquisition of La Hispano Uruguaya. Investments, real estate in Monte Video (£13,360) and other investments (£9,711) stood practically as they did a year ago, the former consisting of their office properties in Monte Video, and the latter of securities at their bankers, which, at present Stock Exchange prices, were worth 10 per cent. more than the figure at which they stood in the books. The profit and loss account showed an increase in net receipts for the year of over £1,000. The directors had been fortunate in arranging for the considerable expenditure of the year without issuing fresh capital, owing to the policy adopted some years ago, and consistently followed since, of putting substantial sums each year to reserve. Continual demands for capital expenditure were to be expected, which after a time would make an issue of debentures necessary; but until this was imperatively demanded, and until a favourable time for such an issue should arrive, they would endeavour to confine expenditure within the limits of their reserve. The directors felt justified in recommending an increased dividend on the ordinary shares from 2½ to 3 per cent. He moved the adoption of the report and accounts.

Mr. CHARLES LOCK seconded the motion, which, after a short discussion, was carried unanimously, as were resolutions approving the dividends and re-electing Mr. F. W. Jones a director.

A cordial vote of thanks to the chairman terminated the proceedings.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—The directors' report for year ended June 30 states that the gross receipts show an increase over the preceding year of $95,717, and the net earnings (after charging renewals) an increase of $39,172. After deducting £10,446 for provision for renewals maintenance, £1,494 bonus to employés, writing £1,000 off preliminary and issuing expenses, and adding £1,594 to capital amortisation fund, the net profit for year (with balance from last year) is £38,398. Deducting interest and interim dividends and providing for dividends on cumulative perpetual preference shares and preferred ordinary stock to June 30, the directors recommend a dividend on the deferred ordinary stock at the rate of 3 per cent., making 5 per cent. for year, to transfer to contingency fund £1,000 and to reserve £3,000, leaving £1,099 to carry forward.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—The twentieth annual report of the directors (for the year ended June 30 last) states that £30,834. 18s. 5d. has been brought forward from profit and loss account. Debenture interest has absorbed £18,760. 18s. 4d.; £5,690. 4s. 2d. has been set aside for depreciation on freehold and leasehold property, plant and machinery; £6,174. 10s. 3d. has been applied in writing down values of stocks; and £1,168. 10s. 3d. has been reserved for bad and doubtful debts; £1,000 has been added to reserve for future stock depreciation. The result (as shown in the balance-sheet) increases the debit balance by £1,959. 4s. 7d. The cost of establishing the business, goodwill, &c. (£443,451. 8s. 1d.) has been brought forward at the previous figures. Freehold and leasehold property, plant, machinery and tools have also been brought forward at their previous value, with the addition of the amount expended to June 30, less depreciation as charged in net revenue account. The shares of the Altrincham Electric Supply (Ltd.), have been taken at par, as in previous years. The indebtedness of this company has been reduced by £151. 15s. 1d. There has been expended on capital during the year £2,770. 2s. 4d.

MAY-OATWAY FIRE APPLIANCES (LTD.)—At the annual meeting on Friday last the report of the directors for the period from Aug. 1, 1902, to June 24, 1903, showed the net profit to be small, but that the company had turned the corner. For the first time in the history of automatic fire alarm industry in the United Kingdom, income from goods sold had been made to meet expenditure, and the transition from a loss of £5,980 shown by their last balance-sheet to a profit of £220 in the present one had been effected by careful management, economy in administration and quadrupling their turnover. During the period covered by the report some large installations had been completed, which were working satisfactorily. Several fires had been detected and announced by their means. Direct connection by the company's system had now been made or was authorised by the headquarters of the fire brigades at Glasgow, Liverpool, Manchester, Birmingham, Leeds, Sheffield, Dundee, Bolton, &c. No rebate had yet been granted by the tariff fire insurance companies to the company's clients in the United Kingdom, but these offices in March last decided to allow a 10 per cent. reduction to users in New Zealand, and it was hardly likely that equally fair treatment will long be delayed here. After consultation with the company's auditors the directors decided to allocate the loss incurred during the initiatory stage of the company's existence two-thirds to capital and one-third against trading profits. To advance the dividend-earning stage of the company's operations the directors recommend the shareholders to agree to a call of 1s. 3d. per share

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METALLIC SEAMLESS TUBE CO. (LTD.)—The chairman (Mr. Wm. Neale) presided at the meeting last week, and congratulated the shareholders on the report, as for the first time in five years they were able to pay a small dividend. The directors intended the company in the long run to be one of the best of the kind in the country. Referring to the proposed new tariffs, he said these new tariffs would not help the company much, for it had only the home trade to look to, and the competition between tube makers for that was so keen as to be absolutely ruinous. If they could agree among themselves that orders should not be taken at prices which involved an absolute loss, as at present, it would be a good thing for them all. Mr. E. Fletcher, a director, said that before the imposition of the McKinley tariffs in the United States, which raised the duty on tubes from 15 to 50-60 per cent., the company did an excellent business with that country, but they had never since sent a foot of tube to America.

RICHARDSONS, WESTGARTH & CO. (LTD.)—At the meeting on Monday the chairman (Sir C. Furness, M.P.) said that on the formation of the amalgamated company the prospectus stated the estimated profits for the ensuing three years at £238,110, but the actual profits had amounted to £258,031. Their policy had always been progressive, and, consequently, considerable extensions had been made in several departments during the year at Hartlepool, Middlesbrough and Sunderland. In connection with the last-mentioned works the substitution of gas for steam engines had been a great success. The directors had decided to build new turbine shops and equip them with the most modern plant, and they had obtained a licence to manufacture the well-known Parsons steam turbines. He explained the system of rewards for apprentices who passed certain technical examinations which the firm have adopted and which was recently described in *The Electrician*. A dividend on the ordinary shares for the half-year of 6 per cent. per annum was declared.

WESTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended June 30 states that the revenue for this period amounted to £229,090 0s. 1d. and the working expenses to £94,791. 8s. After providing £13,578. 18s. for interest and sinking fund, and £3,239. 13s. 5d. for income tax, there remains £117,480. 0s. 8d., added to £5,331. 15s. 7d. brought forward, making £122,811. 16s. 3d. A quarterly interim dividend, amounting to £31,189. 10s., has been paid, £35,000 transferred to general reserve and £2,000 to maintenance ships' reserve. The revenue includes £14,790. 1s. dividends upon the company's investments in other telegraph companies. The directors now recommend a final dividend of 3s. per share, making a total of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both tax free, which together will amount to £51,982. 10s., leaving £2,639. 16s. 3d. to be carried forward. The dividend and bonus will be payable by Nov. 5. The register of transfers is closed from Oct. 25 to Nov. 4 inclusive.

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NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

INCANDESCENT LIGHTING AND ELECTRIC FITTINGS CO. (LTD.)—Reg. in Edinburgh on Oct. 20, capital £2,000 in £1 shares, to carry on, in Glasgow or elsewhere, the business of manufacturers of and dealers in electrical and gas fittings, &c.

SEALE, AUSTEN AND BARNES (LTD.)—Reg. Oct. 6, capital £15,000 in £1 shares, to acquire and carry on the businesses of electrical engineers, &c., at Tonbridge, Kent, of Seale and Austin and Case and Barnes.

STATUTORY RETURNS.

BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)—The return to Aug. 13 gives the capital as £20,000 in 1,000 preference and 1,000 ordinary shares of £10 each, of which 1,000 preference and 906 ordinary shares have been taken up. £10 per share has been called up on 790 preference and 756 ordinary shares, and £15,460 has been received. £3,600 is considered as paid on 210 preference and 150 ordinary. Mortgages and charges, nil.

ELECTRICAL CORPORATION (LTD.)—In return to Sept. 14 the capital is given as £30,000 in £1 shares, of which 3,007 have been taken up. £3,007 has been paid. Mortgages and charges, nil.

ELECTRICAL INKLESS PRINTING SYNDICATE (LTD.)—The return to Aug. 4 gives the capital as £70,000 in £1 shares, of which 63,482 have been taken up. 55,000 shares are considered as fully paid and £1 per share has been called up on the remaining 8,482. Mortgages and charges, £330.

HALIFAX AND BERMUDAS CABLE CO. (LTD.)—According to return to Oct. 8 the capital is £50,000 in 10,000 shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, £62,500.

MORTGAGES AND CHARGES.

BROOKER AND GOSS (LTD.)—Debenture, dated Oct. 9, to secure £500, charged on company's undertaking and property, present and future, including unpaid capital, has been registered. Holder, F. Huth.

CROSS ELECTRICAL ENGINEERING AND MFG. CO. (LTD.)—Debenture, dated Oct. 20, to secure £150, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, H. R. Smith.

ELECTRIC OZONE SYNDICATE (LTD.)—Issue on Oct. 9 of £400 debentures, part of series created Oct. 16, 1901, to secure £6,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £5,600.

FRINTON-ON-SEA AND DISTRICT ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Oct. 12 of £1,300 debentures, part of series created May 7, 1903, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. Holders, W. Webster and Miss A. A. Mackay. No trustees. Previously issued of same series, £500.

SHERARD COWPER-COLES & CO. (LTD.)—Issue on Oct. 12 of £50 debentures, part of series created by resolutions of Dec. 3, 1901, and Feb. 7, 1902, to secure £6,500, charged on company's property, present and future, except uncalled capital. No trustees. Previously issued of same series, £6,225.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 28d. per oz. (Oct. 29). Consols 88¼—88⅜ for money, 88¼—88⅜ for account; 2½ per cent. 88—88½ (Oct. 29). Consols Pay Day Nov. 5; Stocks and Shares Continuation Days, Nov. 10 and 24; Ticket Days, Nov. 11 and 25; Pay Day, Nov. 12; Mining Share Carry-over Days, Nov. 9 and 23.

BRITISH ALUMINIUM CO. (LTD.)—An extraordinary meeting will be held on Nov. 4 to consider and, if thought fit, to pass a resolution reducing the capital from £400,000 by cancelling capital lost or unrepresented by available assets to the extent of £9 per share upon each of the 10,000 ordinary shares of £10 each which have been issued and are outstanding.

BRUNNER, MOND & CO. (LTD.)—It has been decided to declare an interim dividend for the half-year ended Sept. 30 at the rate of 30 per cent. per annum, the same rate as last year.

ELECTRIC TRACTION IN CALIFORNIA.—A syndicate with which Messrs. H. E. Huntington and E. H. Harriman, two American railway magnates, are connected, has been formed for constructing a system of electric railways in Southern California. As a preliminary, Mr. Harriman has purchased one-third of the stock of the Pacific Electric Railway Co. and other corporations of which Mr. Huntington is president.

ENGINEERING AMALGAMATION.—At a special meeting of the shareholders of Charles Cammell & Co. (Ltd.) on Wednesday the resolution to amalgamate with Messrs. Laird Bros. of Birkenhead was confirmed.

MUNICIPAL LOAN.—During the week the Standard Bank of South Africa invited applications for £300,000 4 per cent. inscribed stock of the municipality of Durban at £97 per cent. The loan is for the extension of electric tramways, electricity works, &c., and the proper equipment and future extensions of a telephone system throughout the borough.

NORWICH TRAMWAYS CO.—The annual report of the directors shows that salaries, wages and directors' fees have absorbed £15,676, rent, rates and insurances £2,106, stores £2,855, coals and coke £3,123. Traffic receipts amounted to £33,516, and advertising £139. This report was adopted at the meeting on Wednesday, and a dividend of 2½ per cent. was declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Nov. 5 a special settling day in 20,000 6 per cent. cumulative £5 fully-paid preference shares of *Bruce Peebles & Co. (Ltd.)*, and 6,369 £1 fully-paid shares of the *Querette (Parent) Co. (Ltd.)*, and have ordered the former to be quoted. The Committee have been asked to allow a further issue of £44,435 3½ per cent. preference stock of the *Eastern Telegraph Co. (Ltd.)* to be quoted.

ULSTER ELECTRICAL POWER AND DISTRIBUTION CO. (LTD.)—A meeting was held last week, when the engineers to the company (Messrs. Preece and Cardew) produced their report on the scheme generally and on the selection of sites. The scheme is likely to be favourably received in Ulster. Instructions were given to proceed with the bill and the acquisition of the sites.

WHITEHEAD ELECTRIC SUPPLY CO. (LTD.)—During the week this company has invited subscriptions for an issue of 7,100 ordinary shares of £1 each at par.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Oct. 24	1,141	+ 315	21	27,223	+ 4,141
Ayr Corporation	,, 17	200	- 3	‡23	8,518	+ 40
	,, 24	205	+ 10			
Barnsley	,, 16	177	...	41½	7,525	...
Birkenhead	,, 25	1,080	+ 113	...	...	...
*Birmingham Tramways	,, 24	5,193	...	16	83,103	+ 2,519
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 22	417	+ 15	§29	34,902	- 225
Blackpool and Fleetwood	,, 24	255	- 10	17	18,977	- 150
Bolton Corporation	,, 25	1,745	+ 105	30	56,493	+ 7,255
Bournemouth Corporation	,, 21	921	...	30	32,860	...
*Bradford Corporation	,, 25	3,650	+ 442	30	116,039	+ 16,456
Brighton Corporation	,, 25	810	- 7	48	42,663	+ 6,067
Brisbane Tramways	Sept. 9	2,487	+ 123	10	23,875	+ 292
*Bristol Trams & Carriage	Oct. 23	4,860	+ 395	22	119,144	+ 12,779
*Buenos Ayres & Belgrano	Sept. 27	2,980	+ 129	‡23	40,894	+ 3,093
Burnley Corporation	Oct. 24	822	+ 124	30	32,178	+ 5,064
Burton Corporation	,, 22	376	...	...	...	...
Calcutta Tramways Co.	,, 24	R32,724	+ R6,976	17	R552,532	+ R107,276
Camborne-Redruth	,, 26	109	...	51	6,080	...
Cardiff Corporation	,, 24	1,927	+ 422	30	60,236	+ 17,380
Carlisle Tramways Co.	,, 24	190	+ 16	¶42	8,263	+ 592
Central London Railway	,, 24	6,737	- 506	17	104,320	- 5,590
Chatham and Dist. Lt. Rys.	,, 22	549	+ 42	42	22,921	...
City & South London Rly.	,, 25	2,946	- 811	17	43,030	- 6,625
Cork Electric Trams Co.	,, 22	505	- 228	33	22,487	- 3,100
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 16	489	+ 59	41½	18,979	+ 870
Dover Corporation	,, 24	184	- 16	†30	7,405	+ 121
Dublin & Lucan Railway	,, 25	98	- 9	17	2,379	+ 158
Dublin Southern District	,, 23	832	+ 71	¶16	19,422	+ 7,535
Dublin United	,, 23	3,775	+ 119	¶16	67,845	
Dudley—Stourbridge	,, 16	799	+ 35	41½	34,968	+ 3,414
Dundee Corporation	,, 21	843	+ 89	...	...	...
East Ham Council	,, 24	629	+ 148	†30	20,792	+ 6,168
Gateshead & Dist. Trams	,, 16	915	+ 41	41½	36,175	+ 4,903
Glasgow Corporation	,, 24	18,898	+ 1,954	21	288,426	+ 31,764
Gravesend—Northfleet	,, 16	234	+ 24	41½	10,139	+ 969
Greenock & Port Glasgow	,, 16	559	+ 53	41½	22,924	+ 1,758
Halifax Corporation	,, 14	1,231	+ 154	29	42,126	+ 4,745
	,, 21	1,305	+ 166			
Hartlepool Tramways	,, 16	263	+ 43	41½	11,347	+ 611
Hull Corporation	,, 24	1,883	+ 155	†30	56,277	+ 2,500
Ilkeston Corporation	,, 14	148	...	‡23	4,542	...
	,, 21	145				
Isle of Thanet Co.	,, 24	368	- 50	17	19,884	- 1,006
Kidderminster & District	,, 16	110	- 7	41½	5,161	+ 178
Kirkcaldy Corporation	,, 21	159	...	34	6,065	...
Lanarkshire Trams Co.	,, 22	701	...	§10	8,855	...
Leeds Corporation	,, 24	5,320	+ 410	30	169,951	+ 10,499
*Liverpool Corporation	,, 17	10,242	+ 264	42	424,090	+ 14,021
Liverpool Overhead Rly.	,, 25	1,632	+ 91	17	28,765	+ 1,924
*London County Council	,, 17	9,585	+ 2,813	†29	291,179	+ 50,383
Lowestoft	,, 17	180	...	†13	3,977	...
Manchester Corporation	,, 24	11,500	+ 6,161	19	224,594	+ 123,028
Mersey Railway	,, 24	1,274	+ 275	17	22,529	+ 4,275
Merthyr	,, 16	204	+ 14	41½	8,269	- 191
Middleton	,, 16	262	+ 15	41½	13,538	+ 1,668
Newcastle-on-Tyne Corp.	,, 24	3,644	+ 608	17	59,384	- 5,284
Newport (Mon.)	,, 24	445	+ 174	4	1,835	+ 731
*Oldham, Ashton & Hyde	,, 16	544	- 19	41½	23,805	+ 1,524
Perth (W. A.) Elec. Trams	,, 23	1,236	+ 263	§12	48,590	+ 5,051
Peterborough	,, 16	182	...	38	6,257	...
Poole and District	,, 16	282	+ 35	41½	12,928	+ 1,939
Portsmouth Corporation	,, 24	1,463	+ 84	...	...	...
*Potteries	,, 16	1,702	- 5	41½	65,158	+ 8,418
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 16	51	- 9	41½	6,596	+ 1,603
Salford Corporation	,, 26	3,925	+ 1,104	30	115,489	+ 35,193
*Sheerness	,, 14	63	...	27	2,523	...
Sheffield Corporation	,, 25	4,494	+ 328	17	79,808	+ 5,971
*Southampton Corporat'n	,, 22	967	+ 6	...	...	...
Southend Corporation	,, 21	243	+ 41	29	10,939	+ 1,747
Southport Tramways	,, 16	290	+ 56	41½	13,374	+ 2,455
S. Staffordshire Trams.	,, 16	954	+ 189	41½	37,459	+ 5,652
*Sunderland Corporation	,, 25	1,688	+ 39	30	38,519	+ 1,948
*Swansea Trams	,, 16	514	+ 42	41½	21,728	+ 1,815
Taunton Trams	,, 16	59	+ 3	41½	2,584	- 193
Tynemouth and District	,, 16	287	- 43	41½	13,522	+ 820
Tyneside Trams Co.	,, 21	319	...	42	13,840	...
Wallasey District Council	,, 24	625	+ 80	†30	22,101	+ 2,805
Weston-super-Mare	,, 14	53	- 8	41	5,418	- 491
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 16	393	+ 72	41½	16,318	+ 7,343
Wrexham	,, 16	140	...	28	4,107	...
Yorkshire Woollen District	,, 16	465	...	34½	12,693	...

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed. Oct. 28.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS, WEEK TO OCT. 28 High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅜—4½	5 8 1	April, Oct	4 7/16	4 1/16
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
10	10/0	Barcelona Tramways Ord.	7½—8½	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
5	..	Bri bane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4 —4½	5 11 1	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —102	4 9 6	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10¾	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	108 —110	3 12 8	Feb, Aug	..	..
St.	..	British Columbia Elec. Rlwy. Def. Ord.	84 —87	..	..	86	..
St.	5%	Do. Pref. Ord. Stock	92 —95	5 8 1	..	..	..
10	4/2½	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
4	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	..	..
10	10/0	British Electric Traction Ord.	11⅜—12⅝	6 10 8	..	12½	11⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 4 3	Feb, Aug	11 7/16	11 5/16
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	122⅜	122
5	..	Buenos Ayres and Belgrano Ord.	2⅜—2⅝	..	..	..	..
5	3/0	Do. 6 per Cent. "A" Cum Pref.	5 —5½	5 9 1	..	5	..
5	3/0	Do. "B"	4½—5	6 0 0	..	..	..
St.	5%	Do. 5 per Cent. Debs.	107 —110	4 12 1	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	99 —102	4 18 9	..	99	..
5	2/6	Calcutta Tramways	6½—7	4 12 10	..	6⅝	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —109	4 3 3	..	..	..
1	1/2⅝	Cape Electric Tramways Shares	2⅜—2⅝	6 6 4	..	2 3/16	..
St.	4%	Central London Ordinary Stock	95 — 98	4 2 7	June, Dec	96⅜	95 5/16
St.	4%	Do. 4 per Cent. Pref. Stock	99 —102	3 18 10	..	99½	..
St.	4%	Do. Deferred Stock	99 —102	4 0 0	..	99½	..
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 10	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 —5½	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 5	..	..	..
St.	2¾%	City and South London Rly. Con. Ord.	51 —53	5 17 10	Feb, Aug	52½	51½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	127 —130	3 17 3	Feb, Aug	..	..
St.	5%	Do. (1896)	126 —129	3 17 9	..	..	..
St.	5%	Do. (1901)	122 —127	3 19 7	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	114 —117	3 8 6	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	102 —105	4 16 10	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 —13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3½—4½	6 13 4	..	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 —98	5 2 0	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7½—8½	3 10 7	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9½—10	..	..	..	..
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 3 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾—4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 3	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4⅜—4¾	2 11 3	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼—10¾	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 6	Jan, July	..	..
10	5,0	London United Trams. 5% Cum. Pref.	11½—12	4 3 4	..	11 15/16	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 8	..	..	..
St.	..	Mersey Con. Ord. Stock	7 —10	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	9 —12	..	..	11	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	5/8—5/8	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	1⅝—1¾	4 8 11	..	1	15/16
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 4 1	..	..	..
5	..	New General Traction Ord.	½—½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2—3	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 —102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	9 —10	5 0 0	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	104 —107	4 6 10	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	93 —96	3 7 11	June, Dec	93	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	70 —80	..	..	..	..
St.	15/0	*Anglo-American	46 —49	6 3 0	F,My,Ag,N	47½	..
St.	30/0	Do. Preferred	90 —92	6 10 8	F,My,Ag,N	91⅝	90½
St.	1/0	Do. Deferred	7¼—7¾	0 12 11	F,My Ag,N	7½	..
100	$2	Commercial Cable Capital Stock	145 —155	5 9 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	Jn Ap,Jy,O	92	..
10	9,0	Cuba Submarine Ord.	7½—8½	7 13 0	Feb, Aug	8¼	..
10	10/0	Do. Preference 10 per Cent.	16¾—17½	5 14 3	Feb Aug	17 5/16	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½	Do. 4½ per Cent. Deb.	98⅝—102⅞	4 9 0	Jan, July	..	..
20	3/0	Direct United States Cable	10¼—10½	6 0 11	Jn,Ap,Jy,O	..	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 —102	4 8 10	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	123 —128	5 9 5	Ja,Ap,Jy,O	125½	123½
St.	17/6	Do. 3½ per Cent. Pref. Stock	83 —89	3 18 8	Ja Ap,Jy,O	89	87
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 —109	3 14 4	May, Nov	107½	107¼
10	2,6	Eastern Extension	11½—12	5 16 8	Ja,Ap,Jy,O	11⅞	11½
St.	4%	Do. 4 per Cent. Deb. Stock	104 —107	3 15 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 18 10	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅝—103⅞	3 18 3	May, Nov	..	..
10	5,0	Great Northern of Copenhagen	22¼—23½	5 6 5	Jan, July	22 1/16	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	99 —102	4 8 4	June, Dec	..	..
25	37/6	Indo-European	37 —40	6 5 0	May, Nov	39	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	100⅜	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..
2½	..	West Coast of America	1/16—1/8	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	6½	6
10	..	Do. 6 per Cent. 2nd Pref.	3½—4½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 17 7	Jan, July	103	..
10	3/0	Western Telegraph	12 —12½	5 12 0	Mr,Jn,O,D	12 7/16	12⅜
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 8	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5½	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	8½—9½	4 6 6	Ja Ap Jy O	9	8¼
10	8/0	Do. 6 per Cent. Pref.	12⅝—13½	4 10 7	Ja Ap,Jy,O	13	12 1/16
8	4/0	Reuter's	6¾—7½	5 6 8	April, Oct	..	..
100	6%	†Submarine Cables Trust (Cert.)	115 —120	5 0 0	April, Oct	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed. Oct. 28	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS, WEEK TO OCT. 28. High-est.	Low-est.
		TELEPHONES.					
5	6/0	Chili Telephone (fully paid)	4¾—5¼	5 14 3	August ..	5	4⅞
St.	6%	National Co. Pref. Stock	99 —101	5 19 6	..	100½	99
St.	5%	Do. Def. Stock	72 —74	6 10 2	..	73½	72
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	14	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	4⅞—5¼	4 17 7	Feb, Aug	5	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	92 —94	3 14 11	June, Dec	..	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	102 —104	3 17 5	..	103	..
1	0/8½	Oriental	¾—1	6 0 0	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
5	4'0	United River Plate	5½—6	5 16 8	July	5 9/16	5½
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 — 107	4 13 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝—¾	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	116 —119	3 15 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 —11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 8	..	105½	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	102 —105	4 6 4	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10¼—10¾	4 3 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10 —10½	3 6 8	Mar, Sept	..	..
5	3,6	Calcutta Electric Supply Ord.	6¾—7¼	4 6 8	..	7	..
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	107 —110	3 13 2	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	9 —9½	5 5 3	Feb, Aug	9¼	..
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	3 18 3	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 16 2	..	104¾	..
5	2 0	Chelsea Electric Supply Ord.	5¼—6	4 3 4	March ..	5⅝	5¼
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 —111	4 1 6	Jn, Dec ..	110	..
10	5/0	City of London Electric Lighting Ord.	9¾—10½	7 6 4	Feb, Aug	10¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 —127	3 18 11	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 9 5	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7½—8¼	4 14 2	..	8	7 15/16
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 2 11	..	109	108
St.	..	Do. Second Deb. Stock Prov. Certs.	100 —103	..	..	102	101¾
5	2 0	Folkestone Electricity Supply Co. Ord.	5¾—6¼	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10¾—11½	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
3	..	London Electric Supply Ord.	1¾—2¼	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	5¼—5¾	5 4 4	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	100 —102	3 18 5	Mr,Jn,S,D	..	..
10	8 0	Metropolitan Electric Sup. Ord.	17½—18½	4 3 9	April, Oct	17 1/16	17 1/16
5	..	Do. 4½ per Cent. Cum. Pref.	3¼—3¾	..	..	3⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	110 —114	3 19 8	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 10 0	..	..	..
10	6,0	Notting Hill Electric Ord.	12½—13½	4 8 11	March	12⅝	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..
5	2 6	Oxford Electric Ord.	5¼—5½	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 0	..	..	..
1	..	Rand Electric	1/16—1/8	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	98 —100	4 10 3	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½—15½	4 13 7	Feb, Aug	14⅝	..
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8½	8¼
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 2	..	99	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3 —3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
1	1/9	South London Electric Supply Ord.	3½ - 4	4 7 6	..	3⅝	3⅜
5	2,6	Urban Electric Supply Ord.	4⅜ 5⅛	4 17 7	..	..	..
5	2,6	Do. 5% Cum. Pref.	4¾—5	5 0 0	..	5	..
5	6/6	Westminster Electric Supply Ord.	12 - 13	5 0 0	Mar, Sept	12⅝	12¼
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6 1/16	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—⅝	6 13 4	..	..	..
1	7½d.	Aron Electric Meter 6% Cum. Pref.	⅜—½	..	Mar, Sept	..	..
5	4 0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 5 8	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	103 —105	4 5 8	..	104½	..
5	3/0	British Westinghouse 6% Pref.	5½—5¾	5 4 3	..	5 11/16	5½
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	100 —102	3 18 5	..	101	..
½	..	Brush Electrical Engineering	⅜—1½	..	March ..	1	⅜
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1⅛—1⅜	6 17 2	Mar, Sept	1⅜	1 1/16
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	85 - 90	5 0 5	Jan, July	..	..
5	10,0	Callender's Cable Construction Ord.	11½—12½	8 0 0	Jan, July	11½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	106 —110	4 1 10	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	¾—1	6 0 0	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	89 —94	4 16 9	..	91½	..
1	0 7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 —2½	5 19 10	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	100⅝—104¼	4 16 10	Jan, July	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1½—2½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock (rd.)	72 —77	5 5 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	77½	..
5	4/6	Edmundson's Elec. Corp. Ord.	6½—6¾	5 3 8	H'lf-yearly	6⅝	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6¼—6¾	4 8 11	..	6¾	6 1/16
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 —108	4 4 1	..	107	105
2	1/2½	Electric Construction Co.	1½—1¾	6 17 2	Jan, July	1⅝	..
2	2,9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 3	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅜—⅝	..	..	..	..
1	7½	Do. 7 per Cent. Cum. Pref.	½—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¾—10¼	4 17 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 —99	4 0 10	..	..	..
5	6/0	Henley's Telegraph Works Ord.	14 —15	6 13 4	Feb, Aug	14½	14
5	2,3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	5⅛	5 1/16
St.	4½%	Do. 4½ per Cent. Mort Deb.Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	18⅝	18½
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 8	Mar, July	35¼	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 —103	3 17 8	Jan, July	..	..
5	8/0	Willans and Robinson Ord.	5½—6¼	5 0 0	Apr, Oct	5⅝	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6¼	4 12 4	Apr, Oct	6⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 10	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

A VERY important contribution to our knowledge of the spontaneous heat emission of radium salts appears in last week's issue of *Nature* in the form of a letter from Prof. RUTHERFORD and Prof. H. T. BARNES of McGill University. These investigators find that the heat emission is proportional to the α-radiation, with which it varies directly. Now, it is known that only 25 per cent. of the α-radiation comes directly from the radium itself, and that the remaining 75 per cent. is due to the radio-active emanation occluded by the salt and continuously generated by the radium. The authors therefore perform this instructive experiment: They measure the heat emission from 30 milligrammes of radium bromide. Then, by heating the substance, they drive off all but a few per cent. of the occluded emanation, and condense the latter in a small glass tube cooled in liquid air. The tube is then sealed up, and contains all the emanation which the radium has lost. They now find that the heat emission from the radium has been reduced to 30 per cent., while the glass tube containing the emanation emits heat to the extent of 70 per cent. of that of the original radium. As time goes on and more emanation is produced by the radium, the heat effect from the latter gradually increases, while that from the emanation gradually decays, and, as far as the observations have gone, this recovery and decay of the heat emission follows the same law as the recovery and decay of the α-radiation of the radium and the emanation respectively. The point of fundamental importance is that the actual amount of emanation obtainable from 30 milligrammes of radium bromide is quite invisible and unweighable, and has so far only been detected by its radio-activity, and the phosphorescence and ionisation produced by the latter. Yet 70 per cent. of the heat emission of a radium salt is due to this invisible amount of gas.

THIS result cannot be explained on the view that the radium gains its heat from an external source, whereas the disintegration theory of RUTHERFORD and SODDY leads directly to its prediction. For on that theory the energy of radio-activity is derived from the internal energy of the atom liberated when it breaks up into smaller systems. For each atom of radium the energy is not all liberated at once, but in at least four stages. The first stage—the break up of the atom of radium into the atom of emanation and expelled particles or α-rays—represents 25 per cent. of the total energy evolved, the remaining 75 per cent. being due to further breakings up of the emanation atom with the expulsion of more α-rays. As, however, the emanation systems are disintegrating at a very rapid rate—one-half of the total breaking up every four days—the number of atoms of emanation present at any one time never rises above a fixed infinitesimal proportion of the number of radium atoms present, but this infinitesimal proportion of the whole is responsible for three-fourths of the energy evolved. When the changes occur under conditions where the kinetic energy of the projectiles expelled at the moment of disintegration is destroyed—*i.e.*, under conditions where the α-radiation is absorbed—the energy, of course, appears as heat.

IT is late in the day for fresh precedents with regard to the application of the Electric Lighting Acts, but yet we are able to chronicle one which may prove to be of considerable importance to company electricity undertakers. The Board of Trade has just given its decision in an appeal by the Leatherhead and District Electricity Co. against the Epsom Rural District Council on the question of conditions which the latter authority sought to impose in giving its consent to certain work bein-

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carried out in its streets. The company has a network of mains in Leatherhead and Mickleham, and recently gave notice to the Epsom District Council of its intention to proceed forthwith to lay mains in the parish of Ashstead, which comes within the Council's area and within the area of the Company's Provisional Order. In accordance with the provisions of the Electric Lighting Acts plans were submitted by the Company at the same time, and these showed that the mains were to be laid at a depth of 18in. under pathways and 2ft. under the roadways. It may be mentioned that the mains are Glover's three-core paper-insulated lead-covered, laid "solid" in Howard asphalte conduits. The Council refused their sanction to the laying of the mains unless the Company put them at a depth of 3ft. throughout. On the advice of their consulting engineers (Messrs. Handcock and Dykes) the Company appealed to the Board of Trade against the Council's decision, and the appeal was heard on October 22nd. The Board of Trade has just announced its award, which is in favour of the Company's appeal.

THE report of an appeal on a still more important matter will be found in our Legal columns this week—viz., an appeal by a tramway company against a rating authority. The rateable value of such undertakings is assessed at what a "hypothetical tenant" would pay if he rented the line, and this value is usually arrived at by a comparison of the receipts and expenses, with certain allowance for capital charges and other items. Mr. W. G. BOND in his little book on the "Rating of Electricity Undertakings" summarises this system concisely as follows :—

Gross Receipts – Expenses = Net Receipts.
Net Receipts – 0·175 (Working Capital) = Gross Value.
Gross Value – 'Statutables" = Rateable Value.

"Statutables," it is explained, are "the probable average annual cost of the repairs, insurance and other expenses, if any, necessary to maintain the property in a fit state to command the rent." The Assessment Committee of the Oldham Union, however, found that this process would not give a sufficiently large figure for their purpose, as the line was a new one and the difference between receipts and expenses was still small. They therefore estimated the structural value of the line, and took 3¼ per cent. of this sum as a basis for their assessment. The Company appealed against this at the Salford Quarter Sessions, and, as a result, the assessment was reduced from £2,500 gross and £2,000 net to £1,000 gross and £550 net, costs being given against the Assessment Committee.

WE commence this week the publication of an article by Mr. W. P. DIGBY, in which some interesting statistics relating to electrical exports and imports are summarised. The curves and tables afford an opportunity for useful comparison and much food for thought, but it must not be forgotten that the Board of Trade returns, upon which they are based for the most part, cannot always be relied upon for correct classification. For instance, the figures given for imports of "electrical goods" are undoubtedly too low. There being no import duty on material of this class, traders and shippers need not be so careful to designate the exact character of their shipments as they must be in the case of protectionist countries with more exacting Custom-house requirements; and, in consequence, it is not improbable that as much of the electrical plant imported is classified under other headings as enters under "Electrical Goods." For these and other reasons we cannot endorse all Mr. DIGBY'S conclusions, and we do not share his views in many respects, especially the opinions expressed in the latter part of his article. But as he has put together in so clear and concise a manner the statistics that are available with regard to the electrical exports and imports of the United Kingdom, as well as many relating to the imports of our colonies, we have no hesitation in giving our readers the benefit of the results of his labours.

THE electricity supply accounts of Edinburgh for the year ended on May 15th last, show that that undertaking can now take its place amongst the six or seven British supply works which show total working costs of under 1d. per unit sold. The actual figures are 0·66d. for works costs and 0·98d. for "total costs." The credit for the latter figure is enhanced when it is stated that it includes nearly 0·15d. per unit paid in rates and taxes and when it is recalled that the station is destitute of a traction load. The public lighting supply constituted 14·2 per cent. and the motor load nearly 19 per cent. of the total output of 8,995,808 units sold. In the circumstances it is interesting to turn to the figures of the prices for supply. They bear criticism well, for we find that the average receipts for private supply (lighting and power) work out at 2·85d. per unit, whilst the price received for public lighting (after deducting materials and attendance in respect of public lamps) was 1·39d. per unit. For the last three years at least, the charge for public lighting has been at the low rate of £13 per arc lamp, and at May 15th last this charge was reduced to one of £11 per arc lamp per annum.

IN view of these charges it is worth recording some further particulars of the conditions under which the street lighting is carried out. There are no public glow lamps used, and of the 880 arc lamps installed at May 15th about 30 are 15-ampere lamps; the rest are of 10-ampere capacity. About half the lamps are switched off at midnight, so that their lighting hours in the year are about 2,000, whilst the all-night lamps are lighted for about 3,800 hours. The public lighting maximum demand was about 450kw., showing, in conjunction with the output data, a public lighting load-factor of about 32 per cent. As the demand occurs at the same time as the highest private supply demand, the load-factor given over-represents the value of the public lighting business to the station so far as its effect in flattening the load-curve is concerned.

IT is not difficult to show that the total receipts for public lighting last year at Edinburgh were decidedly under what it actually cost the undertaking to carry out the arc lighting, though it probably pays to undertake the business at the price, and would pay even at a lower price. The accounts show that last year the costs of trimming, repairing and generally attending to the street lamps, including supplies, was about 0·76d. per unit used for street lighting. To

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this must be added a provision for covering the capital expended on the lamps, posts and arc cables—a provision which could not be estimated at less than 0·25d. per unit. The working costs of producing current were 0·98d. per unit, and the corresponding capital costs were 0·64d. This gives, at the lowest estimate, a total of 2·63d. per unit sold for public lighting as the cost of supplying and maintaining the 880 arc lamps installed. The *actual* receipts for this were 2·16d. per unit, and under the new tariff of £11 per lamp now in force, the receipts per unit will presumably amount to little over 1·8d. per unit. It must not be forgotten, however, that the real basis upon which the charge for street lighting is to be determined is an estimate of the extra working cost to the undertaking of lighting and maintaining a given number of additional lamps to those already installed. The Corporation of Edinburgh are evidently satisfied that this low price is remunerative, and a glance at their financial results for last year shows that, notwithstanding the low prices, the working profit came to 7·95 per cent. of the mean capital, leaving a balance of £14,532 after paying capital charges up to 6·07 per cent. on the mean capital. It has been decided, moreover, to erect 115 new arc lamps, bringing the total to 995. Incidentally, it may be mentioned that, owing to extension of the continuous-current mains, the rectifiers are now disused, and a contribution of £1,994 towards their unredeemed capital cost is included in the charges on the gross profit.

THE "electrophone" is no new invention, and, in fact, the employment of a microphone for the purpose of transmitting music and public speech through telephone lines dates back to the earliest days of telephony. Yet it is only recently that it has been employed for commercial purposes to replace the telegraph for transmitting newspaper reports of speeches. A demonstration of the practical manner in which it may be applied for this purpose was given by the *Evening News* on Wednesday night. Mr. CHAMBERLAIN spoke at Birmingham for nearly two hours, and concluded his speech at 10:5 p.m. At 10:32 p.m. an edition of the *Evening News* was issued in London with a verbatim report of the speech. The system employed was precisely similar to that described in our issue of October 9th, with the exception that head-gear receivers were worn by the reporters sitting in the *Evening News* offices. All the arrangements made by the Post Office and the National Telephone Company worked without a hitch. If the telephone trunk lines were used more frequently for similar purposes, the telephone department of the Post Office would benefit as well as the newspapers and general public, for the night load on the lines would utilise capital otherwise lying idle for several hours out of the twenty-four, and the result should be a general cheapening of the trunk service.

DESPITE the many attempts which have been made to convert peat into the equivalent of coal of high calorific value, the desired object has never yet been attained. A demonstration of a new process was given at Messrs. Johnson and Phillips' works yesterday, but no proof was forthcoming that the process constituted an exception to the rule. Peat, said to contain 70 to 80 per cent. of water, was placed in a perforated cylinder, which was rotated so as to throw off free water. An electric current of 220 amperes at 200 volts was then passed through the peat, and this, according to a circular describing the process, generated heat of a particular kind, which drove off the remaining or latent water. We were informed verbally, however, that the action was an electrolytic one, the current splitting up the "cell," driving off the latent water, and leaving all combustible material behind. We were further told that (in spite of there being from 70 to 80 per cent. of water in the raw material) every 30cwt. of raw material is converted into 20cwt. of fuel absolutely free from water. After being beaten by a machine into the consistency of putty, the "fuel" is moulded into briquettes, and in the course of a week or so is in a fit state for consumption. During this period it loses about 25 per cent. in weight, but it appears that this is not due to evaporation, as the "fuel" is devoid of water. This could not be explained, but is probably due to the same cause as the peculiar arithmetical phenomenon described above.

THE gentlemen who showed us the process yesterday assured us repeatedly that they could produce fuel for 5s. per ton which is equivalent in calorific value to the best Welsh coal. As an attempt to prove this contention yesterday's demonstration was a complete failure, and this was strongly emphasised by the entire lack of reliable data. It may be added that, although we asked for reports of tests by experts as to the efficiency of the process, none were forthcoming. We understand that Messrs. Johnson and Phillips are not the proprietors of the process in question, but had merely lent their works for the purposes of the "demonstration."

Institution of Electrical Engineers.—We are asked to remind our readers that Mr. R. Kaye Gray will deliver his presidential address on Thursday next at 8 p.m. The meeting will be, as usual, at the rooms of the Institution of Civil Engineers.

Edison Accumulators.—The *Western Electrician* of Chicago states that over 30 electric launches for use on the lake at the St. Louis Exhibition are to be equipped with Edison accumulators.

High-speed Electric Railway.—In connection with the recent high-speed trials in Germany the *Elektrotechnische Rundschau* states that the electric motor car covered 2km. after the brakes were applied, before coming to a dead stop. Our contemporary also states that the car of the Allgemeine Elektricitäts Gesellschaft is now being tested over the same track, and that, so far, a maximum speed of 171km. per hour has been attained.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Anjer—Kalianda	Aug. 2, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Paramaribo—Cayenne	Feb. 27, 1903
New York—Hayti	Apr. 13, 1903
Trinidad—Demerara	Oct. 23, 1903

Clyde Valley Electric Power Co.—In a gale of wind and rain on Thursday night last week the partially-constructed power house of the Clyde Valley Electric Power Co. at Motherwell, N.B., fell to the ground. No reason can be assigned for the accident, except that owing to its unfinished condition, it was unable to withstand the pressure of the wind. The iron columns supporting the beams and girders had been fixed in place and bolted to the foundations, and there were also guy ropes supporting them. Luckily no one was injured, as all the workmen had left.

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Newcastle Local Section of the Institution of Electrical Engineers.—The annual dinner of the Newcastle-upon-Tyne section of the Institution of Electrical Engineers was held at the County Hotel, Newcastle, on Tuesday evening last, among the guests being the president of the Institution, Mr. R. Kaye Gray, the deputy-mayor and sheriff of Newcastle, and the secretary, Mr. McMillan. Mr. G. Stoney, chairman of the local section, was in the chair, and the total attendance was 70, a number not so great as last year. At the conclusion of the dinner several humorous speeches were delivered.

Ball Bearings for Tramway Motors.—According to the *Zeitschrift für Elektrotechnik*, the Grosse Berliner Strassenbahn recently carried out some tests on two tramway motors built by the Union Elektricitäts Gesellschaft and fitted with ball bearings. The results were, it is stated, so satisfactory that the company has decided to adopt such motors on a large scale, and has given orders for 100 similar machines. Although by their adoption a saving in friction losses of about 1 per cent. is effected, the chief advantage of the ball bearings lies in the direction of economy in lubricants and the ease with which these are applied. The wear of the balls and ball races is said to be very small.

Radium and Cancer.—The Vienna correspondent of the *Daily Chronicle* states that Dr. Exner, commissioned by the Vienna Academy of Science to inquire into the method of curing disease by radium, has submitted his report in respect of the treatment of cancer. According to this report, in nine cases radium has effected very considerable abatement in the cancerous swelling, and in two of these cases the swelling has not reappeared, although five months have elapsed since the treatment. In one case, where it was impossible to operate for cancer in the palate, radium had effected considerable improvement, the swelling having been reduced to a minimum. Dr. Exner concludes that in cases in which an operation is possible this course is preferable, but the radium treatment is advisable in cases where an operation is impossible.

Personal.—We are pleased to announce that the appointment of Mr. A. L. C. Fell as general manager of the London County Council Tramways, in succession to Mr. A. Baker, has been confirmed by the Council. Mr. Fell has, for a considerable number of years, held a similar position under the Sheffield Corporation, and he is known as one of the best authorities on electric tramway matters in the United Kingdom. Previously to going to Sheffield he was with the British Thomson-Houston Co., for whom he took charge of the erection and first year's running of the Croydon electricity works, and he afterwards went to Cork for the same company in charge of the tramways there. He was appointed electrical engineer to the Sheffield Corporation tramways in 1898, and shortly afterwards was appointed electrical engineer and tramways manager.

Relation between Sparking Distances and Impressed Voltage.—In a report of the Standardisation Committee of the American Institute of Electrical Engineers the sparking distances in air between opposed sharp needle points for various effective sinusoidal voltages are given as follows :—

Kilovolts sq. root of mean sq.	Inches sparking distance.	Kilovolts sq. root of mean sq.	Inches sparking distance.	Kilovolts sq. root of mean sq.	Inches sparking distance.
5	0·225	40	2·45	100	9·6
10	0·47	45	2·95	110	10·75
15	0·725	50	3·55	120	11·85
20	1·0	60	4·65	130	12·95
25	1·3	70	5·85	140	13·95
30	1·625	80	7·1	150	15·0
35	2·0	90	8·35		

Armature Conductors of Unequal Section.—A peculiar form of armature conductor has been patented by Mr. Wait, engineer of the Western Electric Co. of America. The copper conductor from which the armature coil is wound varies in thickness, the thinner parts being those which are embedded in the slots when the coil is wound, while the thicker portions of the conductor correspond to the end connections on the finished machine. Thus it is possible to use smaller slots, and to decrease correspondingly the self-induction in the coils, thereby bettering the conditions of commutation. On the other hand, the current density in the slot conductors has been increased, as at the same time the resistance of the end connections is diminished, and the difference in temperature existing between these two parts of the coil is said to be sufficient to conduct away effectively the increased heat generated in the slot conductors.

Weights of German Continuous-current Machines.—In discussing the improvements of continuous-current machines during recent years, the *Zeitschrift für Elektrotechnik* quotes the following interesting figures referring to continuous-current machines made by a leading German electrical firm in 1896 and 1902 respectively. The figures given are based on a speed of 1,000 revs. per min.

Capacity of machine in kilowatts.	Weight per kilowatt.	
	1896. (Kg.)	1902. (Kg.)
1	260	150
5	145	74
10	124	68
50	51	26
90	45	21

Power Supply at Bolton.—The Bolton Corporation Electricity committee, under the advice of Mr. Arthur A. Day, their electrical engineer, are contemplating the introduction of an extra high-pressure system in addition to their present one, with the object of supplying power over the whole of their area. As the area is a large one, and as the prices for power, which are already low, decrease, they expect that a considerable amount of power will be demanded for mill driving purposes in more or less isolated positions. They have, therefore, applied to the Board of Trade for permission to use extra high pressure at 6,500 volts three-phase. The employment of overhead wires, however, is not contemplated. At present, the average charge for power at Bolton, including that supplied to the small consumers as well as to large, is below 1·2d. per unit, and to anyone using power in considerable quantities, the price works out at about 1d. per unit. During the six months of the existing financial year, over 100 H.P. of motors have been connected up per month, the majority of these being for driving fairly large works.

English v. Foreign Tramway Trucks.—We have received the following communication from the Brush Electrical Engineering Co.:—

Arising out of the recent action of the Brighton Tramways Committee in disqualifying a tender for cars on the ground that the firm quoted only for British trucks instead of American, as specified, the employés of the truck shop at Falcon Works, Loughborough, have held a meeting and passed the following resolutions unanimously:—

Resolutions

passed at a meeting of the employés of the electric traction truck department of the Brush Electrical Engineering Co., Falcon Works, Loughborough, November 2, 1903.

1. That this meeting, having heard that in several towns it is the custom to exclude British firms from putting in tenders for trucks in competition with foreign makers, respectfully appeals to members of Tramway committees and other buyers of cars to give fair play to an industry on which the welfare of so many of their countrymen, not only ourselves and our families, but other workers concerned in the preparation of the material, is absolutely dependent.

2. That, while having no right or wish to interfere with the actual placing of orders, we urge that in our own country it is unjust that British truck makers should be barred from opportunities of selling goods which are the product of British labour.

3. That we protest against any suggestion that foreigners can claim superiority or even equality in any branch of steel work, and we are confident that, with fair and open competition, foreign-made electric traction trucks would soon fail to find any market whatever in this country, and that employment would then be provided for a large number of additional men in this industry. (Signed) H. Davis, chairman (erector).
J. Cramble, secretary (fitter).

Electrolytic Drilling.—An interesting article on "An Electrolytic Drilling and Slotting Process," by Sherard Cowper-Coles, appears in a recent issue of the *Electro-Chemist and Metallurgist*, the organ of the Faraday Society. Electrolyte is squirted from a nozzle, down the centre of which is fixed a baffle plate, on to the iron or steel sheet to be drilled. It enters the nozzle above the baffle plate, comes into contact with the material, and, passing under the baffle plate, leaves

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the nozzle by another pipe. A pointed rod, fitted in a gland, is so arranged as to be near the end of the baffle plate; the rod forms the negative electrode, on which iron is deposited as a powder, due to the high current-density, and is washed away by the rapidly-circulating electrolyte. The end of the nozzle is fitted with a removable rubber washer, and the shape and size of the hole to be drilled is determined by the shape and size of the rubber washer. Some of the best results when drilling iron have been obtained with a solution of sulphuric acid; good results have also been obtained with ordinary salt water. In a machine specially designed for cutting out large holes, such as manholes, portholes, &c, the jets of liquid are caused to revolve round an adjustable centre, and the electrolyte circulates by gravity. The nozzles are connected by flexible hose to the pump or reservoir.

An Italian High-speed Electric Railway.—Rome and Naples are connected at present by a railway line, 155 miles in length, but the conditions of the country traversed are such that the express trains take five hours in covering that distance. A new and direct line has been under consideration for some time and a royal commission was appointed to investigate the possibilities of the project. An abstract of its report is given in the *Zeitschrift für Elektrotechnik*. A new double line, possessing maximum gradients of 1·5 per cent. and radii of not more than 2,950ft., and situated at a distance of about 4½ miles from the coast, is proposed. The termini would be in the centre of the towns in each case, and there would be 15 stations on the 126 miles of route. Electric traction is advocated, preferably on a three-phase extra high-pressure system, the trains to consist of three motor carriages, weighing, in the aggregate, 120 tons and running at 62 miles per hour. It is estimated that such a train would absorb on an average 1,500 H.P. A special commission reports that water power to the amount of about 100,000 H.P. is available in the neighbourhood of the line, and that the initial cost of the power station per horse-power may be put down at from £16 to £24. For the first, second and third class respectively, the following fares per kilometre are proposed:—0·091fr., 0·063fr. and 0·036fr.; or, expressed in English units—1·41d., 0·975d. and 0·555d. per mile. The initial costs for the railway proper and for the electrical power plant respectively are estimated at £3,730,000 and £680,000, and the gross receipts are expected to amount to 42,000fr. per kilometre per year (£2,700 per mile per year).

Drainage by Electricity.—Acting on the suggestion of their engineer, Mr. John D. Watson, the Birmingham, Tame and Rea District Drainage Board have decided to carry out an electrical power transmission scheme in connection with the drainage and sewage disposal system under their control. Electricity will be generated at Saltley, near Birmingham, by two steam generators aggregating about 175 B.H.P., and each consisting of a Belliss high-speed engine directly-coupled to a three-phase B.T.-H. dynamo generating current at 2,300 volts and a frequency of 50 ~ per second. This current will be led directly to the overhead transmission line, which is 5 miles in length, and will be tapped at eight points along the route, at each of which a small sub-station will be erected, containing step-down transformers for reducing the pressure to 200 volts. At four sub-stations centrifugal pumps, directly connected to B.T.-H. induction motors, are to be installed for the purpose of pumping the water from the main culvert, running the whole length of the estate, on to the land. In all, 14 motors ranging from 2 H.P. to 28 H.P., are to be provided, and a number of them will drive machinery on the different farms situated on the Board's estate, while others will operate distributors and similar machinery used in connection with the treatment of sewage. The lighting of the principal buildings will also be effected by electricity. We understand that the contract for the complete equipment of the generating station and sub-stations, and for the erection of the transmission line, has been provisionally placed with the British Thomson-Houston Co., and the work is to be commenced after the sanction of the Local Government Board to a loan of £14,000 has been obtained.

Wireless Telegraph Notes.—It is announced by *Electricity* of New York that the International Wireless Telegraph Co. has begun an action against the Marconi Company and Reginald A. Fessenden, in the United States Circuit Court in the district of New Jersey, claiming infringement of patents.

The new De Forest wireless telegraph station at Cleveland, Ohio, is described in a recent issue of the *Western Electrician* of Chicago. Two large masts have been erected 100ft. apart and at right angles to the shore of the lake. Suspended between the tops of these masts is a copper wire, hanging from which are about 20 smaller wires, which form the screen or antenna used in sending and receiving messages. The wires of this screen converge to a point before entering the station, which is a small cottage directly between the two masts. The masts are among the tallest of their kind in America, being 207ft. and 209ft. high respectively. Entering the station two of the wires, which are insulated from the others, are led to the receiving box and responder. These two wires are all that are necessary for receiving. The remainder are connected with the sending machine and transformers. A large current is not necessary in sending, but a small current is passed through step-up transformers until a very high voltage is obtained. This current is obtained from a 10 H.P. gasoline engine, which drives a dynamo. The engine and dynamo house is situated south of the station house proper, at a distance of about 150ft., in order that the noise and jar may not interfere with receiving or sending messages. The station at Cleveland is only a part of the De Forest system which is intended eventually to embrace the Great Lakes in a chain of stations.

An interesting lecture on "Wireless Telegraphy" was delivered by Prof. S. P. Thompson, F.R.S., at the Hampstead Conservatoire on Tuesday evening. The lecturer commenced by giving a brief résumé of the history of the science, including the early experiments of Morse, Lindsay, Preece, Edison and Tesla. He then rapidly touched upon the phenomenon of the production of electric waves by sudden sparks, and said that the discovery of Hertz was foreshadowed by Clerk Maxwell. Coherers, magnetic detectors, anti-coherers, and a variety of receiving devices were described, and their various actions explained. "Tuning" was explained by means of acoustical experiments, and Dr. Thompson was most emphatic on the point that true syntony had not yet been obtained. Many interesting pictures were shown, and the lecture concluded with the transmission of a message, selected by a member of the audience, from the fire station in Adelaide-road to the lecture room. The apparatus used on this occasion was that employed in the Lodge-Muirhead system, and the record on the tape was exceedingly clear. Dr. Thompson advocated an international agreement with regard to the reception of "wireless" signals, and said that the newspaper talk about wireless telegraphy causing bad weather was "bosh."

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, November 10th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street, Glasgow, when the Chairman, Mr. W. A. Chamen, will deliver his Inaugural Address.

THURSDAY, November 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Mr. R. Kaye Gray, the President, will deliver his Inaugural Address.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting in the Royal College of Science, Dublin, when the Chairman, Prof. W. E. Thrift, will deliver his Inaugural Address.

FRIDAY, November 13th.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Concert (Ladies' Night) in the King's Hall, Holborn Restaurant.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "Means of Electrifying the Atmosphere on a Large Scale," by Sir Oliver J. Lodge, F.R.S. (2) "An Arrangement for Driving Mercury Pumps," by Sir Oliver J. Lodge, F.R.S.

SATURDAY, November 14th.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read: "Motor Cars," by A. Govan.

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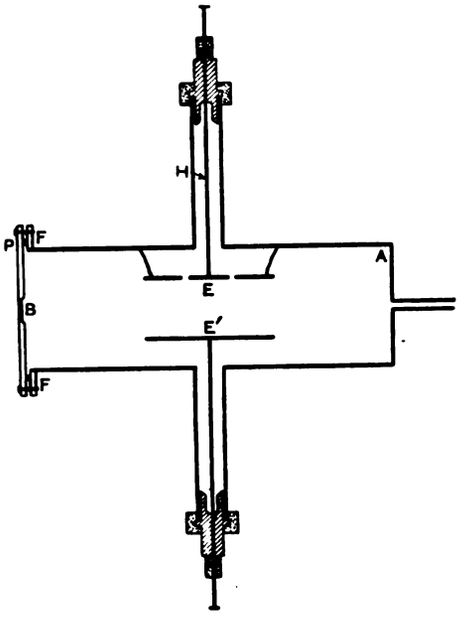
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Temperature and Ionisation.—R. K. McClung has made a separate investigation into the manner in which the ionisation of air by Röntgen rays is affected by the temperature. The chief difficulty was encountered in obtaining a metallic vessel, of necessity containing joints, which should be gas-tight and stand variations of both temperature and pressure. The vessel finally adopted is shown in the diagram, where the brass flange FF is shown attached to the brass tube AB, closed



by the aluminium plate B sealed on by a lead wire, P, compressed with screws. EE' are the electrodes fitted in with heavy rubber stoppers and compression tubes. The results so far show no effect of temperature upon the ionisation of air under X-rays transmitted through B.

[R. K. McCLUNG, *Proc. Camb. Phil. Soc.*, October 21, 1903.]

Magnetic Manganese Alloys.—F. Heusler has succeeded in producing magnetisable alloys of practically non-magnetic metals. He gives a number of data referring to castings of copper alloyed with manganese and aluminium in various proportions. The best results were obtained with a copper alloy containing 26·5 per cent. of manganese and 14·6 per cent. aluminium—*i.e.*, manganese and aluminium in nearly atomic proportions. This alloy showed an induction of several thousand units in fields ranging from 20 to 150 units. It was considerably improved by keeping it at 110deg. in boiling toluol for two days. The induction was then 4,500 units in a field of 10 units and 5,550 in a field of 150 units. When the percentage of aluminium was reduced to 3·6 the alloy ceased to be magnetic. Similar results, though not so good, were obtained with tin instead of aluminium. With one atom of tin to two of manganese there was practically no susceptibility. But an induction of 1,140 in a field of 100 units was obtained in copper containing one atom of tin to three of manganese. There was no iron present in either case, nor could similar results be obtained by introducing considerable iron impurities. The author points out an analogy with solutions of manganous nitrate, which have a higher molecular susceptibility than even the ferro-magnetic metals. Arsenic, antimony, bismuth and boron also yield magnetisable alloys.

[F. HEUSLER, *Verh. D. Physik. Ges.*, June 12, 1903.]

Magnetic Expansion.—Outside the ferro-magnetic group of elements, bismuth has the largest susceptibility of any substance. It shows, however, no magnetic expansion or contraction, and the tacit assumption seems to have been made that, therefore, the still less susceptible metals will not show any either. But in the case of the ferro-magnetic metals there is no direct relation between the susceptibility and the change of length. Thus, iron has six times the maximum susceptibility of nickel, and yet expands far less for any known field. Again, cobalt has a maximum susceptibility one-eighth that of iron, but expands about as much. P. E. Shaw has, therefore, in a course of experiments covering nearly two years, looked for magnetic expansion in the less magnetic metals, including bismuth, silver, aluminium, copper, zinc, brass, bronze, lead and tin. At first the experiments, conducted with a simple form of electric micrometer, appeared to indicate that all the metals contracted to an extent proportional to the field, and that they all showed permanent magnetisation on the hysteresis principle. But step by step these inferences were proved to be fallacious, as greater care was taken in the exclusion of iron from the apparatus and in the exact setting of the rod symmetrical in the coil and free from mechanical connection with it. The final conclusion reached was that no true expansion, positive or negative, can be detected within the limits of the experiment.

[P. E. SHAW, *Proc. Roy. Soc.*, June 18, 1903.]

Radio-active Gas in Tap Water.—J. J. Thomson has found that when Cambridge tap-water is boiled, the air given off is mixed with a radio-active gas. The existence of this gas is easily demonstrated by electrical means, for if the air expelled by prolonged boiling from about 10 litres of water is introduced into a closed vessel whose volume is about 600 cubic cm., the amount of ionisation in the vessel, as measured by the saturation current, is increased five or six times. A second boiling evolves no further radio-active gas. The gas can diffuse through a porous plate, and by comparing its rate of diffusion with that of CO_2 through the same plate its density can be determined by Graham's law; preliminary measurements of this kind indicate that two different gases are present, of which one has a density about twice, the other between six or seven times that of CO_2. The gas obtained by boiling the water always diffused faster than that procured by bubbling air through the water; it seems possible that in the latter case the gas may get loaded with water-vapour to a greater extent than in the former. At the temperature of liquid air the radio-active gas is frozen. A sample of 20 litres of the air was liquefied; the liquid was then allowed to boil away, the gas coming off at the commencement of boiling was collected, and also that coming off when the liquid had all but boiled away. On testing the samples for radio-activity the former was found to be slightly radio active, but not nearly so much so as before liquefaction, while the second was extraordinarily radio-active, its activity being quite 30 times that of the original gas, thus showing, as we should expect from its great density, that the radio-active gas is much more easily liquefied than air. Similar radio-active specimens of air were obtained from various artesian wells, as well as from the tap-water of Ely, Birmingham and Ipswich, but not from surface water.

[J. J. THOMSON, *Proc. Camb. Phil. Soc.*, October 21, 1903.]

Symmetry of Electrotherapeutic Effects.—It sometimes happens in the medical applications of electricity that the current has to be successively applied to the two arms or legs of a patient. During such operations H. Bordier has noticed a diminution of resistance in the limb not subjected to the current. Take the case of a patient whose right arm is galvanised by applying an electrode of 100 sq. cm. to the right shoulder, while his front arm is plunged into water heated to 38deg. and containing a carbon electrode. If now the current is brought up to 20 milliamperes, it is observed to increase gradually to, say, 24 milliamperes within 10 or 15 minutes, after which it remains constant. If then the left arm is similarly galvanised, there is a similar increase of intensity, but it attains, say, 30 milliamperes instead of 24. A further experiment shows that there is a corresponding diminution of resistance in the left arm. Its resistance in one case was reduced from 3,855 ohms to 2,962 ohms by the galvanising of the right arm. The author finds an explanation in the fact that the resistance is controlled by the vaso-motor nerve centres in the bulbo-medullary axis, and that these centres, once stimulated, would produce a simultaneous and symmetrical effect on both sides.

[H. BORDIER, *Arch. d'Electr. Méd.*, October 15, 1903.]

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 45.)

The measurement of radio-activity in an accurate and quantitative manner depends upon the property possessed by the rays emitted of ionising the gas through which they pass—*i.e.*, of rendering it capable of carrying limited quantities of both positive and negative electricity. This was shown for the uranium rays very early by Becquerel. The use of this property as a means of quantitative measurement dates, however, from the work of Rutherford (*Phil. Mag.*, 1899, p. 109), who showed that the ionisation produced by the uranium radiation is of the same character as that produced by the X-rays, and equally with the latter can be simply and directly explained by the theory put forward by Prof. J. J. Thomson that the conduction is brought about by the transport of negatively and positively charged carriers to the positive and negative electrodes respectively. The function of the rays, both the X-rays and the rays from radio-active substances, is to *produce* these ions throughout the volume of the gas. The energy of the rays absorbed by the gas is utilised in the production of ions, so that the number produced in unit time is a measure of the intensity of the radiation absorbed. The current flowing through a gas under certain special conditions will be shown later to be a measure of the number of ions produced per second. Hence it becomes possible to measure radio-activity by electrical means. The actual methods employed will be dealt with later. It is first necessary to obtain an idea of the nature of the ions and their behaviour under given conditions.

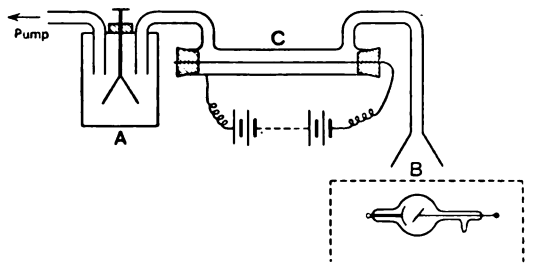

Fig. 3.

Prof. Thomson's ionisation theory of gaseous conduction possesses, however, another quite independent and more fundamental bearing upon radio-activity, for it has recently been shown that the rays from radio-active substances which produce the "ions" of normal gaseous conduction are themselves also "ions" in the Faraday sense of moving particles carrying an electric charge. Thus the α-rays are positive ions and the β-rays negative ions. There is, however, this distinction between the two classes—the ions produced in gases by the passage of the X-rays or rays from radio-active substances are characterised solely by their charge. Their movement in an electric field is the result of the charge carried, and the latter is the only means we possess of detecting and investigating them. With the projected charged particles shot out by radium, the kinetic energy of the moving body and not its charge is its main experimental characteristic. In consequence, this class of ions has a great many properties not possessed by the ions of the first class, and the means of investigation are quite distinct from the two classes. Yet it is possible to start with an ion of the first class and impart to it so much energy that it resembles in properties the ions shot out by radium and uranium. The problems of radio-activity are thus intimately bound up with the electrical properties of gases.

It will be convenient to consider first the ions of normal gaseous conduction which are produced in a gas whenever it is acted on by certain types of radiation of which the X-rays, the cathode or Lenard rays and Becquerel rays are the most important. Ordinary air screened from extraneous influences is in all probability an absolute non-conductor of electricity. Experimentally, it always exhibits an excessively minute conductivity, which is, however, caused by ions, and generally spoken of as the natural or, less correctly, the spontaneous ionisation of the air. But since this continuously decreases as greater precautions are taken to screen it from the action of infinitesimal quantities of radio-active matter, it is a fair inference to regard the air as a perfect insulator when in its normal condition. If it is got into a conducting state by the action of X-rays, for example, it is found that its conductivity persists for a short time after the rays are cut off, so that the conducting air can be blown away from the neighbourhood of the X-ray tube, and will discharge an electrified body, as, for example, an electroscope, at some distance out of the direct line of fire of the rays. Fig. 3 represents an arrangement for showing this. The air under the influence of the X-rays is drawn by a pump from B through wide tubes into the electroscope A and discharges it. If, however, the air is passed through a filter, like cotton or glass wool, or bubbled through liquids, or exposed in its passage to the action of an electric field, it ceases to conduct. Thus if (Fig. 3) an electric field is made to operate on the gas in its passage by connecting the outside of the metal tube C with one pole of a battery, the other pole being connected with a central wire insulated and stretched along the tube, the air passing into the electroscope no longer discharges it. Something is removed out of the air by these means which is different from the main bulk of the air, and this something consists of the charged ions which carry the electricity. Since the gas as a whole shows no charge,

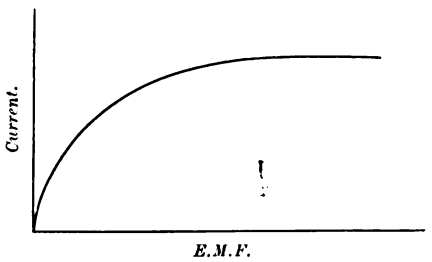

Fig. 4.

it follows that an equal number of positive and negative ions exist in the gas, for it has been shown that the charge carried by the negative ion is equal to that carried by the positive.

It is necessary here to call attention to the distinction between the ions and the radio-active emanations produced by radium and thorium, which we have already seen possess the power of being blown through tubes and discharging an electroscope at some distance from the radio-active substance. The emanations, unlike the ions, pass unchanged through filters and liquids which destroy the ions, and survive the action of the electric field. The reason why the electroscope is discharged is that the emanation is an *ionising* agency, and continually produces fresh ions out of the gas after those first present have been destroyed by passage through cotton wool, &c. The emanation passes through the latter like an ordinary gas, and immediately produces fresh ions out of the gas on the further side.

The most characteristic feature of the conductivity of an ionised gas is the existence of a maximum or "saturation" current, which limits the quantity of electricity the gas is able to convey. In electrolytic and metallic conduction the current obeys Ohm's law, and increases proportionally to the P.D. between the electrodes. This is true also of ionised gases under very small voltage. As the latter is increased, the current soon begins to increase less rapidly than the P.D., until, finally, a stage is reached at which a further very great increase of P.D. scarcely increases the current that passes. This is the saturation current, and it serves experimentally as a very valuable criterion of a true ionisation current. Fig. 4 shows the variation of the ionisation current with E.M.F.

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.
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In the electrical measurements of radio-activity, it is always necessary to make sure either (1) that the current measured is the saturation current, or (2) less commonly, and with very active substances, that the current is proportional to the E.M.F., in order that the results should possess a definite meaning, and be comparable among themselves. The saturation current represents the condition in which the ions in the gas are destroyed, by passage to the electrodes, as fast as they are produced by the ionising agency. Let q positive and q negative ions be produced per second, and let e be the charge carried by the individual ion. If i is the current passing through the gas, i represents the value of the charge received by each electrode per second. i/e, therefore, is the number of ions which give up their charge to either electrode per second, so that i/e positive and i/e negative ions are withdrawn from the gas per second. The number withdrawn by the saturation current represents the number produced. Therefore, $i/e = q$ and $i = qe$ for the maximum or saturation current. If, as is usually the case, the ions are produced uniformly throughout the volume of the gas and q_0 represents the number of ions produced in each cubic centimetre per second, and if A is the area of the electrodes and l the distance between them, $q = q_0 Al$ and the saturation current through the gas $I = q_0 Ale$.

With currents less than the saturation current, some of the ions are destroyed in other ways than by passage to the electrodes. Some will re combine, one positive and one negative ion reproducing the neutral molecule, while others will give up their charge by diffusion to the walls of the containing vessel and so cease to exist as such. The number that re-combine will be proportional to the number of collisions between ions of opposite sign, and this will be proportional to $n_1 n_2$, where n_1 and n_2 represent the number of positive and negative ions respectively present in 1 cubic cm. of gas. Since in the cases generally considered $n_1 = n_2$, the number that re-combine will be proportional to n^2, and may be expressed by αn^2, where α is a quantity independent of n. The number that give up their charge to the walls of the containing vessel is proportional to n and not to n^2, and may be expressed by κn, where κ is a coefficient depending on the size and shape of the vessel.

If i is made to represent the current flowing through unit area of the gas i/le represents the number of ions of each kind withdrawn by the current for unit volume of gas. So that when the gas is in a steady state, the number of ions withdrawn being equal to the number produced,

$$q_0 = \alpha n^2 + \kappa n + \frac{2}{le}.$$

If the gas is not in a steady state,

$$\frac{dn}{dt} = q_0 - \alpha n^2 - \kappa n - \frac{i}{le}.$$

This is the simplest general equation representing the current flowing through a gas ionised by Becquerel or X-rays. The meaning of the saturation current is, thus, the current that is able to flow through the gas when the ions are withdrawn as quickly as produced by the action of a strong E.M.F. before any appreciable number have time to be dissipated by recombination or by diffusion to the walls of the containing vessel.

With no current flowing, $q_0 = \alpha n^2 + \kappa n$. Except for narrow tubes, the number lost by diffusion to the walls is small compared to the number lost by recombination, and, consequently, it is often unnecessary to take the quantity κn into account. With regard to the quantity αn^2, Langevin has recently shown ("Recherches sur les gaz ionisés," University of Paris, 1902) that recombination is brought about by the mutual attraction of the positive and negative ions, for if it were not for this attraction the rate of recombination would be much smaller than it actually is. For further details Prof. J. J. Thomson's "Conduction of Electricity through Gases," p. 545, should be consulted. The simple statement of the ionisation theory here given, and the account that follows, is taken from that work.

(To be continued.)

SOME STATISTICS RELATING TO ELECTRICAL ENGINEERING.

BY WILLIAM POLLARD DIGBY, F.S.S.

Probably no branch of the engineering profession carries its statistical investigations to the searching extent that is habitual to the electrical engineering profession. This cult of statistics is best exemplified by the detailed calculations as to relative works cost in electric lighting, traction and power installations. Also, the various annual publications such as "The Electrician" Electrical Trades' Directory and Handbook and the "Manual of Electrical Undertakings" give in a crystallised form the summaries of progress from year to year, and have accustomed us to comparisons of the capitalistic phase of the development of electricity. The writer, who is indebted to these publications for statistics on which certain of his tables are grounded, wishes to define as clearly as possible another phase of engineering statistics about which there is, among certain of our members, much hasty unfounded assertion, together with gross misrepresentations by papers which sensationally pander to a debauched public taste; about which there is also an underlying feeling of uneasiness among the rank and file of the engineering profession. This phase is termed "foreign competition." The object of the writer is, as dispassionately as possible, to set forth the figures of the import and export trade of the United Kingdom so far as "electrical goods" are concerned, and while avoiding the partisan presentment of the case for either of the schools of economists, to endeavour to contrast these figures in correct relation to the figures of the internal trade of the country so far as the latter can be ascertained.

The writer was led to commence this investigation, in the days before "fiscal revision" had become practical politics, partly by reason of the persistent clanging of cymbals in the non-technical press whenever an order went to a foreign country, partly as the result of a three years' devotion of spare time to an investigation of the trends of trade, and, lastly, by recent utterances which have carried great weight in influencing those who had hitherto discounted the jeremiads of the newspapers. Of these the earlier was that of a member of the Institution of Electrical Engineers, who in a book dealing with Protection said: "To-day . . . we are even compelled to obtain abroad the equipment of our biggest electrical undertakings, such as central stations and tramways."

Speaking at the Society of Arts on January 28, 1903, on the subject of municipal trading Sir Frederick Bramwell is reported to have said:—

> In the meantime the United States and Germany went to work, prospered in their work of machine making, with the result that at the present day England has lost for ever the manufacture of electrical machinery. His friend and partner, Mr. Harris, would be able to state that out of many thousand pounds worth of machinery his firm had ordered, the bulk of it had either come from America or Germany. As the chairman of an electric lighting company in London he had also to state that the whole of the equipment for a new generating station which had been erected, with the exception of the engines and boilers, came from abroad, because they knew it would be good both in manufacturing details and scientifically, and they knew the promise could be relied upon as to when it would be delivered. It was to him a matter of the deepest regret to think that from the desire to pander to municipal trading, which caused the act to be passed, England had, he believed, for ever lost her proper position in the manufacture and supply of electrical machinery.

Further testimony might be cited by the writer to the same effect; instead, he prefers to present the actual figures in their relation to other figures, a process which displays a less pessimistic outlook than Sir Frederick's.

Certain limitations which may slightly affect small fractions while not affecting the most striking comparisons, must be strictly defined. For instance, in regard to the figures which are cited as to the capital involved, so far as electrical manufacturing firms are concerned, the words "aggregate subscribed capital" must be taken to mean only the capital invested in the collected number of undertakings. Of the capital invested in electrical manufactures beyond the bounds of limited liability acts it is impossible to guess. It must be borne in mind that many small private firms have become public or private companies, others have been absorbed by larger organisations, while certain other old-established firms,

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such as ship and engine builders, have established departments in which motors and dynamos are produced.

So far as the invested capital in electric traction or electricity supply works is concerned, we are on sure ground, invested or "aggregate subscribed" capital being taken to mean ordinary and preference shares or debentures by limited liability companies, or authorised loans of municipal authorities.

The Export Trade.

An examination of the various trade returns of the United Kindgom indicates that while "Electrical Goods" are imported we export "Electric Lighting Apparatus."

Table I. gives the exports to all sources of "Electric Lighting Apparatus" since 1887, and the imports of "Electrical Goods" since 1898—the latter were not separately enumerated prior to 1898, but were entered under the general heading of "Goods unenumerated, Manufactured."

Table I.—*United Kingdom.*

	Exports. Electric lighting apparatus. British manufacture only.	Imports. Electrical goods.
1902	617,532	687,514
1901	552,777	849,257
1900	546,155	1,265,946
1899	510,758	613,593
1898	514,632	367,572
1897	448,732	242,185
1896	382,438	—
1895	335,929	—
1894	246,354	—
1893	215,336	—
1892	174,641	—
1891	239,194	—
1890	281,248	—
1889	211,049	—
1888	166,409	—
1887	99,905	—

Table II.—*United Kingdom.—Imports of Electrical Goods, with Country of Origin.*

	1902.	1901.	1900.
United States	£159,601	£388,181	£832,801
Germany	81,759	74,214	86,951
Holland	162,965	149,014	115,016
France	160,115	123,927	140,055
Belgium	104,635	87,242	76,712
Sweden	13,225	17,712	9,155
Other foreign countries	5,039	6,076	3,615
	£687,514	£849,257	£1,265,946

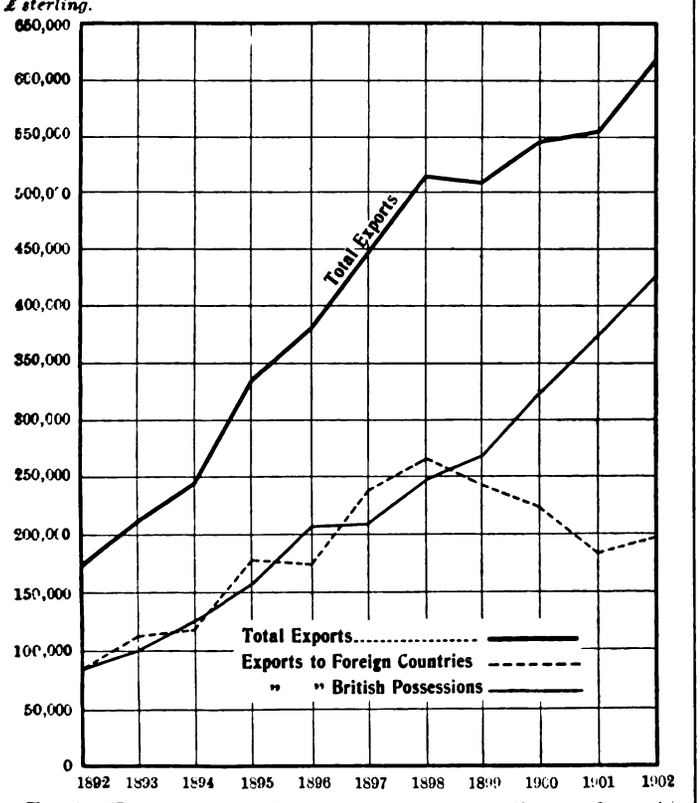

Fig. 1.—Exports of Electric Lighting Apparatus to Foreign Countries and to British Possessions with Total Exports from the United Kingdom, 1892-1902.

Table II. gives the country of origin of imported "Electrical Goods." The separate computation of these dates back to 1900.

Table III.A gives the exports of "Electric Lighting Apparatus" of British manufacture to foreign countries. The persistent fall in the volume of this trade since 1898 is distinctly marked. For the purpose of showing graphically the trends of this trade Figs. 1, 2, 3 and 4 have been prepared. Fig. 1 shows the total exports to foreign countries and to British possessions, with combined total. It will be seen at a glance that the upward tendency of the colonial trade has tended to outweigh the recent fall in the foreign trade. Figs. 2 and 3 show respectively the trade tendencies so far as elec-

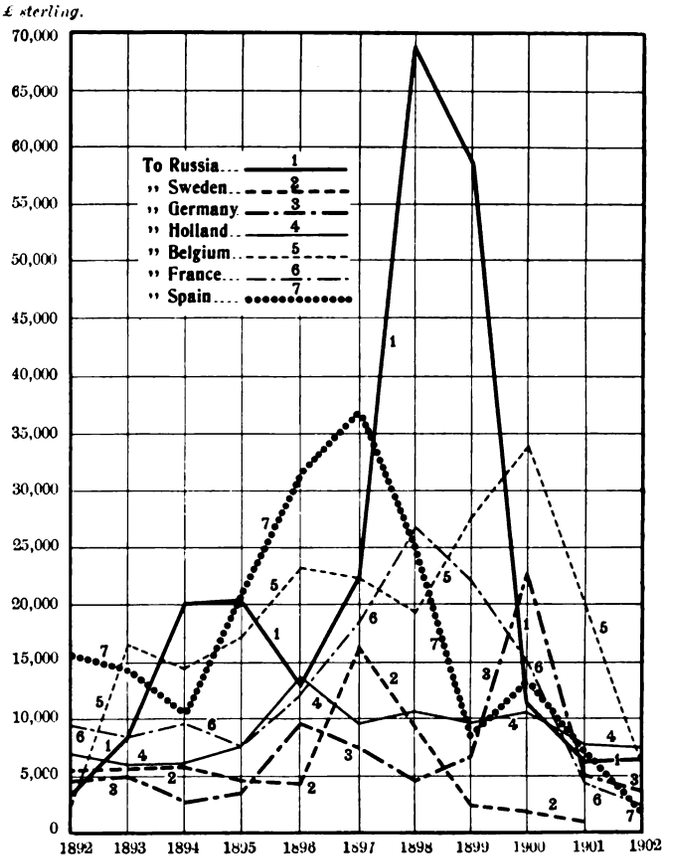

Fig. 2.—The Exports of Electric Lighting Apparatus from the United Kingdom to seven Leading European Countries, 1892-1902.

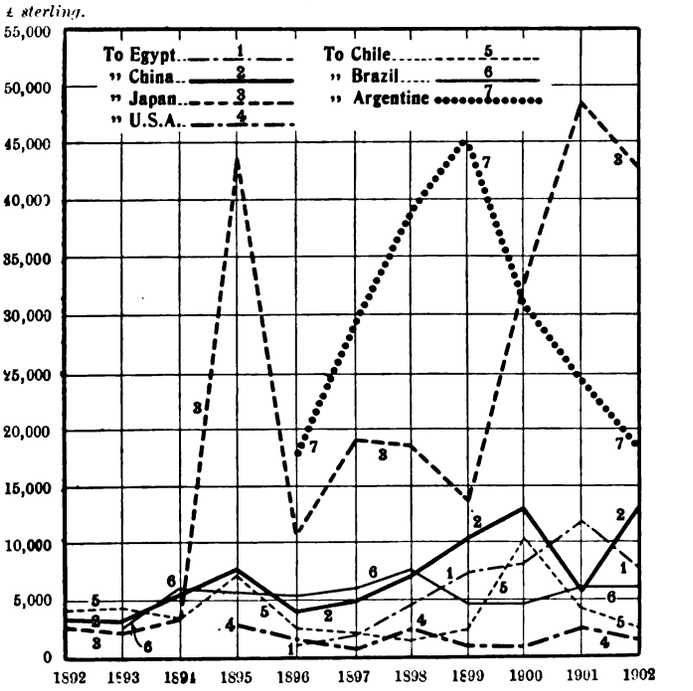

Fig. 3.—The Exports of Electric Lighting Apparatus from the United Kingdom to seven Leading Foreign (non-European) Countries, 1892-1902

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Table IIIa.—*Exports of British Manufacture to Foreign Countries.*

	1902	1901.	1900.	1899.	1898.	1897.	1896.	1895.	1894.	1893.	1892.
Russia	£6,267	£6,141	£11,121	£58,494	£68,237	£23,844	£13,186	£20,672	£20,117	£8,519	£3,647
Sweden	..	853	1,858	2,121	9,673	16,345	4,616	4,846	6,152	5,957	5,927
Germany	3,546	4,968	23,671	6,648	4,562	7,599	9,510	3,671	2,760	4,963	4,801
Holland	7,868	7,755	10,810	9,808	10,668	9,724	14,358	7,768	6,189	5,998	7,055
Belgium	6,050	19,951	33,843	27,957	19,174	22,360	23,123	17,234	14,492	16,939	2,862
France	2,649	4,546	15,178	22,259	27,022	18,761	12,259	7,851	9,982	8,683	9,890
Spain	2,320	7,195	13,455	8,737	25,219	37,082	31,730	21,052	10,432	14,390	15,626
Italy	..	627	1,840	5,507	5,662	5,990	2,324	3,182	3,896	7,367	5,382
Egypt	7,771	11,781	8,073	7,432	4,817	1,939	1,003	..	..	..	5,939
China	13,150	5,746	12,998	10,432	7,036	6,029	4,169	7,606	5,436	3,179	3,204
Japan	43,860	48,836	32,659	13,467	18,558	19,024	10,889	43,805	3,145	2,033	2,474
United States	1,261	2,344	762	924	2,272	688	1,212	2,727	..	..	1,433
Chile	3,339	4,226	10,208	2,165	1,246	1,924	2,472	7,045	3,276	4,767	4,361
Brazil	6,347	6,126	4,820	4,916	7,362	6,006	5,668	..	6,046	2,707	..
Argentine Republic	18,382	24,418	31,050	45,197	38,907	29,419	17,734	..	..	2,216	..
Other foreign countries	73,766	26,228	10,154	15,755	16,888	32,131	19,640	31,490	34,048	14,674	25,681
Total	£194,576	£180,271	£222,500	£241,819	£266,803	£238,135	£173,892	£178,899	£125,971	£102,392	£87,282

Table IIIb.—*Exports of British Manufacture to British Colonies.*

	1902.	1901.	1900.	1899.	1898.	1897.	1896.	1895.	1894.	1893.	1892.
British West Africa	..	£967	£1,722	£2,078	£813	£1,444	£696	..	..	..	..
Cape of Good Hope	£116,003	57,240	54,885	65,409	79,406	59,478	95,497	£81,100	£49,496	£49,807	£31,275
Natal	46,503	42,930	23,555	34,678	33,473	22,080	13,465				
British East Indies	114,094	93,201	72,139	61,387	49,644	42,203	33,651	30,406	25,419	14,760	12,447
Hong Kong	6,255	10,124	9,538	9,496	6,832	3,844	1,662	2,235	4,177	..	1,597
Australia	109,364	142,979	127,227	70,823	57,937	56,584	50,166	30,408	28,827	24,573	33,253
New Zealand	13,566	15,108	19,093	15,993	11,775	12,762	8,050	5,134	5,216	12,941	2,855
Canada	1,734	2,338	3,167	1,597	1,109	2,372	1,251	..	4,000	5,188	..
British West Indies	..	..	683	1,199	564	526	719	1,821	2,625	..	..
Other British possessions	15,437	171,621	11,651	6,279	6,276	9,304	1,389	2,287	623	3,625	5,932
Tot. to British possessions	£442,956	£372,506	£323,655	£268,939	£247,829	£210,597	£208,546	£157,030	£120,383	£112,974	£87,359
Total to foreign countries.	194,576	180,271	222,500	241,819	266,803	238,135	173,892	178,899	125,971	102,392	87,282
Gross tot. Exports from U.K.	£617,532	£552,777	£546,155	£510,758	£514,632	£448,732	£382,438	£335,929	£246,354	£215,366	£174,641

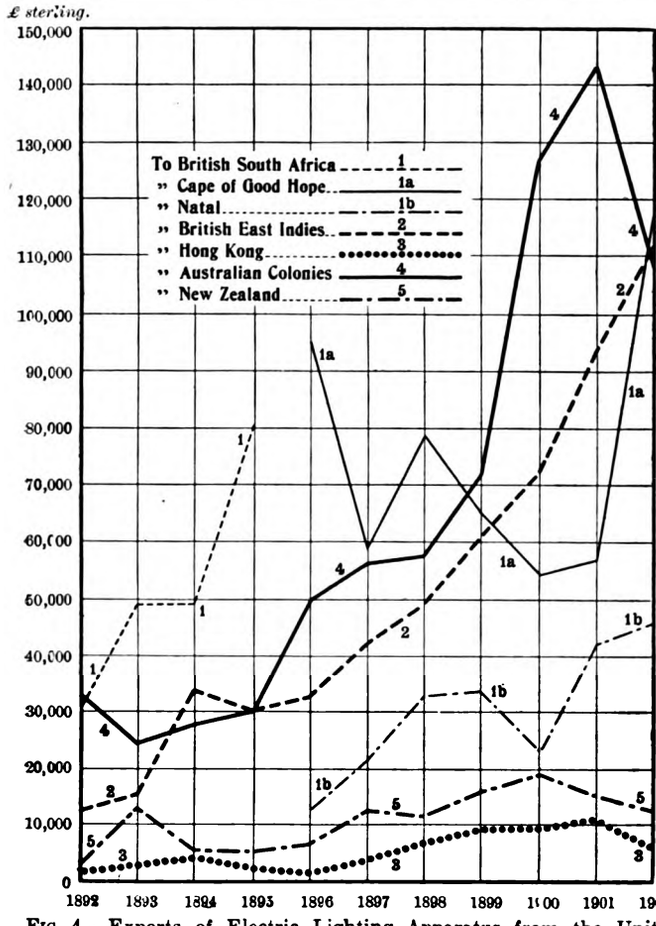

FIG 4.—Exports of Electric Lighting Apparatus from the United Kingdom to British Colonies and Possessions.

trical exports are concerned in (Fig. 2) the seven chief buying countries on the continent of Europe, and (Fig. 3) in the seven chief of the remoter buying countries. Fig. 4 depicts the movements in the principal of the British possessions purchasing electric lighting apparatus. In Fig. 2 the falling off of the export trade to each country is most marked. The totals of these figures are relatively small in amount, and in these countries, some themselves manufacturing and competing with the United Kingdom and with each other for this branch of commerce, evidences of a British loss of position were to be expected. Those countries which are themselves manufacturing have become more capable of supplying their own needs, and others, owing to their geographical position, have the advantage of cheaper freights to adjacent purchasers.

Fig. 3 of the trade to leading non-European countries shows that so far as the totals of British trade are concerned we are holding our own fairly well.

Fig. 4 depicts the healthier conditions of trade in the leading colonies. The effect of the recent war in checking the rise of exports of electrical machinery to South Africa is apparent.

(To be continued.)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"A Handbook for the Electrical Laboratory and Testing Room." By Prof. J. A. Fleming, F.R.S. Vol. II. (London: "The Electrician" Printing and Publishing Co.) 14s. net.

"Transactions" of the American Institute of Electrical Engineers. Vol. XX. No 7. August and September, 1903. (New York: The Institute.) 50c.

"Notes on Electric Railway Economics and Preliminary Engineering." By W. C. Gotshall. (New York: McGraw Publishing Co.) $2.

"Gas Engines: Their Advantages, Action and Application." By W. A. Tookey. (London: Merritt and Hatcher.) 1s.

"Electric Lighting and Power Distribution." By W. Perren Maycock. Vol. II. (London: Whittaker & Co.) 7s. 6d.

"Proceedings of The Royal Society," No. 483. Vol. LXXII. (London: Harrison & Sons.) 2s.

"Gas and Oil Engine Management." By M. Powis Bale. (London: Crosby Lockwood & Son.) 3s. 6d.

"Die Einrichtungen zur Erzeugung der Roentgenstrahlen." By Dr B. Donath. 2nd edition. (Berlin: Reuther and Reichard.) 7m.

"La Télégraphie sans Fil; L'œuvre de Marconi." Translated from the *Scientific American*. By Emile Guarini. (Brussels: Ramlot Bros. & Co.) 2fr. 50c.

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SOME WIRELESS TELEGRAPH PATENTS.

Since the publication of the article on wireless telegraph patents, the last instalment of which appeared in *The Electrician*, Vol. L., p. 233, many fresh ideas have been evolved and a large number of patent specifications have been the result. Some of these relate to ingenious applications of wireless telegraphy to various purposes, others originate from misguided "cranks," and a very few possess real merit.

The first patent of note after 18,105 of 1901 is No. 21,744 of the same year, and this was granted to Mr. A. F. Collins of the United States. The idea consists of connecting one end of the secondary to a condenser and the other to earth. In a similar manner, one end of the receiver, which is a telephone receiver, is connected to a condenser and the other to earth. An ordinary circuit-breaker is employed for the induction coil, and it is so regulated as to vibrate in a certain musical key when the condenser is not being charged. On charging the condenser the secondary current causes reactions on the primary current, and the circuit breaker vibrates at a different frequency, thus emitting a different musical note. The receiver then indicates dots and dashes by the frequency and duration respectively of the two tones as the sending key is closed or open.

Patent No. 24,825 of 1901 was taken out by Dr. J. A. Fleming with Marconi's Wireless Telegraph Co., and relates to improvements in methods for producing electric waves, and describes a way of so suppressing the alternating-current arc across the spark-gaps that a continual oscillatory discharge will take place :—

This arc discharge can, as described in our former specifications, be removed to a great extent by blowing air or other gases upon the spark-gap, also by introducing a regulated inductance into the primary circuit of the alternating-current transformer. The present invention has refe-

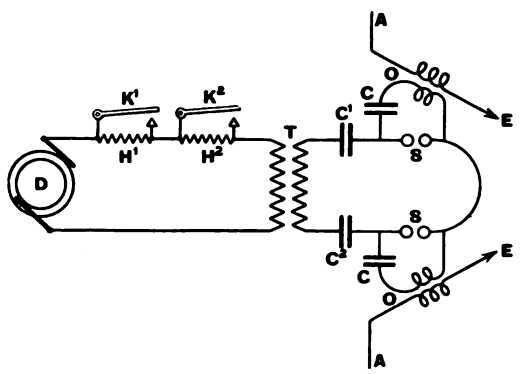

FIG. 1.

rence to another method of achieving the same end. In place of using one single condenser two condensers are used, which may or may not be of equal capacity. Across the terminals of one condenser, which may be called the active condenser, are joined as before the spark balls or air gap in series with the primary of the oscillation transformer. The other condenser is placed in series with the above mentioned active condenser, and the two together are connected to the terminals of the transformer or transformers which supply the alternating current. These transformers may be arranged in parallel or in series, to suit the required conditions of maximum resonance, and more than one active condenser may be employed. The capacities of the active condensers and of the one not closed by a spark-gap, which may be called the arc-stopping condenser, may be varied so as to give the active condensers the benefit of a greater or less share of the impressed voltage. The condenser, which is not closed by a spark-gap, is traversed by the impressed alternating current which charges up the active condensers, but its capacity may be so regulated with respect to the others by trial, that it stops almost completely any true arc discharge from the alternating-current transformer, whilst it permits the active condenser to be charged and discharged with an oscillating discharge at each alternation of the currents supplied by the alternating-currents transformer. If more than one active condenser is employed the oscillation transformers associated with each may be of different form and size. The drawings illustrate the arrangement of apparatus. In Fig. 1, D is an alternating-current dynamo, T is an alternating-current transformer, K^1, K^2 keys by which choking coils H^1, H^2 can be short-circuited, S a spark gap, C a condenser, O an oscillation transformer, A an aerial conductor, and E an earth-plate, all arranged in the well-known manner. According to this invention a condenser, C^1, preferably of about the same capacity as C, is interposed between one of the terminals of the secondary of the transformer T, and one of the terminals of the spark gap. Or, as shown, there may be two condensers, C^1, C^2, symmetrically placed between T and S, in which case the capacity of each is preferably about double that of C. Fig. 2 shows an arrangement similar to that in Fig. 1, except that there are two spark-gaps, S, in series, each short-circuited by its own active condenser C and the primary of an oscillation transformer, O. In such a case all four condensers C, C, C^1, C^2 may have about the same capacity.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is: 1. In apparatus for the production of electric waves, the interposition of a condenser or condensers between one or both terminals of the secondary circuit of an alternating-current transformer and the corresponding terminals of the spark gap, substantially as described. 2. In the arrangement as claimed in claim 1 employ-

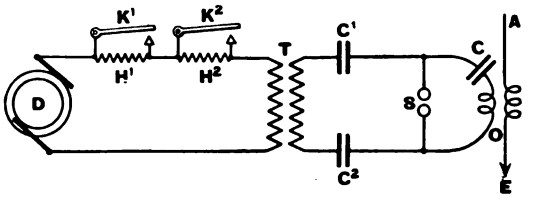

FIG. 2.

ing two or more spark-gaps in series, each short circuited by its own active condenser and the primary of an oscillation transformer substantially as described. 3. Apparatus for the production of electric waves substantially as described and illustrated.

In patent specification No. 6,473 of 1902, Mr. G. L. Hogan describes a system in which he makes use of two oscillators, one below and the other above the surface of the earth. Just above the former and below the latter are fixed metallic screens for preventing one interfering with the other. The patentee maintains that it is preferable to work with the two oscillators operated synchronously, and in the drawing they are shown in series, but there is a switch by which one can be cut out. Telegraphic signals are represented by the spaces between impulses, so that the oscillators are, presumably, working continuously. The coherer employed consists of two metallic plugs with imbricated prongs, surrounded by loose metallic filings.

No. 13,521 of 1902 is granted to Sir Oliver Lodge, Dr. A. Muirhead and E. E. Robinson, assistant to Sir O. Lodge. It relates to the coherer described in *The Electrician*, Vol. L., p. 930. Three devices, all depending upon the same principle, are shown; in one device, a metallic point dips into a pool of mercury covered with a layer of oil, and thus, under normal conditions, there is a film of oil between the metallic point and the mercury. When electromagnetic waves impinge upon the apparatus this film is broken down and coherence takes place. A current registers the signal by a siphon recorder, and at the same instant the metallic point is withdrawn, by means of a coil, from the mercury, and immediately plunged in again through the oil, being once more in a sensitive condition. The second device is very similar, the only difference being that the point is kept in constant vibration by being attached to a tuning fork. The third device depends upon the same principle, and is of the famous revolving wheel type.

An early patent in 1902, of special interest, is that taken out by S. G. Brown, and numbered 750. It deals with improvements in wireless telegraphy, including the use of a piece of apparatus, called the "radioscope," as receiver. This device consists of a fixed adjustable blunt metallic point in contact with a metallic plate. The plate, which, if necessary, may be replaced by a point (or the point replaced by a plate), is mounted on a vibrating telephone diaphragm, or on an electrically-driven tuning fork. The fixed point is carried by a hinged weight which allows the point to "float" and to be thus, to a great extent, self-adjusting. When properly adjusted the contact point should make intermittent contact with the plate, but should not allow a current to pass except when under the influence of the induced currents from the "Hertz" waves. The point and metal plate should be made of a metal such as hard steel, iron, nickelsteel, nickel, zinc, cadmium, aluminium, or one of the contact pieces may be mercury. In another arrangement for working the "radioscope," the plate is mounted on a steel telephone diaphragm, which is actuated by an electromagnet to open the contact, to decohere. When "Hertz" waves are received the induced currents set up in the air wire break down the insulating film of the contact

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between the point and diaphragm, allowing a current to flow from the battery and register the signal. The electromagnet is also energised and acts on the steel diaphragm so as to break contact between the contact pieces and restore the insulating film.

In Fig. 3 is shown another arrangement of the "radioscope." As before A is the air wire and E the earth connection. P is the steel disc mounted on the diaphragm S, the adjustable fixed point, B^{1} is the local battery, the whole of the voltage across the inductive resistances R^{1} and R^{11}, only that part across R^{11} being used. T is a telephone placed across R^{11} so as to allow the signals being read by ear when necessary. On S making

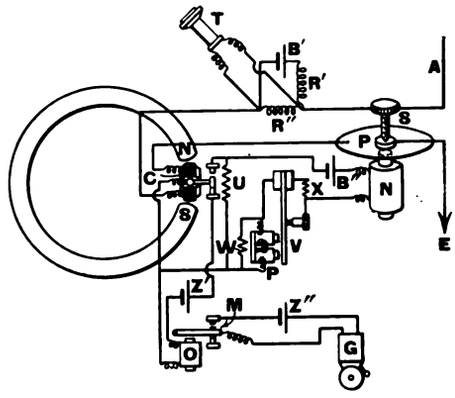

Fig. 3.

good contact with P a current flows from the battery B^{1} through the suspended coil C of the relay; the relay tongue moves so as to make contact with the top contact piece, thus cutting out the resistance U. V is a vibrator constantly at work, P being the electromagnet necessary to cause the vibrations. B^{11} is the local battery. N is the electromagnet in series acting on the plate P. W and X are shunting resistances to reduce sparking. When the relay tongue is in the position as shown in the drawing, the vibratory current flowing through U and the winding on N is not sufficient to set up vibrations in the diaphragm on which P is mounted, but when "Hertz" waves set up induced currents in A, S and P make contact, bringing the relay tongue over against the top stop, the resistance U being short-circuited and enough current delivered to N to cause the diaphragm to vibrate so as to decohere. When the relay tongue leaves the bottom stop the current Z^{1} is cut off from flowing through the electromagnet O, the armature M rises, making contact with the top contact pieces, and thus a circuit is established through the winding of the bell G and the battery Z^{11}; by these means the bell will ring to act as a call.

The principal claim is for a radioscope consisting of two contact pieces, one contact piece being mounted on a vibrating body, such as a tuning fork or reed, so as to produce an imperfect contact for the purpose specified.

Patent No. 10,181 of 1902 was granted to Sir Oliver Joseph Lodge and Dr. Muirhead on June 2, 1903. :—

Our invention relates to improvements in the sending and receiving circuits of systems of syntonic space telegraphy based on the employment of Hertzian waves, whereby the speed is increased and the signals made more reliable. In order that our invention may be fully understood we will, as occasion requires, refer to the accompanying drawings which, with the exception of Fig. 8, are diagrammatic. Referring first to Figs. 4, 5, 6 and 7, it will be seen that, in carrying out our invention, in order to perfect the tuning of the two capacity areas (*i.e.*, the sky-wire *a* and earth *b* in most systems of Hertzian-wave telegraphy) we add a condenser, (capacity) *c*, in series with each of the two capacity areas *a*, *b*, to the various combinations described in the specification of letters patent No. 11,575 of 1897* granted to one of us, and between the two condensers *c*, *d* we insert the adjustable self-induction coil *e* which is required for tuning purposes. One of these condensers is made adjustable for the purpose of assisting in the adjustment of the system for syntony. In the case of the sender, the spark-gap *f* may be placed between the sky-wire *a* and the first condenser *c*, as illustrated in Fig. 4, or anywhere between

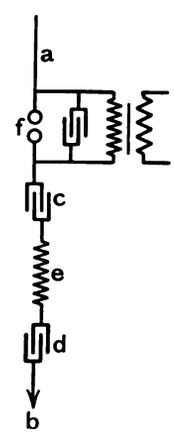

Fig. 4.

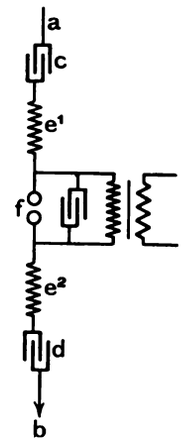

Fig. 5.

the two condensers *c*, *d* in the self-induction circuit e^{1}, e^{2} as shown in Fig. 5. Sometimes the spark-gap *f* is placed across the two condensers *c*, *d* and the self-induction coil *e*—*i.e.*, between the sky-wire *a* and to earth *b*, or preferably between the sky-wire *a* and a third condenser *g* to earth as represented in Fig. 6. When the Tesla mode of charging is employed in the sender, the self-induction coil *e*, between the two condensers *c*, *d*

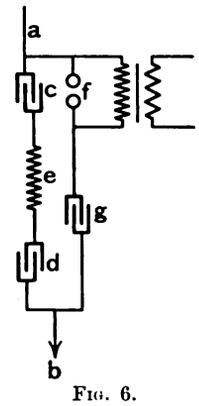

Fig. 6.

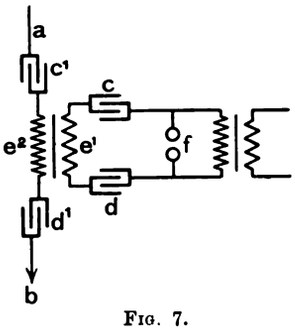

Fig. 7.

in the last arrangement, becomes, as shown in Fig. 7, one circuit, e^{1}, of a transformer whose other circuit, e^{2}, is connected up between another pair of condensers, c^{1}, d^{1}, to which the sky-wire *a* and earth *b* are attached respectively. In place of the ordinary Morse signalling key we prefer, in carrying out our invention, to employ an automatic transmitter in the local circuit of which is inserted another transmitter specially designed

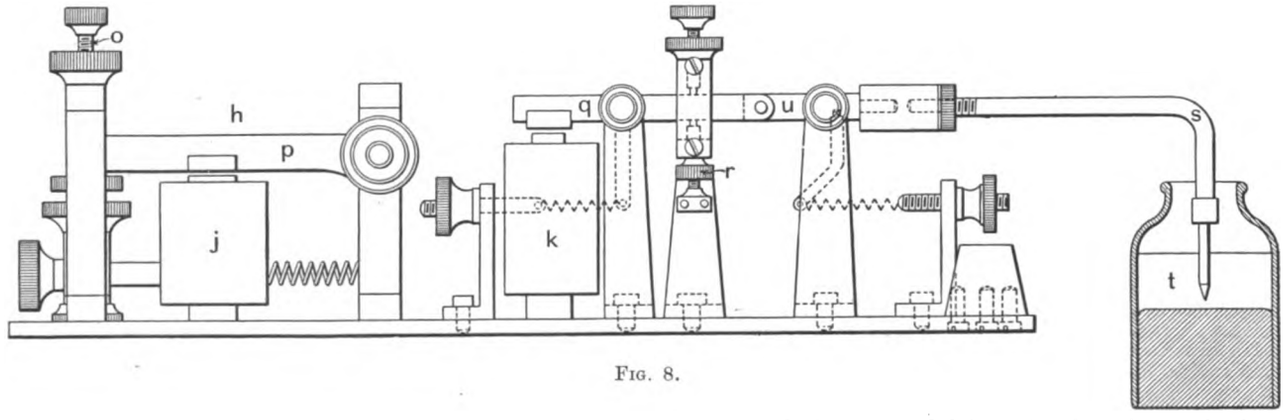

Fig. 8.

to open and close, at a definite rate, the primary circuit of the induction coil in the sender employed for the production of the oscillations of the high frequency and potential required. This local transmitter, which is shown in side elevation in Fig. 8, is made up of two ordinary sounders or electromagnets, *h*, *i*, having armatures, *p*, *q*, respectively. *t* is a cup containing mercury and *s* is a copper rod adapted to dip into it and both of which are included in the

* See *The Electrician*, Vol. L., p. 930.

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primary circuit of the induction coil. The rod s is insulated from, but is attached to, a pivotally-mounted extension, u, which is jointed to the armature q of the sounder i, so that each time the said armature q is attracted the rod s dips into the mercury. The coils j, k of the sounders h, i are joined up in the following manner and as indicated in Fig. 9. l is a local battery having two distinct circuits l^1 l^2. The coil k of the sounder i is in the circuit l^1 of the local battery which may be traced through the armature p and the upper limiting stop o of the sounder h and through the contact lever n of the transmitter m (when the said lever is depressed); and the coil j of the sounder h is in the circuit l^2 of the said local battery which may be traced through the armature q and its limiting stop r (when the said armature q is attracted). When, therefore, the lever n is depressed, the electromagnet i is energised and the armature q attracted, whereupon contact is made between the said armature q and the upper limiting stop r completing the circuit l^2 through the electromagnet h, energising it, with the result that the armature p is attracted. This breaks the circuit l^1 at the limiting stop o, releasing the armature q, and so breaking contact again at the point r. These successive attractions or oscillations of the armatures p, q continue so long as the lever n is depressed. The rate of oscillation of the armatures p, q of the two

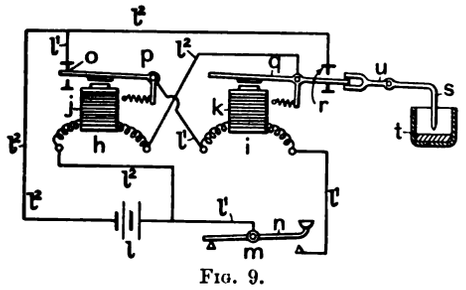

FIG. 9.

sounders h, i between their limiting stops can be varied in a great measure by the adjustment of the screw which holds the armatures against their upper limiting stops. Sometimes shunts are applied to the coils of the sounders to assist in the adjustment of the rate of working the latter. In the automatic transmitter which, with its connections, is shown in detail in Fig. 10, the nose v of the contact lever w is put slightly in advance of the nose x of the other lever y so that there shall be an interval of time between the entrances of the two levers into the perforations of the perforated slip which is used with these transmitters. In wireless telegraph the dot and dash Morse code is used. For a dot, two holes, z and l, are punched opposite to the same central hole as shown in Fig. 11. One contact lever enters the hole z on one side of the central line of holes 2 first, and is followed soon afterwards by the entrance of the other contact lever into the opposite hole 1, the result being first a current from the battery 3 through the electromagnet 4 attracting the armature 5 and thus closing the circuit of the battery l of the local transmitter, followed after the interval of a dot by a current through the electromagnet 6 restoring the armature 5 to the position shown in Fig. 10., when the local circuit of the transmitter is broken. During the short interval a short spark is brought about by the local transmitter at the

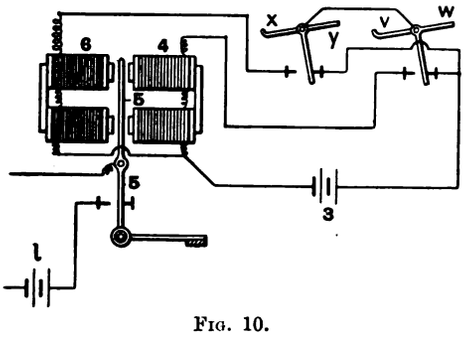

FIG. 10.

spark-gap of the induction coil. For a dash, two holes, 7 and 8, are punched as represented in Fig. 12, one at each side of the central holes 2, one being a whole space later than the other. There is now a longer interval between the contact through the hole 7 and that through the hole 8, and the transmitter is, therefore, allowed to produce a longer succession of sparks, *i.e.*, a longer emission of waves into space and consequently a longer signal at the distant receiving station. In the receiver, which is shown in Fig. 13, we employ a transformer e in the manner described and claimed by one of us in the specification of letters patent No. 11,575 of 1897 (see Fig. 14 of the drawings accompanying that specification). The primary e^1 of the transformer is inserted between the two condensers c, d, and in the secondary circuit e^2 are placed the coherer 9, battery 10, and receiving instrument 11, with an adjustable condenser shunt 12 in the manner described and claimed by us in the specification of letters patent No. 29,069 of 1897. Sometimes we connect the sky-wire a to the coherer circuit through a small condenser 13, as shown in dotted lines in the figure just referred to, and in which b denotes the earth. In applying the duplex principle to our invention, we, as represented in Fig. 14, employ two elevated sky-wires a, a^1, or a double receiving mast, one behind the other, half a wave-length apart, or one higher than the other, and then we place a third or sending sky-wire a^2 on a mast at right angles to the plane of the other two, a, a^1, and equidistant from them if they are equal in height. The receiving wire or a^1 mast is adjustable in position so as to give zero effect from the home sender a^2. For example, it may be tilted towards the home sender till the coherer 9 fails to respond except to the distant signals. The home-sending mast a^2 is arranged at a small distance, say, roughly, equidistant, from the other two masts. The receiving circuit is enclosed in a box indicated by the dotted lines 14 (except the collecting wires), and the wires between the secondary of the transformer 15 and the receiving circuit within the box are shown figure-of-eighted by way of illustration. Or if any part of the receiving circuit is left outside the box, then this part also is similarly figure-of-eighted—as are likewise the collecting wires—so as

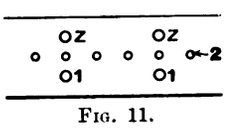

FIG. 11.

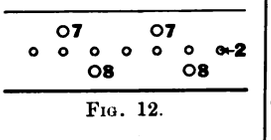

FIG. 12.

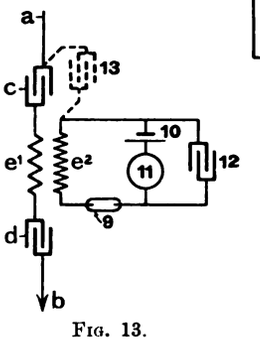

FIG. 13.

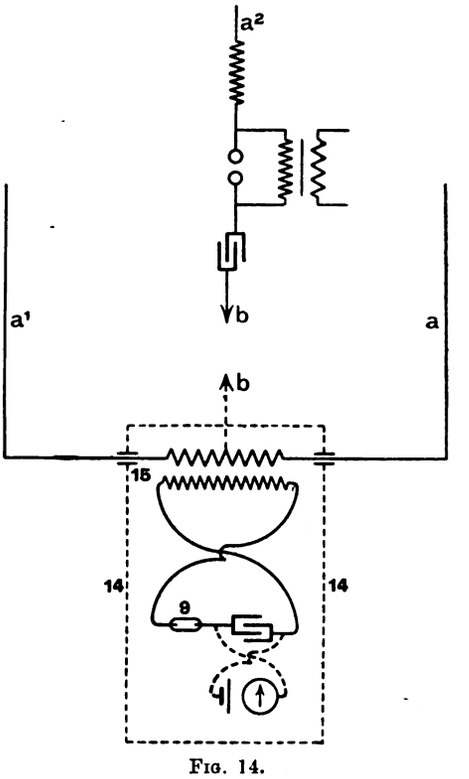

FIG. 14.

to offer zero areas, that is equal + and − areas, to stray disturbances. b indicates the earth. Thus the capacity areas in the receiving circuit are differentially arranged relatively to the capacity areas (one of which may be the earth b) in the sending circuit. The waves emitted by the home sender a^2 act equally and oppositely on the receiving circuit, and thus permit of the impulses produced by waves from a distance being recorded without disturbance.

(To be continued.)

SOME RECENT STREET LIGHTING.

During the last year considerable additions have been made to the street lighting in Hampstead, for which the Gilbert Arc Lamp Co.'s arc lamps and accessories have been employed, and the same firm has supplied the material for the new street lighting of Kilburn, Harlesden and Willesden. In carrying out this work to the specification of Mr. G. H. Cottam, of Hampstead, and Mr. E. T. Ruthven Murray, of Willesden, the company has made use of a number of improvements recently effected in their arc lighting system.

The Hampstead lighting consists of lamps run in series off a constant potential of about 1,800 volts, special machines being provided in the generating station to supply continuous current at this pressure, as the general supply system is alternating. In Willesden, Kilburn and Harlesden, on the other hand, the lighting is carried out with lamps in series off a constant pressure of 480 volts. The lamps are fitted on posts similar to those shown in Fig. 1, to which lowering gear is attached similar to that used by the Gilbert Arc Lamp Co. in other places. In this gear a stout double cord is employed for the suspension; but when the lamp is in position it is supported independently of the cord by special catches. There are also plain knife switch contacts in the hood, so that the effect of lowering the lamp disconnects it from the circuit. The company inform us that they have been making considerable improvements in the details of their arc lamps, a departure from ordinary practice being to pay as much attention to the strike or retrace portion of the motion of the lamp mechanism as to

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the feeding itself. Most of the pillars are fitted with two incandescent lamps provided with substantial cast-iron fittings as seen in the illustration, a reflector being combined with these. The lamps are controlled by the usual class of automatic switch, so that if the arc lamps are extinguished from any cause, the incandescents light up automatically. The particular pattern of this switch employed by the Gilbert Company, however, differs in some respects from that of other makers. The catch takes an appreciable time in accomplishing its motion, so that if the magnet is only energised a short time it does not engage, and the switch is still left open. The whole is contained in a neat cast-iron box, which also contains double-pole fuses and terminals, the whole arrangement, together with the ratchet of the winding gear, being visible in Fig. 2. All the resistances are carefully kept away from the wood, and also from the cables, and an umbrella is provided to keep any direct water off. At the top of Fig. 2 is seen the winch of the lowering gear already referred to, and beneath this is the magnetic switch. Below this, again, is a quick-break double-pole double-break switch. When this latter is switched on to the first contacts, only nine of the lamps out of the series of 10 are switched in circuit, and the substitutional resistance of

Fig. 1.—Lamp-post in Willesden.

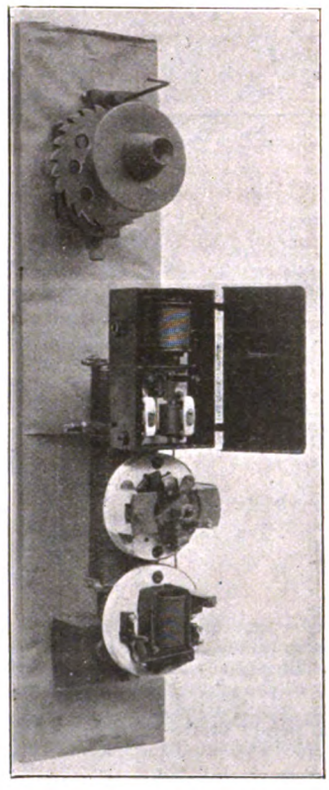

Fig. 2.—Apparatus Fitted in Base of Lamp-pillar.

the tenth lamp is connected in series with these. This resistance, therefore, acts as a starting resistance for the circuit, and prevents too big a rush of current. The switch is left in this position for a minute or two, and then put over to the second position, in which the tenth lamp is put in. This switch, of course, is only put in the base of the tenth lamp in every series. Below the switch is the usual automatic cut-out mounted on a porcelain base, and this is provided with strong terminals capable of gripping and supporting the leads. The resistances are made of steel wire wound on spiral porcelain formers, the formers being clamped securely from end to end, so that no harm is done if they crack from the heat.

We may add that we particularly observed the arc lighting in Willesden a few days ago, and were pleased to see with what steadiness the lamps burned.

New Electric Lighthouse.—A new fast-flashing electric lighthouse has recently been erected by Germany on the island of Heligoland, and is described in *Ueber Land und Meer*. A large arc lamp with a Schuckert glass parabolic mirror is used, and it is said that the light represents 30,000,000 c.p. Each flash lasts only one-tenth of a second, and the flashes follow each other at intervals of 5 seconds. The bluish-white light of the arc appeared red at a great distance.

THE CURTIS STEAM TURBINE.*

At a recent meeting of the New England Cotton Manufacturers' Association, Mr. Austin R. Dodge, of Schenectady, N.Y., read a Paper entitled "Advantages of Steam Turbines for Textile Mills," from which we extract the following portions relating particularly to the Curtis turbine. The author of the Paper is particularly well qualified to treat of the subject, having been connected with the development of the Curtis turbine from the time it was first taken up by the General Electric Co.

Following a discussion of the De Laval turbine, the Curtis turbine is described as a type which, in addition to nozzles delivering steam at high velocity to a single wheel, has also stationary vanes which re-direct the steam discharged at considerable velocity from the first wheel, due to the relatively low bucket speed, into the second wheel. The velocity of the jet leaving the nozzle is about 2,000ft. per second, about half the velocity of the De Laval under the same conditions of exhaust pressure, while the peripheral speed of the vanes in the Curtis is proportionally much less, about 400ft. per second, instead of 1,200ft. per second. By this process of fractional abstraction the speed of revolving vanes need not be excessive to secure maximum economy; in other words, to bring the direction of the jet discharged from the last set of vanes parallel to the shaft, this satisfying the necessary condition. With this high steam velocity only a minimum of revolving vanes are necessary, and they rotate in steam which has a lower density, due to the considerable drop in pressure from one stage to the next. There is a large clearance between the outer wall of revolving vanes and the shell, reducing friction due to water of condensation. End thrust is eliminated, as there is abundant opportunity for the pressure to equalise on each side of the revolving discs, and the entrance and discharge angles of the vanes are the same. In the larger sizes of the Curtis type the shaft

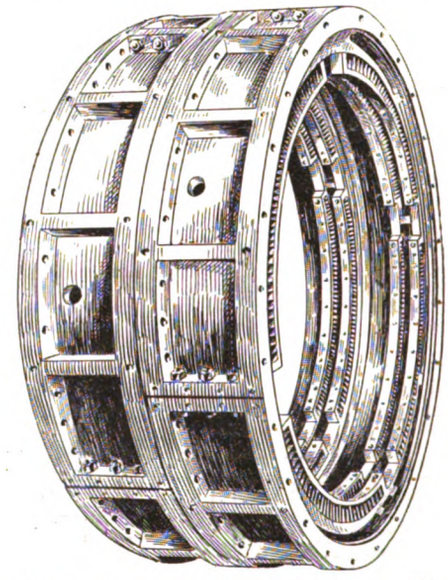

Fig 1.—Two Intermediates for Second Stage of a 500 kw. Turbine.

is vertical and floats on oil under sufficient pressure to balance the weight of the revolving element, which rises a few thousandths of an inch until the clearance is sufficient to permit the discharge of the oil delivered at the centre of the supporting block. That there is no end thrust in this turbine is shown by the fact that the oil pressure necessary to float the revolving element does not change under any condition of load. The vertical arrangement affords great compactness and greater uniformity of expansion due to heat.

The clearances between stationary and moving parts have proven thoroughly commercial, as shown in several months' operation of vertical 500kw. units. In cases in which the oil pressure has failed in the vertical type of this unit during the use of a temporary belt-driven oil pump, there has been no damage to the revolving or stationary vanes. Any contact which may occur is due to the lifting of the revolving element owing to formation of ridges on the step-bearing surface. The weight of the revolving element, therefore, tends to neutralise any tendency to injury. As the vanes are less in width than the metal from which they are cut, nothing more serious happens than a polishing of the solid part of the wheels. Even the step-bearing blocks can be faced off and used again. When using the standard direct-driven oil pump a failure of oil supply to the step bearing is highly improbable. The 500kw. type has two sets of nozzles, each delivering steam to a set of three revolving discs, carrying the vanes, which are machined from the

* From the *Electrical World* of New York.

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solid disc. Governing is affected by operating a series of valves which control the admission of steam to the nozzles on the first stage. This ensures a constant velocity in the first stage nozzles, while the pressure in the first stage diminishes with the steam flow until at no load it is nearly equal to the vacuum in the second stage; a desirable condition, as it reduces the density of the steam in which the first stage wheels rotate, and renders unnecessary adjustment of the valve controlling the second stage nozzles.

After referring to the desirability of an electric drive for cotton mills, and the advantages in this connection of the steam turbine through its obviating the necessity of changing reciprocating to rotative motion, Mr. Dodge took up the matter of first cost of a turbine installation. A Curtis turbine requires only 7 per cent. of

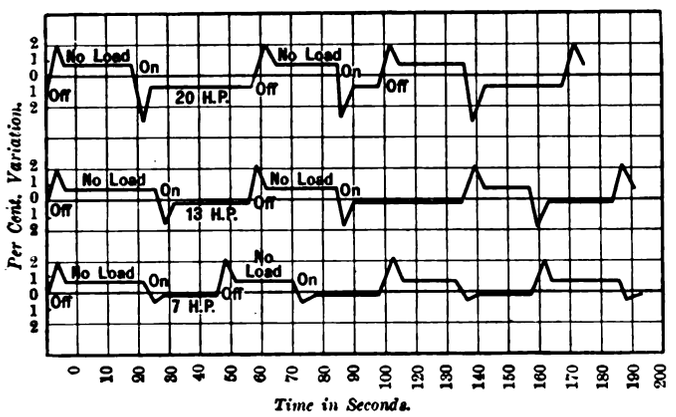

FIG. 2.—REGULATION CURVE OF 20 H.P. TURBINE.

the floor space taken by a horizontal cross-compound engine of the same capacity, and the cost of foundations is in about the same proportion in favour of the turbine. The weight is from 15 to 25 per cent. that of the engine. There is no wear with a moderate amount of superheat resulting from the action of the steam jet on the vanes, even at a velocity of 2,500ft. per second, as shown by long-continued tests. One of the great advantages of a turbine is due to the entire absence of internal lubrication. Consequently the condensed steam can be returned to the boilers, saving the

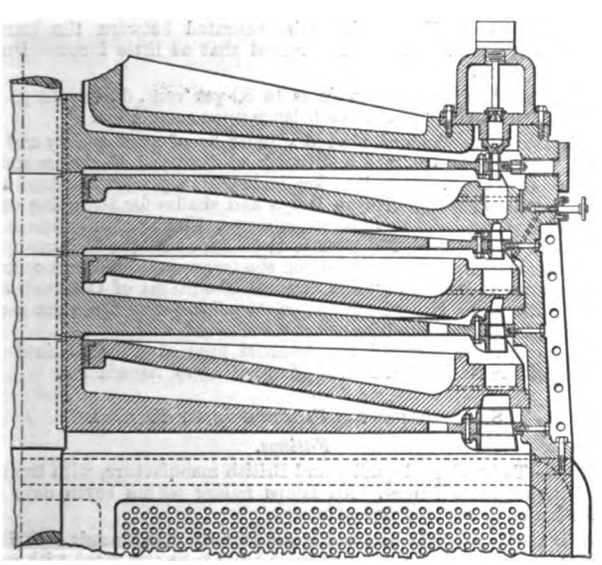

FIG. 3.—SECTION OF 5,000 KW. FOUR-STAGE TURBINE.

cost of oil and feed water, often 10 per cent. the cost of fuel. As no boiler scale is formed while using the same feed water continuously, tube cleaning is unnecessary and the boilers are maintained at the highest efficiency without withdrawal from service. It is estimated that the saving in attendance charges will average 25 per cent. on the entire station pay-roll. A turbine, having but one moving part, requires no adjustment, unlike a reciprocating engine with a large number of moving parts which must be carefully inspected at frequent intervals by a skilled engineer. The economy, therefore, remains constant, which is not true of a reciprocating engine.

One of the principal requirements of textile mills is uniform speed A turbine has a large amount of stored energy in its revolving parts, and is, therefore, well adapted for work requiring close regulation. In Fig. 2 is plotted a curve which indicates the regulation of a 20 H.P. Curtis turbine when full load is suddenly thrown on and as suddenly removed. The variation in speed of the larger units is within 2 per cent. when the load is varied from no load to full load. Flywheels are not required on any type, as the driving force is always transmitted without angular variation; a desirable condition when generators are operated in parallel. The absence of internal lubrication permits a high degree of superheat. In the Newport plant the superheat of the turbine has been raised to 250°F. without increasing the temperature of any part of the revolving wheels or surrounding casing, except the admission valves. The conditions in an engine operating at this high temperature would not be as favourable. Actual experience in commercial operation has shown that water carried over from the boilers in large quantities does no injury to any part of the turbine, a serious condition when reciprocating engines are in use.

The first vertical turbine engine to be installed in this country was at Newport, R.I., and a few engines of this capacity, even when new, can show as high efficiency at full load. The motors required to operate the circulating and air pumps for the condenser are driven from the turbine generator, and this power, about 20kw., is included in the output of the machine. Analysis of the velocities obtained indicate that the result from the first vertical unit will be materially reduced. Lighting, railway and arc load are all carried on the same unit without difficulty. Minor troubles have developed, but no more than with every radically new device, and these have in turn been corrected as rapidly as possible under commercial operation. The station is arranged for four turbines, two of which have been put in service. Similar plants have been installed at Scranton, Pa., Dover, N.H., and within the past year orders have increased to such an extent that 200,000 H.P. of Curtis turbines are under contract. A 600kw. horizontal unit has been in continuous service at Schenectady for two years, operating for two periods of about four weeks each without a single shut-down. A 1,500kw. Curtis unit is in successful operation at Port Huron, Mich., carrying a mixed load of motor power, railway and lighting. This turbine has the standard clearance of 0·03in. to 0·05in. between stationary and moving parts, and can be started cold and brought up to full speed in half an hour. It is easily brought into synchronism with other three-phase generators driven by cross-compound engines. One 800 H.P. and one 500 H.P. engine, both tandem compound, and also one 500 H.P. cross-compound engine, all condensing, have heretofore carried the load, about 750kw., requiring two 500 H.P. and one 250 H.P. Stirling boilers. With the turbine alone carrying the same load, one of the 500 H.P. boilers is cut out.

A 5,000kw. Curtis turbine has recently been installed at the Commonwealth station, Chicago, where provision has been made for 14 similar units. This machine, the first of its size, has been operated continuously for several periods of eight hours each on a water rheostat load of 5,000kw. and will shortly be put in commercial service. On account of water leaks around the condenser tubes, no reliable economy tests have yet been made. In textile mills the first units to be installed are three 500kw. Curtis turbines at the Lane Cotton Mills, New Orleans, and two similar units at the Fulton Bag and Cotton Mills, Atlanta, Ga.

MODEL SPECIFICATION FOR ELECTRIC WIRING AND FITTING.

At a meeting of the London Electrical Contractors' Association on Tuesday, Mr. W. R. Rawlings read a Paper in which he put forward a model specification for wiring and fitting. His object was to arrive at a standard specification, carrying with it general conditions to be known as the National Electrical Contractors' Association (N.E.C.A.) conditions of contract, to avoid a repetition of words in drawing up a specification. Below is given what Mr. Rawlings suggests is a simple form of specification which can be used for various installations of any size supplied from a private plant or supply mains, and one which will be understood by the average householder. But the proposals were only put forward as a basis for discussion. The specification is for the various forms of wiring in use, but does not include concentric. With reference to the general conditions of contract which have been drawn up by the Hon. Solicitor to the Association, the author made one or two suggestions which might be reasonably considered in the interests of the client as well as the contractor:—"(1) When tenders are invited, travelling expenses to and from the site should be paid for if the distance be more than 10 miles from the contractor's office, and it would be a simple matter to insert a provisional sum for this purpose. (2) Not

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to ask for a banknote to be enclosed with a tender, for in my opinion it is an insult to the contractor as to his bona fides to carry out the work. If there is not sufficient confidence in a firm they should not be asked to tender, and I would appeal to members of the Association to refuse to comply with such an unjust request. (3) Contractors should obtain all goods, and no arrangements should be made whereby the employer or his agent should purchase the same except through the contractor. (4) Percentages should be abolished, and substitute: "List price will be paid for all goods selected." (If there is a fear of heavy discounts, a stipulation could be made that not more than .... per cent. profit is to be made under this clause). (5) When penalties are inserted as to time, it is only fair that a similar penalty should be inserted if the purchaser prevents the contractor from completing, and also for the non-payment of certificates when presented.

Mr. Rawlings also had a word to say with regard to the report of the Electrical Standards Committee upon the standardisation of voltages, which was given in our last issue, and expressed the hope that the Association would support any suggestions coming from that body. The last clause in the model specification provides for all goods to be obtained from members of the National Electrical Contractors' Association:—

MODEL SPECIFICATION.

We estimate the cost of installing the undermentioned electrical works, in accordance with the specification and the conditions of contract hereto annexed or referred to, to be as follows:—

Guarantee from this date, *three years.*
Number of lamps, *50 16 c.p. and 40 8 c.p.*
Wires as per clause *A, 1,200 megohms.*
Protection of wires as per Clause *A.*
Number of 16 c.p. lamps to each circuit, *seven.*
Switches, *No. 70 Tuckers' brass-covered and six at 20s. each.*
Fuses *included.*
Cutting away *included.*
Making good *included.*
Fittings, *included as per schedule for the sum of £95.*
Wiring, *included as per schedule for the sum of £83.*
Total— *Wiring and fittings, £188.*
(The italicised portion is filled in merely as an example.)

LONDON ELECTRICAL CONTRACTORS' ASSOCIATION.

The price herein quoted is subject to a written acceptance of the order.

SPECIFICATION FOR ELECTRICAL WORK.

Wiring.

Guarantee.—The whole of the work under this specification is guaranteed for the term specified against faulty material or workmanship, and does not include fair wear to any part of the installation or lamps and fuses, or for faults occurring after another contractor or person has carried out any work on the installation.

System.—The whole of the wiring to be arranged upon the multiple circuit distribution system, and not more than the specified number of 16 c.p. lamps (or their equivalent) to be connected to any one circuit; each circuit to be protected as hereinafter described. The fuses to be arranged in groups, fixed in a convenient approved position to suit the arrangement of the wires. Main cables connecting the fuse boards to be carried to a point near where the supply mains enter the premises, and there protected as per the rules of the Institution of Electrical Engineers; the cable to be left ready for connecting to the supply mains. In the case of six or more lights required in one apartment, two circuits to be employed.

Wires.—(*a*) Vulcanised insulation. The whole of the wires to be of high class tinned copper, of 98 per cent. conductivity compared with pure copper insulated with a layer of pure rubber, then vulcanised rubber, both vulcanised together, taped, braided and treated with a preservative compound; the insulation resistance to be not less than the specified insulation in megohms per mile tested under water. In special cases where wires are subject to dampness they are to be protected with a lead cover, or drawn into metal tubes.

(*b*) Lead-covered wires. The conductors are to be of the size specified, insulated with special compound and lead covered. The wires may be run between partitions and under floors, but to be protected as specified where liable to mechanical injury. The ends must in all cases terminate in the terminals supplied by the makers and properly secured to prevent moisture entering the insulation at the ends.

Size of Wires and Joints.—All wires (except in fittings) to have an area of not less than a No. 18 S.W.G., and those larger than a No. 18 to be stranded, the area of the wires to be such that the current-density shall not exceed 1,000 amperes per square inch, calculated upon the lamps installed. All joints to be properly and carefully made with best material by careful and qualified workmen. In all cases the wires are to be soldered, using resin as a flux and insulated with the proper insulating material, recommended by the maker of the wires.

Protection.—(*a*) Casings. Wood casings to be of the best American white wood, well seasoned and free from knots; the covers in all cases to be fixed with screws, on the edges of casings exceeding 1½in. in width, and, where exposed to view, the covers are to be neatly moulded and fixed to suit the decorations. All wires buried beneath plaster must be run in welded or watertight steel tubes, and wood casings must not be used except on the surfaces of the walls and beneath the floorings.

(*b*) Watertight tubes. The whole of the wires to be drawn into welded steel tubes with screwed fittings and junction boxes, forming a watertight installation; all work to be so arranged that the wires can be as far as possible drawn in or out.

(*c*) Simplex tubes. The whole of the wires to be drawn into simplex tubes with slip socket joints and fittings, the whole to be so arranged with junction boxes to allow as far as possible the wires being drawn in or out.

(*d*) Lead-covered wires. Where lead-covered wires are used, unless properly armoured with steel wires or tape, they must be run in welded steel tubes where buried directly into plaster or passing through brick or stone walls, and other positions liable to mechanical injury, or wood casings may be used for protection under floors or on the surface of walls, &c., where further protection over the lead covering is necessary.

Safety Fuses.—Two single-pole fuses, mounted upon porcelain and properly protected, to be fixed near the entrance of supply mains. One or more distributing fuse boards to be fixed as before described, with fuses so arranged that any one can be replaced without skilled labour. The fuses to be arranged in groups and covered with polished wood cases with glass fronts, the positive and negative fuses to be under separate cases where the voltage exceeds 100. The fuses to be of the best spring clip type, with extra long break (not less than 1¾in.) as required for 200 volts and over. A chart to be provided and fixed near the fuses showing the numbers and positions of lights on each circuit.

Switches.—All branch switches to be of an approved pattern with porcelain bases and to be arranged near the entrance doors of the apartment to be lighted, or other convenient position agreed upon; the number of switches to be provided and fixed as per schedule. The main switch to be fixed near the entrance of the supply mains, and to consist of two single-pole switches of a quick-break type, coupled together and mounted upon separate slate or porcelain bases, and covered with a polished wood case and glass front, fitted with lock and key. The metal parts and contacts to be of a size to prevent heating, and the current density should not exceed 400 amperes per square inch of contact surface.

Blocks.—At all points where switches, pendants or brackets will be fixed, a suitable wood block, well varnished with shellac varnish, is to be cut and cemented into wall with Keen's cement, or, in the case of surface work, face blocks must be properly fixed with plugs, &c., to receive the switches and fittings. Where the wires are brought into the blocks, arrangements must be made that the screws used for fixing the fittings or switches cannot damage the wires by continuing the metal tubes through to the central outlet of the block or other similar protection.

Cutting Away.—If included, provides for cutting away all work necessary for installing the wires.

Making Good.—If included, provides for making good all work disturbed, the plaster to be made good with Keen's or other approved cement. Reinstatement of the decorations is not included in this specification.

Alterations.—Any reasonable alteration may be made as to position of points and switches, provided notice be given before the actual work is carried out.

Testing.—All wiring to be tested during progress of work and also upon completion. The test to comply with the rules of the Institution of Electrical Engineers.

Hours of Work.—The work to be executed between the hours of 6:30 a.m. and 6 p.m., it being understood that as little inconvenience as possible is caused.

Payment.—Payment to be made as to 80 per cent. during the progress of work when applied for and the balance upon completion.

Generally.—The whole of the work must be of good quality and shall comply with the rules of the Institution of Electrical Engineers and the fire offices interested. If fittings are included they are to be fixed as per schedule and left ready with all lamps and shades for switching on the light. Wall plugs, bracket pendants, wiring and fixing of the same are not included in the wiring. The work is to be done and the fittings supplied (if any) and the contract is accepted on the terms and conditions contained in the conditions known as "The General Conditions of Contract of the National Electrical Contractors' Association," so far as the same are not inconsistent with the conditions herein contained.

Unless otherwise specified the material used shall be obtained from members of the National Electrical Manufacturers' Association.

SPECIFICATION FOR ELECTRIC LIGHT FITTINGS.

Fittings.

Lamps.—To be of good quality and British manufacture, with terminals to suit the requisite fittings. All lamps failing within seven days after completion to be replaced free of charge.

Holders.—To be of the best and latest pattern, fitted to suit each fitting. Candle tube holders to be mounted upon brass tube and fitted with rubber or other suitable supports to keep the tube in position, and terminating with a rubber plug to fit into sconce; tubes to cover same to be of the best opal.

Flexible Wires.—All flexible wires to be composed of a number of fine copper wires not less than 35 of 40 S.W.G., insulated with a thick layer of pure or vulcanised rubber, braided over with cotton and an outside braiding of silk, or such other wire agreed upon.

Ceiling Roses.—To be of the best porcelain, fitted with requisite connections, and fixed upon wood blocks where desired.

Wall Sockets.—To be of the best porcelain. Patterns to selection.

Fixing Fittings.—All care to be taken to securely fix each fitting so as to avoid any electrical connection with the earth, and where wires pass through the tubes of the fittings care to be taken to avoid any damage to the insulation of the wires.

Fittings.—Electroliers, brackets, pendants, glass shades, &c., to selection.

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SPECIMEN PAGE OF SCHEDULE OF LIGHTS, &c.

Position.	Fittings.	Lamps. 8 c.p.	Lamps. 16 c.p.	Switch.	Price of fittings only.
Hall (foot of stairs)	One lantern fixed on special hook	3	...	2	£2 10 0
Dining room (centre)	One silk shade balance-weight pendant	...	4	2	4 15 0
„ (fire)	Two one-light brackets with fancy shades at 2s. 6d.	...	2	1	2 0 0
Drawing room (walls)	Four brackets, each for two lights, fancy shades at 2s. 6d.	8	...	4	6 0 0
		11	6	9	£15 5 0
	Brought forward from sheets 2 and 3	29	44	57	£79 15 0
	Total, 90 lights, 66 switches	40	50	66	£95 0 0

The Price quoted for Fittings includes Lampholders, Blocks, all Accessories and Fixing complete. If Fittings are not included, the Schedule to be as follows:—

—		Lights. 8 c.p.	Lights. 16 c.p.	Switches.
Hall (foot of stairs)	1 pendant	3	...	2
Dining room (centre)	1 pendant	...	4	2
„ (fire)	2 brackets	...	2	1
Drawing room (walls, selected position)	4 brackets	8	...	4
		11	6	9

Mr. R. Tweedy Smith in suggesting the following general conditions of contract, states that the way in which he would advise their use is as follows:—

"The National Electrical Contractors' Association should adopt them or a modification thereof, and put them on their minutes. Prints of the same should be supplied for a small charge to members, and they will be scarcely ever asked to be seen by the client, but will always be available if he does. To make them binding, the employer must have notice of them, directly or indirectly, just as railway companies incorporate all their conditions on the back of a ticket. This notice is sufficiently set out by me in a few words in the estimate or specification given in Mr. Rawlings' Paper. In order to cover cases where there is no written contract, I advise that there should be put on the firm's billheads and letter paper the following words:—'All business done is on the general conditions of the National Electrical Contractors' Association.' These words need not take up too much space, and on the face of it looks more like a claim to superiority of work, which, in fact, it is hoped it would become. Condition 8 is an attempt to enable members to compete with the unfair powers obtained by many supply companies and corporations in Acts of Parliament with respect to the supply of fittings."

GENERAL CONDITIONS OF CONTRACT.

1. The specification and quantities of contracts accepted by members of the National Contractors' Association are deemed to be annexed and form part of such contract.

2. These general conditions are deemed to be part of any contract accepted by members of such Association, in so far as they are not inconsistent with any special conditions which may be expressed in the contract.

3. All estimates sent in by members of this Association to employers for work and labour to be done, or materials supplied, are not to be deemed binding on the said member until he has had an opportunity of satisfying himself as to references or financial stability of such employer or customer and of checking the quantities *in situ*, and any variation in the prices since the date of the estimate and the order of the employer shall not be deemed to be binding on such member until he has either accepted the order in writing or commenced the work.

4. The Contractor shall have the right of calling upon the employer or customer at any time for payment for work done and material supplied to the extent of 80 per cent. of the actual value of work done or material or goods supplied or ready to be delivered. Should the employer, when so called upon, fail to make such payment or payments, the contractor shall not be bound to finish the work before requiring payment, but shall be entitled to recover for the full amount of the fair value of the work done and materials supplied.

5. In any case of dispute as to the prices charged for work done or material supplied under the last condition, or of any matter arising under the contract, the same shall be submitted to the president for the time being of the National Electrical Contractors' Association as arbitrator, and he shall have the power, if necessary, or if required, of calling in an expert and of appointing an impartial person to certify the fair price to be charged for such work or material supplied, and these presents shall be deemed to be a submission to arbitration within the meaning of the Arbitration Act, 1889.

6. All expense of preparing and stamping contracts shall be paid by the employer if called upon by the contracting member.

7. In cases where there is a time fixed for the completion of any contract, no penalty or damages shall be recoverable by the employer if there has been any delay in the giving of instructions or delivery of plans, or in payment of certificates or of money demanded under condition 4 hereof, or if there has been delay on the part of the manufacturer or his agent or dealer in the delivery of specialities specified, or in cases where extra work has been ordered, or strikes, or *force majeure*.

8. Any goods or materials delivered on job shall not be deemed to be the property of the employer or customer until such job has been completed, and all payments on account thereof made to the contractor, and such contractor in default of due payment shall be entitled to enter and remove any such goods or material.

9. The whole of the work shall be carried out in accordance with the Rules of the Institution of Electrical Engineers and to the satisfaction of the supply company or corporation and of the fire offices; but in case of any difference in the requirements of the supply company and that of the fire offices or the Rules of the Institution of Electrical Engineers, the requirements of the Institution of Electrical Engineers shall be carried out, and shall be deemed to be a fulfilment of the contract.

10. In the event of fire or accident, the employer or customer shall be responsible for all damage done to work done and material supplied under a contract, and such employer shall pay for any such damage received or shall pay any sum received from any insurance company in respect of such damage to the contractor.

11. In cases where the employer purchases material through other sources, and requires the contracting member to fix the same, the contractor shall be entitled as against the employer to a sum equal to 10 per cent. on the price paid for the goods or material as extra remuneration for fixing the same. Any sums received by the contractor from the firm supplying such goods or materials of less than 10 per cent. must be given credit for to the employer, and the balance only shall in such case be payable by such employer.

12. All fees payable to the supply company or corporation for tests or otherwise shall be paid by the employer unless ordered by the contractor and whose work is proved to be below the requirements of such company or corporation, and the contractor shall not be responsible for any orders or requests given by the employer to such company or corporation, and no payments by the employer to the contractor shall be withheld by reason of the refusal or default of the supply company or corporation to connect through no default of the contracting member.

13. Where the employer engages the services of a consulting engineer, he is to be considered the duly authorised agent of the employer for all purposes, and if the agent is called upon by the contractor to grant a certificate as per clause 4 hereof, he must do so within seven days of a written application for the same; and the agent shall estimate the value of the work done and materials supplied to date. In the event of the agent refusing to issue a certificate, except when the application exceeds the value of work done and goods supplied, any penalty clause which may be inserted shall not be enforceable, and the contractor shall have the right to refuse to carry out further work until the certificate has been issued and paid.

14. The word "contractor" shall mean in these presents the person, company or firm engaged in carrying out the work. The word "employer" shall mean in these presents the person, company or firm, agents or engineers who shall engage or give orders to the contractor.

The discussion which followed the reading of the Paper did not, in most cases, enter into much detail; although some suggestions were made with a view to improving Mr. Rawling's specification, a fairly general opinion prevailed that it was too one-sided, and favoured the contractor more than was advisable if it was to be universally accepted and adopted. Mr. R. W. Hughman suggested that the specification and general conditions should be thoroughly threshed out by the Association, and then, after having secured the co-operation of the National Electrical Manufacturers' Association, and possibly the Plant and Cable Makers' Association, that a deputation should be sent to the Institution of Electrical Engineers. With the approval of the latter body, the chances in favour of its being readily accepted by consulting engineers and others would be greatly increased. This view eventually commended itself to the meeting, and a committee was at once formed with a view to carrying out the suggestion. Messrs. Broadbent, Hughman, Murrell, Blackwell, Alger, Duncan, Bedford, Joseph and Rawlings, agreed to serve, but the committee has power to increase its number, and will probably ask some manufacturers and consulting engineers outside the Association to join.

High-tension Transmission in America.—At a recent meeting of the Street Railway Association of the State of New York, a speaker said that the company he represented had a transmission line operating at 22,000 volts, and of about 31 miles of that line 1,000ft. was in a street in a village of 1,200 inhabitants. A resident in the street in question complained to the Public Health authorities that a line carrying 22,000 volts passed over his sidewalk, and he thought it was dangerous. The matter was referred to the Railroad Commissioners.

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THE MAGNETIC STORM.

The magnetic storm of last Saturday has given rise to much speculation. The general public are wondering whether this is not a final proof that physicists and electrical engineers, who have devoted their whole lives to a study of their particular subject, are still in a deplorable state of ignorance with regard to it. They look upon the occurrence as a further demonstration that "electricity is in its infancy," and that the extinction of an electric lamp, the stoppage of a tramcar, or an error in a telegram, are the result of unavoidable and inexplicable causes over which the electrical engineer has no mastery. Physicists, on the other hand, may speculate as to whether the sudden interest evinced by the multitude in pure science and scientific phenomena is a sign that greater attention and thought is now being paid to the more modern branches of learning, or whether it merely arises from the fact that the earth-current disturbances in the telegraph system of the country interfered with the prompt transmission of the Saturday afternoon football news. Physicists, however, are also led to pursue a more useful line of speculative thought, for magnetic storms and earth currents are among the phenomena to which it is difficult to assign an explanation with any considerable degree of certainty, partly owing to the difficulty of applying an experimental test to a hypothesis based on the occurrence of cosmic disturbances. The connection between sun-spots, magnetic storms and intense earth currents is now practically beyond dispute, for they are invariably observed simultaneously, but the first cause of these phenomena is still to be sought. At present the suggestion made by the late Prof. G. F. FITZGERALD, and supported and carried further by Sir OLIVER LODGE, would appear to be the most easily acceptable hypothesis. In the letter from Sir OLIVER, which we publish in another column, it will be seen that he is still in favour of the view that the magnetic storms are due to the actual projection from the sun of minute particles in enormous number flying past the earth at great speed. As he truly remarks, the fact now accepted that radio-active elements emit charged particles at excessively high velocities, makes it easy to reconcile these views with the present position of fundamental physical theory. Moreover, as ARRHENIUS has pointed out, the aurora borealis which usually accompanies the phenomena of sun-spots and magnetic storms may be explained under the same hypothesis, for the flying electrons would be deflected in the earth's magnetic field and carried towards the poles.

Passing now to the actual results of the magnetic storm upon the working of the telegraphs, it may appear at first sight remarkable to the layman that the short lines were more affected than the long ones. While traffic on the long cables of the Eastern and associated cable companies, for instance, was only affected to a slight degree, inland telegraphic communication in England and France was completely disorganised. The reason of this is twofold. First, the majority of the submarine cable companies employ the syphon recorder, while on land lines and the shorter cables Morse working through a relay is employed; and secondly, the interpolation of condensers between the cables and the instruments shuts off the steady

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part of the current, so that only the variations in the current —which are, for the most part, the actual signals sent—have any effect on the instruments. As a result, while the Post Office lines were troubled with 60 milliamperes, which held over their relays and rendered signalling impossible, the syphon recorders at the ends of the cables at Porthcurnow were recording perfectly legible messages just as usual, the only effect noticeable on the records being a displacement of zero, which is of course immaterial, as the relative positions of the pen and paper can be adjusted to keep pace with it. In fact, inquiries at the offices of the Eastern Telegraph Co. elicit the fact that the only delay of any importance was on the land-lines between Porthcurnow and London, on which it was found necessary to work simplex instead of duplex for some hours.

A peculiar feature of these and similar cases of the occurrence of heavy earth currents is the difficulty of obtaining absolute records of the magnitude of the disturbance in the cables. Naturally, the first duty of the operators and the electricians in charge of the lines is to get the messages through, and there is little time or opportunity to make tests. In some cases, however, records of the current in the cables are obtained. An actual electrometer test on a new section of Atlantic cable about 1,900 miles in length, showed a maximum measured potential difference between the conductor and sheathing of 31 volts, while the range of variation of pressure was probably something like 60 volts. In another case, that of the Vigo–Emden cable, which was broken, and at the Vigo end of which the electrician was waiting for the repairing ship to pick up the broken end of the cable and signal to him, a potential difference of 211 volts is reported, but as this was merely observed on a galvanometer, it is not improbable that the great magnitude of the reading may be due to some extent to the capacity of the cable and the charging effect. Similarly, we know cases in which voltages of over 300 have been noted down during magnetic storms, and although the relative values of a series of readings are doubtless comparable, it would not be safe to base any calculations on the absolute values without taking full account of the circumstances in which the readings were observed, the line constants of the cables themselves, and the resistances and inductances of the instruments connected to them. Similarly, the 60 milliamperes observed by the Post Office must simply be considered as about four times the average working current. However, the occurrence of serious magnetic storms is so infrequent that quantitative measurements will not have any great practical utility, and the theories advanced to explain the phenomena are hardly sufficiently developed to demand figures and quantitative measurements for their corroboration.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Conductors for Electrical Distribution: Their Materials and Manufacture, the Calculation of Circuits, Pole Line Construction, Underground Working and other Uses. By F. A. C. Perrine, A.M., D.Sc. (New York: D. van Nostrand. London: Crosby Lockwood and Son.) 1903. 20s.

The promise of varied reading given in the long sub-title of this book is amply justified by the contents of the volume. Dr. Perrine's treatise includes much that is useful and interesting, much that is interesting without being useful, and a certain proportion of matter that is neither interesting nor useful. It does not give a favourable first impression, however, for the definitions on the first two pages are sufficiently laboured and clumsy to frighten off the most willing student. In the second paragraph, for instance, we read that "the energy absorbed in the transference of a given quantity of electricity over organic bodies and most chemical combinations, such as oxides, sulphides, chlorides, is so great that they are called insulators." After this there is an immediate plunge into symbols to define resistance and specific resistance, without its being deemed necessary to explain in every instance what all of the symbols stand for.

The total quantity of electricity transmitted in a given time is $Q = IT$, while the energy is $W = EIT$, and as we know that $E = IR$, therefore we have energy of transmission $W = I^2RT$, and, consequently, the energy absorbed in any transmission is proportional to R_c, where R_c is the resistance of the conductor.

Now, $$R_c = \frac{L}{A} f(\text{material}).$$

The value of the factor f (material) depends, in consequence, on the terms in which L/A is expressed. In the C.G.S. system of units, f (material) becomes the specific resistance, or the resistance between the opposite faces of a unit cube, of the material used.

The remainder of the two chapters on conducting materials, however, are good, and then follow two readable chapters on wire manufacture. Insulating and cable making is next dealt with, but it is a pity that this part of the book is chiefly occupied with generalities concerning methods of manufacture rather than with the description of the details of actual machines. Details of the construction of braiding machines, for instance, would have been welcome, and although there is a description and drawings of the "sausage-machine" type of rubber-covering machine, there is not enough space devoted to other and better methods of rubber covering employed in this country. The unfavourable experience as to durability of rubber cable when used out of doors and underground should also have been mentioned. A glimpse given as to the methods of some American rubber manufacturers is worth quoting:—

In consequence, the proportion of rubber in rubber shoddy is an uncertain quantity, so that its employment is attended with a considerable danger of producing an irregular product. In spite of this difficulty, however, it is undoubtedly true that certain grades of rubber shoddy may be so employed by skilful rubber mixers as to increase the mechanical strength of the resultant compound, and many rubber manufacturers using a compound containing an admixture of high-grade rubber shoddy obtain a covering which gives good service when exposed to the action of the elements, while others who never employ this material are unable to obtain a wire insulation which will withstand the oxidising action of the air in sunlight to an equal extent, the reason for this apparently being that the previous vulcanisation has rendered the rubber unchangeable under the ordinary influences which will deteriorate compounds of pure gum.

The chapters on the calculation of conductors are here and there too much of the wiring chart and graphical construction character to suit the majority of English readers; but one of them shows clearly to the student the utility of the calculus, and, what is more, the necessity of realising the care which must be taken when applying the mathematical proof of one particular case to another. Occasionally, there are very tiresome passages, in which a small amount of meaning is clothed in volumes of words:—

Since, therefore, the constancy of the potential at one point depends upon the resistance of the wires from the distributing points to the point in question, and upon the currents carried by the wires having this resistance, the condition of perfectly even distribution of potential and no variation can only be obtained when independent wires of equivalent resistance are laid to each translating device from the nearest distributing point; but as this can rarely be accomplished with economy, it is necessary to allow a variation of potential between different devices and at each particular device, which may be accomplished by sub-dividing the system as far as may be economically allowed, and by approaching as near as possible to an independent system.

The possible sub-division of circuits in approaching an independent system is determined largely by the configuration of the system in its relation to the load carried on the different wires, those systems admitting the greatest extent of sub-division in which the loads are heavy and radiate in many directions from the point of distribution, since in such cases many wires may be installed without unnecessarily increasing the cost of insulation and installation; but where loads are light and located along one or two lengths from the distribution centre, the greatest sub-division would entail the use of many small wires, each one separately insulated, and the cost of the circuit would be greatly increased.

The American method of laying out a network for "multiple arc distribution," if it be correctly described in Dr. Perrine's book, differs somewhat from English practice:—

In a sub-divided circuit, beginning at the points of distribution where the potential is maintained constant for all loads, and to which feeders from the generating plant are run, sub-feeders are laid to "distribution

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centers" along the mains, while from the mains are carried service wires to each collection of lights for which the average distance from the mains is nearly constant. The "distribution centers" at which the mains are fed are points for which the distribution moments over the main between points of distribution reduce to zero, the "moment of distribution" about a center being defined as the product of the current at each service point into the resistance of the main from the center, or approximately the product of the currents at each service point into the length of the main to the center.

Commonly, we find the rule stated that the loss in sub-feeders should be taken at 3 per cent., the loss in mains at 1·5 per cent. and the loss in service wires at 0·5 per cent., making a total loss in the system of 5 per cent. This assumes that the variations in demand are greatest in the service wires and least in the sub-feeders, an assumption generally correct in town distributions or in residence-lighting circuits.

A chapter on "Alternating-Current-Line Calculations" explains the effect of capacity and inductance on the regulation of pressure on an overhead transmission line, and this is followed by other chapters on overhead construction. A calculation of the proper taper for poles is given, resulting in the formula $d_2 = 3d_1/2$, and equations are also derived for the diameter of poles. A table of comparative specifications for wooden poles is added, as is also a remark which the reader should not overlook, that "in the consideration of the line it is not the custom to separately determine poles for different parts of the line from a consideration of the stresses applied, but a single general type of pole is chosen for the whole construction . . . ." This chapter concludes with a practical comparison of the efficacy of struts and guy wires. Next comes a chapter on the similar mechanical considerations relating to the wire itself and its span, and a chapter (without illustrations) on line insulators. The last chapter, on underground conductors, relates to American practice, and the English reader who is conversant with the methods employed in his own country will have little to learn from it. On the whole, however, the book has much to recommend it, and even if only portions of it may interest him directly, the English mains engineer will do well to add it to his library.

Practical Electro-Chemistry. By Bertram Blount. (London: Archibald Constable & Co.) Second impression. 15s. net.

The proof of the utility of Mr. Blount's book is the reputation it has attained since its publication in 1900. It is surprising how few students of electrical engineering ever take to electro-chemistry as a means for earning a livelihood; a very large proportion of the workers in this branch of the industry is recruited from students of pure chemistry. Students of electricity, as a rule, seem to live in fear and dread of chemistry, and particularly electro-chemistry. This is, to a large extent, due to neglect of the subject at technical colleges, where it is dealt with in a perfunctory sort of way, and after a year or two the average student has completely forgotten the little he was taught. We believe there is only one teaching institute in this country which professes to be in possession of a well-equipped electro-chemical and electro-metallurgical laboratory, and that is the Manchester University, formerly known as Owens College.

But a glance through the pages of the book under review does not enlighten the reader as to the reason for the neglect of the subject; on the contrary, it makes him ask why there is so little interest taken in electro-chemistry when the field is so wide. For instance, no fewer than 43 pages are devoted to the various electrolytic processes connected with copper. The opening paragraph of this section is eloquent: "This is the largest of all electrolytic industries. It is practised in this country and on the Continent, but the place of its greatest development is the United States; the output there is said to be at least 10 times that of all European factories put together. The electrolytic winning of copper as distinct from its refining is even now scarcely beyond the experimental stage. . . ."

Again and again the economies to be effected by the adoption of water-power in connection with electrolytic refining of copper have been advanced, but, as a matter of fact, the pecuniary advantages accruing from the substitution of water for steam power are exceedingly small. Taking water power at 0·0685d. per horse-power-hour, the cost per ton of copper refined is given as 3s. 4d., and with steam power at 0·411d. per horse-power-hour the cost per ton is 20s. The difference is apparently great, but the higher of these sums is only 1 per cent. of the selling price of the pure metal. Mr. Blount says, however, that in processes such as the manufacture of calcium carbide, where the expenditure of energy is considerable, the economy effected by the use of water-power really demands serious consideration.

The refining by electrolytic means of other metals, such as gold, silver, nickel, zinc, &c., is dealt with at considerable length, and the principal processes are fully described and illustrated. Aluminium, concerning the possibilities of which so much has been written and said, receives its due share of recognition. It is interesting to note that although no serious attempt to manufacture aluminium by an electrolytic process was made as recently as 20 years ago, yet it is now produced solely by electrolytic methods. This industry is, without doubt, a very important one, and we commend the attention of our readers to the descriptions of the processes employed.

Section IV. deals in a very comprehensive manner with the electric furnace, and due credit is given to the Brothers Cowles, who were probably the first to take advanage of electric heating. The book contains little of historical interest, but the invaluable researches of Moissan are briefly described, and the details of a typical furnace are explained.

With the space at our disposal it is quite impossible to do justice to Mr. Blount's excellent work, but the chapters on electrotyping and plating are certainly worthy of special mention. A book which gives reliable and systematic information on this point has long been wanted; the classification in this instance is certainly systematic, and there can be no doubt about the reliability.

We can confidently recommend the above publication to all those who are in any way connected with electro-chemistry.

Elementary Treatise on Electricity and Magnetism. By G. Carey Foster, F.R.S., and Alfred W. Porter, B.Sc. 2nd edition. (Longmans, Green & Co., London.) 1903. 10s. 6d.

This book is based on M. Joubert's well-known "Traité Élémentaire d'Electricité"; it is not, however, a mere translation of the French publication, but has been for the greater part re-arranged and re-written, and to a greater extent even than was the case in the first edition. One feature, however, characteristic of French writers on scientific subjects, remains, and that is the extensive use of higher mathematics such as would not be generally expected in an "elementary" book written in this country. This, of course, is by no means a disadvantage *per se*, but it must necessarily restrict the use of the book to those possessing a fair knowledge of differential and integral calculus. On the whole the treatise follows the development of electrical science, commencing with the elucidation of the fundamental laws of static electricity, and terminating with a description of the most recent discoveries, such as the Becquerel, Röntgen and cathode rays and allied matter. A noticeable and pleasing feature of the book is the clear manner in which the subject is presented to the reader, the laws and phenomena being rendered easy by numerous illustrated descriptions of original experiments. Practical applications of electricity and magnetism are dealt with in a few chapters. This part of the book is at times weak, inasmuch as matter of small practical or theoretical importance has received undue prominence. Many excellent illustrations are distributed over the five hundred pages, and the work can be recommended as a book of reference or for self study.

Tube, Train, Tram and Car, or Up-to-Date Locomotion. By Arthur H. Beavan. (London: Geo. Routledge & Sons, Ltd. 1903.) 6s.

The intention of the author is to give the ordinary travelling public an account in simple language of the present methods of electric locomotion. It is a good idea, but he is not particularly successful in its execution. The book is devoid of any literary merit on the one hand, and as a descriptive treatise it is neither sufficiently methodical nor sufficiently explicit. A description of the Liverpool–Manchester monorail, for instance, conveys to the reader that the line is actually running to schedule time, whereas it has, in reality, hardly passed the "projected" stage. This may, however, be a joke, as may also be the reference to a London County Council tramway through Oxford-street, past the Marble Arch and Notting Hill Gate to Shepherd's Bush, but neither are clearly labelled as such.

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THE MAGNETIC STORM.

A magnetic storm of unusually serious magnitude was observed in practically all parts of the world on Saturday last. Its effect upon the telegraph lines was considerable, especially upon those for which the Morse and relay system of working without condensers is employed. In England serious earth currents affected the telegraph system between 7 a.m. and 8 p.m. on Saturday, and during some hours there was a complete disorganisation of the service, the effect being noticed particularly in London owing to the greater amount of traffic to be dealt with there. Earth currents up to 60 milliamperes were observed, which is about four times the average working current for a long line, and the currents alternated and varied greatly in strength. A similar state of affairs occurred in France, and at 9 a.m. on Saturday morning the Central Telegraph Office in Paris was unable to communicate with the greater number of French towns, and was also cut off from communication with America, Spain, Portugal, Italy, Algeria, Tunis and many other places. Communication was re-established on the French lines at 4:40 p.m., but was interrupted again at about 5:30 for a short time. Working on the London–Paris telegraph cable was also disorganised, but the Post Office submarine cable to Germany was less affected, although there was considerable trouble on the landlines serving it. The insertion of condensers was tried with only moderate success in this case, owing partly to the difficulty of being unable to let the French and Germans know what the English operators were doing. From New York it is reported that a bright aurora was visible early on Saturday morning, as was also the case in some parts of these islands, and that earth-current disturbances were felt in all directions, in some instances causing a total cessation of telegraph business. It is also stated that considerable trouble was experienced on the long-distance telephone lines there. According to the New York correspondent of the *Daily Telegraph*, a voltage of 675 was observed. Disturbances of a like character, but not always of such a serious nature, are reported from Russia, Germany and other countries.

The long submarine cables were less affected than the landlines, and those longer cables on which condensers and siphon recorders are employed were hardly disturbed at all by the earth currents. Some of the cable companies, however, who employed Morse working suffered considerably.

Dr. Chas. Chree, F.R.S., superintendent of the Observatory Department at Kew, has kindly sent us the following notes :—

"The recent magnetic storm is the largest recorded at Kew since February 14, 1892. The photographic curves for October 30th showed an appreciable amount of magnetic disturbance of an ordinary type after 8 p.m. ; but the first distinct precursor of the storm was a sudden movement shown in the traces of all three elements (declination, horizontal force and vertical force) at about 6:3 a.m. on the 31st. Larger movements followed at about 6:45 a.m., and from that hour until 7 p.m. or 8 p.m. the disturbance was very large indeed. It remained, in fact, very appreciable, especially in declination, until 4 a.m. on November 1st. The extreme range of the declination needle was about 2¼deg. Owing to the traces going off the sheet, the total amplitude of the range of horizontal force and vertical force cannot be assigned ; but it certainly exceeded 870γ in horizontal force and 500γ in vertical force ($1\gamma \equiv 1 \times 10^{-5}$ C.G.S.).

"The storm was remarkable not merely for the great range of the magnetic elements, but also for the exceptional number of large oscillatory movements. These movements occurred in such rapid succession between 10 a.m. and 1 p.m. as hardly to appear separable on the photographic sheet ; but the largest oscillations took place later, between 1:30 p.m. and 7 p.m. For instance, there were the following sudden movements of the declination needle (the times are approximate) : At 2:5 p.m., 70′ in three minutes ; at 2:12 p.m., 66′ in three minutes ; at 3:45 p.m., 80′ in six minutes ; at 5:45 p.m., 65′ in six minutes. Between 6:50 p.m and 7:12 p.m. the needle moved 77′ to the west and then 82′ to the east.

"The horizontal force increased 525γ between 1:20 p.m. and 1:26 p.m., its value at 1:26 p.m. exceeding that at 1:2 p.m. by 685γ ; it increased over 500γ between 3:16 p.m. and 3:36 p.m., and fell 450γ between 3:45 p.m. and 3:53 p.m. At 6 a.m. on November 1st, when the storm was practically over, the horizontal force was about 150γ less than at the same hour on the previous day. Such diminutions are a usual, though not invariable, accompaniment of large magnetic storms, and the return to the normal value usually occupies, as Van Bemmelen has shown, several days.

"Though very exceptional in point of intensity, there is no feature—except possibly the suddenness of commencement—which distinguishes the storm from the smaller magnetic disturbances chronicled at comparatively short intervals at all magnetic observatories, especially those in high latitudes. As to the cause of magnetic storms one can at least say that there is no evidence of any connection with earthquakes or other internal troubles of the earth itself. At times of large earthquakes magnetographs are occasionally disturbed, but unless they are close to the earthquake's epicentre the disturbances they show are comparatively microscopic, and, in some cases at least, these tiny movements are clearly to be ascribed to the magnetograph responding, like a seismograph, to simple mechanical shock. There is every reason to associate magnetic storms with electric currents, but the simultaneous earth currents are probably not the primary cause, but simply a common consequence of electric discharges in the upper atmosphere. Aurora is almost invariably seen at the time of any really large magnetic storm. Observers, it is true, in Arctic regions—where auroral displays and magnetic storms are specially prominent—have found that aurora is by no means always accompanied by noticeable magnetic disturbance ; but when the visual display is of a rapidly varying character magnetic disturbance seems a practically invariable accompaniment.

"As to the common cause of aurora and magnetic storms, we are still in the stage of theory. The amplitude, both of irregular and the regular diurnal changes of terrestrial magnetic force are conspicuously larger in years of sun-spot maximum than in years of sun-spot minimum. It is thus natural to regard the two phenomena as related, but the various attemps that have been made to associate them as cause and effect have not been very successful. Recent investigations, for instance, by Fathers Sidgreaves and Cortie at Stonyhurst, show that specially large sun-spots are often unaccompanied by magnetic storms. The present date, as in February, 1892, is by no means one of sun-spot maximum ; and there have been a number of occasions during the intervening 11 years of higher sun-spot frequency unaccompanied by special magnetic disturbance. Again, it has recently been shown that the average sun-spot frequency on days which are specially quiet magnetically does not fall below the average for all days. Sir Norman Lockyer seems disposed to regard solar protuberances and faculæ as a more likely primary cause, but his theory has not, I think, as yet been exposed to minute criticism by others. Prof. Birkeland, who has approached the subject from the experimental standpoint, is disposed to ascribe magnetic storms to the action of cathode rays emanating from the sun. He has succeeded in artificially producing electric discharges in a magnetic field which bear, at least, a family resemblance to aurora. It is, perhaps, needless to add that there are already theories as to the origin of aurora and magnetic storms in which radio-active emanations take a prominent place, and there is, not improbably, something in this suggestion.

"One feature of magnetic storms which has long attracted attention is the, at least, close approach to simultaneity of occurrence in the more prominent changes recorded all over the earth. Eschenhagen, Birkeland and others have found, however, that this feature is equally characteristic of the tiny 'magnetic waves' not infrequently recorded by magnetographs, especially at times of great magnetic calm. With a view to investigating the question more thoroughly, there have been from time to time pre-arranged simultaneous observations at very short intervals during an hour at a number of stations. On one such occasion a minor magnetic storm actually took place. The results seemed to Dr. A. Schmidt (now of Potsdam), who worked them up, to be suggestive of a disturbance centre—in some ways analogous to a cyclone—travelling extremely rapidly, but still with finite velocity through the

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earth's atmosphere. It is not improbable that valuable fresh light may be obtained from the elaborate scheme of international observations carried out in 1902 in connection with the British and German antarctic explorations and the contemporaneous work carried out under Prof. Birkeland's auspices in arctic regions."

Father Walter Sidgreaves, Director of Stonyhurst College Observatory, telegraphed to *The Times* as follows:—

The disturbed state of the telegraph lines on Saturday which for a time interrupted communication between London and Paris was accompanied by the greatest magnetic disturbance recorded by the Stonyhurst photomagnetographs, which have furnished a practically continuous record since 1867. The disturbance was remarkable for the multitude of wide oscillations of very short periods, indicating great and rapid changes of horizontal direction and force. The magnetic storm began at 6 a.m. on Saturday and ended at 5 a.m. on Sunday. The beginning and ending were more or less abrupt, but the storm was preceded and followed by a period of about nine hours of small, rapid oscillations. The greatest oscillation of horizontal direction was 2deg. 46min., but the greatest change of horizontal force is unknown, the spot of light having been off the photographic paper on both sides many times. The surface of the sun was marked by two spots, a new one not far from the centre, and a spot near the eastern limb of the well-known double form. Grouped together they are about three-fifths the area of the great spot of last month. The magnetic storm of Saturday was incomparably greater than that recorded during the first passage of the great spot over the solar disc.

Sir Oliver Lodge, F.R.S., has written us as follows in answer to an inquiry:—

"I have not much further to say than what is contained in my letter in your issue for December 7, 1900 (Vol. XLVI., p. 249) beyond calling attention to the fact that Arrhenius has shown clearly how the flying electrons would be deflected by the earth's magnetic field and carried towards the poles in such a way as to account for aurorae in a very satisfactory manner.

"Furthermore, the known emission by radium of charged particles at excessively high velocities makes it very easy to suppose that the sun is doing the same sort of thing, though possibly not for the same sort of reason. Everything, in fact, tends to make it almost certain that the old speculations of FitzGerald and others as to magnetic storms being due to actual projectiles, of minute size certainly, in enormous numbers, flying past the earth at great speed, is a true explanation of the observed effects.

"The simultaneous occurrence of earthquakes is very remarkable. One of the points on which information is badly wanted is—(1) How can earthquakes generate electric currents in the crust; (2) are earthquakes connected in the relation of 'cause' or in that of 'effect'?"

In this connection we may also refer our readers to a letter by the late Prof. G. F. FitzGerald, in *The Electrician*, December 14, 1900 (Vol. XLVI., p. 287).

The *Standard's* Paris correspondent states that M. Mascart read a Paper before the Académie des Sciences on Monday, the Paper having been sent by the Abbé Moreux. It stated that the needle of the compass deviated 1deg. 40min. in less than three minutes time. Similar observations were made at the same moment at Nice, Perpignan and the Pic du Midi, and probably at all the other observatories of the world. M. Moreux mentions that he had, since October 26th, studied the movement of the spots on the sun, and that he had noted the appearance of an exceptionally large spot on the meridian of the sun on Saturday during the magnetic storm. Such disturbances are less rare than is thought. The records of the observatory contained mention of previous magnetic storms in 1860, 1862, 1870, 1882, &c.

The event is also discussed, and some further particulars are given in our leading article.

PHYSICAL SOCIETY.

At a meeting of the Physical Society held on October 23, 1903, Dr. R. T. Glazebrook, F.R.S., president, in the chair, a Paper on

"The Bending of Magnetometer Deflection-Bars"

was read by Dr. CHREE. A theoretical Paper contributed to the society by the present author in May, 1901, proved, amongst other results, that the bending of the deflection-bar of an ordinary magnetometer, under the combined weight of the bar and its load, must increase the distance between the deflecting and deflected magnets, during a determination of horizontal force, to an extent which is not negligible. This conclusion has been borne out by direct observations made at the National Physical Laboratory on a number of magnetometer-bars, including specimens from the leading makers. The mean results thus obtained are recorded in the present Paper. The great majority of the data were derived from direct observations made with a pair of microscopes. But a method is described whereby the necessary information can be deduced without the aid of microscopes from the magnetometer's own readings. The magnetometer is set up exactly as in an ordinary deflection experiment, with the deflecting magnet on its carriage at any convenient position on the deflection-bar, and equal weights are hung up symmetrically one on each arm. The consequent increase in distance between the two magnets diminishes slightly the deflecting force on the deflected magnet, and a slight change of reading is observed in the magnetometer telescope. The weights are put off and on several times, and the mean change of reading determined. As a check it is well to observe at two distances. From the change of reading it is possible to determine the increase in distance between the two magnets. In many magnetometers the increase in distance due to the bending is roughly proportional to the distance itself. In the case of bars by the Cambridge Instrument Company the bending increased the distance by almost exactly 1 part in 10,000 at all distances. It is hoped that the method employed will prove useful to magnetic observers who have not ready access to a physical laboratory.

Prof. S. P. THOMPSON said that Dr. Chree had pointed out an important matter in magnetometry, and had told us of the existence of various sources of error. He asked why instrument-makers could not design a better instrument, referring especially to the deflection-bar itself, which he said was not of a good form from an engineering point of view. Could not the bending be considerably reduced by making the bar in the form of a girder? Would it not be an advantage to lessen the weight of the carriage by making it of aluminium or of some light alloy? Prof. Thompson said that although the error referred to by the author of the Paper seemed large, yet it could not be greater than errors arising from inaccuracy in the setting of the carriage or from other causes inherent in a deflection experiment.

Dr. W. WATSON expressed his interest in the Paper, and said he had never before appreciated the magnitude of the error due to the bending of the deflection-bar. In the many determinations of horizontal magnetic force which he had carried out, he had increased the effect by placing the thermometer near to the magnet on the same side of the magnetometer. He did not think it would be an advantage to lighten the carriage too much, because of the wear and tear which an ordinary magnetometer must be capable of withstanding. With regard to the accuracy of the setting of the carriage, he said that it was not easy to set it to 0·1mm., but that inaccuracies of setting to a certain extent compensated each other. Dr. Watson also pointed out that the position of the magnet in the carriage was not always absolutely the same.

The CHAIRMAN pointed out that the method described in the Paper might be used to determine Young's Modulus by bending the bar with magnets of known weight. A large number of errors entered into the determination of horizontal force, and they were being investigated one by one at the National Physical Laboratory.

Dr. CHREE, replying to Prof. Thompson's remarks, said that various attempts had been made to get rid of the bending effect. The difficulties were due to the fact that it was necessary that the bar should lie in one vertical plane, and that it should pass through the centre of the magnetometer. The error might be reduced by bending the bar so as to make the distance of the magnet from the neutral axis small, but the introduction of corners rendered the theoretical treatment of the problem difficult, and a bent bar was difficult to measure practically. In some of the magnetometers used on the United States Coast and Geodetic Survey, the deflection-bar consisted of two parts pinned together at the centre of the instrument, and although this arrangement had advantages, a great deal depended upon the pin fitting tightly. He contended that if the bending effect could be measured accurately, its magnitude was of minor importance. In the magnetometers used on the Indian Survey, the carriages were much heavier than those in use on ordinary unifilars and the deflection-bar was constructed something like a girder. There were many causes of error in a force experiment. The formulæ used were complicated, and much depended upon an accurate knowledge of the constants P and Q.

A Paper on

"The Magnetism of Basalt and the Magnetic Behaviour of Basaltic Bars when heated in Air"

was read by Dr. G. E. ALLAN.

Bars cut from basalt obtained from Rowley Regis and from Linz, Germany, were tested by means of a magnetometric method to determine their magnetic properties at temperatures from 15°C. to 800°C. Hysteresis curves were given, and the temperature-permeability curves demonstrated that whilst the English basalt has, in general, a maximum permeability near 500°C. followed by a minimum about 550°C., the temperature of maximum permeability in the case of the German basalt lies in the neighbourhood of 50°C., there being a subsequent gradual loss of strength with rise of temperature. Sections of heated and unheated rocks showed evidence of chemical change in some of the rock constituents, and a table of values of susceptibility of the specimens was appended to the Paper.

The CHAIRMAN expressed his interest in the Paper and said that Dr. Allan had given interesting data which would be of value in the subject of terrestrial magnetism.

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Prof. W. F. BARRETT, in a letter sent to the secretaries, said that Dr. Allan's Paper was one of great interest and considerable importance, and he wished to congratulate the author on the results of his laborious investigation. Several years ago he (Prof. Barrett) examined the magnetic properties of various specimens of columnar basalt which had been taken from the Giant's Causeway in Co. Antrim, and a note on the results of this investigation was published in the *Proceedings* of the Royal Dublin Society for December 1889. Each block was found permanently magnetised with a strongly-marked north and south pole, the magnetic axis running diagonally through the block and inclined to the horizon approximately at the angle of dip. As the blocks formed part of vertical columns in the Causeway, their magnetisation was undoubtedly due to the earth's magnetic field, the concave end of each block—for the ends are not plane but slightly concave or convex—was (in all the blocks examined) found to be a north-seeking pole, and must therefore have been downwards when *in situ* at the Causeway. The weight of the blocks varied from 24kg. to 37kg., and the specific gravity of a fragment of one of them was found to be 2·86. With such large, irregular and feebly-magnetised masses only a very approximate estimate of the magnetic moment was possible by the ordinary method. This was, however, attempted, the blocks being placed on a turn-table with their centres 60cm. distant from the reflecting magnetometer. As might be expected, the magnet moment per gramme was found to be very small and almost alike in each case. The volume of the blocks being known, their permanent intensity of magnetisation was found to be less than that estimated by Everett for the earth, regarded as a uniformly magnetised body—viz., 0·079. Nothing could be inferred from this, as the blocks had been removed a long time from the Causeway and had been lying about in different magnetic positions to that which they originally occupied. The long retentivity of the direction of their original magnetisation in spite of rough usage was, however, somewhat remarkable.

Dr. WATSON then showed some experiments with electrical oscillations.

CORRESPONDENCE.

STEAM TURBINES v. RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of October 23rd you print an abstract of a Paper by Mr. G. Wilkinson on steam turbo-electric generating plants. The author gives in parallel columns the supposed performance of a 1,400kw. set with triple expansion reciprocating engines recently erected by us at the Leeds central station and that of a steam turbine at the Newcastle and District Electric Lighting Co.'s works. We say supposed performance, because the actual result for our set was 19·49lb. per kilowatt, and not 19·9lb., and this, again, was water measured into the boilers, and includes boiler and steam-pipe losses, the actual engine consumption measured at the hotwell (as no doubt in the case of the steam turbine) being only 18·7lb. per kilowatt. The turbine was, moreover, running at 237°F. superheat, whilst we had about 71°F., which, of course, makes an enormous difference. With triple expansion engines of 500 B.H.P., running at 25·4in. vacuum, and with 200°F. superheat, we have obtained 16·1lb. per kilowatt, and with 237°F. superheat we should be prepared to guarantee for the Leeds engine something under 16lb. per kilowatt, as against the 17·73lb. shown for the 1,750 H.P. turbine.

Immediately preceding the above comparison figures are given for a Sulzer-Kolben plant with *saturated* steam and 24in. *vacuum*, and a Parsons turbo-generator with 100deg. *superheat* and 28in. *vacuum*. Such comparisons are, of course, worthless and misleading. The 4in. difference in vacuum at 4 per cent. per inch as given in the Paper means 16 per cent. to the turbine, and the 100deg. of superheat another 12 per cent., as also stated, so that after due allowance has been made for the vacuum and superheat, the result for the turbine comes out worse, and not better than the other. Again, the tests of the 500kw. turbo-alternator at the Cambridge electricity works, after 12 months' running, are made with 9lb. higher steam pressure and 3·3in. better vacuum than on the original test, when 24·1lb. per kilowatt was registered. At the 4 per cent. per inch the vacuum is good for 13·2 per cent., and the consumption should have come down to 20·92lb., or allowing for the working of pumps, say 21·5lb., but instead of this, it goes up to 25lb., and yet the conclusion is come to that the trials show that there has been no deterioration due to wear.

It is, in our opinion, regretable that advocates of steam turbines should make such misleading statements. At the present date, the turbines of Mr. Parsons' make or design are the only ones having any claim to be considered beyond the experimental stage, and the latest tables published in the electrical papers giving the figures for 12 months' running, show that these turbines are very far behind reciprocating engines in economy in actual central station work, though the results with them on the test plate were supposed to be good. The present booming of the turbine will surely result in a serious set-back when experience has been purchased at a heavy cost by the users.—Yours, &c.,

For BELLISS AND MORCOM (LTD.),
Birmingham, Nov. 3. Alfred Morcom, Managing Director.

P.S.—It should always be borne in mind that the cost of obtaining the high vacuum necessary for efficiency with steam turbines may become a very formidable item in the majority of inland stations.

THE OUTPUT COEFFICIENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been interested in two articles which recently appeared in *The Electrician*, entitled "A Basis for the Comparison of Dynamo Designs." The first article appeared September 11th, and was written by Mr. H. M. Hobart, the second on October 23rd, and written by Mr. W. B. Esson. I do not think either of the methods advocated are on a fair comparative basis—the output of a machine does not vary directly proportional to the peripheral surface of the armature, neither does it vary as $D^2 \times L \times C \times$ r.p.m. This, I think, is amply proved by the necessity of changing the value of the coefficient C for every different size of dynamo, although it may be a line of machines designed on the same basis.

I venture to suggest the following method of obtaining a coefficient, the value of which can be easily determined and which, I believe, forms a simple and reliable means of comparing dynamos by their specific output coefficients :—

$C = DL/\sqrt{W_R}$.
Output in watts $= (DL/C)^2 R$.
C = Output coefficient.
D = Diameter of armature in inches.
L = Length of armature in inches (over laminations).
W_R = Watts generated per revolution.
R = Revolutions per minute.

I derived this formula in the following manner :—It is, of course, well known that the total number of lines passing through the gap space do not vary directly proportional to the watts generated per revolution. In a line of machines constructed on the same basis it will be found that the total number of lines (Za) will vary as $\sqrt{W_R}$, or we may write $Za = \sqrt{W_R} \times C'$, this being so, if we select a certain density for gap, it follows that peripheral surface of armature will also vary as the square root of W_R. We therefore get the following expression:

$$\sqrt{W_R} \times C'/dg = D\pi L\beta/2.$$

C' = Constant (a good average value of which is 150).
dg = No. Kapp lines per square inch in gap.
β = Ratio of polar span to polar pitch.

Taking C' as 150, dg 7·5, β 0·67

$$\sqrt{W_R} \times 150/7{\cdot}5 = D\pi L\ 0{\cdot}67/2 = \sqrt{W_R} \times 20 = DL\ 1{\cdot}05,$$

therefore output in watts $= (DL/19)^2 \times R$.

$$C = 2C'/dg\pi\beta = DL/\sqrt{W_R}.$$

It will be seen that knowing the relative proportional flux to W_R, the density in gap and polar angle, we can at once ascertain the value of our output coefficient.—Yours, &c.,

Taunton, Oct. 31. J. W. BURLEIGH.

INSULATING PAPER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As one intimately concerned in the production and sale of insulating papers, I have read with considerable interest the letter appearing in your issue of October 30th signed by Mr. C. Beaver. While I cannot but agree with Mr. Beaver as to the difficulty of obtaining a "pure" Manila paper and the apparent reluctance of English mills to undertake its manufacture, I

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would point out that this reluctance arises from two principal considerations, viz.:—

1. The difficulty of obtaining sufficiency of the fibre.

2. The greatstringency(sometimesamountingtoimpossibility) of the specifications provided by electrical engineers.

To mention one condition only which has come under my own observation, the clause read as follows :—"The paper is to be *absolutely* free from knots, pinholes . . . . ." I leave out the portion relating to carbonaceous particles, sand, grit, &c. Now, as any paper-maker will tell you, in a "pure" Manila paper, a few pinholes and a considerable number of knots and unbeaten fibres, are inevitable; for Manila, unlike most other fibres used in paper-making, must not be beaten too fine if the strength of the web is to be maintained.

With reference to the other point in Mr. Beaver's letter as to pure Manilas—*soi disant*—being composed of wood, straw, &c., this I, with many others, of course know to be the case, and such fraudulent samples reaching my hands are at once consigned to the waste-paper basket; but as to the unsuitability of a wood paper made from a good clean sulphite pulp and carefully cleared from acid, I am afraid I am not in agreement with him. After some years of experience I am of opinion that such a paper (considering its strength, uniformity of texture and price, and also its freedom from the *bête noir* of the electrician, "grits, metallic particles and pinholes") has a more than even chance in disputing the field with its more expensive rival—prejudice apart.—Yours, &c.,

London, E.C., Nov. 4. GERALD M. NEIGHBOUR.

INDIARUBBER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the letter of Mr. Carl Otto Weber, I would say that the double constitution of rubber was first discovered by Faraday, who was also the first to isolate the constituents.

It is rather late in the day to suggest that physicists devote their attention to the question, as the physical side of the matter was thoroughly threshed out more then 10 years ago. It is now a matter for the chemists.

I enclose a couple of paragraphs from my Paper on the "Nature of Electricity and Magnetism," Cornell *Phys. Rev.*, January, 1900, which gives a brief account of the state of the matter and the principal references, and will ask you to reproduce it.—Yours, &c., REGINALD A. FESSENDEN.

Washington, D.C., Oct. 21.

The elasticity of such substances as indiarubber, gelatine and ivory was investigated. It was found that the abnormally high value of Poisson's ratio for such substances was due to the fact that their elasticity, as measured in the ordinary way, bears no direct relation to the true elasticity of the material, but is a matter of configuration. It is shown* that such substances consist of two or more compounds, interpenetrating but not combining with one another. It was shown that the heating on stretching, the cooling on relaxing, and the shortening when stretched and heated, followed as a natural consequence of the configuration.

The different compounds were differentiated under the microscope, and, in the case of indiarubber, by following Faraday's method, isolated chemically. The shape of the elasticity curve was predicted, and the prediction was verified by the writer and by Prof. Thurston.† Substances were made which had the shape of the elasticity curve, the property of polarising light on being stretched, and the value of Poisson's ratio the same as rubber, but which on simple pressure could be differentiated into two substances, each of which had the usual form of elastic curve, now heated instead of cooling on compression, and now had a value of Poisson's ratio nearly one-half of what it was previously. The behaviour of these abnormal substances was thus shown not to conflict at any point with that called for by the electrostatic theory of cohesion.

THE MEASUREMENT OF CABLE CAPACITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have perused with interest the abstract of Dr. Fleming's book on "The Measurement of Cable Capacity," published in your issue of September 11th. The attention of your readers being directed to the question of cable capacities, I would esteem it a favour to be allowed to deal with those points contained in an article by me in the *Elektrotechnische Zeitschrift* of January 15th, but not alluded to by Dr. Fleming.

1. Maxwell has given the following formula for the charge on a conductor, 1, in the presence of other conductors, 2, 3, 4 . . .

$$q_1 = k_{11}v_1 + k_{12}v_2 + k_{13}v_3 \ldots \quad (a)$$

wherein $v_1 v_2 v_3 \ldots$ denote the potentials of the conductors 1, 2, 3 . . . respectively. Looking at the problem from another point of view, and keeping in mind the fact that any two metal surfaces form the two sides of a condenser, we may argue that conductor 1 forms one side of the condensers 12, 13, 14 . . .; therefore

$$q_1 = (c_{10} + c_{12} + c_{13} + \ldots)v_1 - c_{12}v_2 - c_{13}v_3, \quad (b)$$

wherein c_{10} signifies the mutual capacity formed by the lead armour and the conductor in question. The case in which the conductor is partially surrounded by another has been investigated by Maxwell (§91) and expressed in the following equation:

$$k_{11} = c_{10} + c_{12} + c_{13} \ldots = -k_{12} - k_{13} \ldots$$

But, apparently, he has not found it inconvenient to retain in an apparently homogeneous expression different terms, such as k_{11}, relating to the combined influences of many conductors, and k_{12}, k_{13}, concerning the mutual influence of any two conductors. My proposal is to retain c_{10} and to give it the significance of the capacity in regard to the infinitely distant

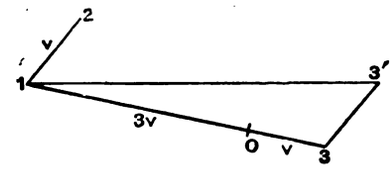

FIG. 2.

surroundings in the general case of a conductor which is surrounded but not completely enclosed by others. Equation *b* then appears in the form:

$$q = c_{10}(v_1 - v_0) + c_{12}(v_1 - v_2) \quad (c)$$

For definitely bounded bodies the potential becomes zero ($v_0 = \lim A/r$, when $r = \infty$), and a partial charge $c_{10}v_1$ in regard to the surroundings remains. With infinitely long conductors the surroundings have to be considered as a conductor in any case, because $\log \frac{A}{r}$ does not vanish at the limit $r = \infty$. To recapitulate, in brief, my proposal is to drop the old notion of capacity as being thought of chiefly in connection with the one coating of the condenser and to substitute the idea that capacity is determined by the total of combinations of the mutual influences existing between any and every two conductor surfaces.

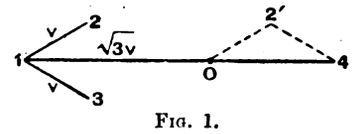

FIG. 1.

2. In his publication, Dr. Fleming indicates the method for determining the apparent charge of a conductor when the mutual capacities are given, and shows that the apparent capacity of a conductor varies with the way in which the others are connected up to the battery. It may be of interest to remark here that, with polyphase currents, conductors may have a charging current, but no definite capacity. The problem comes to this: Can the equation $q_1 = c_{10}(v_1 - v_0) + c_{12}(v_1 - v_2) \ldots$ ever become $q_1 = cv$?

Your readers may, as I have done in the publication cited above, investigate the conditions of a three-phase cable, one conductor of which is earthed, for instance, $v_3 = v_0 = 0$, and they will find that, although the calculation will show a current, no real capacity will be found. If, for instance, in a three-phase cable the capacity between lead and conductor be = 3 and between conductor and conductor = 1, the charging current will be, in the condenser formed by the conductor and the lead, $= \sqrt{3}v$, and in the condenser formed by one conductor and the other = 1*v*. Graphically, the relations may be represented as in Fig. 1. By adding 1 2, 1 3, 1 0, the charging current 1 4 is obtained, this being in phase with the charge of the conductor-lead condenser 1 0. An apparent total capacity in regard to earth is obtained equal to $c = c_{10} + 3c_{12}$, c_{12} being $= c_{13}$. If we now earth conductor 3, we have to rotate angle 2 1 3 in our diagram

* "Molecular Physics," Frank. Inst., September, 1896; *Science*, July 22, 1892, and March 3, 1893.

† *Science*, May, 1898.

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until 1 3 coincides with the direction of 1 0. By adding the vectors, we get 1 3′ as charge of the cable (Fig. 2). The phase of the charge coincides no longer with any of the potentials in the triangle, and we cannot now speak of a capacity, because the phase alters with the diameter of the conductor, &c. We have, therefore, mutual capacities, and may calculate the current, but cannot speak of any capacity, having a physical significance, in connection with the charging current.—Yours, &c., Dr. HUBERT KATH.

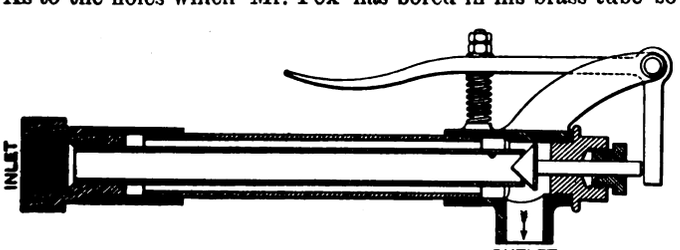
Charlottenburg, Oct. 15.

A NEW STEAM TRAP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the letter appearing in yours of October 23rd over the signature "Transposed," in which it is pointed out that the trap described in yours of October 9th would be working under unstable conditions, and with reference to the reply made through you by the inventor, I have waited before addressing you on the subject, expecting that "Transposed" would have expressed his dissatisfaction with the reply in your next issue. As he has not done so, I venture to suggest that it is not correct to say that "Transposed" is wrong in his idea. The valve of the new steam trap is at the inlet, and consequently the expansion of the parts which closes the valve cannot be actuated until steam has actually passed the valve. The object of a steam trap is to let out the water and to stop the emission of live steam. When there is no water to let out—as may often happen, more especially where superheated steam is used—such a steam trap will discharge live steam. This is a defect which applies not only to the new steam trap, but to other forms of expansion traps where the valve is placed at the inlet.

It may interest your readers to compare the design of this new steam trap—which I see is patented Mr. W. Fox—with that described in my unamended patent No. 21,571 of 1894, of which I enclose a sketch herewith. So far as I can see, the only difference between the two traps is that Mr. Fox places his valve at the inlet, whereas in the trap described in my patent the valve is placed at the outlet, which is the proper place. As to the holes which Mr. Fox has bored in his brass tube so



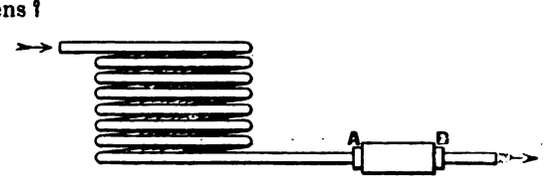
as to allow the steam to play on the iron tube, it would appear that, inasmuch as such expansion as does take place in the iron tube is detrimental, the holes would be better left out.

Being an inventor of steam traps myself, I should not have addressed you on the subject had it not been that I wished to correct the impression which might be left with your readers by your reply to "Transposed."—Yours, &c.

London, Nov. 2. W. GEIPEL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In most steam traps the outlet of the heating system (coils, &c.) is closed at the intake end of the trap. What happens?



The trap does not hold (contain) the live steam until the normal condensation of practical working takes place. The condensation of the entrapped steam has nothing to do with the working of the outlet; the working depends entirely upon the cooling of parts which are in no way controlled by the entrapped steam. This is uneconomical.

The illustration shows a trap working in the above (absurd) manner:—

1. Trap cold. Valve at A open. This is the only valve. B is always open.
2. Steam from coil passes straight through trap and discharges.
3. This causes valve at A to close.
4. Trap now contains nothing but exhaust steam open to the drain. It cools quickly. It is absolutely independent of the steam entrapped in the coil.
5. Trap opens and then acts as before.

What could be more absurd? The trap operates, *not* in reference to the condensation in the working coil, but simply by the independent loss of heat in the parts of the trap which are heated periodically by the exhaust steam in passing out. Suppose, on the other hand, that the trap so operates as to close at B when the coil is filled with live steam:—

1. Trap cold. Valve at B open. This is the only valve. A is always open.
2. Steam from coil passes straight through trap and discharges.
3. B closes, entrapping the live steam to which trap is exposed and by which it is controlled.
4. As soon as condensation of the *working steam* takes place, *but not before*, the valve at B opens and discharge takes place.

What could be more rational?—Yours, &c., CHINTZ.

London, Oct. 28.

THE QUESTION OF THE HOUR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As your correspondent "G. R. N.," in endeavouring to refute my argument, confines himself to my example of submarine cable enterprise, I hope you will grant me the privilege of replying to him. Apart from his protectionist leanings, he is labouring under a misconception as to the landing rights in British Possessions. It is quite true that most of the landing places for cables on the route eastward are British, but British companies have never enjoyed any rights to the exclusion of foreign companies. The right of landing is free to all who are prepared to conform with the requirements of the local authorities. Apart from the eastern route, in the line of communication—viz., transmitting stations—to South America, there are no British Possessions, yet the entire communication to and the network of cables on the east and west coast of that continent have been established by British-made cables.

Passing over his lengthy intermediate remarks, "G. R. N." asks, "If it had been possible for them (our colonies and foreign countries) to levy a 25 per cent. duty on cables (shore ends), would our position be what it is?" Certainly it would, because the rates charged for cable messages would have been correspondingly increased at, of course, the expense of the tariff imposers. Further on he states that "Forty years ago capital for the cable network could not have been raised abroad." Neither could it have been raised here. As soon as public confidence had been established capital for cable enterprise was easily obtainable, both in Great Britain, Europe and America, though cables had to be made in the only country that enjoyed the advantages of free imports.

"G. R. N." then goes on to say that "now our trade rivals both can (make) and do lay long cables, thanks to their accumulated capital due to profits on exports to our free markets." He is probably not aware that the two European countries that have lately entered into the cable making and laying enterprise have done so, not in consequence of any imaginary profits made from exports to our free markets, but in consequence of promoters of such cables receiving from their respective Governments very considerable subsidies.—Yours, &c.,

London, S.E., Nov. 3. H. C. D.

THE INVENTION OF THE DYNAMO-ELECTRIC MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Our client, Dr. Henry Wilde, F.R.S., has seen us with reference to a letter which appeared in your issue of the 30th ultimo under the heading, "The Invention of 'Dynamo,'" over the signature of Prof. Silvanus P. Thompson.

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Our client considers that this letter is misleading and, in some respects, inaccurate, and he instructs us to call your attention to the following facts:—

1. Dr. Wilde has never designated as magneto-electric machines the dynamo-electric machines described in the specifications of his several patents either in those specifications or in any scientific publication with which his name is associated. We have before us the two specifications referred to in Prof. Thompson's letter, and also Dr. Wilde's Paper in the *Philosophical Transactions* of the Royal Society, and observe that the distinction between magneto-electric machines and electro-magnetic (dynamo) machines is always sharply drawn.

2. The allegation that Dr. Wilde furnished to Prof. Thompson in the first instance a statement that the name dynamo-electric machine was first applied in 1867 by Charles Brooke, F.R.S., to the machine of Dr. Wilde's invention is contrary to the fact.

As between our client and Prof. Thompson, the subject was first opened (as Prof. Thompson states) on April 12, 1902, when he sent to our client a piece of his proof. This was the first communication upon the subject, and in that proof, a copy of which we have before us, appeared the following sentence:—

"This (referring to Dr. Wilde's machine) was the first machine to which the name dynamo-electric machine (as distinguished from magneto-electric) was given, the first occurrence of the word in the English language being in a Paper communicated in March, 1867, to the Royal Society by Mr. Charles Brooke."

As further evidence in regard to the point with which we are now dealing, we may say that we have before us a copy of Prof. Thompson's "Elementary Lessons in Electricity and Magnetism," which is dated 1901, and which had been before the public at the very least nearly 12 months before the correspondence with Dr. Wilde commenced. The following is an extract from this book:—"The name of dynamo-electric machines is given (it was first applied in 1867 to Wilde's machine) to such generators to distinguish them from those in which permanent steel magnets are employed."

There are other points in the letter, to which we should have wished to draw your attention, which, having regard to the facts of the case, tend to mislead the reader. The two above mentioned are, however, the most important, and we shall be glad if you will, by inserting this letter, give us an opportunity of explaining the position.—Yours, &c.,

SLATER, HEELIS, WILLIAMSON & Co.

Manchester, Nov. 3.

NEW ELECTRIC LIGHT FITTINGS.

Mr. A. P. Lundberg has sent us for inspection some specimens of electric light fittings of his newest design. A neat pattern of switch, designed to prevent unauthorised persons removing the cover and tampering with the working parts, is illustrated in Fig. 1, and all mechanical details may be gathered therefrom. Schools, asylums, workhouses, hospitals, &c., offer a wide field of application for such a design. This pattern, as well as other standard ones, may be supplied also with a removable handle, and when both preventative measures are applied the switch would seem to fulfil all the desired conditions. A substantially made switch for flush work also possesses considerable merit. Its mechanism is mounted on a porcelain base which is secured to the bottom of an asbestos-lined brass box. Fig. 2 is an illustration of a double-pole switch, and Fig. 3 gives a sectional view of a very neat door contact. As will be gathered from the illustration, the points of contact are kept bright by the rubbing action of the plungers, and the break is double and long. At first sight this compact little switch might be mistaken for a bell push, and no doubt it would answer admirably for this purpose. The price list, which accompanied the samples, contains a description of many more accessories of a similar nature. All articles are of British manufacture, are of substantial design, and show excellent workmanship and finish.

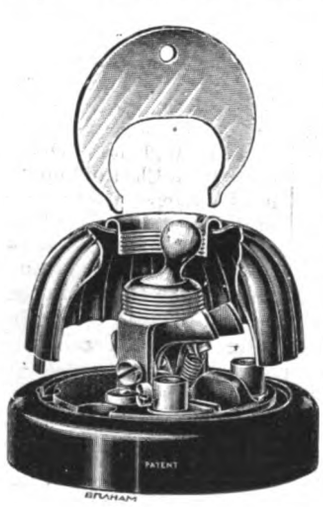


FIG. 1.

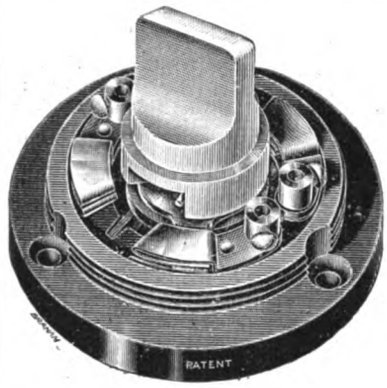


FIG. 2.

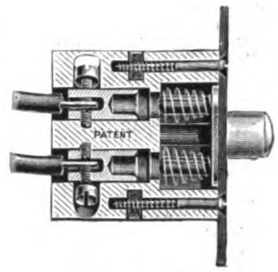
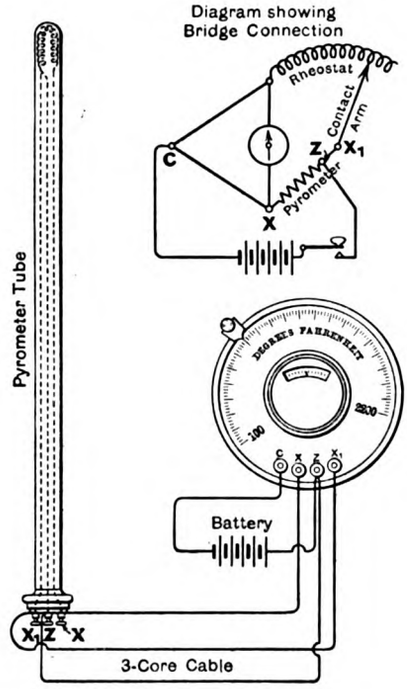


FIG. 3.

ELECTRICAL PYROMETERS.

A pyrometer, manufactured by Messrs. Siemens Bros. & Co, consists of a coil of platinum wire wound upon a cylinder of refractory material and fixed, usually, at the end of a long closed iron tube, where it is protected by a platinum shield. For measuring the resistance of the coil in order to ascertain its temperature, two types of apparatus are used. One, comprising a differential galvanometer and a set of resistance coils, gives readings in ohms, and the temperatures corresponding thereto are ascertained by means of special tables. The other is a combination of a small d'Arsonval galvanometer and a Wheatstone bridge with a circular resistance and sliding contact, and it gives readings directly in thermometric degrees. It is claimed that both types give very accurate readings. Their principal field of application lies with iron, steel, and similar processes, the temperature of which has to be constantly observed and regulated. From the tables appended to a pamphlet issued by Messrs. Siemens Bros. it follows that an increase in the coil resistance of an instrument of type No. 1 from 10 ohms to 44·9 ohms corresponds to a rise in temperature from 58°F. to 2,204°F. In the illustration the diagram of connections of an instrument of the second type is given, and it needs no further explanation.



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LEGAL INTELLIGENCE.

Rating of Electric Tramways.

The continued increase in the rates made by local authorities is a burden which has for some time pressed heavily on all industrial concerns, and especially upon electric tramway and lighting undertakings. In the majority of cases, however, no definite action has been taken against assessment committees. It is satisfactory, therefore, to chronicle a successful protest against the excessive rating of an electric tramway undertaking. This is the first decision of its kind to be given in England.

We refer to the case of the Middleton Electric Traction Co. (Ltd.) versus the Assessment Committee of the Oldham Union, heard on Oct. 29 at Salford Quarter Sessions, before Mr. H. Worsley Taylor, K.C., M.P. The experts retained by the company were Mr. P. M. Faraday, Mr. W. H. Elwell (consulting surveyor to the Great Northern Railway), Mr. W. P. Ryan, Mr. W. M. Rumball and Mr. J. J. Walklate; and for the Oldham Union Mr. Atherton (Bolton), Mr. James Clegg (Oldham) and Mr. Turner (Ashton-under-Lyne). The assessment appealed against was one of £2,500 gross and £2,000 net on 5¼ miles of line owned and worked by the company in the parish of Middleton. Counsel for Oldham Union explained the principle on which the rate had been made. The company (he said) owned about 8½ miles of tramways, of which 5¼ miles were in the parish of Middleton. In view of the fact that the undertaking was a new one, having been first opened for public traffic in March, 1902, the Assessment committee contended that they could not adopt the usual practice which prevailed with regard to the long-established tramway and railway undertakings—namely, taking the gross receipts and expenses as a basis on which to estimate the rateable value. A tramway business necessarily took considerable time to develop to its fullest extent. The returns for the first year's working, therefore, provided no criterion as to what a "hypothetical tenant" would pay for the rent of the line. The committee in arriving at their figures had estimated the structural value of the line, and had taken a percentage of about 3½ per cent. on this sum, which worked out at about £350 per mile. The total original assessment was £2,925 gross and £2,340 net, which had been objected to by the company, whose representative had previously met the Assessment committee, with the result that the figure had been reduced to £2,500 gross and £2,000 net, and it was this amount which was now being appealed against by the company. Counsel then quoted the rental paid for a portion of line which had been leased by Middleton Corporation to Manchester Corporation, and in the case of the Croydon Corporation tramways which had been leased to the British Electric Traction Co. (Ltd.). The only basis to take for arriving at the rateable value of the undertaking was to adopt the contractor's method of assessment and take a percentage on the capital outlay.

The CHAIRMAN considered that comparisons with other undertakings were of little importance in estimating what rental a "hypothetical tenant" would pay in the case of the Middleton lines, as, doubtless, the circumstances of the various cases were entirely different.

Counsel for the appellants, on the other hand, contended that the method of assessment which had been adopted by the committee was unreasonable and without precedent. In arriving at the rate which a tenant would be prepared to pay for the undertaking, the first thing to be calculated was what would be the probable amount of income to be obtained from working the line. The basis of assessment would, therefore, be that of gross receipts and expenses without reference to capital outlay. He submitted that on this basis the sum available as rateable value was in this case a minus quantity. (A valuation was submitted to the Court made by the rating experts retained by the company which bore out this statement.) As the committee had declined to examine the books of the company, they were not in a position to dispute any of the figures in the valuation. By this it was shown that the gross receipts for the year ended March 27, 1903, were £14,431 and the expenses £10,381, leaving net receipts £4,049. From this figure the usual deductions had been made for the rating of the depot, for 17½ per cent. on tenant's capital, for maintenance and renewal of overhead equipment and permanent way, and for insurance, with the result that the sum available for rating was found to be nil. Counsel, therefore, asked that the course generally adopted in such a case should be followed, and the line assessed at a nominal amount only.

The CHAIRMAN asked what were the future prospects of the undertaking. It had been shown that the net receipts had increased during the six months ended September, 1903, compared with the corresponding period of 1902, but not to such an extent as to make it probable that there would be any sum available for rating purposes for some time.

On the suggestion of the chairman, a consultation was then held between the parties, and it was ultimately agreed that the assessment should be reduced from £2,500 gross and £2,000 net to £1,000 gross and £550 net, the committee to pay the cost incurred by the company.

Greenhouse v. South Lancashire Electric Traction and Power Co.

In the Chancery of Lancashire, at Manchester, on Wednesday, plaintiff, on behalf of himself and other holders of first mortgage debenture stock of the defendant company, sought to restrain the company from giving effect to resolutions passed at an extraordinary meeting of debenture-holders on 7th ult., which sanctioned the issue of debentures in priority to those held by plaintiffs. Mr. Grant now moved, on behalf of the plaintiffs, to restrain defendants from holding a second meeting of debenture-holders, pending the trial of the action on Monday week.

The VICE-CHANCELLOR (Sir C. Hall, K.C.) said he did not think the step was a breach of the undertaking given by defendants and he ordered the motion to stand over till the trial.

Speed of Electric Tramcars.

Four drivers of the London Tramways (Ltd.) appeared last week at the West London Police Court to answer summonses taken out by Mr. Moffat Ford for driving their cars at a speed exceeding the regulation 10 miles an hour. For the company it was alleged that none of the cars timed by Mr. Ford could go at a greater speed than 13 miles an hour, and an independent test by the Board of Trade was suggested. An adjournment was ordered for that purpose.

Col. M. H. PURCELL, R.E., who was nominated by the Board to make the tests, said that the highest speed was 14·5 miles an hour.

Mr. J. CLIFTON ROBINSON, managing director of the company, said he gave instructions that the test was to take place under normal conditions.

Two other officials said the speed tests took place under normal conditions.

Mr. FORD called Col. CROMPTON, who said he had tested the cars on other occasions, and they had exceeded the speed given. There was no need of an instrument for testing the speed of the cars.

Mr. SYDNEY EVERSHED said that after he passed Young's Corner, a point on the route of the tramways, on the day the tests were made the voltage was abnormally low, and the next day he communicated with Mr. Ford, whom he had not previously known. He judged by the speed and the lights.

A further adjournment was ordered to to-morrow (Saturday).

Orner v. National Telephone Co.

At the Shoreditch (London) County Court on Friday last a labourer named Orner, in the employ of the National Telephone Co., was awarded £202 (three years' wages) for injuries sustained by a fall from a pole. Stay of execution was granted.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Rotherham Education committee invite applications for the position of lecturer in engineering (including geometry and mathematics) in the Technical Institute. Salary £120. Particulars from the director of Higher Education (Mr. C. H. Burkhardt, M.Sc.), Town Hall, Rotherham, to whom applications by Nov. 10. See advertisement.

A manager is wanted for the development and extension of a leading electric power supply company's business. See also advertisement.

An improver is wanted to assist in the testing department of the Stepney (London) Borough Council. Applications to engineer and manager, 27, Osborn-street, Whitechapel, E. See advertisement.

Salford Education committee invite applications for the position of principal of the Salford Royal Technical Institute. Commencing salary £450 per annum. Applications by Nov. 25.

Mr. H. England, who has been for 2½ years general manager of the Sunderland Corporation tramways, has been appointed general manager of the Yorkshire Tramways Construction Syndicate, which proposes to establish an extensive system of electric tramways in the Leeds, Wakefield and West Riding districts. Mr. England's engagement is to be for five years at a commencing salary of £700, rising to £900 per annum.

Mr. G. W. Briggs, who has been superintendent of the Newcastle-upon-Tyne Electric Supply Co.'s Pandon Dene station since 1889, has been appointed resident engineer of the company's power station at Neptune-road.

Mr. G. T. Pardoe has been appointed electrical clerk of works at Frome at £180 per annum.

Mr. R. E. Shawcross, A.M.Inst.C.E., has been appointed demonstrator in electrical engineering at King's College, London.

Mr. A W. Annetts has been appointed chief assistant electrical engineer at Morecambe.

Acton.—A special meeting of the Council was held last week to further discuss the proposed electricity supply and dust destructor scheme—

The CHAIRMAN (Mr. A. W. W. King, J.P.) said the Council obtained their electric lighting order 12 years ago, and action must be taken by next month or the order would be revoked.

Mr. JARRATT moved (*a*) That the dust destructor be built on land already purchased in Southfield-road; (*b*) that the steam produced be used at the sewage works and for clinker crushing and slab making; (*c*) that the electricity station be erected at the "Friars," and that gas-driven plant be employed.

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Mr. ATHAWES moved that steam engines be employed, and this was arried by a majority of one and confirmed as a substantive motion.

Mr. ATHAWES afterwards moved that the question of the dust destructor be referred to Mr. W. H. Trentham for report, and this was also carried.

Altrincham.—The District Council decided on Friday to apply for a provisional order to construct tramways in the district. The chairman (Mr. J. T. Hughes) stated that no agreement had been come to with Manchester Corporation for the working of the lines within the Altrincham district.

Asylum Lighting.—Cumberland County Council have decided to put down electric lighting plant at Garlands Asylum at an estimated cost of £8,000.

Bangkok (Siam) —The submarine telegraph cable belonging to the Siamese Government, and designed to afford communication between Bangkok and the outer anchorage at Ko-si-chang, was broken in 1899, and not till about the middle of April, 1903, was communication again restored for a short time, and a few messages passed through the cable; but by the end of that month communication ceased and has not yet been renewed. The cable should form an important commercial link between the anchorage and the mainland.

The value of electrical goods imported into Bangkok in 1902 was £8,806, compared with £14,804 in 1901. Of these goods, one-third came from the United Kingdom and Singapore and one-third from Germany.

Barnstaple.—The Corporation have deferred till the end of the year consideration of supplying current at reduced rates to large consumers.

Beckenham.—The Council have decided to accept proposals for the wiring of new buildings on condition that builders indemnify the Council for the outlay until the houses are let. The amount of the indemnity will be settled by the officers, who were also deputed to consider the question of the supply of current for tramways, and to communicate with the British Insulated and Helsby Cables (Ltd.) on the subject.

Bedford.—The charge for electric current for power has been reduced from 2d. to 1½d. per unit.

Bromsgrove.—The Shropshire and Worcestershire Electric Power Co. propose to apply for a provisional electric lighting order.

Caerphilly.—The members of the District Council are undecided as to whether a provisional electric lighting order should be applied for or not. On Tuesday a resolution to defer the application for 12 months, in accordance with the recommendation of the consulting engineer (Mr. A. H. Preece), was defeated by the casting vote of the chairman. It has been decided to make a canvass of the district, and if offers to take current for the equivalent of 1,000 c.p. lamps are obtained, application is to be made for an order next session.

Cheshunt.—The Council have transferred their electric lighting order to the North Metropolitan Electrical Power Distribution Co., the latter repaying the cost of obtaining the order and undertaking to supply current for public lighting at an average of 2½d. per unit, and for private lighting at 4½d.

Cleckheaton.—The District Council have ordered a detailed statement to be prepared of the capital expenditure to date on the electricity works, in order to determine what further borrowing powers, if any, are necessary for the extension of the undertaking to meet probable demands for electric traction.

Cocos-Keeling Islands.—In the Governor's report for the year to September, 1903, just published, it is stated that, after considerable trouble with imported labourers, the Eastern Extension Telegraph Co. have now got their offices, quarters and stores completed. The cables to Perth (Australia) and Rodriguez are as fine examples of the submarine cables manufacturer's craft as exist, and in spite of their length a speed of 120 letters per minute can be maintained on either cable without risk of error from indistinct signals.

There is reason to believe that the Cocos-Keeling Islands will shortly become an important signalling station for vessels steaming between Colombo (Ceylon) and Fremantle (Australia). The islands lie directly in the track of these vessels. It is probable that if the steamship companies concerned desired that their vessels should be afforded facilities for communicating, by means of wireless telegraphy, with the Eastern Extension Company's office, the company would be willing to establish on Direction Island a wireless station on the Lodge-Muirhead system.

Customs Dues.—A duty of 10 per cent. ad. val. has been fixed upon imported electric blasting apparatus and exploders for tree-stump clearing into New Zealand, these articles being classified as electrical machinery and appliances.

Dalton-in-Furness.—The District Council have requested the British Electric Traction Co. to extend their electric tramway system from Barrow to Dalton, about 2 miles.

Derby.—Messrs. J. G. White & Co. are making preparations for commencing next week the construction of the permanent way of the Corporation's electric tramways. The first lines to be laid are those which will not be affected by the main drainage scheme, and which comprise about 6 miles of route.

Devonport.—Electric tramway extensions were opened for traffic on Saturday.

Dorchester.—The Corporation recently decided to erect electricity works and to give a supply of electric current in the compulsory area.

At a public meeting held last week, the chairman of the Electric Lighting committee (Ald. H. Duke), moved that it would be best for the Corporation to lease their electricity undertaking to a company, which has offered to take over the order, pay interest and sinking fund charges, and supply electricity at lower prices than the Corporation could charge without showing a loss on working—viz., 5d. and 3d. per unit for private and public lighting respectively and 2d. for power.

Dr. KERR opposed, alleging that the opposition to the proposed municipal management was a gas company's agitation.

Mr. H. J. BLAKEWAY, chairman of Southampton Electricity committee, who had been invited to address the meeting, supported Ald. Duke's proposal, with the amendment that the company should be required to provide for depreciation.

The motion was then carried by a large majority.

Dumfries.—At a meeting of ratepayers last week, a resolution was passed in favour of selling the Council's electric lighting order to a company.

Electric Lighting at Portrane Asylum —In our description of the interesting installation for electric light and power at Portrane Asylum in last week's issue of *The Electrician* (p. 49) by an oversight the list of sub-contractors was omitted. These were as follow:—

Messrs. Mavor and Coulson; Sayers-wound generators, booster and switchboard.

D.P. Battery Co.: Storage battery.

Messrs. Crompton & Co. and the Electrical Co.: Motors.

Messrs. Crompton & Co.: Arc lamps.

Electricity in Gunpowder Mills.—The Chilworth Gunpowder Co. has placed with the British Schuckert Electric Co. a contract for the complete electric lighting and driving of their mills at Chilworth, Surrey. The estate covers an area of 40 acres, and the 18 buildings as well as the roads are to be lighted by means of 142 32 c.p. incandescent and four outside arc lamps. The buildings in which explosives are manufactured or stored will be lighted by outside lanterns provided with special reflectors. Eight shunt motors (two each having an output of 25 B.H.P., two of 3¼ B.H.P. and four of 1¼ B.H.P.) are to be employed in the manufacturing processes, and five ventilating fans will be supplied for expelling explosive gases. The generating plant consists of two belt-driven machines (one 75kw. and one 30kw.) both generating current at 220 volts. The switchboard is so arranged that either generator may supply the lighting circuits or motor circuits separately, or, if desired, the two generators may be run in parallel and supply the total combined load conjointly.

Employment for Reserve and Discharged Soldiers.—Lieut.-Gen. F. Green-Wilkinson, chairman of the National Association for the Employment of Reserve and Discharged Soldiers, 119, Victoria-street, London, S.W., makes an urgent appeal on behalf of a large number of men who came forward at duty's call during the recent war in South Africa and are now out of employment. Gen. Green-Wilkinson points out that for 18 months past employers of labour in this country have been patriotic and generous in offering situations in civil life to ex-soldiers, and this kindly feeling has led to the employment of a very large number of men during the past 18 months through the head office and its 96 branches here and in South Africa, but of late the applications for men have fallen off owing to various reasons, hence the need for Gen. Green-Wilkinson's special appeal at the present time.

Exeter.—The new electricity works are approaching completion, and the contractors for the plant (the British Westinghouse Company) have agreed with the Council to give a supply of electric energy from the works in aid of the principal supply from the existing works for such hours as may be required by the City electrical engineer (Mr. Munro) between 3 p.m. and 10 a.m. daily (Sundays excepted) from Nov. 1 to March 25 next, on condition that the Corporation supply oil, coal, water, &c., and the contractors supply all supervision and labour, the Corporation paying the contractors all out-of-pocket expenses in carrying out the agreement, and in addition 10 per cent. upon such expenses.

Exhibition —Under the auspices of the Belgian Government an International Exhibition of Arts and Manufactures will be held at Liège from May to October, 1905. Extensive preparations are being made to ensure the success of the show, which will be on a large scale.

Factory Act Prosecution.—At Loughborough Petty Sessions, on Wednesday, the Brush Electrical Engineering Co. were summoned for not protecting certain machinery at their Falcon Works.

Mr. GEO. SEDGWICK, Inspector of Factories, said that sec. 10 of the 1901 Act provided that all dangerous parts of machinery should be fenced in, so as to be safe to persons working in the factory, and by

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sec. 156 the term "machinery" included driving straps. In the motor shop at Falcon Works there was a driving strap connected with a notching machine, running vertically from a pulley and shafting under the floor to overhead shafting. The band was 5in. wide, and there was a space of 21in. between it. On Sept. 16 a boy 14 years of age was working near that machine, when for some reason he left the place where he was working, and went close to the belting. In the act of doing so, it was supposed, the boards forming the floor gave way, and he fell into the pit below, and was so severely injured that he died. Since the accident the belt had been securely fenced in.

For the company, Mr. CLIFFORD said they greatly regretted the accident. There was practically no defence, but he would point out that it could hardly have been expected that anyone would have been so foolish as to go through the belt as the boy was supposed to have attempted to do. The company had acted fairly towards the relatives, and had paid such compensation, whether they were liable or not, as to satisfy them.

A fine of £2, including costs, was imposed, the chairman stating that the bench took into consideration the liberal way the company had behaved in the matter.

Fiji.—Telegraphic communication is being established between Suva and Levuka, a line being in course of construction between these two points. The route is from Suva overland to Namena (22 miles), thence to Bureta, on the island of Ovalau, by cable (11½ miles), thence overhead to Levuka (13 miles).

Telephonic communication has been established between Suva and Lautoka (125 miles), via Nausori and Ba.

Fremantle (W.A.)—A recent poll of ratepayers on electric lighting and tramway matters resulted in a small majority for the proposed municipal scheme.

German-American Electrical Interests.—It is stated that arrangements were made by Herr Rathenau, during his recent visit to the United States, which are calculated to bring into closer working arrangement the German companies of which Herr Rathenau is a director and the General Electric Co. of the United States.

Gloucester.—Sanction has been received to a further loan of £24,673 for extensions of the electricity undertaking.

Hampton Wick.—The District Council have decided to get a report from an electrical engineer as to the terms offered by Twickenham and Teddington Electric Supply Co. for obtaining a provisional order and for electricity supply in the district.

Hexham.—Mr. E. P. Harvey proposes to apply for a provisional order to supply electricity in Hexham and adjoining district.

Kingswood (Bristol).—By seven votes to six the Council have decided to apply for a provisional electric lighting order.

Lagos.—The principal districts of Lagos are now in telegraphic communication with the centre of government. Proposals have been approved by the Colonial Office for the establishment of telegraphic communication with Forcados and Lagos. Steady progress is being made in the development of electric lighting in Lagos. In 1897 the first installation was made; the generating plant consisted of Davey-Paxman engines and boilers and E.C.C. alternators. In 1901 a third unit of plant was added, and a fourth unit is about to be ordered to meet the demand for private lighting and power supply. Detartariser plant has been installed at the station with Korting ejector condensers. Two types of cable are used, rubber-insulated lead-covered in conduits and paper-insulated lead-covered double steel armoured direct in ground. Thirteen transformer chambers have been erected. The whole of the work has been carried out under the supervision of the electrical department of the Lagos Government. The public buildings using the electric light include Government house, the hospital and the principal residences, churches and public halls. Forty-eight buildings in all are using about 1,000 16 c.p. lamps, and about 200 further lights are on order. The unsatisfactory character of the kerosine oil lamps in general use is causing a large demand for electric lighting, and electric fans are also being introduced in this fast-developing colony.

A telephone exchange is established and has already 50 subscribers. Owing to the heavy winds which prevail at Lagos it has been decided to put all telephone wires underground as soon as the dry season sets in.

On the Lagos railway an expenditure of £3,000 has been sanctioned to substitute the electric staff system of train signalling in place of the methods now adopted. Tramway development has not got beyond steam trams, but the increasing popularity of the tramway service will doubtless speedily result in their conversion to electric traction.

Leipzig.—The municipal authorities have recently ordered that electric tramcars shall not run at a higher rate of speed than 9 miles per hour in the business sections of the city, or, if provided with trailers, 7·2 miles per hour. In the residential sections speed is limited to 10·8 miles, or with trailers, 9 miles per hour. In the outlying districts cars can run at 15 miles, or, if with trailers, 12 miles per hour. The penalties are fines up to £3 or 14 days' imprisonment, or both. The running of motor vehicles in the principal thoroughfares of the inner city has been prohibited; in other portions their running is limited to the streets traversed by the electric tramways.

Leith.—In view of the extensions of the electricity works to meet the requirements of the projected municipal electric tramways, ground adjoining the existing station has been purchased by the Town Council at £7,500.

Levis (Quebec).—The electricity works of the Canadian Electric Lighting Co. at Levis commenced a supply of current in April, 1901, and has now connected the equivalent of 12,000 lamps supplying a population of 2.000. In addition 1,000 H.P. of current is supplied to the Quebec Railway, Light and Power Co. and 400 H.P. to the Levis County Railway Co. The total plant capacity of the station is 3,000kw. There are 800 consumers on the company's books.

In this district there is available an estimated water-power of 5,000 H.P. from a watershed 1,900 sq. miles in extent. The flow of water is estimated at 35.000 cubic ft. per minute, with a 110ft. head. No water-power works are yet established.

Light Railways.—On Friday, Sir H. Jekyll heard an appeal from an order of the Light Railway Commissioners, who have granted the Hertfordshire County Council running powers for the Barnet and Bushey Light Railway over the proposed lines of the Watford and District Tramways Co.

Mr. HUTCHINSON, for the latter company, objected to the running powers; but, if they were granted, he asked for reciprocal running powers for the company.

Mr. DANCKWERTS, K.C., for the Hertford County Council, said his clients wished to get the people from the crowded districts into the country, and the Watford and District Tramways Co., whose powers expired in another year, merely wanted running powers, which the Commissioners had refused, to enhance the value of its undertaking, in order to sell it.

Decision was reserved.

Preliminary surveys are being made for light electric railways between Portmadoc and Corwen, via Gwynant Pass and Bettwsycoed.

The Southend and Colchester Light Railways Order has been submitted to the Board of Trade for confirmation. Objections by Nov. 21.

Lincoln.—The City Council are applying for a further loan of £11,500 for extensions of the electricity works. Expenditure to date is £46,400.

Col. Sir Colin Scott-Moncrieff, R.E., K.C.M.G., has been appointed referee to fix the purchase price to be paid by the Corporation for the local tramway system.

London County Council.—At Tuesday's meeting the acquisition of property at Wandsworth, at a cost of £5,500, for a new car shed for the tramways was approved. The Highways committee recommended and it was agreed

That the resolution of Oct. 14, 1902, with regard to the arrangement to be entered into with the London Electric Supply Corporation for the supply of steam power by the company for the working of the Council's tramways, be varied so as to provide for the payment by the Council to the company in respect of supply of steam, running of mechanical plant, carrying out necessary repairs, cost of maintenance and supply of stores, &c., at a rate not exceeding 1·65d. per unit of electricity generated.

Engine Contracts.—A discussion arose upon the recommendation of the Highways commitee that the tender of Messrs. John Musgrave & Sons for the supply of steam engines to the Greenwich generating station should be accepted. (The full list of tenders is set out in another column.) 16 tenders had been received. Of these nine offers were from English, four from Scotch, two from German and one from Danish firms, the lowest tender of all being from Messrs. Cole, Marchent and Morley (£84,921. 10s., or 12 per cent. below Musgrave's offer). A keen discussion arose around the award of the contract to Messrs. Musgrave. The report of the Council's electrical engineer (Mr. J. H. Rider) had been considered by the committee, who appended to their recommendation in favour of Messrs. Musgrave's tender the following remarks:—

Certain details of construction of the engines were left to the tenderers to decide, and we have, therefore, in considering the matter, borne in mind the relative advantages of the various proposals submitted by the firms who have tendered, having regard to the Council's requirements. Moreover, in view of the vital importance of the engines to the success of the tramways undertaking, we have also felt compelled to take into account the experience and qualifications of the firms submitting tenders to undertake so large a work, as it involves the largest order for engines which has ever been given by a municipal body. In order that there should be no risk of failure, and that the best possible form of construction should be secured, we are of opinion that the extra expenditure involved by accepting the tender of Messrs. John Musgrave & Sons (Ltd.) is fully justified, as it is essential to the successful completion of the large and costly tramway works which the Council has in hand that the most satisfactory results should be obtained from the engines. Messrs. Musgrave have submitted the names of certain firms to whom they propose to sub-let different portions of the work, and we are advised that no objection need be raised to that course.

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Mr. TORRANCE said the expenditure of the Council on its tramways during the last twelve months had been very heavy, and ratepayers of the metropolis would want some adequate reason why the much lower tender was not accepted.

Mr. D. S. WATERLOW supported the recommendation of the committee, and said there was a vast difference in the machinery which would be supplied to the Council by the successful tenderers. It was most essential that every precaution should be taken against possible disaster later on.

Mr. BENN (chairman of the committee) read the report of Mr. Rider, their responsible officer, on the various firms who had tendered. Messrs. Musgrave had made engines of similar pattern for Glasgow Corporation, for Manchester and for the City of London Electric Lighting Co., and these had proved successful.

The Committee's recommendation was then agreed to.

South London Tramways.—The Highways committee reported upon the question of the Council's acquiring the undertaking of the South London Tramways Co. The length of these tramways is 5¾ miles, and the lines are not remunerative. The report states that to electrify the tramways would require street widenings costing £188,000. The Council would have a further opportunity in seven years to serve notice for purchase, and the committee recommended that no steps be taken to purchase.

Mr. DOLMAN moved that the matter be referred back, and said if the Council did not purchase they would possibly find a private company come along and electrify the lines, and the Council would then have to buy the new company out.

Mr. MCKINNON WOOD said they could not electrify all their lines at once, and they had to pick and choose the best.

Lord WELBY reminded the Council of its capital commitments, and said the tramways would demand at least £2,000,000 for several years.

At the end of a long discussion Mr. Dolman's amendment was carried by 61 votes to 40.

Ludlow.—An inquiry was held here last week into the application of the Council to borrow £8,250 for electric lighting and refuse destructor.

The town clerk (Mr. J. H. Williams) stated that the Board of Trade had refused sanction to a transfer of their electric lighting order, and ultimately it was decided to erect the joint works. The chairman of the Electric Lighting committee (Mr. W. H. Marston) gave evidence in support, and the mayor (Ald. Sheldon) opposed, as he considered the time inopportune for proceeding with the scheme.

Market Lighting.—The lighting cables have been extended from Filey-street to St. James' Market, Bradford, and about 20 stalls are now lighted electrically, while an equal number are being wired.

Municipal Telephony.—At the meeting of the Hull Telephone committee last week it was reported that inter-communication with the National Telephone Co. had been arranged, involving an additional expenditure of £200 on the switchboard tender which had been accepted. A general manager and an assistant are to be appointed.

In reply to certain statements made recently by Ald. Buckwell (Mayor of Brighton), Mr. W. E. L. Gaine, for the National Telephone Co., makes the following rejoinder:—

In reference to some observations relative to the telephone service by the mayor, at a dinner on 29th ult., I wish to say that he is in error. He says that previous to the Corporation starting their telephone undertaking a committee was formed and had an interview with the representatives of the National Telephone Co., and promised them that if they reduced their charges from £10 to £6 a year, they would advise the Council not to compete. As the official representative of the company, I can only say that this is the first I have heard of any such promise. On the other hand, it is but fair to say that even if such a proposal had been made it would not have been accepted, for the reason that the company's experience teaches that unlimited service at £6 per annum cannot be supplied with any hope of avoiding bankruptcy. The mayor further stated that the company is bringing down its rates, and is giving an unlimited service for £5. This also is incorrect. The company's rate for unlimited service remains at what it has been for many years past, but to meet the requirements of all classes of users, even the smallest, the company has introduced a number of tariffs, giving limited service in proportion to the payment.

Swansea Town Council, who are equipping a municipal telephone exchange, have given notice to the National Telephone Co. to remove all telephone poles erected upon Corporation property.

N.W. Territories (Canada)—The town of Yorkton covers an area of 1,000 square miles, and is, as yet, only sparsely populated, although it is filling up very fast. The telephone system of the Yorkton (N.W.) Electric Co. was established in 1896. There is only one exchange, with 200 subscribers—125 in the town and 75 scattered over the country districts. The company's chief object is to supply farmers and growers in the outlying districts with a telephone service. For want of capital the demand for the service is at present beyond the supply powers of the company. As the population increases the demand for extensions of the service becomes more pressing.

Arrangements are in progress for installing the electric light at Yorkton, which has a population of between 1,200 and 1,500 persons.

In a communication to us, Mr. Thomas Paul, manager of the Yorkton Company (an Englishman) points out the difficulty of purchasing his supplies from the old country. He says:—"If I could secure my supplies from home I would do so, but the prices of the goods I require from England are prohibitive. I can purchase these in the United States, pay 25 per cent. duty, and still be 25 per cent. in hand, as well as obtaining goods specially adapted to this country."

Naval Engineers.—The question of responsibility for the efficiency of machinery and mechanical appliances on His Majesty's ships has been under the consideration of the Admiralty, and a scheme has been approved which came into operation this month in the ships of the Channel Fleet. The scheme provides that

The Engineer officer will have charge of and be responsible for all machinery, however driven, in engine rooms and boiler rooms (except efficiency and repairs of dynamos), and all steam, oil and gas-driven machinery, wherever situated. He will also have charge of any hydraulic machinery which is not specifically detailed as being under the care of the gunnery or torpedo lieutenant. He is to be regarded as the mechanical expert of the ship, and, under the captain's direction, may be empowered to inspect any of the mechanical fittings not in his charge, and report to the captain on their efficiency.

The Gunnery Lieutenant will have charge of and be responsible for all guns, gun mountings and machinery in connection with them, including firing gear and night sights, except where the machinery referred to is a steam, oil or gas engine.

The Torpedo Lieutenant will have charge of and be responsible for all torpedoes, torpedo tubes and gear in connection with them outside the point where the engineer's responsibility ends. He will have charge of, and be responsible for, all electrical machinery in the ship not in the care of the engineer or gunnery officer, of all lighting and power circuits and all bell and communication circuits, and is to repair all electrical instruments. The torpedo lieutenant is to be regarded as the electrical expert, and will be held responsible for the electrical efficiency of the ship. Under the captain's directions he may be empowered to inspect any of the electrical fittings and machinery of the ship and report to the captain on their efficiency. The captain will be responsible that the necessary engine-room staff is told off as required to assist the gunnery and torpedo officers in the care of the machinery under their charge.

The engineer's workshop in charge of the engineer officer is to be considered the main workshop for any mechanical repairs that may be necessary throughout the ship, and the engineer officer is to carry out all mechanical repairs, of whatever nature, that cannot be dealt with by the armourers' or torpedo staff. The gunnery and torpedo staffs are not required to carry out large mechanical repairs, and the captain will be responsible that the engineer officer has such repairs done expeditiously by the engineering staff when duly requisitioned. If the gunnery department requires any repairs necessitating the use of the main workshop machines, the gunnery officer is to requisition the engineer staff who will, after consultation with the officer in charge of machinery, direct and carry out the work as necessary.

It is further provided that if any machinery in charge of the engineer or gunnery officer fails electrically, the torpedo staff is to be requisitioned to repair it. Similarly if any electrical machinery outside the engine room develops a mechanical defect which the torpedo staff is unable to repair, the engineering staff is to be requisitioned, and they will direct and carry out the necessary work.

These regulations apply for the present only to ships on which gunnery and torpedo lieutenants are borne.

Newhaven.—The Council have consented to the application of the Southern District Electricity Corporation for a provisional electric lighting order.

Nova Scotia.—The electricity supply undertaking of the Halifax Electric Tramway Co. serves a district with a population of 40,000, and had a total connection at Oct. 15, 1903, equivalent to 62,300 8 c.p. lamps, including 550 H.P. for motors. There were 3,600 consumers. The total capacity of the plant is 2,900kw.

The same company owns 12 miles of electric railway built on 4ft. 6½in. gauge which has been running since 1896. 38 cars are employed on this line, including 32 motor cars and six trailers.

The telephone service of the Nova Scotia Telephone Co. employs 14 exchanges, and on the Halifax exchange alone there are 1,700 subscribers. 100 persons are employed in the service, 40 males and 60 females. The service has been in operation since 1887.

Paisley.—A dispute has arisen between the Town Council and Mr. Wm. Murphy as to the material to be employed in the construction of the permanent way of the electric tramways, and Sheriff Lyall, on the petition of the Council, has granted an interim interdict against proceeding with the works.

Shortly after the work was commenced on Monday last a meeting of the committee was held to consider the quality of the granite setts to be used. It was stated that Mr. Murphy intended putting down Norwegian or Swedish stone throughout the system, to which the committee objected. They were willing to accept foreign stone for the outskirts, where traffic is light, provided hard Scotch material was used for the portions of the town where traffic is heavy. Mr. Murphy could not agree to this proposal, and the Council then resolved to appeal to the Board of Trade, and in the meantime to apply for an interim interdict, with the result stated above.

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Peterborough.—The Council last week approved plans for alterations of the boiler house and the provision of water-softening and filtering apparatus at £650.

Portrush (Ireland).—The District Council have deferred the question of acquiring the gasworks until it has been ascertained whether the Belfast and Northern Counties Railway Co., who propose to adopt electric lighting at their station and the Northern Counties Hotel, would supply current for lighting the district.

Portsmouth.—The Tramways committee have decided to increase the salary of the tramways engineer (Mr. V. Lironi) from £200 to £250 per annum.

Portugal.—An electric railway is to be constructed between Cintra and Praia das Maçãs.

Presentations.—On Thursday last week a presentation was made at Reading Corporation tramway offices to Mr. R. J. Fardell, chief clerk of the tramways department, in the form of a leather travelling toilet bag, from the officials and staff of the tramways department as a token of their esteem and good wishes on the occasion of his marriage. The general manager (Mr. W. Binns), on behalf of the staff, made the presentation, which Mr. Fardell suitably acknowledged.

On Tuesday Mr. J. Parmley Graham, who has been for 15 years with Messrs. J. H. Holmes & Co., was presented by the officials and commercial staff of the firm with a roll-top desk and silver tea service on severing his connection with the firm in order to take up an agency in the North of England.

Preston.—The Council last week accepted a tender (referred to in another column) for 30 electric tramcars, but a recommendation to accept the tender of Dick, Kerr & Co. for the permanent way construction and overhead equipment (with Lorain Steel Co.'s special work) at £80,592 was withdrawn by the chairman of the Tramways committee (Ald. Copeland), who explained that

The specification was sent out with the special proviso that the permanent rails should be of British or American manufacture. The reason why other countries were specially excluded was because it was thought that the steel from which the particular articles was manufactured was not satisfactory. The special work was to be done by the Lorain Company, which was an American company, and if they accepted Dick, Kerr & Co.'s tender, which was the lowest, with Messrs. Hadfield's tender for the special work, the cost would be an additional £650. They had all received a letter from the latter company complaining of certain things, and making certain charges, but he did not see how they could take official notice of either company, as they were only sub-contractors to Dick, Kerr & Co. It was now stated that sooner than lose that particular order Hadfield's Company would come down to the price quoted by the Lorain Company. Such a suggestion was entirely contrary to precedent. They had an equal chance in tendering with the other firm and they should have taken advantage of it. If the Council was determined to have British manufacture entirely then "American" ought not to have been put in the specification. But they must, he thought, also bear in mind that if it had not been put in they would have found that the British manufacturer would have taken considerable advantage of it, and probably the price would have been raised.

After some discussion the withdrawal of the tender was agreed to.

Railway Electrification in Australia.—The Victorian Railways Standing Committee have consulted electrical engineers as to the proposed conversion of the St. Kilda-Brighton line (3½ miles in length) to electric traction, and the Victorian and South Australia Governments are conferring as to the advisability of engaging an American electrical expert to prepare a report upon the suitability of electric traction for suburban lines generally.

Ramsgate.—At a special meeting of the Council last week it was resolved to consent to the promotion by the Ramsgate and District Electric Supply Co. of an electric lighting order for Ramsgate, subject to the insertion of purchase terms, &c., and to the agreement submitted by the Electric Light committee being duly entered into.

Reading.—At a special meeting of the Council on Friday last the report of the tramway engineers (Messrs. John Bowen and I. E. Winslow) was presented:—

The report stated that the fractures which had taken place in tramcar axles were primarily due to the weakness of the axles, owing to an unnecessary penetration of the axle below the key-bed, which had to be cut into to remove some of the gearing. All fractured axles had, they believed, broken at the point of penetration. There might be secondary causes, such as a slight variation from the normal gauge in one or two places in the Lorain special work, &c., which could easily be corrected. That would not of itself constitute a reason for the breaking of a sound axle. The axles were being tested, and the contractor (Mr. E. Nuttall) was to be asked to substitute axles with properly cut key-beds.

The Tramway committee recommended that an investigation into the cause of the breaking of the axles be made by an expert. This recommendation was adopted.

Redditch.—The District Council have approved the proposals of the Electrrc Light committee to apply for sanction to a loan of £8,000 to provide for excess expenditure on the electricity undertaking and also for some further extensions of the mains.

Richmond.—The inhabitants are agitating for an extension of the London United Tramways to pass over the new bridge at Kew, forming a direct link between Richmond and Shepherd's Bush.

Sarnia (Ontario).—One of the earliest electric street railway lines was that established in 1875 at Sarnia (Ontario), Canada, by the Sarnia Street Railway Co. This company owns 10 miles of track on the overhead trolley system, constructed and equipped by the company's own staff, under the supervision of their manager, Mr. H. W. Mills.

Shoreditch (London).—The Council propose to apply to the London County Council for approval to a change in their system of distribution from the 150-volt direct-current two-wire system for lamps and motors to a direct-current three-wire supply at 240 volts for lighting and 480 volts for power. Objections to the clerk of the County Council, Spring Gardens, S.W.

Southend.—Last week the borough engineer (Mr. E. J. Elford) sat as arbitrator in the dispute between Messrs. Dutilh-Smith, McMillan & Co. and Southend Town Council as to a contract for electrical machinery. The firm claim £9,047. 9s. 7d. as balance of a contract of £87,288. 8s. 10d. for the construction and equipment of the Southend tramway system, and the Corporation counter-claim £6,591. 9s. 5d., alleging delay in work, breaches of contract, and bad material and workmanship. Plaintiffs claim in addition £1,500 damages for loss through alleged delay on the part of the Corporation and for damage to plant by incompetent municipal employes.

Spain.—Appliction has been made for a concession for a new line of electric tramway at Barcelona, in extension of the existing system. The new line will be 900 metres in length.

Spalding.—Messrs. Pressland and Fippard have decided to postpone their application for an electric lighting provisional order for a year.

Stoke-on-Trent.—An inquiry will shortly be held into the application of the Council for sanction to borrow £30,640 for electricity supply and refuse destructor works.

The Council have offered to give a supply of electricity in bulk in Fenton, and negotiations are proceeding between the Councils.

Stretford.—Powers are to be sought, next session, for the construction of additional electric tramways.

Sutton-in-Ashfield (Notts.).—A provisional electric lighting order is to be applied for by the District Council.

Sydney (New South Wales).—The engineer to the City Council (Mr. T. Rooke) reports good progress with the construction of the municipal electricity works."

Tariff for Use of Electric Cranes.—The erection of electric cranes by the Table Bay (Cape Colony) Harbour Board has required a table of tariffs to be prepared, and the charges made for the use of the cranes has been fixed as under:—

During ordinary working hours, 5s. per hour; Out of working hours, 7s. 6d. per hour; Minimum charge for each crane during working hours, 12s. 6d.; Out of working hours, £1. If cranes are required during men's dining hour 2s. 6d. extra. The charge commences from the time set out in the requisition for use, or from such time as the crane is ready for use, until the work is finished for the day or night, exclusive of stoppages caused by defects in the electric service.

Teignmouth.—The Town Council have decided to apply for an amending order to enable them to transfer their provisional electric lighting order to Messrs. Crompton.

Telephonic Development in Russia.—It is announced that the Russian Administration of Posts and Telegraphs will next year proceed with the preliminary work for a telephone service between Tiflis and Baku.

The Telephone in Australia.—A meeting of the Government electrical engineers of the Commonwealth was held last month to consider and report upon the steps to be taken for the improvement and extension of telephonic communication in the States and as to the adoption of the metallic circuit system and the use of automatic switchboards.

Walsall.—Trial trips have been made over the new electric tramway route to Walsall Wood and Willenhall, and the line will shortly be opened for traffic.

Wandsworth (London).—The Borough Council have approached the Board of Trade with a view to compelling the County of London and Brush Provincial Co. to keep separate accounts of their undertaking with regard to the borough from the rest of their London district.

West Bromwich.—A new feeder cable is to be laid at a cost of £1,433. Application has been made for sanction to a further loan of £12, 217 for electric lighting extensions.

The Spon-lane and Bradford-lane tramway routes were officially inspected on Tuesday.

Whitby.—Application has been made for a further loan of £2,000 for an additional feeder cable and for further extensions of

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the cables, with a view to lighting the whole of the public lamps electrically.

Wimbledon.—It has been decided to discontinue the use of the maximum demand system of charging for electrical energy from Jan. 1, when a flat rate of 5d. per unit will be charged. Consumers paying accounts within 14 days are to have a discount of 5 per cent. The charge for current for power, heating, &c., has been fixed at 2d. per unit, except between 5 p.m. and 8 p.m., when the charge is to be 5d.

Wolverhampton —Extensions of the electric lighting mains were authorised at the Council meeting last week at an estimated cost of £1,302.

The Council also decided to establish a "free" wiring system for houses with rentals of from £40 to £65 a year, and to borrow £1,000 for that purpose.

The Tramway committee recommended (and the Council approved) that the electrical engineer (Mr. Shawfield) be instructed to invite tenders for six double-deck cars for the Dudley-road extension, and that he be authorised, jointly with the chairman and deputy chairman of the committee, to accept a tender. The committee have decided to abandon a portion of the tramway between Coleman-street and Newbridge, as it did not pay.

The Council in committee also decided to promote a bill for extensions of the tramways to Wednesfield. The Council of the latter district favour the proposal.

Wood Green.—The District Council has decided in favour of municipal electricity supply, and application has been made for sanction to borrow £43,200 for the erection of joint electricity and refuse destructor works.

Woolwich.—The formal opening of the electricity supply and refuse destructor works, erected on Plumstead Marshes, was opened on Thursday last week.

Worthing.—The Council last week decided that from Jan. 1 next consumers of between 1,000 and 5,000 units of current per annum for lighting shall be allowed 5 per cent., and those taking upwards of 5,000 units 10 per cent., off present flat rate of 6d. per unit.

Yardley.—The District Council are desirous of retaining electric lighting powers in their own hands and the application of the Shropshire and Worcestershire Electric Power Co. will, therefore, be opposed.

Electro-Harmonic Society.—The next concert of this Society is a "Ladies' Night," and will be given in the King's Hall of the Holborn Restaurant, London, on Friday evening, Nov. 13. Mr. Robert Kaye Gray, president of the Institution of Electrical Engineers, will be chairman.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Brighton Corporation invite tenders for the supply and erection at their Southwick power station of six water-tube boilers, two separately-fed superheaters, economisers, induced-draught fans and motors, steel chimney stack, feed-pumps and exhaust heater, together with foundations and brickwork for same; a system of steam, exhaust, feed, blow-off and suction pipes, together with their valves; cast-iron storage tanks, hot-well tank and water purifier, and 30 cast-iron circulating water pipes. Forms of tender, &c., from the town clerk (Mr. F. J. Tillstone) after Nov. 9. Further information can be obtained from the consulting engineer (Mr. Arthur Wright), Star-chambers, 30, Moorgate-street, London, E.C., where specifications and conditions can be inspected. Tenders, addressed to Mr. Tillstone, Town Hall, Brighton, by 10 a.m. Dec. 7. See advertisement.

Swindon Corporation invite tenders for supply and erection of one complete traction switchboard and for the supply and laying of tramway feeder cables, pilot wires, arc lamp services, &c. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey and Sillar), 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, and can be obtained from the latter office only. Tenders to the town clerk (Mr. Robert Hilton) by Nov. 23. See advertisement.

Swindon Corporation also invite tenders for steel poles, overhead line section-boxes, arc lamps and accessories. Tenders to town clerk (Mr. Robert Hilton) by Nov. 16.

Hornsey Urban District Council invite tenders for meters, indicators and consumers' fuse boxes. Specifications from the resident electrical engineer (Mr. Norman Staniland), electricity works, Tottenham-lane, Hornsey. Tenders to the clerk (Mr. F. D. Askey), 99, Southwood-lane, Highgate, N., by 4 p.m. Nov. 30. See also advertisement.

Dublin Corporation invite tenders for 50,000 pairs of carbons. Tenders to the city electrical engineer (Mr. Mark Ruddle), central electric station, Fleet-street, Dublin, by 5 p.m. 14th inst. See also advertisement.

Whitehaven Guardians invite tenders for wiring and fitting up their workhouse and infirmary for electric lighting. Plans may be inspected at the office of Mr. George Boyd, C.E., 33, Queen-street, Whitehaven, where specifications, &c., may be obtained. Tenders to the clerk (Mr. William Henry Atkinson), Union Hall, Whitehaven, by noon Nov. 18. See advertisement.

Kirkcaldy Corporation invite tenders for combined steam engine and dynamo (about 400kw.) for lighting or traction. Forms of tender, &c., from the burgh electrical engineer and tramways manager (Mr. O. F. Francis). Tenders to the town clerk (Mr. Wm. Macindoe) by noon Nov. 23. See advertisement.

Messrs. Preece and Cardew are authorised by the Municipal Council of *Sydney* (N.S.W.) to invite tenders for continuous and alternating-current meters of a pattern approved by the Board of Trade. Specifications, &c., from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W., and tenders there by noon Nov. 18. See also advertisement.

The directors of the *Caledonian Railway Co.* invite tenders for stores for six or 12 months from Jan. 1, 1904, including telegraph appliances, telephones, &c., electric lighting materials and fittings, bolts and nuts, copper rivets, &c., drysalteries, hardware, glass, india-rubber and asbestos goods, galvanised wire, wire fencing requisites, locks, oils and grease, tools, screws, &c. Specifications, &c., may be obtained after Nov. 9 from the stores superintendent, Mr. Thos. Lorimer, Caledonian Railway, Charles-street, St. Rollox, Glasgow, where patterns may be inspected from Nov. 9 to Nov. 20. Tenders to the secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by 23rd inst. See also advertisement.

The directors of the *Great Western Railway Co.* invite tenders for the supply and erection at their proposed power station at Park Royal, near Acton, of water-tube boilers, engines, three-phase generators and auxiliary plant. Specifications, &c., from the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to the secretary (Mr. G. K. Mills), Paddington Station, London, by Dec. 7. An advertisement contains further particulars.

The directors of the *Midland Railway Co.* invite tenders for stores for 12 months from Jan. 1, 1904, including telegraph instruments, stay rods, bolts, insulators, &c., telegraph and signal wire, indiarubber goods, varnish, steel castings and files, copper and brass tubes, &c. Patterns and samples can be inspected at the General Stores department, Derby. Tenders (addressed General Stores committee, Midland Railway, Derby), by 9 a.m. Nov. 10.

The *Cheshire Lines Committee* invite tenders for stores for 1904, including telegraph materials, electric signals, glass, screws, files, bolts, signal wire, &c. Tenders to secretary, Central Station, Liverpool, by Nov. 27.

Kilmarnock Corporation invite tenders for three Lancashire boilers, engines and dynamos, overhead travelling crane, storage battery and switchboard. Tenders to town clerk (Mr. W. Middlemas) by Nov. 18.

Kynoch Limited, Witton, Birmingham, invite tenders for stores for six or 12 months, including electrical supplies and engineers' stores. Tenders by Nov. 20.

Leeds Lighting committee invite tenders for about 45 tons of steel or wrought-iron and cast-iron pipes and valves, oil extractors, &c. Tenders to town clerk (Mr. W. J. Jeeves) by Nov. 13.

Harrogate Corporation invite tenders for supply and part laying of two high-tension concentric paper-insulated lead-covered trunk mains. Tenders by 16th inst.

Epsom District Council invite tenders for supply of 0·008 and 0·035 three-core and 0·062 and 0·125 triple-concentric fibre cables. Tenders by noon 11th inst.

The *Metropolitan Asylums Board* invite tenders by Nov. 17 for installing a system of telephones at the Darenth Asylum.

Edinburgh Corporation require tenders for wiring and fittings for Gayfield-square police station. Tenders by 21st inst.

Tenders are called for the establishment and working of an electric lighting installation for the city of *Alcala la Real*, in the province of Jaen. The concession will be for 19 years. Tenders will be opened on Nov. 20. The *Madrid Gazette* of Oct. 21 contains further particulars.

The municipal authorities of *Wisby* (Sweden) invite tenders for the erection of electricity works.

TENDERS RECEIVED AND ACCEPTED.

London County Council have accepted the offer of Messrs. F. J. Coleby & Co. to continue a contract (expiring Nov. 5), entered into three years ago with Mr. F. J. Coleby (whose business is now taken over by the company), until Dec. 31, for the maintenance of electric bells and telephones belonging to the Fire Brigade at £315 per annum.

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The London County Council have received the following tenders for the supply of four 5,000 H.P. engines required for the tramways electricity generating station at Greenwich :—

John Musgrave & Sons (*accepted*)		£93,713
Willans and Robinson		131,857
Gourlay Bros. & Co.		107,168
Aktieselskabet Burmeister and Wains		105,683
D. Stewart & Co.		£109,068 and 105,492
Yates and Thom		100,680
Allis-Chalmers Co.		99,750
Ferranti Limited		99,250
Davey, Paxman & Co.		96,693
Wallsend Slipway and Engineering Co.	(English steel)	92,525
Ditto	(German steel)	88,525
Cole, Marchent and Morley		84,922
A. Borsig	(incomplete)	92,995
Maschinenfabrik Buckau Aktien-Gesellschaft	(not to spec.)	58,871
Fullerton, Hodgart and Barclay	(incomplete)	36,817

The successful tenderers are to be allowed to sub-let the following portions of the work: to Messrs. John Brown & Co., heavy forgings; to Messrs. J. Webb & Co., light forgings; and to Messrs. W. Jessop & Sons, steel castings.

Brighton Tramways committee have placed a large order for manganese points and crossings with Hadfield's Steel Foundry Co. at £2,023. 0s. 3d. for their extension lines. This is Brighton's first manganese work, all the existing special track work being in crucible cast steel.

Brighton Corporation have also accepted the tender of Bolckow, Vaughan & Co. for tram-rails, &c., at £5,962. 10s., and that of Edgar Allen & Co. for sole plates at £637. 2s. 9d.

Brighton Corporation have accepted the offer of their Telephone committee for the installation of a series of street police fire calls at £250 a year.

Halifax Corporation have placed an order with the Electric Construction Co. for a 750kw. direct-current dynamo and Pollit-Wigzell steam engine at £6,631.

Launceston (Tasmania) City Council recently placed orders for 73 Burnand transformers with spare coils at £2,330, feeder cables at £1,387 and testing sets at £32.

Hadfield's Steel Foundry Co. during October obtained large tramway contracts for points and crossings in "Era" manganese steel for Paisley (through Messrs. Murphy & Sons), King's Norton (through Messrs. R. W. Blackwell & Co.), Scarborough (through Edmundson's Electricity Co.), Brighton, Aston Manor (through Mr. G. Trentham), Liverpool, Sheffield, and for the Edinburgh Tramways Co.

Wood Green District Council have placed an order for cables, &c., with W. T. Henley's Telegraph Works Co. at £7,678. 2s. 5d. in connection with their electric lighting scheme.

Peterborough Corporation have accepted the tender of E. W. Beech, at £95. 15s., for the erection of a workshop for the electricity department.

Nelson Town Council have accepted the tender of Bruce Peebles & Co. for a 400kw. steam dynamo.

Preston Town Council have accepted the tender of Dick, Kerr & Co. for 30 tramcars at £472.

Epsom District Council have accepted the tender of the Reason Mfg. Co. for the supply of electricity meters, that of Mather and Platt for oil filters, and that of Meldrum Bros. for refuse destructors.

The tender of Milnes, Voss & Co. has been accepted by Ilford Council for nine car roof coverings at £70. 10s. each.

Hull Telephone Co. has accepted the tender of the Ericsson-Bell Telephone Co. for telephone instruments and switchboard at £2,757.

Wolverhampton Corporation have accepted the tender of Joseph Evans and Sons for surface-condensing plant at £1,292. 17s. 6d.

BUSINESS NOTICES.

We are informed that Messrs. Mather and Platt have sublet a contract for 44 motor starting switches (from 1½ B.H.P. to 42 B.H.P.) and 44 double-pole switches, for a contract in South America, to Messrs. Bray, Markham and Reiss.

Messrs. J. C. Dixon and R. Swann, electric bell hangers, &c., Garden-street, The Groves, York, have dissolved partnership. Debts by Mr. Swann, who continues.

Messrs W. T. Drabble and S. and T. Carter, electrical engineers, West-street Leeds, trading as Drabble, Carter & Co., have dissolved partnership as from Aug. 24. Debts by Mr. Drabble, who continues.

Messrs. F. W. Walker and W. R. Gray (trading as Gray and Harris), electrical engineers, 124, Putney Bridge-road, and 39, Page-street, Westminster, London, S.W., have dissolved partnership.

BANKRUPTCIES, LIQUIDATIONS, &c.

The examination of Edwin Ward, electrician, &c., trading as E. Ward & Co. at Southampton, took place last week. Liabilities £397. 4s. 5d., assets £86. 3s. 6d., deficiency £347. 6s. 11d. Failure attributed to want of capital, losses on contracts, bad debts, &c. Examination closed.

The Electro Neurotone Co. (Ltd.) is being wound up voluntarily for reconstruction purposes. Mr. F. G. Lloyd, 40, King-street, Cheapside, London, E.C. and Mr. T. C. Hodgkinson, electrical engineer, 35, Ravenscourt-park, London, W., are liquidators.

The trustee in the bankruptcy of W. Morton and W. T. Trevitt, electrical and mechanical engineers, Trinity-buildings, Corporation-street, Warrington, has been released.

Winding-up Petition. — A petition for the winding-up of Ferranti Limited, presented by Messrs. Estler Bros., will be heard on Nov. 17 at the Royal Courts of Justice, London, W.C.

Sale of Old Post Office Stores.—Tenders are invited for the purchase of about 45 tons of gutta percha, 100 tons of copper and a quantity of other metals, indiarubber-covered copper wire, glow lamp tops, &c. Forms of tender from the controller of stores (G.P.O.), 17-19, Bedford-street, London, W.C. Tenders by 10 a.m., Nov. 11.

Factories to Let. – Messrs. Geo. W. Dawes & Co., auctioneers, 11, Basinghall-street, E.C., have large factories to let in London and suburbs, and also in Birmingham, Derby, Cheltenham, Colchester and other leading towns.

Gate Sawing Machines.—Messrs. Edward G. Herbert (Ltd.), Manchester, have placed on the market a machine for sawing the "gits" of brass and other castings, which brassfounders will find useful. In this machine the "git" to be cut is rested in the angle of the bar support, and the operator, who has both hands free to hold the castings, presses the foot-lever by means of which the machine is started and the saw is fed through the "git." The feed is a gravity feed which can be checked but not accelerated by the operator, who cannot jam the saw in the work. The saw stops running as soon as the treadle is released. The saws are of special make, and will cut the harder alloys of copper and also delta metal and aluminium. "Gits" up to 1½in. diameter can be dealt with at one cut, and larger sizes can be severed by two or more cuts.

Turbine Generators.—The British Schuckert Electric Co. has received an order (through Messrs. Willans and Robinson) for a 1,000kw. continuous-current generator for Messrs. R. and W. Watson's works at Linwood, N.B. The generator, which will be direct-coupled to a steam turbine supplied by Messrs. Willans and Robinson, will generate a current of 4,000 amperes at 250 volts, and will be subdivided into two separate portions of each 500kw. capacity, placed in tandem upon the continuation of the turbine shaft. This plant will be one of the largest of its kind in this country, and probably the largest of the direct-current type. The Schuckert Company has paid special attention to the design of continuous-current turbine-driven generators, and the commutation of the machines will be such that no shifting of the brushes will be required for changes between no load and full load.

"Luna" Nernst Lamps.—Since the publication in *The Electrician*, Vol. LI., p. 801, of a description of a new burner of the continuous-current Nernst lamp, alternating-current lamps have been placed on the market by the Electrical Co. In outward appearance the burners of both forms are the same, the sole difference lying in the chemical composition. The switching mechanism is exactly the same of both types of burner. With regard to efficiencies, useful life and sizes, we are informed that these coincide with the figures given for the continuous-current type of burner quoted in our issue above mentioned.

Organ Blowing by Electricity.—Messrs. Bergtheil and Young have ready a neatly illustrated pamphlet on organ-blowing by electricity, and enumerating the churches, chapels, colleges and other buildings already equipped with this apparatus.

Catalogues.—A pamphlet price list describing the Stellite patent central battery exchange telephone system is issued by the Electric and Ordnance Accessories Co., Stellite Works, Birmingham. The following points may be specially mentioned :—The system has only one central battery, which means a saving in initial outlay and general maintenance charges; power may be obtained either from primary or secondary batteries, and for large installations a special motor-generator is supplied by the company which has three windings on one armature where it is desired that the ringing current may be alternating. If direct current is used for ringing as well as for speaking, the company advise the use of a battery of Leclanchés or accumulators. The instruments made by the company are arranged to be used either as wall or table sets, and the conversion is made without any addition of loose parts. A switchboard is supplied embracing all the latest telephonic improvements, and avoiding all complicated action. The calling and clearing indicators are self-replacing, and, being under cover, are protected from damage or getting out of order. Copies of the pamphlet can be obtained from the company by anyone interested in this class of work.

We have received from the Perfecta Seamless Tube Co., Plume-street, Birmingham, a copy of their new catalogue No. 8 of "Perfecta" steel conduit tubes and fittings for the conveyance of electric cables for lighting, power transmission, bells, &c. The

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lighter type of these conduits are made from ⅜in. outside diameter by 21 gauge thickness to 2in. outside diameter by 16 gauge thickness; and the heavy type conduits from ½in. outside diameter by 17 gauge thickness to 2in. outside diameter by 14 gauge thickness. The catalogue gives full particulars of the sizes of these conduits of both types generally stocked, and particulars and prices of a varied assortment of goods manufactured by the company, including stocks, dies, taps, limpet plugs, conduit tools, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Oct. 28 to Nov. 3 with the ports of destination:—

Africa—Alexandria, £67; Cape Town, £83; Delagoa Bay, £100; Durban, £984 (including £212 telegraph material); East London, £377; Port Elizabeth, £202. Port Said, £49. *Australasia*—Auckland, £400; Brisbane, £16; Fremantle, £360; Launceston, £798; Lyttelton, £67; Melbourne, £1,675 (including £1,530 telegraph cable); Perth, £597 (including £60 telegraph material); Sydney, £256; Wellington, £308. *Azores*, £500. *Belgium*—Antwerp, £248; Brussels, £130; Ghent, £35. *Brazil*—Maceio, £21. *Burma*—Rangoon, £395. *Canada*—Halifax, £131 (telegraph material); Montreal, £17; Vancouver, £180 (telegraph apparatus). *Ceylon*—Colombo, £22. *China*—Shanghai, £68. *Corea*—Chemulpo, £40. *Germany*—Hamburg, £36. *Gibraltar*, £25. *Holland*—Amsterdam, £75; Rotterdam, £66 (including £36 telegraph wire). *Hong Kong*, £511. *India*—Bombay, £778; Calcutta, £1,355; Madras, £56. *Japan*—Yokohama, £283. *Russia*—St. Petersburg, £115 (telegraph cable). *Siam*—Bangkok, £215. *Straits Settlements*—Penang, £19 (telegraph material). *Sweden*—Stockholm, £170 (telegraph wire). *Zanzibar*, £20. Total £11,850 against £23,646 in the corresponding week last year (Oct. 29 to Nov. 4.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 6, 1903.

14,940 E. Neuberg. Birmingham. Device for indicating or preventing exceeding specified speeds on dynamos, motor cars and the like.*
14,963 P. R. J. Willis. Kingston-on-Thames. Electric furnace. (E. A. Sjosted, Canada.)
14,979 and 14,980 H. Aron. Electricity meters.*
14,994 A. J. Boult. Process and apparatus for obtaining a continuous electric current from a high-tension alternating-current source. (F. J. Koch, jun., Germany.)*

July 7, 1903.

15,037 T. A. Edison. Nickel plated articles or sheets and process.*
15,048 A. Bonemeyer. Electric signalling for railway trains.*
15,050 W. P. Thompson. Liverpool. Galvanic batteries.
15,059 Siemens Bros. & Co. Electrical hauling apparatus. (Siemens and Halske A.G., Germany.)*
15,065 M. Kotyra. Keyboard telegraphic transmitters.*
15,076 L. Legoy. Circuit make and brake for induction coils.
15,077 A. P. Hanson. Apparatus for telephone exchanges. (Date applied for, July 7, 1902, date of application in U.S.)*

July 8, 1903.

15,089 G. Smith. Manchester. Electric signboards and the like.
15,090 C. A. Randall. Insulators for line construction.
15,120 J. C. Anderson. Germany. Sparking plugs for gas engines.*
15,142 H. H. Lake. Bearings for high-speed rotating bodies. (E. C. Kiichenmeister, Germany.)*
15,143 A. Goldschmidt. Electric apparatus for use in medicine and surgery

July 9, 1903.

15,186 S. Z. de Ferranti. Automatic electric welding machine.
15,199 Marconi's Wireless Telegraph Co., S. W. Ashley and K. A. Hinde. Induction coils for ignition apparatus for motors.
15,212 J. Heibling. Manufacture of soda and caustic potash chlorine and hydrochloric acid by electrolysis of aqueous solutions.
15,217 G. L. Hogan. Apparatus for varying resistance.
15,218 H. Swanton. Cutouts, contact breakers, meters, &c.

July 10, 1903.

15,243 S. Watkins. Wolverhampton. Automatically regulating currents generated by dynamos. (Consolidated Railway Electric Lighting and Equipment Co., U.S.)
15,247 H. M. Darrah and L. A. Hackett. Manchester. Incandescent lamp-holders.
15,257 W. Millar. Glasgow. Operating rail and condition points in electric tram- or railways.
15,266 C. M. Dorman and R. A. Smith. Salford. Switches.*
15,286 H. Richards and G. Davis. Staples for electrical installations.
15,302 J. St. V. Pletts. Recording and reproducing sounds.
15,317 J. H. Collis, A. Collis and W. Head. Electro-deposition of metals.
15,337 and 15,338 W. Roos. Magneto-electric igniting apparatus.*

July 11, 1903.

15,345 H. J. Creffield. Eritb. Electric sparking plugs.
15,366 D. Martin. Birmingham. Electric safety fuses.
15,359 A. Taylor, W. Moorehead and T. H. Kingscote. Manchester. Operating trolley cords.
15,403 C. C Gerrard and Ferranti Limited. Electric circuit controlling apparatus.
15,420 K. Kaiser. Electrolytic production of zinc.*

July 13, 1903.

15,438 C. Gandy. Newcastle-on-Tyne. Self-acting adjusting trolley fork.
15,479 and 15,480 P. M. Justice. Regulating systems of electric distribution. (National Battery Co., U.S.)*
15,481 E. R. Viale. Arc lamps.*
15,494 and 15,495 I. S. McDougall. Insulating materal.
15,500 A.G. Brown, Boveri & Cie. Alternating-current contact apparatus. (Date applied for, Nov. 13, 1902, date of application in Switzerland.)*
15,506 W. P. Thompson. Armatures for induction motors. (E.G. Alioth, Switzerland.)*
15,514 G. A. Meyer. Electrical alarm device for indicating fall in level of liquids in closed vessels.

July 14, 1903.

15,532 Electric and Ordnance Accessories Co. and R. F. Hall. Birmingham. Dynamo-suspension gear for electric lighting systems for railways.*
15,552 C. G. Burke. Manchester. Wireless telegraphy.*
15,562 W. Aitken. Liverpool. Telephone exchange systems.
15,569 H. W. Ladd. Wireless signalling for vessels.*
15,591 E. A. Carolan. Preventing arcing between commutator brushes. (G.E.Co., U.S.)
15,592 E. A. Carolan. Synchronising alternators. (G.E.Co, U.S.)
15,595 E. A. Carolan. Arc lamp-hanger and cutout. (G.E.Co., U.S.)
15,599 V. Poulsen. Production of alternating currents.
15,600 J. W. Gladstone. Voltaic batteries. (Date applied for, Dec. 17, 1902, date of application in U.S.)*
15,605 W. H. Turner and W. H. Isherwood. Wiring of overhead conductors.
15,623 W. McDevitt. Protecting the live parts of switches, cutouts, or the like *

July 15, 1903.

18,637A/02 R. T. Piscicelli. Electric post for the collection, transmission and distribution of letters, parcels, &c. (Date applied for, Aug. 25, 1902.)*
15,636 D. S. Semple. Paisley. Electric contact-breakers for doors and windows.
15,647 H. Brecknell, E. M. Munro and H. I. Rogers. Bristol. Insulated frogs or crossings.
15,662 L. H. Walter. Southport. Wireless signalling.
15,682 E. Blumenthal and Siegfried Schlesinger. Electricity meters.
15,684 F. A. Darton. Portable electricity meters.
15,700 O. Imray. Process for reducing organic substances in an electrolytic bath. (Farbwerke vormals Meister Lucius and Brüning, Germany.)

July 16, 1903.

15,746 Guest, Keen and Nettlefolds and W. E. Symons. Arc lamps.
15,772 W. K. Dickson. Magnetic separation of ore.

July 17, 1903.

15,787 L. H. Walter. Southport. Detectors of electrical oscillations.*
15,793 T. H. Webb. Glasgow. Device for quick repair of broken trolley wires.
15,796 C. Davies and C. G. Lawless. Manchester. Clockwork to be adjusted to electricity meters for timing, registering, measuring, &c.
15,810 C. M. Dorman, R. A. Smith and H. G. Baggs. Salford. Fusible cutouts.*
15,811 Lancashire Dynamo and Motor Co. and R S. McLeod. Liverpool. Dynamo electric machines for regulating charge and discharge of storage batteries used with train generators.
15,816 P. Baxendale and T. F. Gamble. Liverpool. "Duvolt" contact-breaker screw.
15,817 W. K. Dickson. Electrically actuated musical instruments.
15,821 W. Hibbert. A magnetic balance or magnetometer and galvanometer.
15,831 H. F. A. Klein-Schmidt. Welding rail joints by electricity.*
15,834 H. F. A. Klein-Schmidt. Handling and cooling track-welding transformers and welders.*
15,838 K. W. Hedges. Fusible cutouts.

July 18, 1900.

15,911 C. A. Shanks. Interlocking electric lamps to their couplings.
15,940 F. J. Gordon. Electric lamps for testing purposes.

July 20, 1903.

15,968 A. Blackman and C. E. Warren. Batteries.
15,970 J. A. Lycett and G. J. Conaty. Birmingham. Electric tramcars.
15,972 F. O. Hunt. York. Switches and rheostats for starting and controlling electric motors.
15,975 R. T. Grocott. Stoke-on-Trent. Suspender for balance weights.
15,979 G. Casperson. Leeds. Switch lamp-holder.
15,980 J. Wilson. Manchester. Indicating attachment on fuse ways.
15,992 H. Seggel. Electromagnetic brake for electric cars.*
15,995 H. P. Maxim. Charge indicators for secondary batteries. (Date applied for, Aug. 4, 1902, date of application in U.S.)*
16,014 W. V. Smith. Casings for conductors.
16,038 H. W. Butler. Regulating supply of current in electric mains.

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July 21, 1903.

16,078 W. HAMILTON. Electricity motor meters.
16,100 H. H. LAKE. Circuit-controlling devices for use with electric flash signs. (Automatic Time Switch Co., U.S.)*
16,113 J. N. MASKELYNE, Jun. Producing and detecting Hertzian oscillations.
16,114 J. N. MASKELYNE, Jun. Interrupters for use with induction coils and other electrical apparatus.
16,115 F. HUBBER and W. G. HIGGS. Electric fire alarm.
16,132 W. E. EVANS. Rectifying polyphase alternating currents by means of unipolar cells. (A.E.G., Germany.)*
16,138 C. W. MILLS and W. W. PIDDINGTON. Electric signalling for railways.*

July 22, 1903.

16,142 R. F. HALL and T. L. JONES. Birmingham. Switch hook for telephones.
16,148 A. REAME. Hull. Fuse board for any number of ways.
16,159 A. T. COOPER. Liverpool. Electric measuring.
16,190 H. H. LAKE. Tension limiting devices. (Cie. de l'Industrie Electrique and Mecanique, Switzerland.)*

July 23, 1903.

16,232 T. E. WEAVER. Manchester. Electrical resistances.
16,258 A. G. BROOKES. Rotors for electrical machines. (E.G. Alioth, Switzerland.)*
16,294 H. BECK. Arc lamps.*
16,300 J. E. SPAGNOLETTI. Coupling for wires and cables.

July 24, 1903.

16,348 J. B. WHITNEY. Electrical stop motion for textile machinery.*
16,360 C. B. AUEL and J. R. SPURRIER. Means for breaking circuits.
16,366 S. GOODMAN. Electric lamps for road vehicles.

July 25, 1903.

16,388 VERITYS LIMITED and D. E. ROGERS. Aston. Tumbler switch.
16,425 W. AITKEN. Liverpool. Telephone exchange systems.
16,450 SIEMENS BROS. & Co. Signalling apparatus worked by alternating currents. (Siemens and Halske A.G., Germany.)*
16,454 J. RIENACH and H. SCOTT. Shuttles and electrical mechanism for indicating approaching failure of weft in looms.

July 27, 1903.

16,456 H. HOGGE and J. BARROLLIER. Manufacture of incandescent lamps. (Date applied for, April 8, 1903, date of application in France.)*
16,469 O. R. St. J. PALMER. Northumberland. Electrical fog signalling.
16,481 W. WALMSLEY. Liverpool. Electrically locking railway carriage doors.
16,487 W. SCHÜTZ. Germany. Telegraph pole.*
16,509 T. A. HEARSON. Field magnets. (E.G. Alioth, Switzerland.)*
16,511 W. H. SCOTT. Electric hoist controllers.
16,513 W. R. MACDONALD and G. E. HEYL-DIA. Cutouts.
16,514 W. R. MACDONALD and G. E. HEYL-DIA. Indicating devices for use with cutouts.

July 28, 1903.

16,534 M. SCHNEIDER and J. BEISSBARTH. Manchester. Secondary batteries.
16,594 H. R. ROMNEY. Fireproof casings for electric conductors.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

19,999 FIEDLER and PUCHMÜLLER. Secondary battery elements.
20,084 EVANS (Electrochemische Werke G.m.b.H.). Production of metallic calcium.
20,426 MCCANDLISH. Portable testing and comparing instrument for incandescent lamps.
20,502 GOOBD. Operating rail and conductor points from vehicles.
21,201 ADAM (Engelmann). Manufacture of accumulator plates.
21,604 IOANNIDI and HESFORD. Cord grip lampholder and shade carrier.
22,057 MARSDEN. Wind or water motors, and accumulators.
23,328 SPENCE and BRITISH ELECTRIC PLANT Co. Driving gear.
24,112 MORDEY and HANSARD. Alternate-current traction systems.
24,220 PETO and KENT. Connections for conducting wires.
24,714 CAROLAN (G.E. Co., U.S.) Switch control mechanisms.
24,755 JOHNSON and BASS. Cables.
24,943 HIGHFIELD. Switches for starting electric motors.
24,986 LAIDLAW and SCHOLES. Pendant incandescent lamps.
25,195 ECKSTEIN and COATES. Electrical influence apparatus.
25,232 BROWN. Fire alarm posts.
25,196 LEWIS. Resistances.

1903.

3,837 BALL. Circuit breakers.
7,701 UYTENBOGAART. Electric receiver clocks.
7,714 EVANS (A.E.G.). Monophase and polyphase alternating-current machines.
10,788 EDGERTON and BOWERS. Dynamos and motors.
14,286 DORMAN and SMITH. Covers for protection of electrical apparatus.
15,623 MCDEVITT. Protecting live parts of switches, &c.
15,810 DORMAN, SMITH and BAGGS. Fusible cutouts.
15,992 SEGGEL. Electromagnetic brake for electric vehicles.
15,995 MAXIM. Charge indicators for secondary batteries. (Date applied for, Aug. 4, 1902.)
16,100 LAKE (Automatic Time Switch Co.). Circuit-controlling devices.
16,509 HEARSON (E.G. Alioth). Field magnet for electrical machines.
16,653 WIRTH and BEECH. Apparatus for soldering armature leads to commutator bars. (Date applied for, Oct. 22, 1902.)
16,754 VIVES. Barometer alarms.
16,808 BREWER. (E.G. Alioth.) Holding devices for collecting brushes.
17,564 WHITE and WALDRON. Junction or inspection boxes.

COMPANIES' MEETINGS AND REPORTS.

Western Telegraph Co. (Ltd.).

The sixtieth ordinary general meeting of the shareholders was held on Wednesday, under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. E. Steer Hodson) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: Gentlemen, I do not think that the present report calls for many remarks from me. The message revenue for the half-year under review amounted to £213,000, and that for the corresponding half-year ended June 30, 1902, to £196,500, showing the satisfactory increase of £16,500, of which the larger portion is attributable to increased trade with the River Plate. The interest we received from deposits, rents and transfer fees are practically the same as in the corresponding period of last year. Dividends on investments in other telegraph companies which are feeders to our general system show a small decrease of £800. Turning to the expenses, which we compare with the preceding, not the corresponding half-year, those in London show a small decrease of £41, but no item calls for remark. At the stations there was a net increase of £1,737, of which £556 was due to a larger expenditure in travelling expenses, in consequence of more clerks having been sent out and a larger number having been sent home on leave. Rent, house allowance, and other items were increased by £539, principally due to our having to grant an allowance to our Rio Janeiro staff pending the completion of their new and very greatly improved quarters on the other side of the harbour. Repairs and renewals of furniture were also higher by nearly £500. When we come to the important matter of the repairs of cables and the expenses of our ships, we find that they were comparatively small in the previous half-year, and those for the June half-year show an increase of £14,589. But of this increase nearly £11,000 is for new cable (over 100 knots) which has been used in repairs, and for depreciation written off cable in stock. We have sent out the small steamer called the "Cormorant," which was purchased at the beginning of the year. She has been very usefully employed since she arrived in South America, and the expense of her maintenance and that of a temporarily chartered steamer for repairs to our Lisbon-Maderia-St. Vincent cables account for the remainder of the increase under the head of "Repairs of cables and expenses of ships." We have invested on account of reserved funds nearly £50,000 during the half-year. The difference between the cost of the investments we hold on account of reserve and the present market price represents an average depreciation of 5¾ per cent. That, the shareholders will readily realise, is due to the abnormal depreciation of all securities, even the most gilt-edged, during the past year or two. We have, however, during the past three or four years made considerable profits when a sale of investments has been necessary, and the shareholders will, of course, remember that interest is always carried to the credit of the reserve fund. The broad result of the half-year's working is that, after providing £13,500, in round figures, for debenture stock and debenture interest and sinking fund, and £3,200 for income tax, there remains a balance of £117,500, again in round figures; and to this is added the sum of £5,300 brought forward from Dec. 31 last, making a total of £122,800. A quarterly interim dividend, amounting to £31,000, has been paid, £35,000 has been transferred to the general reserve fund, and £2,000 to the maintenance ships' reserve fund. The Directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, all free of income tax, which together will amount to £51,982, leaving a balance of £2,639 to be carried forward. The dividend and bonus will be payable on Nov. 5 I may say now, perhaps, that the revenue to date for the current half-year, ending Dec. 31 next, is not quite so satisfactory as that for the corresponding period of 1902. The decrease is not serious, but there is no sign of increase; and the decrease we find is due to the continued falling off in our receipts from inter-South American traffic. We have to compete for that with the Government, and being in competition, we must take the matter as we find it; and although we do the best we can, we find that that description of traffic does not show any sign of increase, but rather a serious decrease. On the other side of the account the expense of repairs to cables is thus far below the average. I have often said at these meetings that our revenue depends on the course of trade in the countries we serve, and also, to a considerable extent, on the amount of repairs to cables, both of which matters are outside the control of the directors of a public company. On the whole, I think I may congratulate the shareholders on what I may call a satisfactory but uneventful report, and it is a source of gratification that there are no matters calling for special attention. I now move the adoption of the report and accounts, and the declaration of the dividends therein set out.

The DEPUTY-CHAIRMAN (Sir John Denison-Pender, K.C.M.G.), briefly expressed his pleasure at seconding the resolution.

Mr. MOUNTCASTLE said he saw in the newspapers the other day that Mr. Marconi's system was hindered through the sun's light. He would like to know if this was so, because they would not be troubled with any serious competition through wireless telegraphy if it was only at night that messages could go safely by it.

Mr. ENNIS enquired if the Company's lines were in any way affected by the recent magnetic storm.

Mr. HOUSTON said he also desired to ask whether the Directors had fixed on any limit for the reserve fund, and whether the shareholders might expect to receive another ½ per cent., or perhaps another 1 per cent., added to their dividend.

Mr. MOUNTCASTLE said that a portion of the reserve fund was invested in other companies, but interest was only credited from the

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choice investments. Did not the fund get some dividends from that portion which went into these shares ?

The CHAIRMAN : I will take the last question first. The reserve fund is not invested in the shares of other companies. We hold shares in other companies but not *quâ* reserve fund. Our reserve funds are in what may be called more liquid investments. The list of our investments at the end of the report shows that they are in other enterprises. There has been no default of interest. As to there being any limit with reference to the amount of the reserve fund, I should be very sorry indeed to bind the Board in any way on such a point as that. We have always pursued the policy in these companies of keeping the dividend as steady as we can and fortifying the enterprise, as a whole, by building up a reserve fund. That reserve fund is, from time to time, looked at by the Directors from the point of view of the length of cable we have in operation, and from the actuarial point of view of what is really necessary as prudent business people to put to the reserve in an enterprise such as a cable company. I, therefore, do not hold out any immediate hope, certainly, of any increase of dividend, and I hope that the shareholders will endorse the policy of the Directors, which is now an old one, and which has proved to be of the very greatest utility to the stability of these telegraph companies, of treating the reserve fund in a liberal way. With reference to wireless telegraphy, I cannot say anything more than I have said before. Within certain limits wireless telegraphy is a useful invention, but I do not myself see any more reason to apprehend serious competition from it with cable companies than I did on the first occasion when I alluded to the subject some two or three years ago. I think that matters are just as they were. With respect to the magnetic storm, it was a storm of an unusual character, not only in severity, but in the large area over which its effects were felt. The effects were felt in Brazil, and we felt the effects in this country, and on traffic generally. It is only one of those examples of a particularly severe storm of a nature which we have experienced on other occasions in a less severe way, and to that extent it is, of course, extremely interesting from a scientific point of view. But it has passed away, the business is being conducted as usual, and except that it was a very severe storm, I do not think it calls for any special remark. Apparently it was felt all over the habitable globe in different degrees of intensity, and it interfered in some parts to a small degree and in other parts to a larger degree with telegraphic working.

The motion was then carried unanimously, and resolutions were afterwards passed re-electing the retiring Directors (Mr. W. S. Andrews, Sir John Wolfe-Barry and the Hon. Arthur G. Brodrick) and the auditors—(Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. Gane, Jackson, Jeffreys, Wells & Co.).

Mr. JOHN NEWTON, in proposing a vote of thanks to the Chairman and Directors, asked whether the extraordinary magnetic storm referred to had left the cables throughout the world in as good a condition as before.

Major COTTON seconded the motion, and desired that the names of the secretary and the staffs in London and on the other side might be added to the resolution.

The motion, as amended, was carried unanimously.

The CHAIRMAN, in returning thanks for this kind expression of confidence on the part of the shareholders towards the Board and the staff of the Company, said, as far as they knew the cables were left in just the same condition as they were before the storm.

The proceedings then terminated.

CAPE ELECTRIC TRAMWAYS (LTD.)—The report of the directors for the year to June 30, states that, after provision for interest and redemption of debentures, there is a net credit balance of £66,372. 1s. 4d., which added to £14,540. 5s. 7d. brought forward, makes £80,912. 6s. 11d. From this 15 per cent. has been paid in three interim dividends (absorbing £72,000), £8,000 has been placed to reserve, leaving £912. 6s. 11d. to be carried forward. The result of the year's transactions shows that the traffic on the tramway systems in South Africa has maintained itself at the high level of previous years, while expenditure and maintenance have shown a large increase over 1902, reducing the profit by about £15,000. The improvements and additions to the car shed and power house, with additional machinery in Cape Town, have been completed, at a total cost of £84,919, an excess over the original estimate of £30,000. This increased expenditure is mainly due to the enhanced prices for labour and material. The reserve fund (£137,000), has met this expenditure, and it has not, consequently, been found necessary to raise further capital. The power station, with its new engine and boilers, is now fully adequate to all requirements; and the large addition recently made to the rolling stock enables the company to cope successfully with the increased development of the traffic in Cape Town. The Port Elizabeth system also has benefited by the extension to Humewood. The directors have found it necessary, owing to the development of the traffic and the system generally at Port Elizabeth, to supplement the rolling stock and to proceed with the erection of additional power. On Jan. 1, the company leased from the Cape Town Consolidated Tramways and Land Co. their Camps Bay tramways, to work them for a period of three years, with option of purchase at the expiration of the lease. The first six months' working has shown a loss of £3,283. 19s. 1d., caused by the exceptionally bad weather prevalent in Cape Town.

ROSARIO ELECTRIC CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. W. T. Western) said that the company took over a going concern which had been in operation for some years, and also took over some machinery and plant of fair quality, but it had unfortunately been put in the wrong place. It had, therefore, been decided to construct a new station and to lay down new plant. During the last 14 months they had been engaged in the erection of the new building and in getting the new plant into order. The new engines and dynamos were ready to run about the middle of July for trial work ; and after running them for a short time the contractors handed them over to the company's staff. It was only then they could begin to seek new consumers. The directors now recommend a dividend equal to 6 per cent. per annum from the due dates of instalments to June 30 last, representing practically just 3 per cent. ; and out of the surplus they proposed that the preliminary expenses (about £1,400) should be extinguished. Both stations would have to be run for a time, and the full benefit of the new customers would not be derived for the whole of the current year.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

ALERT ELECTRICAL CO. (LTD.)—Reg. Oct. 29, capital £2,000 in £1 shares, to carry on business as electricians, electrical engineers, generators, accumulators, distributors and suppliers of electricity, motor and motor-car manufacturers, &c. The subscribers include H. Lavy, electrical engineer (50 shares). First directors, H. Lavy and Mrs. A. E. J. Webber (each of whom may retain office while holding £200 shares or stock).

EASTERN IMPORTERS (LTD.)—Reg. Oct. 24, capital £15,000, in £1 shares, to carry on the business of importers and merchants of india-rubber, caoutchouc gum, elastic, guttapercha or other gums, &c. First directors are J. W. Postlethwaite and W. Fox. Reg. office, College Hill Chambers, College Hill, London, E.C.

HODGSON, HARTLEY (LTD.)—Reg. Oct. 6, capital £3,000 in £1 shares to acquire and take over the businesses now carried on at Cleckheaton as H. E. Hodgson & Co., and at Manchester as James Hartley & Co. of Manchester (Ltd.), and to carry on business as electrical, mechanical and hydraulic engineers, manufacturers of machinery, tools and boilers, producers and suppliers of electricity, &c., manufacturers of electrical plant, electricians, &c. First directors R. Hodgson, J. Butterworth, J. Hartley (Manchester), H. Kohler, J. Hartley (Hyde, managing), G. Board, H. E. Hodgson (managing) and W. A. Wilkinson. Reg. office, 55, Victoria-buildings, Manchester.

LAWRENCES LIMITED.—Reg. Oct. 21, capital £500 in £1 shares, to acquire business of electrical, mechanical and sanitary engineer now carried on as Lawrence & Co., and to carry on the business of electricians, suppliers of electricity, &c. Reg. office, 6, Spur-street, Leicester-square, London, W.C.

LIGHT CURE AND ELECTRO-THERAPEUTIC INSTITUTE (LTD.)—Reg. Oct. 27, capital £12,000 in £1 shares, to provide, furnish and maintain an establishment for the cure and relief of diseases and ailments by electrical and other kindred treatment, and to carry on the business of electric light bath proprietors, electricians, suppliers of electricity, manufacturers of and dealers in all apparatus and things required for the generation, distribution, supply, accumulation and employment of electricity, &c. The subscribers are Sir E. N. Walker, K.C.M.G., J. W. Sidley, D. S. Ward, J. T. Shone, R. King, W. J. Spratling, B.Sc., and P. V. Gibson. First directors, Sir E. N. Walker, K.C.M.G., J. W. Sidley, D. S. Ward and J. T. Shone.

MUNICIPAL FOUNDRY AND ENGINEERING CO. (LTD.)—Reg. Oct. 6, capital £5,000 in £1 shares, to adopt an agreement between C. Hall and J. H. Bardsley, and to carry on the business of electrical, mechanical, chemical and general engineers and contractors, electricians, suppliers of electricity, manufacturers of electrical apparatus, manufacturers and suppliers of electricity, &c. Mr. J. H. Bardsley has power to appoint one director.

P. L. RICHARDSON (LTD.)—Reg. Oct. 20, capital £5,000 in £1 shares (2,500 preference), to carry on the business of wire manufacturers, drawers, galvanisers and weavers, makers of metal tubes, wire coverers, electrical and mechanical engineers, &c. First directors, P. L. Richardson (chairman), F. M. Appleton and J. Barlow. Reg. office, Museum-street, Warrington.

TRANSPORTER CO. (LTD.)—Reg. Oct. 26, capital £20,000 in £1 shares (5,000 5 per cent. cumulative preference), to acquire certain inventions for improvements in appliances for loading and discharge of steamships, and for mechanical handling and transport of goods, to take over and carry on the business of the Pirrie Transporter Co. First directors are Col. W. C. Underwood, W. Pirrie, and G. S. Gunnis. Reg. office, 7-8, Great Winchester-street, London, E.C.

T. H. WATHES & CO. (LTD.)—Reg. Oct. 27, capital £3,000 in £1 shares, to acquire the business of an electric power, light and telephone engineer now carried on by T. H. Wathes at Leicester, and to carry on the business of electricians, mechanical and electrical engineers, manufacturers of and dealers in electric and other motor cars, suppliers of electricity for all purposes, &c. The subscribers include T. H. Wathes, electrician, and G. E. B. Hales.

WEST SURREY LIGHT RAILWAY CO. (LTD.)—Reg. Oct. 18, capital £1,000 in 995 preference or "A" shares of £1 each and 100 ordinary or "B" shares of 1s. each, to provide and work a light railway or railways, tramway or tramways in Surrey, and to carry on the general business of light railway proprietors, carriers of passengers and goods, &c. First directors, R. P. Gardner and C. Hall. Reg. office, 27, Chancery-lane, London, W.C.

STATUTORY RETURNS.

BRITISH ALUMINIUM CO. (LTD.)—According to return to July 21 the capital is £400,000 in 10,000 "A" 6 per cent. preference, 20,000 7 per

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cent. preference and 10,000 ordinary shares of £10 each, all of which have been taken up. £10 per share has been called up on 10,000 "A" 6 per cent. preference, 16,770 7 per cent. preference and 8 ordinary shares and £267,780 has been received. £132,220 is considered as paid on 3,230 7 per cent. preference and 9,992 ordinary. Mortgages and charges, nil.

INGLETON ELECTRIC LIGHTING AND POWER CO. (LTD.)—The return to March 30 (filed Aug. 11) shows capital £4,000 in £1 shares, 3,175 of which have been taken up and paid for in full. Mortgages and charges, £2,600.

KEIGHLEY ELECTRICAL ENGINEERING CO. (LTD.)—The return to Sept. 28 gives the capital as £10,000 in 8,000 ordinary and 2,000 preference shares of £1 each, of which 4,100 ordinary and 1,000 preference shares have been taken up. £1 per share has been called up on 4,000 ordinary and 1,000 preference, and £5,000 has been received. 100 shares are considered as fully paid. Mortgages and charges, £3,000.

RAILWAY LIGHTING LIMITED.—In return to June 30 the capital is given as £75,000 in 50,000 ordinary and 25,000 deferred shares of £1 each, of which 38,404 ordinary and 20,000 deferred shares have been taken up. £1 per share has been called up on 34,707 ordinary shares, and £34,657 has been received, leaving £50 in arrears. £23,697 is considered as paid on 3,697 ordinary and 20,000 deferred shares. Mortgages and charges, £56,000.

MORTGAGES AND CHARGES.

ADAMS-RANDALL TELEPHONE PATENTS CO. (LTD.)—Issue, on Oct. 13, of £250 debentures, part of series created April 22, 1899, to secure £10,000, charges on company's property, including patent rights and leasehold premises. Holders, London and Foreign Contract Corporation. Trustee, F. Davies. Previously issued of same series, £9,700.

BATH ELECTRIC TRAMWAYS (LTD).—Mortgage or charge, dated Oct. 19, 1903, to secure £35,000 and further advances up to £92,500, with 7 per cent. interest, has been registered. Property charged (as specific mortgage)—Undertakings authorised by Bath and District Light Railways Order, 1901, and Bath Electric Tramways (Light Railway Extensions) Order), 1903, with all permanent ways, stations, power houses, car sheds, rolling stock, cables, plant, equipment and rights appertaining thereto, running powers or rights over other tramways or railways, certain leasehold land, buildings, fixed plant and machinery at Ladymead, St. Michael, Bath; and (as floating security) all company's other assets, present and future, except uncalled or unpaid capital. Holders: Law Debenture Corporation.

ROYCE LIMITED.—Issue, on Oct. 23, of £100 debentures, part of series created March 27, 1903, to secure £25,000, charged on company's undertaking and property, present and future, excluding uncalled capital. Trustees, Law Guarantee and Trust Society. Previously issued of same series, £22,700.

SHERARD COWPER-COLES & CO. (LTD.)—Issue, on Oct. 19, of £125 debentures, part of series created by resolutions of Dec. 3, 1901, and Feb. 7, 1902, to secure £6,500, charged on company's property, present and future, except uncalled capital. No trustees. Previously issued of same series, £6,275.

H. SUTTON & CO. (LTD.)—Debenture dated Oct. 19, 1903, to secure £250, and a second debenture of like amount, both charged on company's undertaking and property, present and future, including uncalled capital, have been registered. Holders (first debenture), G. A. Benton and (second debenture) W. E. Collingridge.

WORCESTER ELECTRIC TRACTION CO. (LTD.)—Trust deed, dated Oct. 22, 1903, to secure £10,000 debenture stock, has been registered. Property charged, all company's assets, present and future. Trustees, Electric and General Investment Co. The company has power to issue further debenture stock ranking pari passu up to half issued capital.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 27¼d. per oz. (Nov. 5). Consols 88$\frac{3}{16}$—88$\frac{5}{16}$ for money, 88$\frac{3}{8}$—88$\frac{1}{2}$ for account; 2½ per cent. annuities 88—88½ (Nov. 5). Consols Pay Day Dec. 1; Stocks and Shares Continuation Days, Nov. 10 and 24; Ticket Days, Nov. 11 and 25; Pay Days, Nov. 12 and 26; Mining Share Carry-over Days, Nov. 9 and 23.

BRITISH ALUMINIUM CO. (LTD.)—At an extraordinary meeting held on Wednesday the resolution for the reduction of the capital from £400,000 to £310,000 by cancelling £9 per share upon each of the 10,000 issued ordinary shares was carried.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—At the meeting on Friday last, Mr. G. P. Norton said that during the year considerable development and progress had taken place. After December next, when they hoped to have the advantage of partial utilisation of the water power installation, their progress would be even more rapid. Since the close of the financial year the net earnings for the three months ended Sept. 30 showed an increase upon the earnings of the corresponding period of 1902 of £3,647.

CATHCART DISTRICT RAILWAY CO.—At the half-yearly meeting Mr. Hugh Mayberry said that what was really wrong with their company's affairs was the competition of the Corporation tramcars. So long as they had municipal cars running cheaper and cheaper day by day they would have the greatest difficulty in earning a dividend for their shareholders. From present appearances free Corporation cars would soon be running, and then they could make a present of their undertaking to the Corporation. The Council were pushing out private enterprise altogether by the course they had pursued.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have ordered to be quoted and have appointed November 11 a special settling day in 40,000 City Undertaking 4½ per cent. cumulative £5 fully-paid preference shares of the *Charing Cross and Strand Electricity Supply Corporation (Ltd.)*, and a further issue of £206,000 4 per cent. first mortgage debenture stock of the *London United Tramways* (1901) *Ltd.* The committee have been asked to appoint a special settling day in and to grant a quotation to 61,000 fully-paid 6 per cent. £5 cumulative preference shares, and £300,000 4½ per cent. debenture stock of *Dick, Kerr & Co. (Ltd.)*, and to allow 59,394 fully-paid 5 per cent. £1 cumulative preference and 73,606 fully-paid £1 preferred ordinary D shares of the *Bath Electric Tramways (Ltd.)* to be quoted.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—The directors have decided to recommend a dividend of 8s. per share on account of arrears of dividend on the first preference shares.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Oct. 31	1,226	+ 353	22	28,449	+ 4,495
Ayr Corporation	...	...	...	...	...	...
Barnsley	,, 23	175	...	42½	7,700	...
Birkenhead	Nov. 1	1,050	+ 69	...	...	...
*Birmingham Tramways	Oct. 31	5,207	+ 9	17	88,616	+ 2,528
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 29	386	+ 20	§30	35,288	- 199
Blackpool and Fleetwood	,, 31	272	+ 14	18	19,248	- 136
Blackp'l, St. Anne's & Lytham	,, 31	259	+ 152	22	12,805	+ 6,498
Bolton Corporation	Nov. 1	1,790	+ 87	31	58,283	+ 7,342
Bournemouth Corporation	Oct. 28	877	...	31	33,737	...
*Bradford Corporation	Nov. 1	3,717	+ 305	31	119,757	+ 17,262
Brighton Corporation	,, 1	861	+ 64	49	43,545	+ 6,131
Brisbane Tramways	Sept. 16	2,306	+ 185	11	26,181	+ 477
*Bristol Trams & Carriage	Oct. 30	4,625	+ 178	23	123,769	+ 12,952
*Buenos Ayres & Belgrano	,, 4	3,239	- 89	‡24	44,133	+ 3,004
Burnley Corporation	,, 31	820	+ 141	31	32,998	+ 5,905
Burton Corporation	Nov. 1	356	...	...	...	...
Calcutta Tramways Co.	Oct. 31	R32,023	R5,494	18	R584,555	+ R112,770
Camborne-Redruth	Nov. 2	107	...	52	6,187	...
Cardiff Corporation	Oct. 31	1,931	+ 376	31	62,167	+ 17,756
Carlisle Tramways Co.	,, 31	200	+ 80	¶43	8,464	+ 622
Central London Railway	,, 31	6,746	- 409	18	111,066	- 5,999
Chatham and Dist. Lt. Rys.	...	...	...	...	...	...
City & South London Rly.	Nov. 1	2,799	- 485	18	45,830	- 7,110
Cork Electric Trams Co.	Oct. 29	490	- 239	38	22,967	- 8,339
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 23	506	+ 65	42½	19,486	+ 935
Dover Corporation	,, 31	184	- 17	†31	7,650	+ 105
Dublin & Lucan Railway	Nov. 1	94	- 15	18	2,473	+ 142
Dublin Southern District	Oct. 30	741	- 28	¶17	20,163	+ 7,451
Dublin United	,, 30	3,623	- 82	¶17	71,468	
Dudley—Stourbridge	,, 23	831	+ 116	42½	35,799	+ 8,530
Dundee Corporation	,, 28	833	+ 68	...	...	...
East Ham Council	,, 31	613	+ 158	†31	21,405	+ 6,326
Gateshead & Dist. Trams	,, 23	942	+ 80	42½	37,117	+ 4,984
Glasgow Corporation	,, 31	13,996	+ 1,237	22	302,324	+ 32,903
Gravesend—Northfleet	,, 23	233	+ 36	42½	10,372	+ 1,005
Greenock & Port Glasgow	,, 23	514	+ 64	42½	23,438	+ 1,822
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 23	259	+ 46	42½	11,606	+ 657
Huddersfield	,, 31	1,225	+ 196	30	39,353	+ 6,191
Hull Corporation	,, 31	1,935	+ 202	†31	58,212	+ 8,002
Ilkeston Corporation	...	...	...	...	...	...
Isle of Thanet Co.	,, 31	357	- 23	18	20,241	- 1,029
Kidderminster & District	,, 23	111	+ 4	42½	5,575	+ 182
Kirkcaldy Corporation	,, 28	147	...	35	6,213	...
Lanarkshire Trams Co.	,, 29	596	...	§11	9,451	...
Leeds Corporation	,, 31	5,307	+ 246	31	175,259	+ 10,745
*Liverpool Corporation	,, 24	10,031	+ 112	43	434,121	+ 14,133
Liverpool Overhead Rly.	Nov. 1	1,588	+ 61	18	30,353	+ 1,985
*London County Council	Oct. 24	9,902	+ 2,855	†30	301,080	+ 52,687
Lowestoft	,, 31	175	...	†15	4,322	...
Manchester Corporation	,, 31	11,591	+ 6,275	20	240,185	+ 129,503
Mersey Railway	,, 31	1,310	+ 258	18	23,839	+ 4,533
Merthyr	,, 23	203	+ 22	42½	8,472	- 169
Middleton	,, 23	285	+ 32	42½	13,822	+ 1,700
Newcastle-on-Tyne Corp.	,, 31	3,644	+ 597	18	63,028	- 4,687
Newport (Mon.)	,, 31	414	+ 168	5	2,279	+ 899
*Oldham, Ashton & Hyde	,, 23	571	+ 19	42½	24,376	+ 1,513
Perth (W. A.) Elec. Trams.	,, 30	1,342	+ 220	§13	49,932	+ 5,271
Peterborough	,, 23	127	...	39	6,385	...
Poole and District	,, 23	274	+ 23	42½	13,202	+ 1,966
Portsmouth Corporation	,, 31	1,494	+ 117	...	...	...
*Potteries	,, 23	1,678	+ 84	42½	66,835	+ 3,497
Reading Corporation	,, 29	570	...	...	...	...
Rothesay	,, 23	46	- 1	42½	6,642	+ 1,602
Salford Corporation	Nov. 2	3,875	+ 985	31	119,364	+ 36,183
*Sheerness	Oct. 21	60	...	28	2,583	...
Sheffield Corporation	Nov. 1	4,500	+ 370	18	84,308	+ 6,340
*Southampton Corporat'n	Oct. 29	969	+ 4	...	...	...
Southend Corporation	,, 28	238	+ 31	30	11,177	+ 1,778
Southport Tramways	,, 23	274	+ 33	42½	13,648	+ 2,483
S. Staffordshire Trams.	,, 23	1,042	+ 325	42½	38,501	+ 5,977
*Sunderland Corporation	Nov. 1	1,072	+ 9	31	39,592	+ 1,957
*Swansea Trams	Oct. 28	518	+ 64	42½	22,246	+ 1,879
Taunton Trams	,, 23	53	...	42½	2,637	- 194
Tynemouth and District	,, 23	260	+ 13	42½	13,781	+ 833
Tyneside Trams Co.	,, 28	300	...	43	14,139	...
Wallasey District Council	,, 31	631	+ 84	†31	22,735	+ 2,890
Weston-super-Mare	,, 21	47	...	42	5,465	- 491
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 23	894	+ 92	42½	16,712	+ 7,435
Wrexham	,, 23	131	...	29	4,238	...
Yorkshire Woollen District	,, 23	527	...	35½	13,220	...

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed. Nov. 4.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business, Week to Nov. 4 Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4½–4¾	5 2 7	April, Oct	4⅝	4½
St.	6%	Do. Permanent 6% Deb. Stock	125 –130	4 12 4	..	..	..
10	10/0	Barcelona Tramways Ord.	7⅞–8½	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 –102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 –3	.. ..	..	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	3¾–4½	5 17 8	..	..	..
St.	4½%	Bristol Tramways and Carriage Ord.	98 –102	4 9 6	..	..	..
10	8%	Do. Cum. Pref. (fully paid)	20 –21	3 10 10	Feb, Aug	..	..
10	4%	Do. 4 per Cent. Debs.	10¼–10¾	3 15 11	..	..	..
St.	4%	British Columbia Elec. Rlwy. Def. Ord.	108 –110	3 12 8	Feb, Aug	..	..
St.	..	Do. Pref. Ord. Stock	8¼ –87	.. ..	..	..	..
St.	5%	Buenos Ayres and Belgrano Ord.	93 –96	5 6 5	..	95½	93⅜
10	4/2½	Do. 5% Cum. Perp. Pref.	10 –10¼	4 15 3	..	10 1/16	10⅛
4	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝–104⅞	4 6 7	..	..	..
10	10 0	British Electric Traction Ord.	11½–12	6 13 4	..	12	11⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	11 –11½	5 4 3	Feb, Aug	11⅝	11⅜
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –123	4 1 4	..	122½	121¾
5	..	Buenos Ayres and Belgrano Ord.	2⅜–2⅝	.. ..	..	2½	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5 –5½	5 9 1	..	..	..
5	3/0	Do. "B"	4½–5	6 0 0	..	4⅛	..
St.	5%	Do. 5 per Cent. Debs.	107 –110	4 12 1	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	99 –102	4 18 9	..	..	..
5	2 6	Calcutta Tramways	6½–7	4 12 10	..	6⅞	6⅝
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 –109	4 3 3	..	..	..
1	1/2½	Cape Electric Tramways Shares	2 –2⅛	6 13 4	..	..	..
St.	4%	Central London Ordinary Stock	95 – 98	4 2 7	June, Dec	97	95½
St.	4%	Do. 4 per Cent. Pref. Stock	99 –102	3 18 10	..	..	..
St.	4%	Do. Deferred Stock	99 –102	4 0 0	..	..	..
100	4%	Do. 4 per Cent. Debs.	116 –119	3 7 6	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 –5¼	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –101	3 19 5	..	52½	52
St.	2½%	City and South London Rly. Con. Ord.	51 –53	5 17 10	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	127 –130	3 17 3	Feb, Aug	129	..
St.	5%	Do. (1896)	126 –129	3 17 9	..	..	..
St.	5%	Do. (1901)	122 –127	3 19 7	..	124½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	110 –115	3 9 7	May, Nov	112½	112
St.	5%	†Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 –103	4 17 0	..	102	100½
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 –13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract. ofAust.6%Cm.Prf.	3½–4½	6 13 4	..	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 –98	5 2 0	..	..	..
10	3/0	†Gt. Northern & City Rly. Prf. Ord. (4%)	7⅛–8½	3 10 7	..	8	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9½–10	.. ..	..	..	..
10	10%	‡Imperial Tramways Ord	20 –21	4 18 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 –14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 –111	4 3 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾–4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 –95	4 4 3	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4½–4¾	2 12 6	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10½–10⅝	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	3 19 6	Jan, July	..	..
10	5,0	London United Trams. 5% Cum. Pref..	11½–12	4 3 4	..	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 –106	3 16 8	..	105½	104½
St.	..	Mersey Con. Ord. Stock	8 –11	.. ..	..	9	..
St.	..	Do. 3 per Cent. Perp. Pref.	12–15	.. ..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	.. ..	..	..	..
1	..	Metropolitan Electric Trams Def	3/16–1/4	.. ..	..	¼	..
1	0/6	Do. 5% Cum. Pref.	¾–1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly. St'g 5%Mrt. Dbs.(1908)	102 –104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 –107	4 4 1	..	..	..
5	..	New General Traction Ord.	⅛–¼	.. ..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2–3	.. ..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 –102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	9 –10	5 0 0	..	..	..
St.	5 0	Do. 5 per Cent. Cum. Pref.	8½–9½	5 5 3	Feb, Aug	..	..
1	4½%	Do. 4½ per Cent. Deb. Stock	104 –107	4 6 10	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	.. ..	.. ..	..	..	..
St.	..	Do. 6% Pref. (£1 paid)	.. ..	.. ..	April, Oct	..	..
St.	3½%	Do. 4½% Deb. Stock (100% paid)	.. ..	.. ..	Jan, July	..	..
		Waterloo and City Ord.	93 –96	3 7 11	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 –103	3 18 0	Jan, July	..	..
10	..	Amazon Telegraph	2⅛–3⅛	.. ..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	70 –80	.. ..	..	..	..
St.	15/0	*Anglo-American	46 –49	6 3 0	F,My,Ag,N	47½	47½
St.	30/0	Do. Preferred	91 – 93	6 9 10	F,My,Ag,N	93	91⅝
St.	1/0	Do. Deferred	7⅛–7¾	0 12 11	F,My Ag,N	7 1/16	7 1/16
100	£2	Commercial Cable Capital Stock	145 –155	5 9 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	Jn Ap,Jy,O	90½	90⅛
10	7/0	Cuba Submarine Ord. ..... xd & bonus	7 –8	10 0 0	Feb, Aug	7 1/16	..
10	10/0	† Do. Preference 10 per Cent.	16 –17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝–102⅝	4 9 0	Jan, July	..	..
20	3/0	Direct United States Cable	10¼–10¾	6 0 11	Ja,Ap,Jy,O	..	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 –102	4 8 10	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	123 –128	5 9 5	Ja,Ap,Jy,O	125½	123⅜
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 –89	3 18 8	Ja Ap,Jy,O	87½	86
St.	4%	*†Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 –107	3 14 9	May, Nov	106	104½
10	2,6	Eastern Extension	11½–12	5 16 8	Ja,Ap,Jy,O	11⅞	11½
St.	4%	Do. 4 per Cent. Deb. Stock	104 –107	3 15 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 –102	3 18 10	Feb, Aug	..	..
25	4%	† Do. 4% Mauritius Sub. Debs. (red.)	98⅝–101⅞	3 19 3	May, Nov	100½	..
10	5,0	Great Northern of Copenhagen	22½–23½	5 6 5	Jan, July	..	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	99 –102	4 8 4	June, Dec	99⅜	..
25	12 6	†Indo-European	36 –39	6 8 2	May, Nov	..	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 –102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 –100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 –6	3 6 8	..	5⅛	..
2½	..	West Coast of America	1/16–⅛	.. ..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 –98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜–½	.. ..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 – 6½	9 4 8	May, Nov	6½	..
10	..	Do. 6 per Cent. 2nd Pref.	3½–4½	.. ..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 –104	4 17 7	Jan, July	..	..
10	3,0	Western Telegraph	12 –12½	5 12 0	Mr,Jn,O,D	12¼	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 –103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 –101	3 19 8	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅜–5¼	5 14 3	..	..	..
10	2/0	†Globe Telegraph and Trust	8⅜–9¼	4 6 6	Ja Ap Jy O	8⅝	8⅜
10	3/0	† Do. 6 per Cent. Pref.	12⅜–13½	4 10 7	Ja Ap,Jy,O	12¾	..
8	4/0	Reuter's	6⅜–7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	115 –120	5 0 0	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed. Nov. 4	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business, Week to Nov. 4 Highest.	Lowest.
		TELEPHONES.					
5	6'0	Chili Telephone (fully paid)	4¾–5¼	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	99 –101	5 19 6	..	100⅜	99⅜
St.	5%	Do. Def. Stock	74 –76	6 5 0	..	75½	74½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 –14	4 5 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 –5¼	4 15 3	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	93 –95	3 14 6	June, Dec	93½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 –104	3 17 5	..	103½	103
1	0/7½	†Oriental	⅞–1	6 13 4	April, Oct	⅞	..
1	..	Do. 6 per Cent. Cum. Pref.	1 –1⅛	.. ..	..	..	..
5	4/0	United River Plate	5¼–6	5 16 8	July.....	5⅝	5 1/16
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾–5⅛	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 – 107	4 13 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅛–¼	.. ..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	116 –119	3 15 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12¾–13¼	5 18 6	..	13½	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 –11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 –106	4 5 8	..	..	..
St.	4½%	†Bromley (Kent) El. Lt. &Power 1stDebs.	100 –103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10¼–10⅜	4 3 9	..	10½	..
5	3/6	Do. 7 per Cent. Pref.	10 –10½	3 6 8	Mar, Sept	..	..
5	3/6	Calcutta Electric Supply Ord.	6½–7¼	4 6 8	..	7¼	7
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	107 – 110	3 13 2	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	9 – 9½	5 5 3	Feb, Aug	9⅜	9⅛
5	2/3	Do. 4½ per Cent. Pref.	5¼–5⅜	3 18 3	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾–5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	104 –106	3 16 2	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5½–6	4 3 4	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb Stock (red.)	108 –111	4 1 6	Jn, Dec ..	108⅜	..
10	5/0	City of London Electric Lighting Ord.	9¾–10¼	7 6 4	Feb, Aug	10 1/16	10⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 –127	3 18 11	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 –105	4 9 5	..	104½	..
10	4/0	County of London & Brush Prov. Ord.	7¼–8½	4 14 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12¾	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 11	..	..	..
St.	27/6	† Do. Second Deb. Stock Prov. Certs.	99 –102	.. ..	..	100¾	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5¾–6¼	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 –103	4 7 5	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10¾–11¼	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾–7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –104	3 16 11	..	..	..
3	..	London Electric Supply Ord.	1⅞–2⅛	.. ..	..	..	..
5	3/0	Do. 6 per Cent Pref.	5¼–5⅜	5 4 4	..	5 1/16	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	100 –102	3 18 5	Mr,Jn,S,D	..	..
10	8 0	Metropolitan Electric Sup. Ord.	17½–18¾	4 8 9	April, Oct	17⅝	17½
5	..	Do. 4½ per Cent. Cum. Pref.	4⅛–4⅜	.. ..	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –114	3 19 8	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 –100	3 10 0	..	77	..
1	6 0	Notting Hill Electric Ord.	12½–13½	4 8 11	March....	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –101	3 19 3	..	..	..
5	2 6	Oxford Electric Ord.	5¼–5¾	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 –101	4 0 0	..	..	..
1	..	Rand Electric	1/16–⅛	.. ..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	98 –100	4 10 3	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½–15½	4 13 7	Feb, Aug	15	14 1/16
5	3 6	Do. 7 per Cent. Pref.	8 – 9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 –100	3 10 2	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3 – 3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	..	..
5	1/9	South London Electric Supply Ord.	3½ – 4	4 7 6	..	3⅝	..
5	2 6	Urban Electric Supply Ord.	4⅜–5⅛	4 17 7	..	5	..
5	2,6	Do. 5% Cum. Pref.	4⅜–5	5 0 0	..	5	..
5	6/6	Westminster Electric Supply Ord.	12 – 13	5 0 0	Mar, Sept	12⅝	12⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	6 – 6½	3 16 11	..	6 1/16	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref...	½–¾	6 13 4	..	..	..
1	7½d.	Aron Electric Meter 6% Cum. Pref.	½–⅝	.. ..	Mar, Sept	..	..
5	4 0	British Insulated & Helsby Cables Ord.	6¼–6⅜	7 8 2	July, Feb	..	..
5	3'0	Do. 6 per Cent. Pref.	5¼–5½	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 8	..	..	..
St.	4½%	British Thoms'n-Houst'n4½%1stMt.Db.	103 –105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	5⅝–5¾	5 2 2	..	5¾	5 1/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	100 –102	3 18 5	..	..	..
½	..	Brush Electrical Engineering	¾–1½	.. ..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½–1⅝	6 17 2	Mar, Sept	1 1/16	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	85 – 90	5 0 5	Jan, July	..	..
5	5,0	†Callender's Cable Construction Ord.	11 –12	6 5 0	Jan, July	11¼	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5⅜	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	106 –110	4 1 10	Nov, May	106½	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝–¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	89 –94	4 16 9	..	91¼	..
1	0 7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜–2	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	100⅝–104⅞	4 16 10	Jan, July	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	½	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1¼–2⅛	.. ..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 –77	5 5 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 – 81	6 3 5	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6½–6¾	5 3 8	H'lf-yearly	6 1/16	6 1/16
†	6/0	† Do. 6 per Cent. Cum. Pref.	6 – 6½	4 12 4	..	6 1/16	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	105 –108	4 4 1	..	106½	..
2	1/2½	Electric Construction Co.	1½–1⅝	6 17 2	Jan, July	..	..
2	2 9⅜	Do. 7 per Cent. Cum. Pref.	2⅜– 3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –100	4 0 3	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅝–¾	.. ..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	½–1	.. ..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¾–10½	4 17 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 –99	4 0 10	..	..	..
5	6/0	Henley's Telegraph Works Ord.	14 –15	6 13 4	Feb, Aug	14⅜	14¼
5	2/3	Do. 4½ per Cent. Pref.	5 – 5¼	4 1 10	Feb, Aug	5⅛	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 –112	4 0 9	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½–19½	5 2 6	Feb, Aug	19½	18⅛
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 –103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾–11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 –37	6 9 8	Mar, July	35⅜	34
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –103	3 17 8	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	5¼–5¾	5 0 0	Apr, Oct	5⅛	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6¼	4 12 4	Apr, Oct	6⅛	6 1/16
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –102	3 18 10	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these

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NOTES.

In another column of this issue will be found a report of a conference presided over on Tuesday by Mr. Bonar Law, M.P., Parliamentary Secretary to the Board of Trade. The Westminster City Council is seeking to prohibit electricity supply companies, whose mains are situated within the jurisdiction of the Council, from examining their street boxes except during certain specified hours. There is no doubt that it lies in the power of the Council to make regulations in order that public traffic may not be inconvenienced, but the specific hours suggested by the Council, between which supply companies must not inspect their boxes, must receive the approval of the Board of Trade. While the continued obstruction to pedestrian traffic, caused by the opening of street boxes, is admittedly a serious evil, there is an equally serious objection to the proposal of the Westminster Council, which would allow the companies to inspect their boxes only at night or during the early hours of the morning, for the liability to failure of supply in consequence would be much increased. With reference to this point, Mr. Seale, Secretary of the Charing Cross and Strand Electricity Supply Co., very properly suggested that the undertakers' liability to supply ought to be limited in some way if irksome, and, perhaps, impossible, restrictions were placed upon them. It appears that a temporary agreement has already been come to with the Postmaster-General, but, apart from the fact that the two cases are not at all similar, it seems that the Postmaster-General has the matter entirely in his own hands. If he considers some particular case an emergency, he may go on working at the box after the "closing time," and the Council have no remedy. We trust that the Board of Trade will not sanction the imposition of regulations which might tend in any way to prejudice the efficient working of electricity supply systems.

There is no particular reason to be gratified at the success of Mr. Moffat Ford's case against the London United Tramways for exceeding the legal speed limit. The action was brought simply because he desired to show that other vehicles than motor cars are guilty of running beyond the limit, and electric tramcars were chosen as examples. But it was quite unnecessary to take any such steps, for everybody knows that motor cars are not the only offenders. Bicycles, and many horse-drawn vehicles constantly run at a greater speed than 12 miles an hour, but so long as the practice does not constitute an actual danger or nuisance our guardians of the peace cannot interefere, except in the case of tramways and motor cars. On the other hand, it cannot be denied that a large proportion of motorists are thoroughly selfish and that their behaviour is often a menace to the public safety. For this reason a distinction has rightly been made, and the authorities, in their ardour to remedy the evil, have perhaps been rather harder on some of the harmless members of the motoring fraternity than the occasion warranted. Mr. Ford's method of bringing the matter before the public is rather a childish one, and is hardly likely to assist his cause or even to result in any useful notoriety either for himself or the firm with which he is connected. We trust that his proceedings in this case have not received the sanction and encouragement of the Automobile Club.

The photometric tests of the Nernst lamps carried out by the National Electric Light Association of America, and described in another column of this issue, are exceedingly important and interesting. One peculiar feature of this type of lamp is the fact that change in candle-power is out of all proportion to change of voltage. This explains to a large extent the makers' warning that the sum of the voltages specified on the glower and auxiliary resistance should never be less than the *maximum* voltage at the consumer's terminals. The distribution of candle-power is considerably better than that given

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by an ordinary arc lamp, the greatest intensity being obtained immediately under the glower. Moreover, it possesses the advantage of being workable in almost any position.

It is pointed out in the report that the efficiency of the lamp increases with the number of glowers, and at first sight this appears a paradox when it is considered that the glowers shield each other to a certain extent. But it should be borne in mind that temperature enters very largely into the question, and since each glower radiates a considerable amount of heat to its neighbours, the phenomenon may be ascribed to the consequent increase in temperature. One point, particularly emphasised by the appearance of the curves, is the great difference caused by the use of frosted globes. Apart from the physiological effect on the eye, which is by no means small, it will be seen that much more uniform illumination is obtained. Everything depends, of course, on the use to which the lamp is to be put, but for ordinary indoor work, the tests indicate that clear globes should not be used.

Considerable dissatisfaction has been occasioned in Dublin by the action of the Corporation Electricity Department with regard to its alteration in frequency. Originally, it will be remembered, the supply was at 83 ∿ per second, but one of the changes in connection with the new station has been the adoption throughout of a frequency of 50 ∿ per second Naturally, arc lamps constructed for the higher frequency will not work well when supplied with current at a frequency 40 per cent. lower, and in consequence new arc lamps have had to be installed by a number of consumers. The Corporation, however, have left the replacement or alteration of the private arc lamps to be done by the consumers themselves, and obviously, from the consumers' point of view, this is extremely unfair. The circumstance probably arises from the fact that when a change was made in Dublin from 100 to 200 volts, the Corporation themselves made the alteration in the consumers' wiring—as has been done by other electricity supply undertakers in similar circumstances—but were surcharged with this expenditure by the Local Government Board auditor. The surcharge was remitted with a caution, and the Corporation now fear to be caught tripping again. Neither in the Electric Lighting Acts nor in the Board of Trade regulations is the contingency of a change of frequency provided for, so the Corporation feel secure in their position. This, however, is not fair to the consumers; and if the Corporation do not possess the authority to exchange old lamps for new in a case of this kind, they should have taken steps to obtain it before the alteration in frequency took place.

Herr E. Wikander, writing to the *Elektrotechnische Zeitschrift*, advocates raising the capacity of low-tension electricity distribution systems—where such an increase becomes necessary—by means of a slight increase in the supply voltage. He considers chiefly the older three-wire distributing systems at 2 × 110 volts. The writer objects to raising the voltage to 2 × 220 volts, on the ground that this would mean re-winding or replacing generators and motors, substituting for the highly efficient 110-volt lamps less economical ones for 220 volts, re-wiring in most cases, and doubling the number of cells of the storage battery. But, by raising the voltage, say, from 110 volts to 120, 125 or 130 volts, these inconveniences, Herr Wikander suggests, are avoided, especially if, as he proposes, the voltage is gradually increased in steps of about 5 volts per annum. By adopting as new pressures those cited above, the capacity of the system would be increased by 19, 29 and 40 per cent. respectively. Practically, the only addition necessary to the existing plant would be in connection with the storage battery, the number of cells of which would have to be increased accordingly. The idea is highly ingenious, but in view of the 4 per cent. clause in the Board of Trade Regulations, and the trouble which would be occasioned by notifying a new "declared pressure" yearly, we hardly think the proposal will commend itself to English central station engineers.

It appears, from the official notice in our New Companies column this week, that the telephonic apparatus industry in this country is to be extended by the establishment of a new firm—the British L. M. Ericsson Manufacturing Co. (Ltd.). From the terms of this notice it may be concluded that the company is not to be merely an agency for the sale of Messrs. Ericsson's Swedish manufactures; for, from the inclusion of a number of the National Telephone Company's Directors among the list of original subscribers, it is reasonable to suppose that the new company will take over the National Company's factory and proceed to make instruments and apparatus in England. At present there is, we believe, only one firm manufacturing large telephone switchboards entirely in England, and if the formation of the new company implies an addition to this industry its advent will be most welcome.

Faraday Club.—We regret to learn that the Faraday Club, whose quarters have been at the St. Ermin's Hotel, London, S.W., was closed on November 11th.

Royal Society.—The announcement is made that Sir Michael Foster intends to retire from the senior secretaryship of the Royal Society on November 30th.

Medical Applications of Radium.—A quantity of radium has been placed at the disposal of a member of the staff of the Cancer Hospital, Fulham-road, S.W., and arrangements are being made for an extensive trial of this new method of treatment.

Royal Society Medals.—The list of awards of medals by the Royal Society has been published. The Davy medal has been awarded to M. Pierre and Mme. Curie for their researches on radium, and the Hughes medal to Prof. Wilhelm Hittorf for his long-continued experimental researches on the electric discharge in liquids and gases.

Society of Arts.—The opening meeting of the one hundred and fiftieth session of the Society of Arts will be held on Wednesday evening, November 18th, when an address will be delivered by Sir William Abney, K.C.B., F.R.S., vice-president and chairman of the Council. On November 25th, at 8 p.m., a Paper on "The Universal Exhibition at St. Louis, U.S.A., 1904," will be read by George F. Parker, when the Lord Chief Justice will preside. Sir William Preece, F.R.S., will read a Paper on "Science and Industry" on December 16th, and, after Christmas, Prof. Vernon Boys, F.R.S., will read a Paper on "Thermit." Three Cantor lectures on "Recent Advances in Electro-chemistry" will be delivered by Bertram Blount on March 7th, 14th and 21st.

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Opening of the Swansea Municipal Telephone Exchange.—A municipal telephone exchange was opened in Swansea on Thursday last week in competition with an exchange owned by the National Telephone Co. which has been in operation for several years. The new exchange is a small one, the switchboard being only designed for the accommodation of 750 lines at present with an ultimate capacity of about double that number. A "ring through" system has been adopted.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Guadeloupe—Martinique	May 9, 1902
Anjer—Kalianda	Aug. 2, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Paramaribo—Cayenne	Feb. 27, 1903
New York—Hayti	Apr. 13, 1903
Trinidad—Demerara	Oct. 23, 1903
Tourane—Amoy	Nov. 10, 1903

Proposed Electrical Examiners in Chicago.—It is announced by the *Western Electrician* of Chicago that at a recent meeting of the Chicago City Council an ordinance was introduced and referred to the judiciary committee, providing for the establishment of a board of electrical examiners. The proposed ordinance provides that it shall be unlawful for any person, firm or corporation to engage in the business or have full charge of electrical machinery for furnishing light, heat, power or transmission within the city without a "licence for chief mechanical engineer," costing $10. It is made unlawful also to operate an electric light, heat or power plant without first having a "licence for operating electrical machinery," costing $1. There is constituted a board of electrical examiners, to be composed of one dynamo tender, one switchboard tender and one person selected by the city electrician.

Liverpool University.—On the occasion of the formal inauguration of the University of Liverpool, which took place on Saturday at St. George's Hall, the Lord Mayor (Mr. Watson Rutherford, M.P.) presented the charter to the chancellor, the Earl of Derby. In the course of a speech Sir Oliver Lodge said he regretted that the registration duty, which was doing no harm, and which was hardly a subject of controversy, should have been flippantly thrown away instead of being ear-marked for higher education. The amount would have been sufficient to put the education of the country on a sound, thorough and magnificent basis, and would have enabled us to hold up our heads once more among the educated nations of the world. If our people were not highly trained in science no artificial scheme of salvation would long preserve our industries, and something would have to be done before long.

The Birthday Honours.—The following names appeared in the list of honours on the occasion of the birthday of His Majesty the King:—A knighthood was conferred upon Prof. C. le Neve Foster, F.R.S. Mr. Thomas Pitts, Assistant Secretary to the Local Government Board, was appointed a Companion of the Bath (Civil Division). The following were appointed Companions of the Imperial Service Order:—W. D. Cramp, Deputy Chief Inspector of Factories; W. C. B. Hall, Assistant Director of Contracts to the Admiralty; H. Hatfield, Chief Examiner, Patent Office; H. Hautrive, late Clerk, Secretary's Office, Post Office; E. W. Pike, late Postmaster, House of Commons; T. Stevenson, Postmaster, Newcastle-on-Tyne. The Imperial Service Order has also been granted to 176 members of the Civil Services of the Empire on their retirement after 25 years' service or more.

Emergency Lighting for Tramcars.—A new automatic switch is being manufactured by Mr. H. McGillivray of Newcastle-on-Tyne, the object of which is to switch on lights in a tramcar automatically if the trolley comes off the wire or the main supply is interrupted from any cause, so that the car should not be left in darkness. The ordinary lamps of the car are connected in series with a battery and an electromagnetic device, by means of which the circuit containing the emergency lamps is held open. When the trolley is on the line, current flows through the ordinary lamps and charges the battery, returning to earth through the car wheels in the ordinary way. If the trolley comes off the line, the armature of the electromagnetic device is released and the emergency circuit closed. A similar device is made for theatres, and in this case the coil of the electromagnet is simply connected across the main circuit through a resistance.

Mercury Vapour Lamps.—We have received from the Cooper-Hewitt Electric Co. of New York a pamphlet and price list relating to the Cooper-Hewitt mercury vapour lamps described in *The Electrician*, Vol. L., p. 509. From this pamphlet it appears that the lamp is now on the market in a commercial form for various purposes, including private and public lighting and photographic work. Copies of testimonials from printers and photographers are given, and it seems the unanimous opinion that the lamp is superior to other forms of illumination for offices and workshops, in addition to being admirably suited to all kinds of photography. It is said that it does not affect the expression of the face, although it is equal to daylight, and, in certain cases, prints three times as fast. Type V4 lamp has, it is stated, an average life of 1,600 hours, and is intended to be run singly on 50—60 volts, two in series on 100—120-volt circuits, or four in series with 200—240 volts. This particular lamp can only be started by the tilting method (see *The Electrician*, Vol. LI., p. 917), and is to be suspended at an angle of 20deg. from the ceiling, or fastened to the wall. It is recommended for offices and general interior lighting when it is not desired to have a lamp of very high candle-power. The current taken is 3 to 3·5 amperes, the length of light-giving tube on a 50-volt circuit is 18in., and on a 100-volt circuit 21in., while the respective over-all measurements are 25in. and 28in. At 60 volts the lamp gives a candle-power of 300, and the diameter of the tube is 1in. A complete outfit is listed at $30, while each new lamp costs $8. No mention of the colour difficulty is made in the pamphlet.

Edison Accumulators.—The *Electrical World* of New York states that a Mr. H. M. Wilson, driving a Columbia service waggon used by the Edison Electric Illuminating Co. of Boston, arrived at Central Bridge, New York City, at 4 p.m. on Saturday, October 24th, after a run that had occupied nearly four days. The machine was equipped with the new Edison storage battery, to test which the trip was partly undertaken. Two records were established for electric vehicles for the 245-mile course, one being the time from Boston and the second the total cost for re-charging en route, both of which were considerably lower than the record established a few days previously by F. A. Babcock in a Buffalo electric surrey. Mr. Wilson stated that the total cost of re-charging was $7.50, or one-half of that of Mr. Babcock's trip. Mr. Wilson left Boston at noon on Tuesday, and his night stops were at Worcester, Springfield, New Haven and Stamford. The batteries were charged at Worcester, Springfield, Hartford, New Haven, Bridgeport and Stamford, all being short charges, averaging two hours at high rate. The longest run on a single charge was 53 miles, from Worcester to Springfield, and the machine could then have gone on for at least 10 miles. The formidable Leicester Hill, of 18 per cent. grade, on the run to Springfield, was successfully climbed, though the rate of discharge was as high as 102 amperes. According to Mr. Wilson, the trip proved to his satisfaction the durability and flexibility of the new battery. The only trouble was with hot motors on the heavy roads near Port Chester on Saturday afternoon, when a stop was made to take off and clean the rear wheels and gears. The vehicle weighs 2,500lb., and the wheels are fitted with solid tyres. So far as known, the batteries came through in splendid condition. A notable feature is the general ease and facility with which charging arrangements can now be found along this and other routes.

Glasgow Local Section of the Institution.—The second annual dinner of the Glasgow Local Section of the Institution of Electrical Engineers took place at the Grand Hotel, Glasgow, on November 4th. Mr. W. A. Chamen, chairman of the section, presided, and among those present were the Lord Provost, Sir John U. Primrose, Mr. R. Kaye Gray, Mr. W. G. McMillan, Mr. W. R. Copland, chairman of the Glasgow Technical College, Mr. John Young, Mr. M. B. Field, and

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Mr. E. George Tidd, hon. local secretary. The toast of the "Lord Provost and Corporation of Glasgow" was proposed by ex-Provost Wood, and suitably responded to by the Lord Provost. Mr. W. R. Copland proposed "The Institution of Electrical Engineers," and Mr. R. Kaye Gray, in replying, said the parent institution viewed the development of the local sections with considerable favour. The profession of electrical engineering was as well equipped as any other profession in Great Britain; other branches of engineering were more or less fettered by conventionalities. He looked upon Glasgow as the cradle of the electrical industry. Mr. W. G. McMillan proposed the "Glasgow Local Section," and said the local sections were as colonies to the parent institution, and the latter was anxious to render them every possible assistance. The Glasgow section he considered one of the strongest in the country. Much praise was due to the chairman, Mr. Chamen, and to Mr. Tidd, the hon. secretary. Mr. Chamen, in replying, said he thought that as the members of the local sections were not usually so highly technical as their brethren in London it would probably be wise to encourage the reading of Papers before the local sections of a less highly technical nature than those read in London. In any case, the local sections did a good work if they merely got the members together and induced them to discuss matters of professional interest over a cup of coffee and a smoke. Between the speeches music was contributed, and the evening passed off very pleasantly.

German Fire Insurance Companies' Rules.—The "Vereinigung der in Deutschland arbeitenden Privat-Feuerversicherungs-Gesellschaften" (Union of the private fire insurance companies working in Germany) have decided to adopt, from January 1st, 1904, the regulations drawn up by Dr. Oscar May, which are a revised form of those compiled by the same engineer some 12 years ago. These new rules are even less elaborate and exacting than those of the Institution of Electrical Engineers in this country. No mention is made of the maximum pressures allowable in supply circuits, so that, apparently, no restrictions are to be enforced in this direction. Bare conductors are only prohibited in living rooms and in places where highly inflammable materials are manufactured or stored. Twin flexible cable is totally debarred from rooms where explosive mixtures may form or accumulate. No kind of electrical machinery or instruments is permitted in such rooms unless they are hermetically enclosed. In all installations the normal voltage and current have to be marked on every switch. Wood casing is forbidden. Conductors may be connected to one another either by soldering or by any other equivalent mechanical method. Portable electrical apparatus must be connected to the supply by means of plug-contacts. No given current densities are insisted upon, but the heating of the conductors must be kept so low that on touching with the hand no considerable rise in temperature is detected. In three-wire continuous-current systems the middle wire is to be earthed, and no fuse must be connected in it. Several circuits may be protected by one fuse, provided the latter is designed for a normal current not exceeding 6 amperes. The fuses are to be dimensioned so as to blow at double the normal current, and means have to be adopted so that fuses designed for larger currents cannot be inserted in place of low capacity ones. No definite figures as to the permissible maximum of leakage or the minimum of insulation for a finished installation are given, but after completion the plant is to be examined by experts, and periodic inspections—at least once a year—are to be made. The above particulars apply to the bulk of electrical installations with ordinary fire risks; special cases (in connection, for instance, with theatres, shop-window lighting, &c.), are considered separately and according to their nature.

Electrically Operated Regulator for Superheaters.—The *Western Electrician* of Chicago states that Prof. Elihu Thomson has recently invented a combined boiler and superheater to be used in steam automobiles, where it is well known that the best practicable efficiency is none too high. The valve mechanism is operated electromagnetically. In a boiler using liquid fuel, such as gasoline or kerosene, this invention finds application. It is desirable in running an automobile that when the speed is greatest, and therefore the power required greatest, the steam supply should be a maximum. To bring this about, Prof. Thomson has so constructed his apparatus that when most power is required a maximum supply of fuel and water shall be given to the boiler. Water is supplied from a tank by a pipe, and after passing through a pump, which is driven from an eccentric on the shaft, it passes through the pipe into the superheater. Here the pipe loops around in the fire chamber and passes out again, the water entering the superheater, and after passing through the loops coming out as superheated steam. The supply of fuel for the burners in the heating chambers is also pumped from the same eccentric, and therefore the faster the machine is running the faster the water and fuel will be pumped to supply the increased steam demand. Between the water pump and the loops in the boiler and between the fuel pump and the burners are electrically operated valves which are simply solenoids so arranged that when the current is turned on a little steel ball is pulled up on to its seat, and the supply of water or fuel, as the case may be, is shut off. These solenoids are connected to a battery and contact is made for the circuits by a thermostat. This thermostat is attached to a straight portion of the steam pipe after it leaves the superheater, and is so arranged that upon the expansion of that part of the pipe, caused by undue overheating, a contact is made in the circuit controlling the fuel valve and the valve is closed, or nearly closed, allowing the vapour to cool down to a certain extent. On the other hand, if the pipe contracts on account of insufficient heating of the steam the other contact is made and the water is shut off by the water valve and the fire left on, which immediately superheats the steam to the proper degree. As the contacts are adjustable, the water and fuel supply may be fed at a rate to approximate ideal running conditions.

Wireless Telegraph Notes.—*The Times* of November 10th states that during Mr. Marconi's voyage to Gibraltar on board H.M.S. "Duncan," from October 24th, the date on which the vessel left Portsmouth, messages were received on board daily. The weather was exceedingly rough in the Bay of Biscay, and one of the special wireless telegraph gaffs which had been fitted to the topmasts to support the elevated conductors connected to the special Marconi instruments was carried away. Notwithstanding that this mishap necessitated a considerable reduction in the height of the masthead wires, the reception of messages on board continued in an uninterrupted manner. The messages generally consisted of ordinary current news bulletins and a few private messages; but on October 28th, the day the ship arrived at Gibraltar, an official message of instructions to Capt. Jackson from the Admiralty was received on board. During the stay of the "Duncan" at Gibraltar, from October 28th until November 3rd, various other tests were carried out with the object of ascertaining the relative efficiency of different forms and arrangements of aerial wires. Messages were always received at the anchorage from England with regularity when the arrangement which Mr. Marconi had anticipated would be necessary for the purpose was used. Numerous tests were also carried out between Poldhu and the Marconi naval station situated on the Rock of Gibraltar. Messages were correctly received at this station (notwithstanding that the whole of Spain intervened between it and the station in Cornwall) in the presence of Rear-Admiral Sir William Acland, Capt. Jackson, and several other officers. On November 3rd a complimentary messsage was received at the Gibraltar wireless station from the directors of the Marconi Company addressed to his Excellency the Governor of Gibraltar and duly delivered. These tests were watched on board the "Duncan," on behalf of the Admiralty, by Capt. Jackson, and at the Poldhu station by Lieut. F. G. Loring, R.N. It was ascertained that the ordinary short-distance Marconi instruments supplied to the Admiralty were not interfered with or affected by the action of the electrical waves radiated from Poldhu.

A Reuter telegram from Rome states that the work of constructing a large wireless telegraph station at Bari is far advanced, and the station may be opened towards the end of the present year. This station will be able to communicate

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with the other stations established along the Italian coast, with vessels in the Adriatic and with the Montenegrin station at Antivari, where the work of installation will be commenced in a day or two. The wireless telegraph stations at Maddalena, Monte Mario, near Rome, Palmaria, Cozzo and Spadafora are already working. The first two are exclusively intended for military purposes; the other two will also be open to the public. Another station will be opened immediately at Santa Maria di Leuca. The site for another powerful Italian station has been definitely chosen at San Rossone, where the Villa Royale has been selected. It is said that this station will be able to communicate not only with Argentina, but also with the stations at Table Head, Cape Cod and Poldhu. With an expenditure not exceeding 100,000 lire (£4,000) communication can also be established with Massowa (Eritrea). It is added that the rate for wireless telegrams between Italy and England "is expected to be 10 centimes (or 1d.) per word, and for telegrams to Canada and the United States, 30 or 40 centimes (3d. or 4d.) per word." Negotiations for a station in Argentina are reported as being in an advanced state.

The erection of a new Marconi station has been commenced at Fraserburgh on the Aberdeenshire coast, for the purpose of testing the large power stations overland.

In the report of the Indian Telegraph Department for the year 1902-3 it is stated that wireless telegraphy has been established between Sangor Island and the Sandheads, and difficulty is only experienced during thunderstorms.

Electrolytic Copper Refining.—Prof. W. D. Bancroft read a Paper on this subject before a recent meeting of the American Electrochemical Society, in which he stated that in determining the best conditions for the electrolytic refining of copper, the cost of the power necessary to precipitate a tank full of copper under different current densities and at different temperatures must be considered. The cost of heating the tank, the deterioration of the electrolyte, the interest charge on the copper in the tank, the cost of pumping, and the quality of the copper deposited, were also factors of the problem. Good adherent copper could be obtained at almost any current density, provided the rate of circulation was sufficient. To operate at a temperature of 90°C. and a low-current density was entirely out of the question, not only on account of the cost of power to heat the solution and precipitate the copper, but also on account of the deterioration of solution, which took place very rapidly under these conditions. At this high temperature and the higher current densities, the cost rapidly approached a minimum, but here also the deterioration probably more than offset the advantage of reduced cost of power. To operate at 20°C. was not so costly as would seem at first thought. The cost was maximum at the lowest and the highest current densities, reaching a minimum between 2¼ and 2½ amperes per square decimetre. At 50°C. it would not be economical to operate at 1 ampere per square decimetre, but the cost dropped off very rapidly between 1 and 2 amperes. At the higher current densities the cost fluctuated but very little, reaching a minimum at about 2½ amperes per square decimetre. The results at 70°C. seemed the most satisfactory, and it was at this temperature that the best results would be obtained. Although the cost ran very high at this temperature for a current density of 1 ampere per square decimetre, it began to drop off very rapidly as the current density increased, until it assumed a practically constant value at the higher current densities. Between 3·5 and 3·75 amperes per square decimetre would be the best current density for obtaining economical results, for at this density no extra power would be required to heat the solution. Operating at this current density, and with the tanks covered, the current alone would be sufficient to heat the electrolyte to over 80°C. In order to secure a good circulation, essential for a good deposit with high-current densities, the present method of pumping could be retained. If the gutters leading to and from the pump were properly insulated, the solution would not drop below 70deg. before returning to the tanks. Moreover, running at this high-current density, there would be a considerable saving in the first cost of the plant, inasmuch as fewer tanks would be needed for the precipitation of a given amount of copper in a given time. The lower the cost of heating, the greater the advantage of a high temperature. Lowering the rate of interest decreased the advantage of a high current density. With covered tanks it would be possible for men to work in the tank room even with the electrolyte at 70°C. It had been suggested by various people that covering the tanks would interfere with detecting short-circuits, but this point seems insignificant. If the covers were so arranged that they would swing or lift open easily, the only difference would be the slight extra time necessary to remove the covers. Comparing the cost of working under so-called standard conditions of open tanks, a current-density of 14 amperes per square foot, and a temperature of 50°C., with the cost of working with covered tanks at 70°C. and a current density of 3·5 amperes per square decimetre (31·5 amperes per square foot), the saving by the latter method would be very close to $1 a ton of refined copper with all power at $20 per horse-power-year. Therefore, in order to operate a plant most economically, copper should be refined electrolytically under the following conditions:—(1) Covered tanks; (2) current density, 3·5 amperes per square decimetre; (3) temperature, 70°C.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

To-day (FRIDAY), November 13th.

North-East Coast Institution of Engineers and Shipbuilders.

7:30 p.m. General Meeting in the Literary and Philosophical Society, Westgate-road, Newcastle-upon-Tyne. Included in the business of the evening will be a Paper on "Technical Education in Germany," by Mr. Max Wurl.

Electro-Harmonic Society.

8 p.m. Concert (Ladies' Night) in the King's Hall, Holborn Restaurant.

Physical Society.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "Means of Electrifying the Atmosphere on a Large Scale," by Sir Oliver J. Lodge, F.R.S. (2) "An Arrangement for Driving Mercury Pumps," by Sir Oliver J. Lodge, F.R.S., and B. Davies.

SATURDAY, November 14th.

Glasgow Technical College Scientific Society.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read: "Motor Cars," by A. Govan.

MONDAY, November 16th.

Institution of Electrical Engineers: Newcastle Local Section.

7:30 p.m. Opening meeting of the session at the Durham College of Science. Mr. Gerald Stoney, the chairman, will deliver his address.

TUESDAY, November 17th.

Institution of Electrical Engineers: Manchester Local Section.

7:30 p.m. Meeting at Owens College, when Mr. E. W. Cowan, the Chairman, will read his Inaugural Address. Dr. Schuster will afterwards give a short demonstration of the Properties of Radium.

WEDNESDAY, November 18th.

Institution of Electrical Engineers: Students' Section.

7:30 p.m. Meeting at 92, Victoria-street, S.W. The Paper has not been announced.

Liverpool Engineering Society.

8 p.m. Meeting at the Royal Institution, Liverpool. Paper to be read: "Fuel Economy from the Chemical Point of View," by J. B. C. Kershaw.

Society of Arts.

8 p.m. Ordinary Meeting. Opening Address of the 150th Session, by Sir William Abney, F.R.S.

THURSDAY, November 19th.

Institution of Electrical Engineers: Leeds Local Section.

7:30 p.m. Meeting at the Yorkshire College, Leeds. Paper to be read: "Destructor and Electricity Stations in Small Towns," by S. D. Schofield.

FRIDAY, November 20th.

Institution of Mechanical Engineers.

8 p.m. Meeting at Storey's-gate, St. James's Park. Papers to be read: (1) "Roofing Existing Shops while Work is Proceeding," by R. H. Fowler. (2) "Experiments on the Efficiency of Centrifugal Pumps," by T. E. Stanton.

Junior Institution of Engineers.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "Fires on Shipboard, their Chief Causes and the Method for Prevention and Extinction," by G. Canning.

SATURDAY, November 21st.

Junior Institution of Engineers.

2:30 p.m. Visit to Orchard Dock, Blackwall, to witness a demonstration of fire extinguishing, &c., by the Clayton Company.

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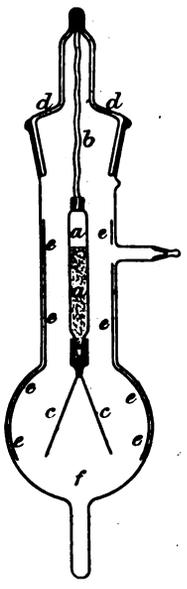
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Spinthariscopic Phenomena.—H. Becquerel has studied the phenomenon described by Sir W. Crookes in order to determine to what kind of radium rays it is due, and what physical process the scintillations represent. For the screens he used the hexagonal zinc blende or diamond dust. In a strong magnetic field he found that the rays producing the scintillations were not deflected. This confirms Crookes' supposition that the rays producing the sparks consist of positive electrons. As regards the nature of the scintillations, they are in general the more pronounced and vivid the smaller the crystals are which compose the screens. If a comparatively large crystal is placed near a grain of sodium chloride it becomes phosphorescent, and shows a general luminosity without sparks. Occasionally a luminous point appears on the fragment, grows, and then slowly disappears, sometimes recurring several times in the same place. If the same crystal is broken into smaller fragments, certain pieces present several variable points of light, and on powdering the fragments the usual Crookes phenomenon is produced. These facts go to show that the sparks are most likely due to cleavages taking place in the crystal, and not to the mere impact of the positive ions. There is here an obvious analogy with the scintillations observed on breaking a piece of sugar.

[H. BECQUEREL, *Comptes Rendus*, October 27, 1903.]

Loss of Negative Electricity by Radium.—R. J. Strutt describes a simple apparatus which exhibits in a permanent and striking manner the dissipation of negative electricity from radium by the cathode rays evolved by it, and the accumulation of a positive charge. A thin-walled glass tube, *a*, hermetically sealed, contains the radium preparation. It is supported from above by the quartz rod *b*. From the bottom end hang a pair of gold or aluminium rods *cc*. The glass tube *a* is smeared over with a conducting coating of phosphoric acid, and the whole system hangs from the stopper *d* of the glass bulb *f*. Strips of tinfoil, *ee*, at the sides of the bulb are connected to earth. As long as the air remains in the bulb no divergence of the leaves is observed, since the radium rays make this air a conductor. But if a good vacuum be made in the vessel the leaves soon begin to diverge, owing to loss of negative electricity by the radium. This divergence increases until the leaves touch the tinfoil strips. When this happens they are discharged and collapse, and the cycle recommences. With a weak radium preparation the author obtaineda full divergence in about 20 hours. But with a more preparation a active cycle should be completed in the course of a lecture.



[Hon. R. J. STRUTT, *Phil. Mag.*, November, 1903.]

Ionisation by Positive Ions.—In *The Electrician* of April 3, 1903, J. S. Townsend gave an outline of a method by which some properties of positive ions may be investigated. He now gives a fuller account of the theory of the genesis of ions by positive ions and its application to experiments which have been made with air and hydrogen. The theory is founded on the determination of the conductivity produced between parallel plate-electrodes when ultra-violet light falls on the negative plate. The investigations show how the potential required to produce a continuous discharge may be found by this theory, assuming that all the ionisation is produced by collisions of positive and negative ions with neutral molecules in a uniform field of force. There is a very accurate agreement between the potentials thus calculated and the sparking potentials determined experimentally. It requires much larger forces to develop new ions by the motion of positive ions in air than in hydrogen. If the positive ion be regarded as being approximately the same size as the molecule of the gas in which it is generated, the free paths of a positive ion in hydrogen would be 1·85 times as long as the free paths of a positive ion in air at the same pressure, this number being the ratio of the mean free paths of molecules in hydrogen and air. For a force of 370 volts per centimetre there are about nine times the number of ions produced in hydrogen as in air for the same number of collisions and the same falls of potential between the collisions.

[J. S. TOWNSEND, *Phil. Mag.*, November, 1903.]

Charge by Ion Absorption.—Of the numerous theories framed to account for the permanent negative charge on the earth's surface none has been so generally accepted by geo-physicists as that due to Elster and Geitel, which ascribes the phenomenon to a charging of the surface through absorption of ions from the surrounding atmosphere. G. C. Simpson, however, points out that it rests upon an experiment by Zeleny which had a different result when repeated by Villari. He therefore undertook a series of experiments to find the conditions under which a conductor can become charged, and to what extent, in consequence of ion absorption. He proved first of all that Villari's explanation of the better absorption of negative ions by metals as depending upon the friction of the gas against the metal is erroneous, and that Zeleny's results are best accounted for by ascribing a higher rate of diffusion to the negative ions. He demonstrated this higher rate of diffusion by the novel expedient of sending out vortex rings from a box in which the air had been highly ionised by means of Röntgen rays. When the rings impinged on a cage 20cm. away and connected with an electrometer, a positive charge was indicated, owing to the negative charge having been diffused on the way. But in naturally ionised air, no "absorption of negative ions" can be detected such as is supposed to account for the earth's permanent charge. All charges apparently produced in that manner are really due to the Volta effect.

[G. C. SIMPSON, *Phil. Mag.*, November, 1903.]

Water Radio-activity.—E. P. Adams has studied the nature of the radio-active gas found in Cambridge tap-water by J. J. Thomson, and has found that it possesses properties remarkably similar to the emanation of radium. The value obtained for the rate of decay is in sufficiently good agreement with that of radium emanation to make it very probable that the radio-activity of the gas is actually due to radium emanation. The conductivity produced in air by bubbling through tap-water is probably due to the same cause as the conductivity of the dissolved gases in water. Contrary to the opinion of Rutherford, the author succeeded in showing conclusively that a small amount of radium emanation can be absorbed by water. But this can be entirely got rid of by boiling, whereas tap water behaves as if, in addition to dissolved emanation, it contained an extremely minute quantity of a radium salt in solution. All attempts to evaporate a large quantity of water to dryness, and to find any radio-activity in the solid residue, have so far failed. But the evidence for the presence of the radio-active salt is indirect. If a flask of tap water is closed up air-tight and allowed to stand for several days, it is found that the rate of decay of its radio-activity is considerably less than that of the gas driven out of it. In fact, on one or two occasions the radio-activity actually increased on standing.

[E. P. ADAMS, *Phil. Mag.*, November, 1903.]

Influence of Electrons on Colloidal Solutions.—W. B. Hardy describes a remarkable effect of radium rays in producing a colloid substance. Specially purified globulin from blood was dissolved (*a*) in a trace of acetic acid, (*b*) in a trace of sodium hydrate. In presence of acetic acid the globulin was found to move in an electric field from anode to cathode, in presence of alkali it moved from cathode to anode. In the former case, therefore, the globulin particles carried a positive charge, in the latter a negative charge. These two solutions were exposed to the radiations from radium bromide, and it was found that the electro-negative solution of globulin was turned into an opaque jelly in three minutes, while the electro-positive solution became more mobile and less opalescent.

[W. B. HARDY, *Proc. Camb. Phil. Soc.*, October 21, 1903.]

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MR. ROBERT KAYE GRAY'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.*

Gentlemen, another session has opened, and another president addresses you, the twenty-eighth person who has had this privilege. On this occasion one of our usual forms of procedure must be dispensed with, or I should have to fill the rôle of vacating the chair in my own favour. You will remember that Mr. Swinburne, who gave us an extremely interesting and valuable address a year ago, resigned the presidentship two months before his term was completed. This he did in order to permit a telegraph man to be at the head of the Institution during the recent International Conference in London, to which telegraph delegates from foreign Governments were invited. For obvious reasons, I cannot criticise Mr. Swinburne's action in this matter, but I feel at full liberty to say that the manner in which he carried out what he thought to be the best interests of the Institution was accomplished with great consideration, and for this, so far as it affected me personally, I tender him my sincerest thanks. You, gentlemen, have placed me in the honourable position which I now fill, but the honour which you have conferred is one that carries with it a responsibility which might better have been confided to other hands.

The Institution is ever growing, and shows the life that dwells in every healthy hardy plant which from a seedling becomes a well-grown tree. Not one of the founders of the Institution in 1871 could have foreseen the developments of a third of a century later. The guidance of your former presidents and Councils have been wise, and it is for us to follow in their footsteps with the same open minds which have led to the consolidation of many diverging interests into one complete whole. We are under a debt of gratitude to the Institution of Civil Engineers for many advantages they have conferred on us, and not the least is the cordial hospitality they give us in their magnificent building. Your successive Councils have continually had brought to their notice the desirability of our Institution possessing a permanent habitation, and it is believed this feeling is general among the members. I take this opportunity of stating that in deference to this view a site has been acquired which, in the opinion of the Council's technical advisers, will amply suffice for the erection of an Institution building in which a suitable lecture theatre and other necessary offices could find place. Your Council has no intention of proceeding with the construction of the Institution building until they believe the Institution to be strong enough financially to meet the necessary expenditure while remaining in possession of a handsome surplus. It is also thought that developments in the near future may permit of an alliance with kindred institutions for the erection of one large temple of engineering, where the various branches may find their homes. A portion of this building could be allotted to the joint occupation of the various sections of engineering, and each section could, in addition, possess the accommodation it might require for its own particular work, a senate or court of governors appointed by the sections being constituted the supreme body. I understand that the late Sir William Siemens had such a conception, and perhaps its realisation may now be within the range of practical politics. In the event of such a scheme maturing, the property in Tothill-street, which the Institution has acquired, can be sold, as it will always be a realisable asset so long as no special building is erected on it. A temple of engineering costing a quarter of a million would be a fit home for the engineering bodies of this country

Many opinions have been advanced as to the scope and aim of an institution such as ours—as to what it should do and what it should not do, and as to its relations with kindred societies. This, of course, is contentious matter, and should not, probably, be touched in an address, but I take advantage of the immunity from criticism in this room which my position to-day grants me, and will make a few remarks on the subject In early days the Institution was the only Association or body which could voice the views of electrical men, and therefore everything touching their interests was fit matter for discussion. To-day the necessity is not so imperative, as, owing to the great development of the electrical industry, other bodies are springing up who can more properly deal with a variety of questions which affect, but only indirectly affect, the Institution as an Institution of Electrical Engineers. As time goes on, this necessity will become less and less, and the Institution will fall back into its proper function as an Institution of Electrical Engineers, and will not fill the part of an Association of Electrical Engineers, which it has often been obliged to do in the past. The word "institution" in this connection bears in my mind the meaning of a body for dealing with technical interests, while "association" implies a corporation whose functions are related to everything affecting general interests. I hope that the Institution, for some time yet, will continue to take an interest in things general as well as technical, and conserving the open mind and progressive spirit, to which I referred in my preceding remarks, will assist in every reasonable way the aspirations of the different electrical associations which are being formed from day to day. These associations must not be looked upon as rival or interfering bodies, but rather as bodies formed to meet a real want, and from that point of view deserving every assistance and encouragement from the older body. There is one more point in this connection which from time to time provokes comment and criticism, and that is that many members of this Institution contribute Papers to the Institution of Civil Engineers and other bodies which, in the opinion of the critics, should have been presented to this Institution. I do not think this is a fair or a wise criticism. People, readers of Papers or others, will always carry their wares to the best market, and the only effective way of dealing with the situation is for the members and officers of this Institution to strive to make our market the best. Those who read Papers on electrical subjects in other institutions are in reality doing a great good to the electrical industry and to this Institution, as they play the part of the missionary who goes out into the wilds, spreads the light and eventually gathers converts into the fold. I therefore say that our members who read Papers before other institutions or societies are well-doers, and should not be submitted to the unfair criticism which emanates from a spirit akin to some of the elements of trade unionism, and is much to be deprecated. While admitting the desirability of the existence of these electrical missionaries, I also urge that the members and officers of the Institution should leave no stone unturned in their search for what is good and useful to the Institution. Our predecessors have done this, and the task of the present Council and members should be much easier than the task which their forerunners have performed. What they accomplished is made clear by a reference to our membership. An institution, which in 1871 numbered 80 persons, and to-day numbers 4,800, has every reason to be proud of its development and growth. It is my belief that the Institution will continue to develop, and if it is governed in a tolerant and broad-minded spirit will never cease to be the referee in all cases affecting electrical science and industry.

I now propose to lay before you some matter I have had collected relating to the effect that existing legislation has had on electrical enterprise, and containing a few suggestions for the betterment of the present situation. As the generation and supply of electricity for lighting, power, or traction are strictly regulated by Act of Parliament, it is obvious that electrical progress must be seriously affected for good or for evil by the state of the law relating to electricity. It is impossible to attempt here to cover the whole field of electrical legislation, but attention may be directed to one or two special points.

If we omit the Electric Lighting (Clauses) Act of 1899, which merely codifies the provisions usually incorporated in a provisional order granted by the Board of Trade, we find that there has been no public legislation upon the generation and distribution of electricity since 1888, when an act was passed to amend certain defects in the original Act of 1882. This absence of legislation during a period in which the applications of electricity to the service of mankind have been enormously improved and extended, would not be remarkable if the original acts had been adequate, not only to the needs of the time at which they were passed, but to those of the present day; but, as every one knows, this is far from being the case. Those statutes were framed to meet the case of distribution of electricity over a small area, and no provision was made for the time, which has long since arrived, when it would be possible and even economical to distribute from a given centre over a wide area, extending far beyond the boundaries of any particular parish or municipality. There might still have been a chance that the parochial idea embodied in these early statutes, would, in the course of time have been abandoned, had not Parliament fixed this idea as a permanent feature of British electrical distribution by giving to the local authorities the right of purchase of the undertakings supplying their areas after a period which was first stated at 21 years but afterwards extended by the Act of 1888 to 42 years. In addition to this, the Act of 1888, although intended to promote the introduction of electric lighting, went far towards stifling private enterprise in this direction, by giving to the local authorities a veto on any petition to supply electricity within their areas. Thus it came to pass that in spite of the great progress made since 1888 in the science of distribution, no one but a local authority can to-day obtain free unimpeded access to the Board of Trade with a petition for a provisional order, and as local authorities are as jealous of one another as they are of private companies, the general result is that the municipal area is still the unit area for distribution.

There are, of course, many other prominent defects in the Electric Lighting Acts. They do not, for example, provide for the compulsory purchase and sale of sites for generating stations, nor yet for the erection of these stations outside the area of supply. If promoters of an undertaking desire either of these things they must proceed by special act, not by provisional order; and the best proof of the inadequacy of the Electric Lighting Acts to modern needs is that these private acts usually contain special clauses, of which the

* Delivered last night.

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object is to render inapplicable a larger or smaller number of the sections of the controlling public statutes. The whole subject was considered in 1898 by Lord Cross's Committee, which made many recommendations of the highest value—among them the abolition of the veto and the removal of the defects just noticed; but until the present year the Government has shown no sign of being desirous or willing to give these recommendations the force of law. The Institution of Electrical Engineers, which has always been alive to the serious consequences of this defective legislation, sought in June of last year to bring pressure upon the Government by sending a deputation to the President of the Board of Trade. It is impossible to express more forcibly or more clearly the objections to the present law than was done by the members of our deputation on that occasion; but although we were then promised a measure to remove these objections, nothing was attempted until May of this year, when a bill, embodying most of the recommendations of Lord Cross's Committee, was introduced in the House of Lords by Lord Wolverton at the instance of the Board of Trade. But the bill did not get beyond the introductory stage, and at the close of the session no progress had been made. The measure, however, must not be allowed to drop; and as the President of the Board of Trade has told us that his department desired to 'press forward" this measure when opportunity offered, we may express the hope that next session it may not only be introduced, but may be placed upon the statute book.

With regard to the distribution of electricity for power purposes, the Electric Lighting Acts make no special provision. Any consumer may use his supply either for lighting or power, or both. But in recent years the idea of promoting large power schemes to supply very wide areas has come prominently to the front, and since 1900 several such schemes have been authorised by special Acts of Parliament. The powers of supply conferred upon companies under these acts are twofold: they may supply energy for power purposes to any person, and they may supply energy in bulk to authorised distributors. In this connection it may be noted that if the bill introduced by Lord Wolverton becomes law it will be possible to obtain powers for supply in bulk to authorised distributors by provisional order, instead of proceeding, as at present, by special act. The most important point, however, about these modern power schemes is that in many cases the promoters come into sharp conflict with local authorities and other authorised distributors supplying urban or rural districts within a large area which they desire to cover by their scheme. The local authorities are especially antagonistic to any proposal which would allow another body to come into their area to supply electricity, and in some cases Parliament has cut out, from the area which a particular scheme desires to cover, various towns and districts possessing their own electricity supply undertakings. Now it seems desirable that the local authorities should consider carefully the advantages of taking their supply in bulk from a power scheme instead of generating for themselves on a small scale. In very many cases it would be much more economical to do so, and they would still be left the sole distributors in their own areas. But if local authorities will not do this, Parliament must consider what is best for the country at large; and as the rural districts must obviously gain by the supply of electrical energy at cheap rates, the towns should not be allowed to prevent this gain by obstructing or rendering ineffective the scheme for the larger area. The point is, that if all the towns, which constitute the "fat" districts, are cut out of these schemes, leaving only the "lean" rural districts for the large-area companies, there can be little or no hope of financial success. In order to obtain, therefore, the greatest good for the greatest number, the larger authority ought to be allowed, wherever possible, to prevail over the smaller municipalities opposing it, especially when we consider that this does not entail an injustice to these municipalities, but only a slight narrowing of the field of municipal enterprise.

It remains to consider what is, perhaps, the most remarkable feature in recent electrical progress—the development of the electric tramway The law relating to this branch of the subject is, unfortunately, still more unsatisfactory than that dealing with lighting and power, for the controlling act is still the Tramways Act of 1870, which was passed before electric traction was introduced, and was intended to deal simply with the ordinary horse-tramway. The defects of that act are too well known to require mention here; the objectionable veto given to the local authorities has once more been sufficient in itself to retard progress to an extraordinary degree. The fact that in the last few years electric tramways have developed so much in this country is not due to the existence of the Tramways Act, but principally to the fact that it was found possible to evade that act to a considerable extent by promoting these concerns under the Light Railways Act, 1896—an act which was really intended for another class of undertaking altogether. That act has proved beneficial to a high degree, as it lowers the cost and simplifies the procedure when a tramway scheme is promoted; but in the years during which it has been in operation various defects have been discovered and attempts have from time to time been made to have them remedied. My predecessor, Mr. Swinburne, pointed out these defects to the President of the Board of Trade when our deputation waited upon that Minister last year, and here, again, we were promised a measure to remedy them. A bill *was* introduced this year, but it was unsatisfactory in the extreme, as it made no attempt to deal with the whole subject, but merely tinkered at one or two details; and we cannot regret, therefore, that it made no progress. The Board of Trade had previously appointed a committee to consider what amendments of the Act of 1896 were desirable, and as the President of the Board of Trade told our deputation that a report had been received from that committee, we naturally expected that the new bill would deal comprehensively with the subject, but in this we have been disappointed. The old Tramways Act ought to be repealed, and replaced by a measure suitable for modern needs. Under the Light Railways Act the powers of the Commissioners might with great advantage be extended. At present they are hampered by the feeling that, if not bound by the letter of the Tramways Act, they must, as far as possible, respect its spirit; and hence the absence of consents from local authorities has more weight than is proper. In cases where a light railway scheme is likely to compete with an existing railway company, the provision that the promotors must proceed by private bill, and not by an inquiry before the Light Railway Commissioners, also militates considerably against the usefulness of the Light Railways Act by curtailing the powers of the Commissioners; and this restriction ought to receive attention in any amending measure.

These are but a few of the numerous points in the present law which call for attention The whole of our electrical legislation is in urgent need of reform; and, after so many promises have been made, it will be very regretable if nothing is done to remove the existing defects.

While the electric light and power undertakings have obtained but little legislation in their favour, it is a relief to see that Parliament has granted railway companies certain advantages. By the Railways (Electrical Power) Act, which received the Royal assent on August 14th last, existing railway companies, desiring to convert any of their lines to electric traction, are enabled to obtain sufficient powers for so doing by means of an order of the Board of Trade. They may become interested in power companies and may take from them electrical energy for the supply of their main or branch lines.

In spite of the legal impediments referred to, it will be found on investigation that substantial progress has been made in Great Britain in the utilisation of the electric current for both light and power purposes. Exclusive of traction motors, in March of this year, lamps and motors equivalent to over 14,000,000 8 c.p. lamps were connected to the mains of public electricity supply undertakings, the metropolis being represented to the extent of about 5,000,000. There were about 300 towns enjoying the advantage of an electricity supply, this number including, with two exceptions, all the towns whose population exceeds 100,000. The exceptions were Tottenham and the Rhondda district, which did not seem anxious to be alongside of their 38 fellows. It appears that at this period, exclusive of power companies, the public supply stations had motors amounting to 55,000 H.P. connected to their mains. Municipal undertakings own generating plant of a rated capacity of 320,000kw., and private undertakings are represented by 160,000. In the metropolis the companies are proprietors of about 100,000kw., whereas the public bodies are responsible for, approximately, 28,000. The pre-eminence of the companies in London is due to the fact that they acted as pioneers and were first in the field. The average rated capacity of a British station appears to be about 1,400kw. It is to be remarked that, while in the provinces the average municipal station has a capacity of nearly three times that of a company station, in the metropolis the ratio is reversed. Again, the average metropolitan company has, approximately, ten times the plant capacity of the average provincial company.

It is interesting in this investigation to note that modern tendencies in this country are decidedly in favour of the direct-current system with a three-wire distribution. The number of direct-current undertakings increased from 139 in 1901 to 214 in 1902 and 260 in 1903. For these three years the alternating-current stations numbered 67, 68 and 69 respectively. There are now established in Great Britain 13 two-phase and five three-phase stations, exclusive of power-transmission stations. In 29 cases supply is given on two or even more systems. Many of the alternating-current stations have taken up the supply of direct current, others have added two-phase or three-phase supply to their single-phase service, or have changed over completely to one of these. The direct-current system appears to be in no immediate danger of supersession, in part owing to the raising of the voltage, and the consequent possible extension of the service area. The number of voltages in use is somewhat confusing, and presents to the Standards Committee a difficult problem to solve. These voltages now amount to about 16, and out of 289 examples of pressures nearly one-third are declared at 230, more than one-sixth are given as 220, while voltages of 240, 200 and 100 claim about one-eighth each. There are between 50 and 60 stations

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which revel in more than one declared pressure. The extent to which the change from one voltage to another has taken place may be judged from the fact that in 234 cases the pressure is upwards of 200 volts; 64 supply current both above and below 200, and there are only 29 whose supply is entirely under 200 volts.

Although at the present moment the efficiency of carbon glow lamps, and, in certain cases, of arc lamps, is not so great at the higher voltages, yet it cannot be gainsaid that the change of voltage has been a beneficial one both for the supplier and the consumer. The supplier has benefited through a more profitable use of his current conductors; this benefit has considerably more than outweighed the expenditure, in other directions, that the change entailed. In many cases one of the large expenditures must have been in the purchase of storage batteries, for it appears that out of 330 stations no fewer than 240 use these batteries to a greater or less extent. The only drawback to the change would appear to exist in the case of small motors.

Some remarks on the methods of charging for current could be made, but I limit myself to pointing out that the number of lighting undertakings in which the maximum demand system is employed alone is now 104 as compared with 114 in 1902, or say 31½ per cent. instead of 40 per cent. of the totals of the respective years. The maximum demand system in conjunction with one or more other systems is used in 74 cases, as against 38 in 1902, or say 22½ per cent. as compared with 13½ per cent. A simple uniform rate gives the corresponding figures of 70 and 63, representing 21½ per cent. against 22 per cent. I regret I have not been able to collect information with regard to private installations in Great Britain which would prove sufficiently comprehensive. I have, therefore, decided to leave this portion of the subject alone.

There is still room for improvement in the carbon glow-lamps. I am given to understand that 16 c.p. lamps for 200 volts and upwards, with a life of 1,000 hours at an average consumption per candle of even 4 watts, can hardly be obtained as a commercial article. The production of the Nernst lamp seems to be improving, and its employment in a large number of towns for street lighting, and in many private installations, will enable people to thoroughly appreciate its merits and utility. I find that the most recently introduced pattern gives three-quarters of a candle per watt when new. Nernst lamps are used by about 1,000 supply companies in the United States, the Hartford (Connecticut) Company alone employing about 4,000. In many cases these lamps are maintained by the supply company without extra charge, or at a nominal cost. The Osmium lamp of Auer von Welsbach is well spoken of for low voltages in some quarters. Twenty-five to 30-volt lamps have been made which show little diminution in light-giving power after 800 to 1,000 hours burning. Apparently they absorb about 1·5 watts per candle, but are expensive to purchase. We shall doubtless hear more of the mercury vapour lamp associated with the name of Mr. Cooper Hewitt.

While, with alternating-current work, the tendency is always to simplify the switch-gear to the utmost, this does not seem to be universally the case in direct-current practice, at any rate in the smaller public supply stations. Some of these have elaborate plug-boards, numerous bus bars, expensive battery regulators, and all sorts of alternative ways of doing the same thing. In many cases where these complications do not exist, not only the comfort of the staff but the efficiency of the service are greatly increased. It appears to be forgotten that everything tending to simplicity has a beauty of its own which no complication can ever rival. In spite of the absence of any notable development in switch-gear, a very high standard has been attained by British designers, especially in heavy power and lighting work with alternating currents at high pressure. Following a totally different line from the Continental and American practice, our engineers have evolved apparatus which is at the same time safe, simple and reliable, while occupying a minimum of space.

In the early days of the electrical industry, when the range of possible distribution of current was restricted, the engineer had to seek a site for his generating station in crowded and expensive districts. To economise space he employed high-speed reciprocating engines and water-tube boilers. At that period he could doubtless do this with advantage, as the generator units in use were, comparatively speaking, small. To-day the units are larger and the range of possible distribution is increased. It is not, therefore, so necessary to follow the old practice, and in many cases to do so is inadvisable.

Among the remarkable things of the year may be mentioned, as in course of construction, four turbo-generators of the Parsons type, each rated at 5,500kw. to 8,280kw., and occupying a space measuring only 51¾ft. by 14ft. by 12ft. A 6,500kw. turbo-generating set is being built by Brown, Boveri & Co. which measures 59ft. by 10ft. by 10ft. A Curtis turbine of 5,000kw. is running in Chicago; this turbine is a combination of the Parsons and De Laval systems, and is arranged with a vertical shaft, a somewhat inadvisable design. In shape it is cylindrical, and, including turbine and generator, stands 25ft. high with a diameter of 14ft. It may be interesting to note that there are over half a million H.P. of turbines in use or on order, and 24 stations in this country use the turbine more or less. While referring to large units, it may be of value to state that the Société Cockerill of Seraing is expected to show at the St. Louis Exhibition next year a gas engine of 3,000 H.P.; this engine will have two cylinders, each of 51in. diameter, and will run at 85 revs. per min. It is said that the Gasmotoren Fabrik Deutz is designing a 6,000 H.P. engine.

With relation to electric driving in factories and ships, we all remember the excellent Papers read before the Institution by Mr. Williamson and by the late Mr. C. E. Groves. The contribution of the latter was especially interesting to me, as it showed in a striking manner the progress in the employment of the electric current on shipboard from the time of the Silvertown Company's installation on their cable steamer "Dacia" in 1879, down to the huge developments already reached at the time the Paper was read. Among the recent varied uses to which electromotors can be put may be mentioned gold mining at the Klondike, where they are employed in dredging, washing and conveying the material to the tip. Another instance is the driving of a rolling mill, where a 400 H.P. motor is coupled direct to the rolls. In a large plate-glass works in America there are four generating sets of 4,000kw. each and one set of 350kw.; there are also 20 motors of 450 H.P. each and 20 of 200 H.P.; the three-phase system is in use at 5,800 volts with frequencies of 40 and 25 cycles per second. A large colliery in the same country has plant of 2,900kw., the installation comprising 44 mining locomotives and 75 miles of underground trolley wire; the power is transmitted at 5,600 volts, three-phase 25 cycles per second, but is converted for use at 275 volts. At the Carnegie Works electricity is used for almost everything requiring power, and it is stated that in the Homestead Steel Works of Pennsylvania, by the aid of electricity, 4,000 men make as much steel as is made at Krupp's with 15,000 men.

Since the establishing of the Portrush electric tramway in 1883 the electrical engineer has encroached on the field of the tramway engineer, and, consequently, the purely tramway work, as apart from the electrical work, has often shown the mark of the active, clever but untrained mind, impossible curves and grades being attempted, and unnecessarily expensive work being done. There has been some advantage in this no doubt, as the experience gained by these works, although expensive, has tended to improvements in practice. There is an American manner in this mode of procedure which leads to a free use of the scrap heap. The individual suffers, but the community eventually gains by the survival of the fittest. It is, I suppose, a rule which applies and must apply to all young nations and industries. The rough and tumble while it lasts is interesting and exciting, and doubtless drives the workers to put their best foot foremost. The golden rule, "Be sure you are right and go ahead," is the best to follow, but it often happens that one dies and is taken from the arena before even the first part of the rule is complied with. On the whole, therefore, it is perhaps as well that chance should be allowed to play its part, and that activity and energy should not be troubled with a too severe bearing-rein. The rule before cited should probably be modified in the manner of the saying of the northern farmer to his son, and should read, "Be sure you are right and go ahead, but go ahead." I think this has been the motto that has been adopted by electrical engineers since 1877, with the much desired effect that sufficient improvement has been made to enable the electrical bark of this country to be steered into still water for a time. This happy condition does not, I believe, exist in Germany or America, where apparently there are "more heads to be broke." We have been toiling up a steep hill for many years, and the time has now arrived when we should stop and survey the landscape as a whole, instead of narrowing our view to the particular point towards which we happen at the moment to be ascending. Already many of the paymasters are questioning the scrap-heap theory, as they know by experience that this is often evolved from nothing but a craving for change and a want of appreciation of the true value of money on the part of their advisers. I make these remarks with no desire to convey the idea that work in this country is not carried out conscientiously and well, but rather with the view of suggesting a curbing of the expenditure of money which produces a semblance for the moment of unbounded prosperity, while in reality it only means riding full gallop for a fall. If the fall should occur, the many men who are entering our ranks every day and swelling our numbers will find their prospects blighted owing to a disturbance of the trust which is placed in the electrical engineers of to-day by those who supply the sinews of war. I, therefore, think it incumbent on every electrical engineer to carefully weigh every recommendation he may make, not from the point of view of immediate, but rather from that of ultimate efficiency, and to deal with every possible factor in drawing his estimates. The Papers read, and the discussions which take place in this hall, and in the meeting places of our local sections, tend to this end.

I am afraid I am wearying you by reiteration, but I feel strongly on this subject, which, in my opinion, affects the vital interests of

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the Institution, and I venture to lay before you things that, though perhaps to many of you are platitudes, may prove of use to our younger colleagues. The establishing of electrical tramways and the electrification of existing railway and tramway lines are rapidly assuming great proportions, and it is not difficult to predict that this branch of electrical engineering will continue to advance by leaps and bounds, providing employment for many electrical engineers connected with the Institution. From the report of the London County Council on the excellent work they have been doing in South London, it would appear that the difference in prime cost between laying an urban line on the conduit system and construction on an overhead trolley system is not so great as to render the former altogether impracticable. I think, therefore, those authorities in the municipal areas are acting in the best interests of the inhabitants of this crowded metropolis who refuse to authorise erection of the unsightly, and in many cases dangerous, overhead conductors. The utilitarian may argue that whatever increases prime cost goes in restriction of development, and in this he is to a certain extent correct. But apart from the question of danger avoided, it is usual in civilised communities to have some respect for forms and appearances as well as for the purely useful. Moderation should reign in all things, and in relation to electrical tramways London does better to employ the conduit system and follow the example of Budapest and Paris, rather than erect an overhead system similar to that which disfigures my native city of Glasgow, and many other towns in this country. The conduit system has cost London per mile of single line about £14,000, an overhead installation would have cost £7,000. In my opinion the difference is well spent. It may be argued that this difference does not represent the whole difference, and that many electrical arrangements can be made in an overhead system that would not be permitted in a conduit system. My answer to this is that it comes within the province of us engineers to overcome these difficulties; overcome them we shall if we only apply ourselves seriously to the task, and produce results which will pass the severest test that the Home Office, Board of Trade or other authority may impose.

Passing on to the nature of the current supply, the continuous-current system predominates at present in Great Britain for all kinds of electric traction. Its supremacy is again being threatened by the monophase system, whose employment in certain cases possesses advantages that are greater than the disadvantages. The efficiency for traction purposes of polyphase working has not been sufficiently proved, but as regards the method of transmitting power to considerable distances for conversion to continuous current to be applied to tramway purposes, the three-phase system has so far held the field at pressures up to 6,500 volts. A most complete system of high-pressure polyphase traction work was inspected by many members of the Institution during a visit to Northern Italy in the spring of this year, and to those interested in this subject it will be useful to closely follow the fortunes of the electrified Valtellina, Lecco and Milan Railway. For this line there are in course of construction electric locomotives, which have been designed to exert a tractive force of from 7,500lb. to 11,000lb., at a speed of 40 miles per hour, their individual output being, I understand, from 800 H.P. to 1,200 H P. The exceedingly interesting experiments being made on the Marienfelde-Zossen military railway have resulted so far in the attainment of a speed rated at 125 miles per hour. The railway from Berlin to Zossen is about 15 miles in length, and the current generating station is about 8 miles from the head of the line. The car, a Siemens and Halske design, was supplied with power from the line wire at a pressure of about 14,000 volts.* The inauguration of through traffic between Liverpool and Bolton, a distance of 40 miles, marks an important epoch in the progress of the South Lancashire tramway project, which embraces a network of more than 500 miles of track, and will serve an area whose population is about 5,000,000

The application of electric traction to our railways is progressing. At present the sections which are being dealt with are those which have a great traffic density or a frequent service. This policy is doubtless a wise one, as the railway companies limit the application of a considerable capital expenditure to the best paying division of their lines, and to those portions where the benefits to be derived are the most apparent. During the current year, the first section of the Metropolitan-District Railway conversion has been made and it is expected before March of next year that the Moorgate Street–Drayton Park and Drayton Park–Finsbury Park sections of the Great Northern and City Railway Co. will be in operation. The Mersey Tunnel Railway has been completed, and the conversion of the Wirral Railway is under consideration. The North-Eastern Railway has had trial runs along Tyneside, and good progress is being made with the Liverpool–Southport line. The Central London Railway is completing the change from locomotive to motor-car driving. The motor-car system is generally accepted as the best form for passenger traffic for many reasons which I need not recapitulate. The direct-current system at 500 to 700 volts appears to remain as a standard for railway work of this class, as well as for tramway work, but there are signs that single-phase alternating current may prove a rival. In the United States the Washington Annapolis Railway is being equipped with an overhead system, which will deliver direct to the motors a single-phase current at 3,000 volts. The three-wire system of feeding tramways and railways, though not without examples abroad, has not been adopted in this country save on the City and South London Railway, where it seems to have proved satisfactory.

The only surface-contact system in this country is that which has had nearly a year's trial at Wolverhampton. Troubles have arisen between the Corporation and the company; it is, therefore, impossible to say exactly how the matter stands. It is believed that the Kingsland mechanical switch surface-contact system may be tried at Dresden shortly.

Although accumulators are being extensively used for private carriages in London and elsewhere, yet this country has not seen its way to employ them for rail or tramways. In Italy and Germany some use is made of them, and it is stated that, as the result of two years' working on lines running out of Bologna, the cost of battery traction has proven 28 per cent. cheaper than steam. The use of storage battery locomotives in America for shunting and mine work appears worthy of mention, as it seems to have attained considerable proportions, and to have proved successful in practice.

In the provinces the great power distribution undertakings are getting to work by degrees. Besides the Midland and Newcastle concerns we can now count the Durham, Lancashire, North Metropolitan and South Wales Companies. The advantages of electricity as a motive power seem to be readily appreciated by the industrial populations of these districts. Among some of the large schemes in project is the electrification of the National Railways of Sweden, the original power being derived from water pressure or the combustion of peat. Estimates are being drawn for 2,700 miles of railway, calling for over 100,000 H.P. The official estimate shows that there will result a saving of 50 per cent. in the present working expenses, which amount to about £800,000 per annum. Switzerland again speaks of a conversion of its national lines, entailing the use of 30,000 H.P. to be obtained from water pressure.

The utilisation of the Victoria Falls of the Zambesi is a project under serious consideration, and at least a portion of the scheme may be near realisation. Some three months ago certain details of the scheme were made public, and from these it appears that whereas the Niagara Falls are equivalent to a continuous loss of 7,000,000 H.P., at the Victoria Falls of the Zambesi the loss is five times as great. In advocating the utilisation of this waste, it is pointed out that tramways near San Francisco are driven by a current which has its origin in the Ubax Falls about 220 miles away, and that some American engineers estimated that power giving a steady load of 24 hours per day could be delivered 330 miles from the generating plant at about £4. 10s per kilowatt. At Niagara six syndicates are carrying out work which, when completed, will be capable of generating over 1,000,000 H.P. Some of the generating sets will be of 10,000 H.P. working at 11,000 volts. The pressure will be converted to 60,000 volts. The highest pressure as yet made use of in Europe for power transmission is in Italy—namely, 40,000 volts. This plant is not yet completed. It is intended that water power will develop 7,500 kw. at 9.000 volts (42 cycles per second), which will be transformed to 40,000 volts for transmission. In the United States, in Montana, where a similar pressure is employed for transmission, the voltage was increased to 80,000 for a few hours with success. Consideration of these voltages recalls the experiments made in March, 1883, just 20 years ago, by Marcel Deprez, in power transmission between Paris and Creil, a distance of 57km. at a pressure of 5,700 volts. One also thinks of the transformer of Gaulard of about that period.

I now turn to the subject which gave birth to this Institution and from which its first title was derived, I mean the subject of telegraphy. Between May 26th and July 7th of this year an International Conference of the Telegraph Administrations was held in London at the invitation of His Majesty's Government. These meetings are, so far as may be, quinquennial, and are usually held in the capitals of the Great Powers. The last meeting in London took place in 1879. The discussions which now are carried on between the Government delegates, and with the representatives of the telegraph companies who are also invited to be present, are purely of an administrative order, and principally deal with tariffs and the rules for carrying out the international exchange of telegrams. Technical questions such as the size of conductors and the classes of instruments to be employed in the international service are either already agreed upon or are the subject of separate and private understandings between the Administrations interested. These have been fairly well standardised during the 38 years that have elapsed since the first conference was held in Paris.

Since 1879 the growth in the length of telegraph landlines has been very large, and the development of submarine telegraphy has been almost phenomenal. At that date the public were just begin-

* Since writing the foregoing I notice that the car designed by the Allgemeine Electricitäts Gesellschaft has, on the same line, attained a speed of 130½ miles per hour.

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ning to realise what power for good or for evil was being placed at their disposal. Merchants were beginning to feel that the submarine telegraph had a centralising effect which enabled them to carry on their business with smaller stocks of goods. The large merchant had no longer the control of the foreign markets which his wealth had formerly given him, and the small merchants began to have an innings. When this state of things came home to the traders, submarine telegraphic facilities were in great demand; the cables across the Atlantic and other oceans began to multiply, and new centres of industry were connected to the chain. The men at the head of cable affairs, and notably the late Sir John Pender, were not slow to meet these developments by increasing the ramifications of the telegraphic network, and bringing the charges for telegrams to such a figure as to encourage the public to make full use of the means of inter-communication placed at their disposal. This policy was hastened by the wholesome dread of competition, where such did not exist, and by competition itself. A year ago the gap in the world's telegraphic girdle was completed by the laying of the trans-Pacific cable, which now unites Canada with Australia, and this year has seen completed a second line across the Pacific from San Francisco to the Philippines and China by way of the Sandwich Islands, Midway and Guam.

It is strange that during this development the improvements in the types of telegraph cable employed have not been great, nor has there been any great advance made in the design of the instruments used for the transmission of signals, but the administrative work has been vastly bettered. Messages which formerly took hours in transmission are now received from the public and delivered to the addressees in a few minutes. I am informed that a telegram announcing the result of the yacht race for the America Cup was carried, in August last, from London to South Australia in four minutes. This message, which was forwarded via South Africa, was handled by 15 operators, passed through 11 stations, and traversed 14,404 nautical miles of submarine cable and 1,515 statute miles of land-lines. Ordinary commercial traffic cannot be dealt with at this speed, but the instance I quote shows what can be accomplished when special arrangements are made to carry news which is of peculiar interest. The manager of an American cable company has told me that the result of the America Cup Race reached London one minute after the termination of the race, having been transmitted through 3,400 nautical miles of submarine cable, and some 200 statute miles of land wire. The record time between New York and London is 30 seconds, and messages have been sent and replies received in one minute and 30 seconds.

During the last 25 years the engineers engaged in submarine telegraph work have devoted more care to the surveys of route than was previously the practice; to a great extent this means that the engineers have succeeded in persuading the capitalists that these surveys are of prime importance. The Atlantic cables of 1857-8, of 1865, 1866, and on to 1874 were laid on the data as to the ocean bed furnished by perhaps 30 soundings taken over a route some 1,700 nautical miles long. In 1871 Lord Kelvin furnished a means for sounding which did not exist previously, and in 1872 the Silvertown Company made a first trial. The late Sir William Siemens, in 1874, carried out the first systematic sounding in the Atlantic, and from that time forward until 1883 it was the habit to take soundings, but not to make a full and careful survey. With the results obtained from these soundings our knowledge of the ocean bed was increased to the extent of teaching us that submarine mountains, plains, and gullies exist, and that the physical conditions of the submarine floor are very similar to what one observes in travelling through Europe from Calais to Brindisi. In 1883, the first thorough preliminary survey of any cable route was made, but as this has been the subject of a Paper read before the Institution on November 10, 1887, I need not enter into detail, further than to say that the result of this survey materially altered the original plans for laying the cable on account of unsuspected elevations and depressions of the ocean floor having been discovered. In addition to the configuration difficulties to be encountered by a submarine cable, the chemical composition of the soil is important, as it greatly affects the cable's life. A paper referring to this subject was read before the institution on March 11, 1897. I had the pleasure of handling, about a month ago, a piece of submarine cable which had lain at the bottom of the sea in deep water for nearly 30 years, and its appearance was such that I was unable to say whether it could not have lain for another 30 years without showing any deterioration. To-day there are employed in cable work 47 ships representing 92,094 tons. The largest, the *Colonia*, belongs to the Telegraph Construction and Maintenance Company, and has a dead-weight capacity of 11,000 tons. When he considers the comparatiye facilities with which cables are now repaired, no shareholder in a submarine telegraph company need fear for the permanancy of his property. In July, 1879, there were 50,450 nautical miles of cable in operation; there are now under the sea 222,253 nautical miles, and I have every reason to believe that this mileage will continue to increase.

On wireless telegraphy I have no new developments to report. The Cantor Lectures delivered by our Vice-President, Prof. J. A. Fleming, before the Society of Arts in March of this year, and the description of the Lodge-Muirhead system in *Page's Magazine* for last May, give to any one interested in the subject the latest communicated information of any value.* I need only add that there seems no immediate prospect of its seriously competing with the business of the existing telegraph companies.

In my remarks concerning the means of transmission through submarine cables, I omitted to make reference to the relay of Mr. S. G. Brown, which was described by him in the Paper he read before the Institution on May 1st of last year. I may also mention that since 1879 considerable improvements, though of a minor nature, have been made in duplex transmission.

The use of the telephone continues to extend, and in addition to the greater facilities offered in Great Britain there are gradually being established international wires which place in telephonic communication the principal towns of Great Britain and several of the commercial centres on the Continent. So far as I am aware, no practical use has yet been made of Poulsen's teleautograph, which I had the pleasure of inspecting with our Vice-President, Mr. Gavey, and of which he gave a description in a communication to the Institution on November 22, 1900.

Before passing to the next portion of my subject, I should like to make a short reference to a very early investigator into the phenomena of magnetism. I mean Dr. William Gilbert. Our Past-President, Dr. Silvanus Thompson, who has taken so great an interest in the bibliography connected with Gilbert, tell me that the tercentenary of the death of this remarkable man will occur on December 10th next (new style), and that probably some notice of the fact will be taken by his native town (Colchester) and by the Royal College of Physicians, of which body Gilbert was President at the time of his death. As you are doubtless aware, the work by Gilbert, notably his "De Magnete Magneticisque et Magno-magnete Tellure," shows a patient observation and careful recording of results, which resemble in many ways the method of Michael Faraday. Your council have not yet decided what steps, if any, will be taken by the Institution in connection with this celebration.

Whilst reviewing the state of electrical progress, mention should be made of the work of the Engineering Standards Committee. This committee is making some progress in its work, and it is pleasing to note that the government has recognised that the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and this Institution should be assisted in the useful work they are doing. A government grant has been made which will lighten the burden of these Institutions, as until this assistance was received they were not only doing the work, but were also providing the funds necessary for carrying it out Sir William Preece and Colonel Crompton, two of our past presidents, are members of the general committee and represent the Institution. The former is chairman of the electrical plant divisional committee, which is most directly connected with our branch of the subject. It is to be hoped that some of the results of the deliberations of the electrical plant committee may shortly be published, and should they be, I shall append them to this address by way of further publication.

While speaking of the work of the Engineering Standards committee, I cannot resist the temptation to protest against the continual attempts which are made to apply to our weights and measures and money what is called the decimal system. However regrettable it is that scientific men should not have boldly recommended for adoption 12 instead of 10 as the place ratio of figures when so many sweeping changes were made at the time of the French Revolution, I am afraid they are too indolent to do so now, and that 10 will continue in use until another universal upheaval changes all things. Because 10 is conventionally adopted for this ratio, there appears to me no reason why the system should be extended to all the weights and measures necessary for common use, bringing about many absurdities, and in many cases establishing very inconvenient standards. The adoption of the metre or any other measure of about its dimensions as a unit of length matters little, but if the metre be adopted, it is no reason because a millilitre of distilled water is supposed to weigh 1 gramme at 4° Celsius in vacuo that butter, coals, diamonds and wood should be compulsorily dealt with in metres or their decimal derivatives. I am the first to admit that in physics and chemistry there are undoubted advantages in having, so far as one can, a common relation existing between the various units, but that is no reason why we should combine to force on the public a system of weights, measures and money which is so much against nature that it hardly obtains currency in the countries of its adoption. In France, precious stones are to-day bought and sold in carats; firewood in cordes; milk in pintes; gravel in toises; grain, potatoes and charcoal in boisseaux; wine in barriques, feuillettes, demi-setiers and chopines; wood for construction in pieds, pouces and lignes; beer in canettes and pots; sugar and coffee among the poor people are

* See *The Electrician* of March 27th for a technical description of the Lodge-Muirhead system and, for the most recent developments, *The Electrician* of October 16th.—Ed. *E.*

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dealt with in livres, demi-livres, &c. Cattle dealing is carried on in pistoles and écus, and not in francs. Finally, they have just issued a 25 centime piece, doubtless because it represents a quarter of a franc. In my opinion, the decimal system applied to weights and measures and money offers too limited a field for the operations of ordinary life: and I should be sorry to see it with all its disadvantages forced upon us by legislation to the exclusion of other systems, when the admitted advantages to be gained are so small.

I should now like to make a few remarks, if time will admit, on the present functions of electro-chemistry. This is one of the most progressive branches ot electrical industry; although striking advances are rare, constant improvements in detail are being made, and processes which have been long outlined are being developed into commercially practicable methods. Probably there has been no step so noteworthy during the year as the announcement by Mr. James Swinburne of his invention of a new process for the reduction of metallic sulphide ores, which, with the collaboration of Mr. Ashcroft, he has put to test on a commercial scale. The process consists in treating the ores with chlorine, displacing the sulphur, which is recovered—the essence of the invention being the fact that this reaction takes place without the formation of cloride of sulphur; various precipitations follow, according to the metals present, the final result, after all the other materials have been extracted, being zinc chloride. This is electrolysed, the zinc being obtained in the metallic state, and the chlorine is ready to be utilised again. Thus the process is cyclic, and it is applicable to almost all kinds of ores, including the huge piles of waste which have accumulated as the result of less complete processes. This system may well prove of the utmost importance in metallurgy.

Another valuable process, which has made considerable progress during the past year, is the reduction of iron ores by means of the electric furnace. At Livet, in France, the process is in practical operation, generators of 1,200 H.P. each giving single-phase current at 30,000 amperes each, and driven by water power, being employed. The output is 12 tons of steel per day. At these works ferro-silicon is also made from quartz, scrap iron and coke, at less cost than that of smelting, and copper pyrites is reduced to copper and iron sulphides rich in copper, and ready for the ordinary smelting process. Steel of high quality is similarly produced in Sweden as the rate of 1,500 tons per annum. With the Stassano process the expenditure of energy is said to be 3,000 H.P. hours per ton of iron; but with the Ruthenburg system it is said that 500kw. hours suffice, and that ores of poor quality can be treated. Large deposits of iron ore exist in Canada, remote from coal mines, but within reach of Niagara Falls, and it is said that a Canadian syndicate has been been formed to work the Ruthenburg system with power derived from the Canadian Niagara Falls hydro-electric works.

Already in Canada the Betts process for refining lead is in operation—at Trail, B. Columbia—the daily production amounting to 7 tons of lead. The crude lead is used as anode in a bath of lead fluosilicate and fluosilicic acid; there are 22 anodes per vat, through which 4,000 amperes are passed, and the pure metal is deposited on the cathode, leaving the impurities, including the precious metals and copper, on the anode in a skeleton of spongy lead.

In a quite different direction electricity is being used for the purification of the water supply of towns. There are two installations of this kind in Germany—Schierstein and Paderborn—where the Siemens ozonising tubes are in use; air is charged with ozone by means of these, and is passed up dripping towers, down which the water trickles, with the result that it is completely sterilised as regards all deleterious organisms. At Schierstein the capacity of the plant is nearly 50,000 gallons per hour, and the power required is 50 H.P., of which, however, only 27 is used for ozonising, the remainder serves for pumping, &c. The pressure used is 8,000 volts. The working cost is in all from 3½d. to 4½d. per 1,000 gallons. By the Jaruti process water is electrolysed to give pure hydrogen and oxygen, consuming 115kw.-hours per 1,000 cubic ft. A solution of caustic soda is used, with a perforated iron diaphragm to separate the gases.

At Stangfjorden, in Sweden, the Jebsen system is used for the manufacture of briquettes from peat. The latter is carbonised by heating with the electric current, derived from water-power, and the tarry by-products are recovered.

The production of nitric acid from the atmosphere has long been the subject of experimental research; it is now in active operation at Niagara Falls, where by means of electric discharges at extremely high pressures and frequencies the nitrogen and oxygen are caused to combine. The same subject has been dealt with on the Continent, where a return of 52 to 55 grammes of nitric acid per kilowatt-hour has been obtained, using a current of 0·05 ampere at 50,000 volts, and 6,000 to 10,000 cycles per second. As Sir William Crookes has shown, the fixation of atmospheric nitrogen may in the distant future have a most important bearing upon the existence of the vast population of the earth, when natural sources fail to furnish an adequate supply of food. In connection with this subject, the synthesis of sugars by the electrolysis of carbonic acid, ammonium, phosphate, &c., which has been accomplished by Walther, is of no little interest.

The extraordinary potency of electrolysis and the electric furnace in chemical and metallurgical processes has been most largely made use of in America, which is, in fact, the electro-chemical headquarters of the world. The various works which derive their power from Niagara Falls are producing caustic soda, chloride of lime, carbide of calcium, chlorate of potash, sodium and sodium peroxide, sodium cyanide, baryta, phosphorus, nitric acid, lead, carborundum, graphite, corundum, &c. A single American concern is producing 4,500 tons of aluminium per annum, while the United States produces 278,860 tons of electrolytic copper per annum, no less than 86·5 per cent. of the world's output. Siloxicon, a highly refractory compound of silicon, carbon and oxygen, is one of the latest products of Niagara. The electrolytic rectifier, which depends upon the peculiar properties of aluminium in an electrolytic cell is a device which will have many applications, especially since it has been so arranged as to ingeniously utilise both positive and negative waves of an alternating current.

One of the most important branches of electro-chemistry is that which relates to secondary batteries, and, in spite of the immense amount of work which has been done in this direction in the past, remarkable progress has been made of late. The most notable invention in this department is the Edison nickel-iron cell, which appears to be on the verge of adoption on a commercial scale. Elaborate machinery has been designed and constructed at great cost for the rapid manufacture of the cells, and trial cells have been in the hands of European experts for many months, while complete sets have been exhaustively tested in America and England. There seems to be no question that the cells have fulfilled the claims made for them, and that their introduction in quantity will give an immense impetus to the electric automobile industry, and even to accumulator traction in general. The cleanliness, capacity, and seeming indestructibility of the cells, joined to their highly perfected mechanical construction, render them admirably adapted to automobilism, and the stated ability to charge them with 75 per cent. of their full capacity in one hour is a feature of the first importance. Other cells have been brought forward, notably the Elieson cell, which is an improved lead plate cell, with the property of enduring remarkably high rates of charge and discharge without injury, and the "N.S." (Niblett Solid) cell, in which the whole of the positive and negative elements are packed tightly in a container. Each of these has meritorious features, but whether they will stand the test of time cannot yet be decided.

Besides the foregoing examples, a vast amount of work is being done in every branch of electro-chemistry, and the recent formation of the Faraday Society, admirably named, to further the interests of the science and industry in this country—long after the birth of similar societies abroad, it is true—can well be included as one of the most important and fruitful "recent developments" in the electrical world.

I will now bring this address to a close, as I began it, with a reference to the growth of this Institution. In my opening remarks I omitted an observation which I should have made concerning this growth, and that was in reference to the source from which our members are drawn. Had not a great wave of educational fervour passed over this country some 20 years ago, had not the establishment of technical institutes all over the country taken place, had not Lord Kelvin and others educated their pupils in a way which best fitted them for the position of efficient teachers in these technical colleges, our Institution would not have attained its present importance, and the posts filled by many of its members would, perforce, have been filled by the better educated foreigner. It is a great advantage to the taught that their teachers should be concerned with the practical side of the subject they treat, and this in itself is a justification for those who teach being members of our Institution and taking an active part in its management. Teaching from text-books which are written on an undeveloped science causes the student to learn many things that he has to unlearn, and launches him into the world full of information which may have been abandoned altogether, or is at least five or six years old. If the teachers are in touch with everyday practice the taught profit immensely, and leave their colleges with knowledge which, although it may later require modifying, has at any rate, the advantage of being the knowledge of the day. I believe the electrical industry in this country is almost entirely in the hands of electrical engineers educated in England. Can this be said of the chemical industry? I doubt it, and presume that it is because the latter is a much older science, and has not been favoured in possessing in this country so many educational advantages as are offered to those engaged in the electrical industry. It certainly has not, as a general body, had teachers with the same practical experience, although there undoubted signs that the younger generation is being better taught.

To cite one instance in my personal knowledge, out of many which might be selected: I remember my father introducing into Scotland, for purposes of calico printing and dying, the use of certain coal-tar dyes, the employment of which had just been made practicable by Mr. W. H. Perkin. Forty-five years have elapsed since then; and although Great Britain has practically been the

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home of the raw material and one of the greatest consumers of these products yet, through the application of greater knowledge and skill, Germany to-day furnishes our printers and dyers with the greater proportion of their requirements. We are being beaten in a race in which the foreigner is handicapped. Is this due to the natural incapacity of the Englishman, or is it due to the want of the opportunities which his foreign competitor possesses? Despite the opinion recently expressed by Prof. Karl Pearson, I like to accept the latter explanation, although, given the opportunities, we must always bear in mind that a chemist's work is laborious in the extreme, and this may not as a rule satisfy the ordinary class of English student. In adopting this illustration, I do not wish to be misunderstood. I have no intention of implying, and it would be foolish to imply, that this country does not possess chemical knowledge of the very highest order, as witness the number of distinguished men whom we know by name, and the work they have done, and also the large number of chemical works established in the London, Manchester, Glasgow and other districts. I also fully recognise that the chemical industry cannot be fairly compared with the electrical industry, as it occupies a much wider field, and is a more difficult subject to master. I use the illustration, as I do not believe the mass of the people engaged in the industry have placed at their disposal sufficient opportunity for proper instruction, or for acquiring knowledge, as is the case in Germany and some other countries.

With wisdom, we in this country open our arms to the skilled man of other countries, and through his skill we can, in certain directions, maintain supremacy in some of our productions. The pity of it is that we have not amongst our own countrymen men of equal education and skill. One may say that the electrical industry is also suffering, and that the signs of it are the large importation of American and German machinery into this country at the present time; but I venture to disagree. Americans and Germans are doubtless appearing on our markets, and, in many cases, owing to greater skill in manufacture; but the financial side of the question has a great deal to do with their incursion, and especially is this so with their competition in our colonies and in non-manufacturing countries. We must, as a policy, continue to welcome all comers, but while so doing we should equip ourselves so that by sheer skill and ability we may conquer in the end. The equipment we require is, every one now admits, technical education, and this we are developing in all directions. The electrical engineers as a class are better equipped than any other class I know of, thanks to the teaching received in our technical institutions from very capable men, some of whom we are proud to see numbered among the Past-Presidents of this Institution.

During the recess, several powerful advocacies for the furnishin of greater educational facilities to the students of this country have been published, and it is gratifying to see that these publications were made in a manner to bring them before every one who cares to read them. Sir Norman Lockyer, in his presidential address to the British Association meeting at Stockport, made a stirring appeal, which must sink into the soul of every thinking man who has the welfare of his country at heart. Sir William Abney, as chairman of Section L—Educational Science—placed before the public what has been done since 1853 by the Science and Art Department with the small amount of funds at their disposal. Prof. Meldola's lecture, delivered in August last at Oxford, on Chemical Industry and Research, should also be mentioned, as it deserves careful reading. Opportunely, Prof. H. E. Armstrong has just had published by Macmillan & Co. a collection of his writings on Education. Sir William Ramsay, the President of the Society of Chemical Industry, and many others who are interested in industrial development, are actively forwarding the cause; and it is to be hoped that some good may be evolved from the atmosphere of public interest which has been created, and that we may thus eventually find the men of this country as well furnished as their foreign competitors with the necessary knowledge, and with the means of applying it in investigation. Our Past-President, Dr. John Perry, informs me that there is under consideration the formation of a Science Guild, whose fundamental object will be the encouragement of the application of scientific principles to industrial and general purposes. We must all hope those engaged in the matter will succeed in founding this guild, as there doubtless exists a blank which it can fill.

I am glad to see some of our members—notably, my predecessor, Mr. Swinburne, and our honorary member and past-president, Mr. Swan—are interesting themselves in the formation of the Electro-Chemical Society, to which I have already referred; and I am sure we all wish them every success in their effort to specialise in Great Britain this very important subject.

For the future development of the usefulness of the Institution there appears to me to be one matter worthy of our utmost attention. The Institution membership extends all over England and the Colonies, and we have found it a useful addition to our constitution to establish local sections in different centres. Since these sections have been formed, many valuable contributions have been incorporated in the *Journal* of the Institution which might not have appeared there had the opportunity of having a meeting-place in the author's neighbourhood been absent, and had there not existed an organised assembly to discuss the subject submitted by him. The local sections are growing, and must by the nature of things increase in importance. The development of the electrical industry in the provinces must advance with greater strides than in London, where manufacturers are hampered by high local rates, and sometimes obstructive legislation, which appears to be a necessity in our large metropolis, and which is, fortunately, not so essential in smaller communities. Again, in the neighbourhood of London the cost of raw material is appreciably higher; fuel is also higher, and the charges for the transport of the finished goods to their destination handicaps the London manufacturer. These, in addition to the higher scale of wages paid, are fast driving manufacturers into the provinces.

Such a migration, from a general point of view, is perhaps advantageous; but it indirectly affects the Institution in a way which is not of advantage to the central body. If the migration continues to the same extent as took place in the case of London shipbuilding many years ago, the centre of production, so to speak, of the electrical industry will gradually gravitate northwards, and nothing but consumers will be left in the metropolis. Many of our ablest members are already in the provinces, and it is quite a question for the Institution to consider whether the day is not fast approaching when we should extend our system of decentralisation. Is it not time that we should consider the establishing of a local section in London, similar in all respects to the local sections we have in Birmingham, Dublin, Glasgow, Leeds, Manchester and Newcastle? In this new local section Papers affecting London could be read, and be published or not in the *Journal* of the Institution in the same manner as Papers in the other local sections are dealt with. London would continue to be the headquarters of the Institution, and Institution meetings could be held, say, four times a year. At these Papers of general interest could be contributed. If any such scheme as this were adopted, the constitution of the council of the Institution would be somewhat affected. The chairman and committee of the London local section would, of course, be all London men; but the Institution would have a larger field from which to select its president and council, as men who have their business in the provinces, and who cannot spare the time to attend the present numerous council and Institution meetings, might be able to attend the less numerous meetings which would be the outcome of some such re-arrangement.

ELECTRIC POWER CRANE.

Power cranes, running on rails, are used for hoisting materials to a considerable height from the ground, and depositing them at any point within reach of the crane and of the track. Such a crane (Figs. 1 and 2),

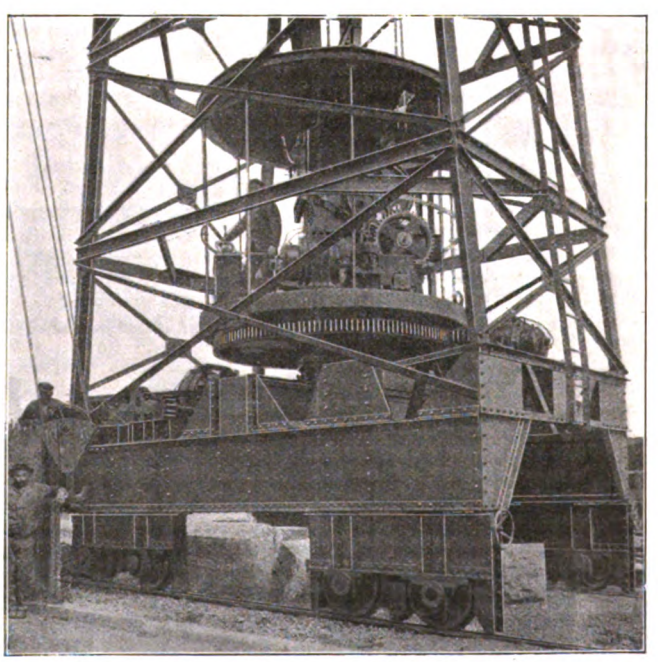

Fig. 1.—Construction of the Crane at its Base.

remarkable for its dimensions, was recently employed in Brussels in connection with the erection of some barracks, which were 23 metres (73ft.) high and about 200 metres (220yds.) long. According to the *Elektrotechnische Rundschau*, the crane is capable of dealing with

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10 tons. The three cardinal movements are performed by three separately-controlled motors, and the crane is capable of lifting materials 23·5 metres (77ft.) high, and works over a radius of 6 metres (20ft.) Since the wheels of the crane are not connected by axles, in order to leave a maximum clearance for materials deposited on the track, it was deemed advisable to strengthen against transversal forces that part of the crane construction which carries the wheels, and this has been accomplished by constructing the track of double rails, between which the wheel flanges pass with relatively small play. By this means the sleepers are substituted, as it were, for the missing axles. The track is about 200 metres (220yds.) long, its gauge is 3,250mm. (10ft. 7¾in.), and it has been laid at the side of a rather narrow road (21½ft.), with a slope of about 1 : 30. As mentioned, the crane passes above stones and other building materials which might have been set down between the rails, the clearance being, in fact, 2,400mm. by 1,600mm. (7½ft. by 5ft.). The extreme width of the structure is 3,850mm. (12½ft.) At a height of 15 metres (49ft.) the

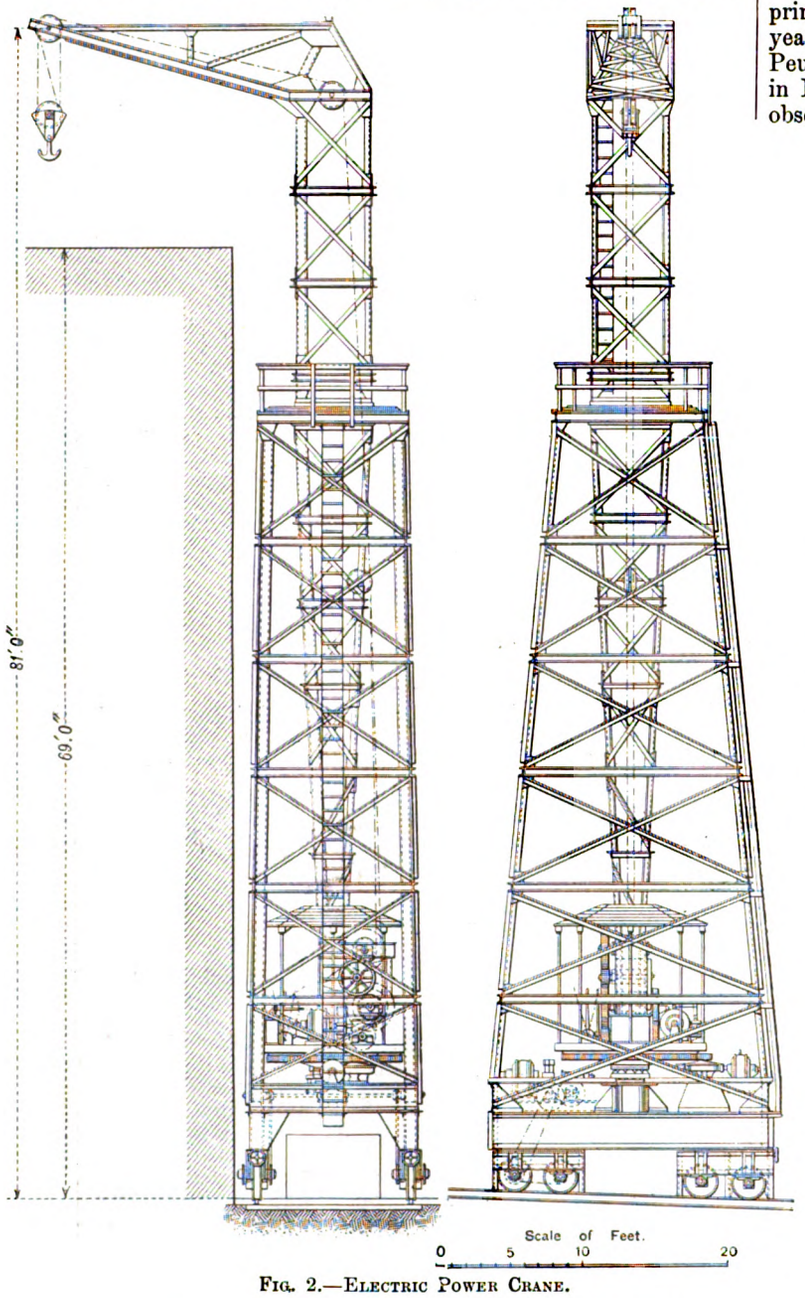

Fig. 2.—Electric Power Crane.

crane carries a small gallery, from whence the work can be conveniently superintended and orders given. At this height also is situated the vertical bearing which guides the crane when it revolves. One motor-man stationed on a platform just above the clearance referred to above, can control all the crane movements.

Automatic devices prevent the overloading of any of the motors. Roller and ball bearings respectively are used in connection with the double lifting hook, and with the guide and the base bearing of the revolving part of the crane. As is seen in the illustrations, the girder principle is employed in the construction of the crane. It is stated that the whole crane can easily be dismounted and erected again where required. Loads of 10 tons are hoisted at a speed of 5 metres (16½ft.) per minute, and weights of 3 tons or less are lifted at a speed of 17·5 metres (57ft.) per minute, the swinging-round motion being performed at the rate of about 40 metres (130ft.) in one minute. The crane was built to the order of the Société Anonyme de Waele Bruxelles by the Gesellschaft für Elektrische Industrie. Fig. 1 shows the construction of the crane at its base.

MEASUREMENT OF THE FREQUENCY OF VERY RAPIDLY ALTERNATING CURRENTS.

BY J. WERTHEIM SALOMONSON.

Some time ago I published a short Paper on the variation of pitch of the whistling arc, caused by variation of the primary current. I had observed the phenomenon some two years ago, but I only gave some careful measurements by Peukert's method of the frequency of the "Duddell currents" in November, 1902. A frequency of 268,000 ∿ per sec. was observed.

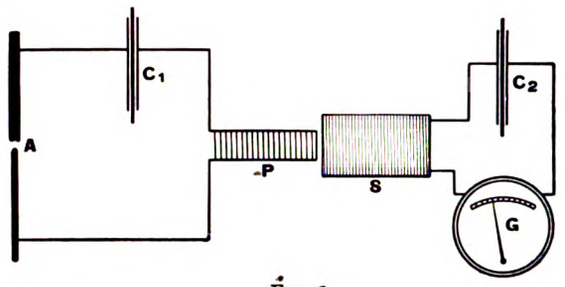

Fig. 1.

In *The Electrician* of September 18, 1903, Mr. Duddell, in a letter, gave it as his opinion that a measurement showing a frequency of the order of 100,000 ∿ per sec. ought to be distrusted, as with very high frequencies $\delta V/\delta A$ was always positive. He thinks that deducing the frequency from the readings of a direct-current instrument, assumed to give the mean value of the current, and a dynamometer giving the root mean square value, appears to be particularly liable to error, especially at high frequencies. Peukert's method consists in the simultaneous measurement of the voltage at the carbons with a Deprez-d'Arsonval instrument (giving the value E_1), with a hot-wire instrument (giving E_2) and of the current-strength in

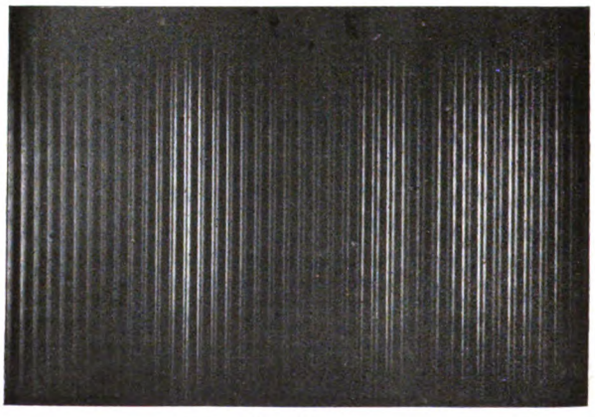

Fig. 2.

the condenser circuit with a hot-wire ammeter (giving T ampere). If C be the capacity of the condenser, the frequency is $n = T/2\pi C \sqrt{E_2^2 - E_1^2}$. If the root mean square values be measured with dynamometric instruments possessing a certain amount of self-induction, I agree with Mr. Duddell that this method cannot be regarded as reliable with high frequencies. But, as a matter of fact, I only used hot-wire instruments by Hartmann and Braun, which are practically devoid of self-induction, even for the highest frequencies. Yet there might be a reason for this method not being correct. When the

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alternating current is not a simple periodic one of a pure sine-form, the curve of which cannot be represented by single sine expression, but, for instance, by the sum of two or more sine expressions, Peukert's method is not available, neither for high nor for low frequencies. Though I felt confident that no overtones were present to any appreciable extent, I was not yet prepared to prove it. In order to make sure of this, I discarded entirely Peukert's method and substituted for it a new one which is extremely simple and seems to me to be perfectly reliable.

The arc lamp, for which I use a shunt-regulator, is shunted in the well-known way by a self-induction and a condenser. The self-induction consists of the primary of an induction-apparatus of the Dubois-Reymond type, extensively used in physiology. Only the iron core has been removed, and I have several primaries of thick wire, with 36 to 200 turns, which may be substituted for each other. I use two secondary coils: One of 72 turns of 0·9mm. wire, and one of 450 wire rings of 0·3mm. wire. On this last bobbin the wire is wound in two layers of 225 turns each, which may be used separately or in series. The secondary circuit is completed by a hot-wire galvanometer, reading to 0·3 ampere, with a mica condenser in series. This mica condenser, by Carlmann, has a capacity of 1·11mfd., divided into sections of 0·001mfd. It has been very carefully calibrated and its inaccuracies are known.

There are two neighbouring circuits in Fig. 1, each of which contains a condenser and a self-induction. If periodic currents are generated in one circuit by establishing a singing arc, an impressed E.M.F. will be set up in the secondary circuit, where it will generate a current of the same frequency as that of the original primary current. This current will be a maximum when the natural frequency of the secondary circuit corresponds with the frequency of the impressed E.M.F. As this current is indicated by the hot-wire instruments, we are able to change the capacity of the condenser 2 till the reading of the ammeter is a maximum. The adjustment of the capacity till a perfect resonance is attained is done with the greatest ease, as the slightest deviation from the true resonance causes the current to fall; in some cases the current strength falls nearly 40 per cent. when a corresponding change of only 5 per cent. in the value of the capacity takes place. When large capacities—*i.e.*, of 0·05 – 1mfd. are necessary in the secondary, the final adjustment may be effected by means of the plugs of the condenser only. With small capacities—from 0·001—0·05mfd.—it is preferable to make the final adjustment in the primary circuit, either by changing the constant current or by small variations in the capacity or the self-induction.

If perfect resonance be obtained, we can easily calculate the frequency by the formula $T = 2\pi\sqrt{LC}$ if we know the self-induction and capacity of the secondary circuit. The resistance need not be considered when we calculate the results: it is only of importance with regard to the capacity which gives the truest resonance. The smaller the resistance, the better and the more sharply defined is the capacity giving the maximum current. With my method we want an exact knowledge of the coefficient of self-induction of the secondary circuit. I have measured these coefficients for my coils and I found (*a*) coil of 72 turns, $L_1 = 788{\cdot}4 \cdot 10^{-7}$ henry; (*b*) inner layer 225 ohm, $L_2 = 6{,}640 \cdot 10^{-7}$ henrys; (*c*) outer layer 225 ohm, $L_3 = 6{,}847 \cdot 10^{-7}$ henry; (*d*) two layers in series, $L_4 = 26{,}980 \cdot 10^{-7}$ henry. For these small coils the coefficient of self-induction as calculated from the dimensions cannot be relied upon; I tried this and found differences of nearly 5 per cent. from the measured value, principally owing to the difficulty of exactly measuring the lengths and values of the coils. The electrical measurement may be effected to within 0·3 per cent. To control the electrical measurement, I have balanced the coil A and C in the Wheatstone bridge and I found that $L_3/L_1 = 8{\cdot}72$, which agrees closely with the results of the direct separate measurement $6{,}847/788{\cdot}4 = 8{\cdot}69$. The advantages of this method are obvious. Whereas with Peukert's method I needed three persons to take the simultaneous voltmeter and ammeter readings and had to take at least 10 readings, I can now adjust the capacity with the greatest facility, and I get much more exact results. Formerly I never knew what would be the frequency. Now I can produce any desired frequency at will; I have only to adjust the secondary circuit to get the calculated proper periodic time and afterwards adjust the primary capacity, or self-induction or the strength of the circuit-current till the hot-wire instrument indicates maximum resonance.

By this method I have been able to produce pure sinusoidal currents with a frequency of more than 400,000 ∽ per sec. ($L = 788{\cdot}4 \times 10^{-7}$, C = 0·002 mfd.) Up to 100,000 ∽ per sec. my method gives the same numerical results as Peukert's method; but whereas Peukert's method is only correct to perhaps 5 or 10 per cent., my method may be correct to about 1 per cent. With frequencies of over 100,000 ∽ per sec. Peukert's method is still much more inexact owing to the difficulty of getting simultaneous voltmeter readings.

From my experiments I may conclude that the current in the primary circuit closely approximates a simple periodic current without many harmonics of any appreciable intensity. If higher terms were present we should not find one single sharply-defined maximum with one capacity only; either the maximum would be much less sharply defined or we should be able to find other capacities giving at least some slight elevation of the secondary current strength. This not being the case we may assume the primary current to be quite, or nearly, a simple harmonic one. As the special purpose for which I use the Duddell currents demands that they should be purely sinusoidal, my method of determining the frequency is doubly convenient, as it is an excellent method for clearing the current of higher terms. Owing to the fact that I have been able to produce sinusoidal currents of a frequency of more than 400,000 ∽ per sec. by the method described, I must suppose that under certain circumstances the resistance of the electric arc remains negative even at that frequency. I cannot see why this should not be the case, why even a frequency of a million or more might not be reached. For getting these high frequencies the direct voltage of the arc should be very low, as low as 35 volts. Even with 38 volts I could not start an alternating current when the capacity was not at least 0·2 mfd. With 0·1 mfd. in the primary condenser circuit, I think that about 35 or 36 volts is the maximum voltage allowable, giving an arc of only a few tenths of a millimetre in length.

To dispel any doubt that might still exist about the possibility of high frequencies, I have measured the frequency by photographing the arc. Meisel's method, which gave perfect results with small frequencies of about 1,700 revs. per sec., was not available with a frequency of nearly 150,000; to separate the alternating waves by directly photographing them on a moving plate would have necessitated a speed of the plate of nearly 50yds. per second. I tried the classical method of Feddersen's rotating mirror, and combined it with a moving plate, to obviate the difficulty of the successive images falling over each other. After some trials I succeeded in getting a satisfactory photograph (Fig. 2). The following are data of the apparatus employed:—Direct voltage of arc, 34·7 volts; current strength, 2·1 amperes; homogeneous carbons of 7mm. and 4mm.; primary capacity, 0·104mfd.; secondary self-induction, $788{\cdot}4 \cdot 10^{-7}$ henry; secondary capacity, 0·017mfd.; frequency calculated from secondary self-induction and capacity, 138,000 ∽ per sec.; distance from arc to mirror, 29·4cm.; photographic reduction to 0·579; speed of mirror, 241 revs. per sec.; distance of photographed waves on plate, 3·87mm. Hence frequency $= \frac{4\pi \times 241 \times 29{\cdot}4 \times 0{\cdot}579}{0{\cdot}387} = 133{,}200$ ∽ per sec.

The speed of the mirror was measured by inscribing each fiftieth rotation on a rotating drum fitted with smoked paper, and at the same time inscribing second marks.

The plate was moved by hand. The length of the alternating waves as measured on the plate is the mean of about 60 individual wave lengths, which differed about 1 per cent. in the different images, so the result is not more exact than to 1·5 per cent. I believe that the electrical method given in this Paper is more exact than the measurement by means of the rotating mirror.

I may still point to a difficulty in getting good photographs, caused by the rotation of the musical arc. In my photographs there is evidence of this in the fact that not all the images show the alternating waves, and that some of the lines representing

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the extended image of the arc are usually thinner, and show less reduced silver; at that moment the arc could not be seen by the photographic objective.

I think that the photographic method, as well as any resonance method of measuring the speed of the Duddell currents, prove beyond doubt the existence of frequencies far above 100,000.

The seeming discrepancy between Mr. Duddell's opinions and my experiments is probably caused by the fact that there seems to be a critical P.D. at the carbons, or a critical length of arc, above which the resistance of the arc ceases to be negative. With small frequencies this critical P.D. may be as high as 42 to 50 volts, or even more, whilst with higher frequencies the critical P.D. is lowered, until with the highest obtainable frequencies the critical length of arc is not more than a few tenths of a millimetre and the critical P.D. not more than about 35 volts.

PHOTOMETRIC TESTS OF THE NERNST LAMP.*

The fourth progress report of the N. E. L. A. Committee for Investigating the Photometric Values of Arc Lamps is devoted to the Nernst Lamp, and to tests of the mantle and naked gas flame. The work has been carried on, as heretofore, at Purdue University, by Prof. C. P. Mathews, assisted by Messrs. Paul G. Winter and Terry T. King. Prof. W. E. Goldsborough is the chairman of this committee.

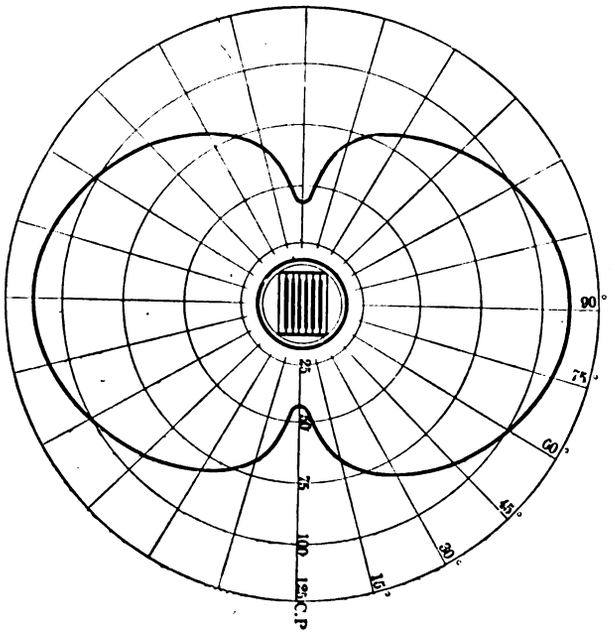

FIG. 1.—Horizontal Distribution of Candle-power about Six-glower Lamp, equipped with Clear Globe.

A careful series of tests was conducted upon the Nernst lamp of the one, three and six-glower types, equipped with the various globes, shades and heater cases furnished by the manufacturers. In making candle-power measurements on the Nernst lamp, constancy of voltage is of the utmost importance. A special test given in the report shows that a change of 1 per cent. in the voltage makes in this particular case a change of more than 14 per cent. in candle-power. It was found that operation of the Nernst lamp under conditions of a constant current of 0·4 ampere per glower gives the most satisfactory result from a photometric standpoint. Fig. 1 shows the distribution of candle-power from a six-glower lamp in a horizontal plane containing the glowers. It will be seen that the candle-power in this plane varies between wide limits. Normal to the glowers the value is 260 per cent. of that parallel to the glowers. This horizontal distribution of candle-power is characteristic of the parallel arrangement of glowers in a horizontal plane. It is interesting to contrast this curve with similar curves obtained from the naked gas flame, the mantle burner and the arc lamp. These last-named sources give candle-power distributions in the horizontal plane that are circular or nearly so. When the Nernst lamp is equipped with a diffusing globe, its horizontal distribution of candle-power is, of course, considerably rounded out. Because of this peculiar distribution of candle-power, the computation of the mean spherical intensity presents some difficulties not found in the case of the other sources referred to. The difficulties are, in fact, precisely those encountered in spherical measurements on an incandescent lamp. In Table I. the relative errors in the three different methods of computing the mean spherical intensity from candle-power distribution are shown. The methods are:—(1) From the mean of six distribution curves in vertical planes 15deg. apart. (2) From the mean of two distribution curves, namely, parallel and normal to the glowers. (3) From a single distribution curve in a vertical plane 35deg. to the glowers.

Considering the first method as correct, the errors in the other two methods are as tabulated. The second method seems to yield a result correct to about 1 per cent. when diffusing globes are used, and about 4 per cent. when clear globes are used. It was found that there is no single plane, in which a candle-power distribution can be taken and integrated for the mean spherical intensity, with correct results for all types of globes and shades. With an integrating photometer, however, the matter becomes simply that of the taking five or six photometer settings, the mean of which yields the value sought. From the records of the many Nernst lamp tests contained in the report, those on a six-glower lamp, equipped with various globes and shades, are reproduced here as being fairly typical. Figs. 2 and 3 show the distribution of candle-power from this lamp in vertical planes respectively parallel and normal to the glowers. Figs. 4 and 5 show candle-power distribution in the same planes from the same lamp when equipped with opal and metal shades. The results show that the Nernst lamp equipped as indicated gives maximum candle-power directly beneath the lamp. It may be said that for many purposes this distribution of light is very satisfactory, there being sufficient upward light for the purpose of general illumination, while the light thrown downward within an angle of 45deg. from the vertical is very strong, making a desirable source for the illumination of reading tables, counters, machines, &c. A comparison of Figs. 2 and 3 brings out the great difference in the distribution of candle-power in the two vertical planes respectively parallel and normal to the glowers, to which reference has already been made. The use of opal and sand-blasted globes alters the distribution of candle-power in such a way as to diminish the downward intensities and increase the outward and upward intensities.

The marked effect of various shades and globes on the downward flux of light is well illustrated in the case of the tests upon the three-glower Nernst lamp. As tested with a constant current of 0·4 ampere

Table I.—*Errors in Computation of Mean Spherical and Mean Hemispherical Candle-power.*

Lamp.	Mean of 6 curves every 15deg. around glowers.	Mean of parallel and normal. 5% error.	35deg. to glowers.
6-glower, clear, M.H.S.	0	−4·3	..
6-glower, clear, M.S.	0	−4·0	..
6-glower, pearl opal, M.H.S..	0	+0·8	−2
6-glower, pearl opal, M.S. ..	0	+1·8	−1
3-glower, pearl opal, M.H.S..	0	+0·5	..
3-glower, pearl opal, M.S. ..	0	+0·9	..

Table II.—*Relative Power Consumption per Candle-power of One, Three and Six-Glower Lamps with Various Globes and Heater Cases.*

No. glowers.	Opal heater case.	Clear heater case.	Clear globe.	Opal globe.	Sand-blasted globes.
Watts per Mean Hemispherical Candle-power.					
1	..	..	2·31	4·19	2·78
3	3·09	2·22	2·33	4·18	2·72
6	2·31	1·90	1·88	3·25	2·29
Watts per Mean Spherical Candle-power.					
1	..	..	4·11	4·95	4·30
3	4·55	..	4·04	4·51	4·28
6	..	..	3·30	4·01	3·64

Table III.

Angle.	Nernst six-glower.	Candle-power. Series arc, A.C.	Series arc, D.C.
Hor.	87	310	352
15° B.	248	375	404
30° B.	335	440	410
45° B.	373	445	375
60° B.	372	420	295
75° B.	380	355	200

Globes.	Clear.	Opalescent inner, street shade.	Opalescent inner, clear outer.
E.M.F.	226·0	73·8	71·0
Current	2·4	7·5	6·6
Watts	542·0	469·0	459·0
Mean hemispherical c.-p.	289·0	394·0	360·0
Watts per mean hemispherical c.-p.	1·87	1·19	1·27

* From the *Electrical World* of New York.

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per glower, this lamp consumes approximately 260 watts. It yields mean hemispherical candle-power ranging from 64·3 for the pearl opal ball to 118·4 for the clear heater case. The corresponding values of watts per mean hemispherical candle-power is 4·18 and 2·22. The wide variation in these values indicates clearly how it is possible to alter the flux of light below the horizontal plane by the use of different globes and shades, and is a strong argument against the rating of lamps on the basis of mean hemispherical candle-power, or, for that matter, on any basis that does not take into account the total volume of light emitted by the source. Coming now to a comparison of the light output, based on the mean spherical candle-power, we find a minimum of 51·9 and a maximum of 68·7, the power consumption being the same as in the previous case. The corresponding variation in specific power consumption or watts per mean spherical candle-power is from 5·09 to 3·84. It is evident that the variation in mean spherical candle-power can be due only to differences in the absorbing power of the globes and shades used. glowers in close proximity must, through mutual radiation, operate at higher temperature than would an isolated glower. The result is an increase in light output in spite of the fact that multiple glowers must screen the light from one another in certain directions, dependent upon their arrangement in the holder. Thus, if the number of glowers be increased, in the type of lamp with which we are dealing in these tests, the horizontal intensity will not increase in the same ratio as the downward intensity, because of the screening action of one glower upon another.

The report contains interesting results on the effect of varying the number and arrangement of glowers in the holder. The whole matter may be summed up by saying that, increasing the number of glowers, augments the efficiency of the lamp in candle-power per watt, notwithstanding the screening action of the glowers one upon another. Although the six-glower Nernst lamp takes about 20 per cent. more power than either the direct or alternate-current series arc lamps commonly used in street service, yet it is, as regards

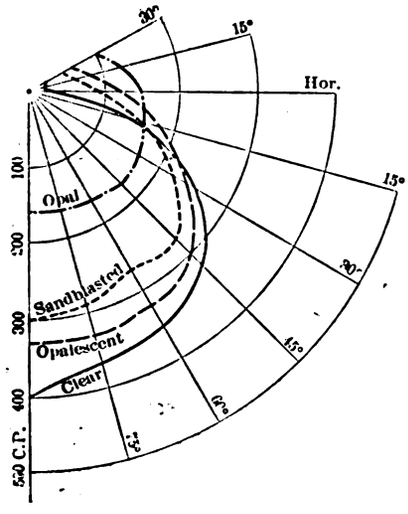

FIG. 2.—Distribution of Candle-power in a Plane parallel to Glowers for Six-glower Lamp, equipped with Globes as indicated.

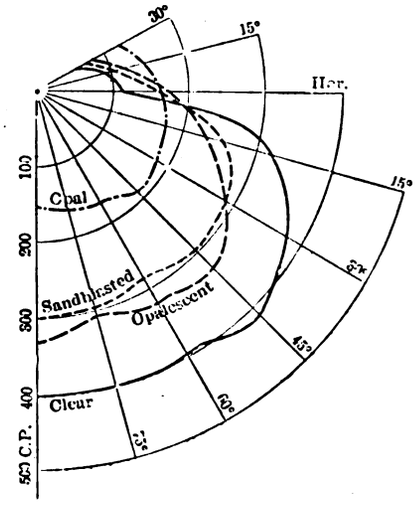

FIG. 3.—Distribution of Candle-power in a Plane normal to Glowers for Six-glower Lamp, equipped with Globes as indicated.

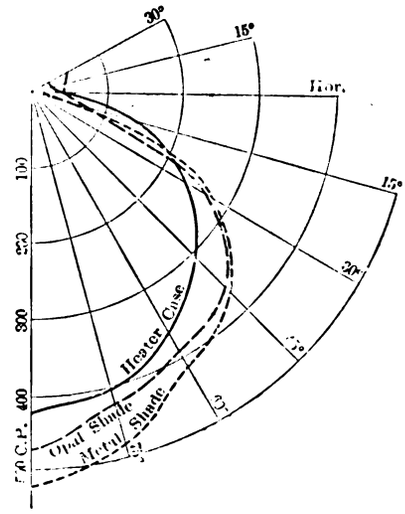

FIG. 4.—Distribution of Candle-power in a Plane parallel to Glowers for Six-glower Lamp, equipped with Clear Heater Case and Opal and Metal Shade as indicated.

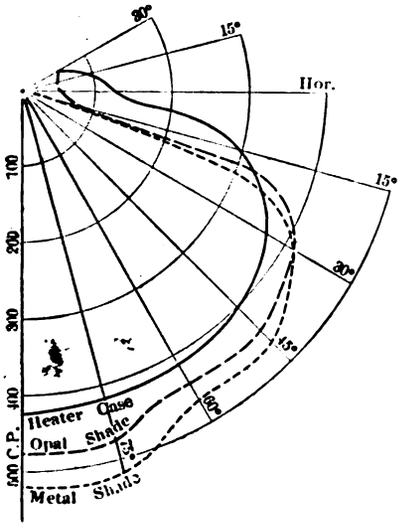

FIG. 5.—Distribution of Candle-power in a Plane normal to Glowers for Six-glower Lamp, equipped with Clear Heater Case and Opal and Metal Shades as indicated.

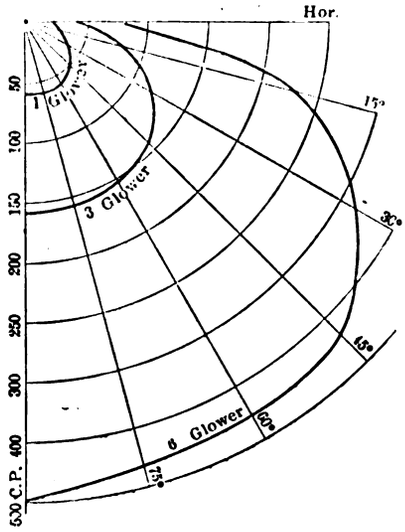

FIG. 6.—Mean Distribution Curves, equipped with Clear Globes.

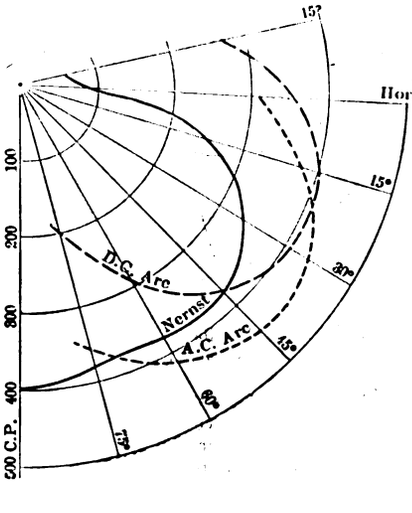

FIG. 7.—Comparative Distribution Curves of Nernst and Arc Lamps.

To put the matter in another way, this three-glower lamp, consuming approximately a constant power, is made to yield, through the agency of its nine different equipments, a maximum variation of 84 per cent. in mean hemispherical candle-power and a maximum variation of 32 per cent. in mean spherical candle-power. It is interesting to note the relative candle-power of the one, three and six-glower lamps. In Fig. 6 will be found distribution curves plotted to the same scale for the three lamps, equipped with clear globes. These curves are the mean of parallel and normal distributions. The relative power consumption per unit of candle-power is shown in Table II., which gives the watts per mean hemispherical and per mean spherical candle-power for each of the three types of lamp.

The table shows clearly that the three-glower lamp is slightly more efficient than the single-glower lamp, and the six-glower lamp considerably more efficient than the three-glower. This increase in efficiency can be accounted for, if we remember that a number of maximum candle-power, a light source of the same order of brightness, and hence a comparison of the three sources is justifiable. Fig. 7 shows the mean distribution curve of the six-glower Nernst lamp, equipped with metal shade, plotted on the same sheet with the curves for the 6·6 ampere direct-current series arc and the 7·5 ampere alternating-current series arc (see Table III.). These arc curves have been taken from a previous report of the committee. The lamps on which these measurements were made were equipped for street service. The direct-current lamp having an opalescent inner globe and a clear outer globe, the alternating-current lamp having an opalescent inner globe and a metal shade. It will be noted that the candle-power distribution of the Nernst lamp is altogether different from that of either arc lamp. The Nernst lamp is strong where the arc lamps are weak, and vice versa. The points of intersection of the curves form segments which show the superiority in certain zones of each lamp over the other two.

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THE INSTITUTION OF ELECTRICAL ENGINEERS.

The inaugural address delivered last night by Mr. Robert Kaye Gray, President of the Institution of Electrical Engineers, covered a variety of subjects, and the full report of it, which we publish in this issue, will not fail to interest electrical engineers in every branch of the profession. Mr. Gray passed in review topics which are at present engaging the attention of those at the head of these several branches of what is becoming the most important of all the industries, and it is most beneficial that these topics should be placed clearly before the rank and file also. Those who are engaged in making their way in the particular path in which they find themselves placed, will do well to pause occasionally and cast a glance round in other directions; and a general summary, such as Mr. Gray has given, will facilitate this by putting in their hands, as it were, a field-glass which will enable them to examine more carefully the prominent features of the surrounding country.

Besides this general survey, Mr. Gray has also considered, in the beginning and end of his address, the position occupied by the Institution of Electrical Engineers itself. He commences by differentiating between the names of "Institution" and "Association." "Institution," he thinks, implies a body for dealing essentially with technical interests, whereas an Association is "a corporation whose functions are related to everything affecting general interests." This distinction is somewhat artificial, however, and we cannot allow that the objects of the Institution of Electrical Engineers should be limited by any such arbitrary definition of the word "Institution." Although, on the one hand, we have no desire that our representative institution should become a society analogous to a trades union, yet we should be sorry, on the other hand, if it degenerated into a mere debating society. If "association" is the correct word to employ for a society which watches over and protects the vital interests of its members, our Institution of Electrical Engineers must also be an association; for, although smaller associations of manufacturers, municipal engineers, wiring contractors, and others perform useful functions, and should not be discouraged, a body is still required to uphold the broader interests of the electrical industry as a whole. In this connection, we may turn to the concluding paragraph of Mr. Gray's address. In it he suggests the formation of a London Local Section on the same lines as those offshoots of the Institution which have proved so successful in the provinces. The meetings of this section would presumably take the place of the present ordinary general meetings in London, and Papers on technical matters would be read and discussed at them as at present. Actual Institution meetings, as distinguished from Local Section meetings, could then, Mr. Gray

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suggests, be held about four times a year, and at these matters of general interest—as distinguished from those of local interest—should be discussed. The proposal has much to commend it, but in practice it is found that there is no such clear distinction between questions of local and general interest when applied to electrical engineering in this small country of ours. If, however, the London Local Section meetings were to discuss the technical matters which Mr. GRAY considers the function of an "Institution," and if his four general meetings became what Mr. GRAY would define as the meetings of an "Association," and dealt with broad questions partly of technical and partly of general interest affecting the welfare of the electrical industry at large, then there would appear to be much in favour of the innovation. Mr. GRAY in his Presidential Address recalls the action which the Institution of Electrical Engineers has taken to induce the Government to amend the present unsatisfactory condition of the law of electric lighting, traction and power supply. This surely is a matter which no other association could take up with such good effect as the Institution of Electrical Engineers, and we should indeed be sorry if the Council relaxed its efforts in this and similar directions. The Institution can afford opportunity, as it does now, for debates on technical questions without retiring in any degree from its position as an association representative of the general interests of electrical engineers.

RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 82.)

[ERRATUM.—The equation $q_0 = an^2 + \kappa n + \frac{2}{le}$ on p. 82 of the last issue should read $q_0 = an^2 + \kappa n + \frac{i}{le}$.]

The rate at which the ions move in an electric field was first measured by Rutherford (*Phil. Mag.*, 1897, p. 422), and was found to be very slow. Zeleny subsequently showed that the negative ions move appreciably faster than the positive ions, and the ratio of the two velocities varies very much with different gases and with their state of dryness. Water vapour tends to equalise the velocities by diminishing that of the negative ion. The following table of ionic velocities, taken from Prof. Thomson's book, expresses the results obtained by Zeleny (*Phil. Trans.*, A. 195, p. 193, 1900). The ionisation was produced by X-rays:—

Ionic Velocities.

Gas.	Velocities in cm. per sec. under a potential gradient of 1 volt per cm.		Ratio of velocities of negative and positive ions.	Temperature. Degrees centigrade.
	Positive ions.	Negative ions.		
Air dry.....	1·36	1·87	1·375	13·5
Air moist.....	1·37	1·51	1·10	14·0
Oxygen dry....	1·36	1·80	1·32	17·0
Oxygen moist..	1·29	1·52	1·18	16 0
CO_2 dry	0·76	0·81	1·07	17·5
CO_2 moist	0·82	0·75	0·915	17·0
Hydrogen dry..	6·70	7·95	1·19	20·0
Hydrogen moist	5·30	5·60	1·05	20·0

Townsend has also measured the coefficients of diffusion of the ions produced by various agencies, and his results are given in the following tables. The X-rays were the ionising agent used.

Coefficients of Diffusion in Dry Gases.

Gas.	D for + ions.	D for − ions.	Mean value of D.	Ratio of D for + and − ions.
Air	0·028	0·043	0·0347	1·54
Oxygen	0·025	0·0396	0·0323	1 58
Carbon dioxide	0·023	0·026	0·0245	1·13
Hydrogen	0·123	0·190	0·156	1·54
Coefficients of Diffusion in Moist Gases.				
Air	0·032	0·035	0·0335	1·09
Oxygen	0·0288	0·0358	0·0323	1·24
Carbon dioxide	0·0245	0·0255	0·025	1·04
Hydrogen	0·128	0·142	0·135	1·11

These coefficients of diffusion are remarkably slow compared with the values obtained for the coefficients of diffusion of the uncharged gas molecules. For example, the value for the positive ion in air (0·028) is less than the value of a heavy vapour like ether or isobutylamine diffusing into carbon dioxide (0·055 and 0·03 respectively).

But the ions show the same coefficient of diffusion whatever the agency employed to produce them. The negative ion diffuses about half as fast again as the positive in dry gases like oxygen or hydrogen, but this difference is much diminished by moisture. The diffusion coefficient D is connected simply with the velocity u of the ions under unit electric force, by the equation

$$D = \frac{u}{N} \Pi,$$

where N is the number of molecules in 1 cubic cm. of a gas, e the charge on the ion and Π the pressure of the gas in dynes per square centimetre. It is thus possible to determine Ne, and, since N is known from the kinetic theory of gases within certain limits, to obtain an estimate of e, the charge carried by the individual ion. But the quantity NE, where E is the charge carried by the hydrogen ion in electrolysis, is accurately known, for 2NE (since one molecule of hydrogen contains two atoms) represents the number of electrostatic units of electricity which must pass through acidulated water to liberate 1 cubic cm. of hydrogen as gas. Now $NE = 1{\cdot}22 \times 10^{10}$, whereas the mean of the values of Ne obtained by the aid of the above equation is $1{\cdot}24 \times 10^{10}$. Hence it may be inferred that the charge carried by the positive or negative ion in gases is independent of the nature of the gas, of the ionising agency used to produce it, and is equal to the charge carried by the hydrogen atom in electrolysis.

One of the most beautiful and striking developments of the ionisation theory arises out of a discovery by C. T. R. Wilson that if dust-free air, free from ions and saturated with water vapour, is suddenly expanded, so as to chill it and cause supersaturation, no deposition of moisture occurs provided the expansion is not too great. If, however, positive or negative ions are present, these serve as nuclei for the condensation, and a cloud is produced, provided the expansion is above a certain limiting value. If the ratio of the volumes, before and after expansion is below 1·25, no deposition of moisture occurs. For the ratio 1·25 up to 1·3 only the negative ions serve as nuclei, while for ratios above 1·3 both positive and negative ions are caught and carried down by the cloud. The drops are so small that the cloud takes a measurable time to settle down under the action of gravity, so that the rate of fall can be used to determine the size of the water drops. If the quantity of water present in the cloud is known, the number of drops can be determined, and, therefore, the number of ions which served as the nuclei for the formation of these drops can actually be counted. The total charge carried by the ions can be simply determined by electrical means, and thus a direct measure can be obtained of the charge carried by the ion. Prof. Thomson has accomplished this result for the ions produced by X-rays, by the radium rays, and for the negative ions which are emitted from metals under the influence of ultra-violet light, and he has proved that the value of e is the same for all ions, positive or negative, and is equal to $3{\cdot}4 \times 10^{-10}$ electrostatic units ($(\text{gr.})^{\frac{1}{2}}(\text{cm.})^{\frac{3}{2}}(\text{sec.})^{-1}$). From $NE = 1{\cdot}22 \times 10^{10}$, and the identity of E and e, N can be directly calculated for the first time in an accurate manner.

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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The value thus obtained for the number of molecules in 1 cubic cm. of hydrogen gas at normal temperature and pressure is $3{\cdot}9 \times 10^{19}$, a value which is in good agreement with the estimates based on the kinetic theory of gases. For fuller particulars and for the experimental methods employed to obtain these results the reader is again referred to Prof. Thomson's book. (Compare also Sir Oliver Lodge: "On Electrons," *The Electrician*, Vols. L. and LI.)

No direct measurements of the masses of the ions produced from gases have yet been accomplished. From considerations connected with the slow rate of diffusion and of movement in an electric field it seems probable that they consist of aggregates of several molecules of the gas, perhaps held together by the attraction of the field due to the charge carried by the ion. This cluster of molecules seems to be smaller for the negative ion than for the positive in dry gases, whereas when moisture or vapours like alcohol or ether are present they tend

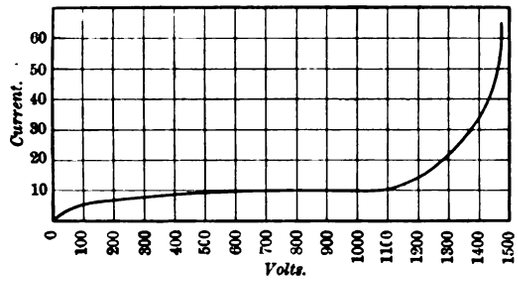

FIG. 5.

to condense on the negative ion more than on the positive, and so diminish its freedom of movement. A remarkable change, however, comes over the property of the ion when the pressure of the gas is sufficiently reduced. Its movement then appears to be no longer hampered by the condensation of an aggregate of molecules around it and it travels free. Under the action of a sufficiently powerful electric force it then acquires enormous velocity and the increase in its kinetic energy above a certain critical value causes a change to come over its properties; that is, the ion passes from the first class, where its charge is its characteristic, to the second class, where its energy begins to dominate its properties. It is true in the case just considered the energy is the result of the action of an electric force on the charge carried, but in the case of radio-active substances projected charged particles are shot out spontaneously

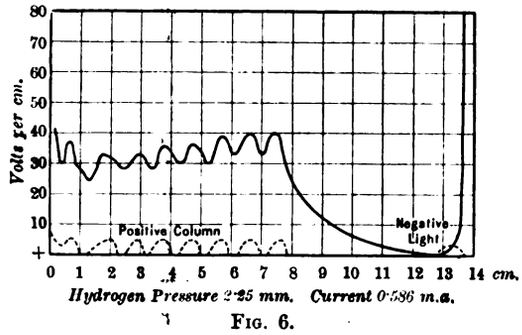

FIG. 6.

which do not owe their velocity or energy to the action of any external force upon the charge they carry. The velocity of these particles is far higher than any that have been obtained by the action of the electric field.

The most characteristic property of the ions above their critical velocity is their power to ionise the gas through which they pass. This has been particularly studied by Townsend (*Phil. Mag.*, 1901, p. 198). If the E.M.F. is increased far beyond that required to produce the saturation current in a gas at low pressure, it is found that above a certain point the current again commences to increase and does so with great rapidity as the E.M.F. increases, until finally the point is reached at which a spark or luminous discharge passes through the gas. This is shown in Fig. 5, which would represent the relation between current and voltage for plates 10cm. apart at about 3mm. pressure. A potential gradient of 40 volts per centimetre is sufficient for the ions to acquire sufficient velocity at a pressure of 1mm to start ionising the gas. It can be shown that at first it is only the negative ion which acquires this power, and the number of ions produced, although largely increased, still remains finite. For the negative ions all travel in the one direction, and of the ions they produce by collision with the gas molecules, it is only the negative ions which acquire sufficient velocity to ionise fresh molecules. Hence, as soon as these ions reach the electrode, the action is at an end. But when the positive ion, which at these low pressures is far more massive than the negative ion, reaches the critical velocity and begins to produce fresh ions, the ions travelling in *both* directions produce ions in their path. This action must go on cumulatively, for it no longer ceases when the ions reach the electrode, as the ions of opposite sign are always travelling anew back to the other electrode and ionising the gas in their path. In consequence, the number of ions increases rapidly to an almost infinite extent and a spark passes through the gas. Under some circumstances, however, the sudden increase of the number of the ions and their electrical convection tends to so diminish the force of the effective electric field that this is lowered below the point at which ions are produced by collision. It is probable that the striated discharge in vacuum tubes is produced by this action, as the distribution of electric force through the tube shows a rapid alternation in intensity corresponding with the position of the striæ. This is shown in Fig. 6, which represents the electric force per centimetre on the vertical axis for different parts of a tube showing striæ plotted on the horizontal axis. The discharge thus consists of a succession of periods in which the electric force alternately rises above and sinks below the critical value necessary for the ions present to produce other ions out of the

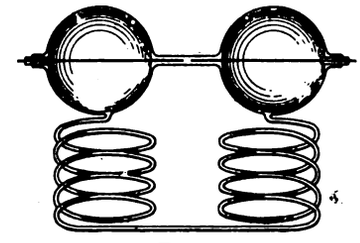

FIG. 7.

gas. The well-known experiment of Hittorf, who showed that a discharge refused to pass between electrodes 1mm. apart in a gas at low pressure, but preferred a circuitous route 375cm. long (Fig. 7), is to be explained by similar considerations. In the space of 1mm. the ions moving under the electric field cannot acquire the critical velocity required to ionise the gas.

(To be continued.)

SOME STATISTICS RELATING TO ELECTRICAL ENGINEERING.

BY WILLIAM POLLARD DIGBY, F.S.S.

(*Continued from page 84.*)

Tables III.C and III.D show how nearly £37,000 worth of imported electrical apparatus was re-exported per annum in 1900, 1901 and 1902. Table III.E merely shows the total exports of electric lighting apparatus of English and foreign manufacture. Table III.F is gleaned from the statistical returns of the colonies. It is most singular that in even the most recent returns, figures of the trade in electrical goods are only separately reckoned in seven colonies. It is also interesting to note the varying sub-headings appropriated to designate what are presumably the same goods. The United Kingdom exports "Electric Lighting Apparatus," and imports "Electrical Goods." Victoria imports, "Electric Fittings, not Telegraphic"; New Zealand, "Machinery, Electric"; Canada, "Electric Apparatus"; Newfoundland, "Electric Motors"; Bahamas, "Electrical Appliances"; Jamaica, "Electric Lighting Apparatus"; and New South Wales, "Electric Machinery."

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Table IIIc.—*Exports of Electric Lighting Apparatus from United Kingdom.—Foreign Manufacture.*

	1902.	1901.	1900.
Russia	£1,049	£306	£2,325
Sweden	1,283	693	6,163
Germany	10,440	926	2,503
Belgium	952	1,951	1,807
France	2,826	1,267	2,559
Spain	390	1,321	1,759
United States America	4,270	2,279	3,286
Other foreign countries	1,285	3,006	2,317
	£22,495	£13,326	£21,142

Table IIId.—*Exports of Electrical Goods and Apparatus from United Kingdom.—Foreign Manufacture.*

	1902.	1901.	1900.
British Colonies	—	—	—
British South Africa	£2,077	£1,979	£168
British East Indies	5,258	6,194	6,910
Australian Colonies	5,228	11,925	7,154
Other British possessions	1,824	3,316	1,687
	£14,384	£23,414	£15,920

Table IIIe.—*Total Exports from the United Kingdom, including Foreign Manufacture.*

	1902.	1901.	1900.
To foreign countries, British goods	£194,576	£180,271	£222,500
To foreign countries, foreign goods	22,495	13,326	21,142
To British colonies, British goods	442,956	372,506	323,655
To British colonies, foreign goods	14,384	23,414	15,920
Grand total	£674,411	£589,517	£583,217

Table IIIf.—*Imports of Specific Colonies, with Country of Manufacture.*

Victoria.—Electric fittings, not telegraphic.

	1900.	1899.	
United Kingdom	£47,033	£23,750	Not given before 1899.
New South Wales	3,707	2,313	
Germany	2,847	3,600	
United States	2,792	3,537	
Other countries	316	505	
	£56,695	£27,393	

New Zealand.—Machinery (electric).

	1900.	
United Kingdom	£37,942	Not given before 1900.
New South Wales	5,784	
United States	2,797	
Other countries	1,997	
	£48,520	

Canada.—Electric apparatus.

	1900.	1899.	1898.	1897.	1896.
United Kingdom	$8,480	$21,664	$7,427	$7,738	$5,778
United States	952,298	873,366	543,943	428,218	436,948
Other countries	7,041	2,946	2,851	4,895	1,219
Germany	—	—	—	—	969
	$967,819	$897,976	$554,221	$440,851	$444,914

	1895.	1894.	1893.	1892.
United Kingdom	$2,346	$9,332	$10,389	$7,858
United States	279,657	304,513	498,439	299,503
Other countries	815	2,176	7,995	903
Germany	1,053	3,019	—	—
	$283,871	$319,040	$516,823	$307,264

Newfoundland.—Electric motors.

	1900.	
United States	$16,825	Not given before 1900.
Other countries	438	
	$17,263	

Bahamas.—Electrical appliances.

	1900.	1899.	
United Kingdom	£26		Not given before 1899.
United States	£6,880	£7,589	
	£6,906	£7,589	

Jamaica.—Electric lighting apparatus.

	1900.	1899.	1898.	1897.
United States	£2,163	£2,938	£11,893	£4,147
United Kingdom	—	—	1,209	188
Other countries	316	418	59	13
	£2,479	£3,356	£13,161	£4,348

New South Wales.—Electric machinery.

	1900.	1899.	1898.	1897.	
United Kingdom	£16,432	£6,681	£8,927	£8,005	Not given before 1897.
United States	22,452	1,354	40,714	387	
British possessions	—	15,522	—	—	
Other countries	3,155	1,354	1,073	1,859	
	£42,039	£28,577	£130,143	£94,046	

Dealing with the returns gathered from the colonies forming Table III.F seriatim, we find that the only returns available from Victoria show that relatively to competing foreign countries the United Kingdom here controls the trade. The New Zealand returns are only for one year. Over 75 per cent. of the imports come directly from the United Kingdom. As to the proportions of British goods among those coming from New South Wales it is impossible to define. But from these indications one can surmise that New South Wales is largely a depot whence trans-shipments to the other Australian colonies takes place. The New South Wales returns show the most violent of fluctuations, the due reasons for which could only be given by one having a good knowledge of local conditions, such as works in progress and stocks carried by the merchants during each year.

Before leaving this trade zone, it is to be regretted that for Western Australia, Tasmania, South Australia and Queensland there are no published figures in this Parliamentary return whereby the proportion of electrical machinery from the United Kingdom to that from other countries is shown. The same remark applies to the returns from India, which are published in a separate volume. Of the returns in the volume of total colonial trade details are again lacking in regard to the South and West African colonies, together with the majority of the West Indian islands.

The Canadian figures merely illustrate the predominance of the United States over the North American continent. Apparently the Yankee has interfered with German as well as English imports. It should be explained with regard to the Canadian figures that the apparent discrepancy between the returns III.B and III.F are in part due to the years in the former table ending on December 31st in each year, while the Canadian fiscal year ends on June 30th; the discrepancy is also in part due to the fact that the returns for the United Kingdom give the value at port of shipment, whereas the Canadian figures give the value at port of unloading. The Newfoundland figures are only for one year, and these, with the figures from the Bahamas, show a trade wholly American. The Jamaica returns show an active trade in 1898, of which the United Kingdom had about 10 per cent., followed by a decline in which the United Kingdom disappears as a country for separate enumeration.

The writer ought, perhaps, to apologise for having devoted so much space to the foreign export trade of the United Kingdom. The total value of the export trade for last year was less than the expenditure of a single large English or American city on its lighting. On the other hand, the money spent by the United Kingdom on imports, even in 1900, the year of amazing electrical imports, would only suffice, on the basis of the capital expenditure per mile of the Central London Railway, to have entirely equipped 4½ miles of single track of tube railway. Yet the outcry has been so great and the dominance of the foreigner in the English markets so loudly heralded, that the writer feels justified in citing this one of many possible comparisons.

(To be concluded.)

THE OPENING OF STREET BOXES.

On Tuesday, November 10th, Mr. Bonar Law, M.P., Parliamentary Secretary to the Board of Trade, sat at the Board of Trade offices in Whitehall to hear an application by the Westminster City Council, under the Electric Lighting Acts, that the hours within which the undertakers of electric lighting in Westminster should be allowed to have access to their street boxes should be limited, in the case of one schedule of thoroughfares to between 12 midnight and 9 a.m., and in the case of another schedule to between 8 p.m. and 10 a.m. With Mr. Bonar Law were the Hon. T. H. W. Pelham (Assistant Secretary of the Fisheries and Harbour Department of the Board of Trade) and Mr. A. P. Trotter (electrical adviser to the Board). On behalf of the Westminster City Council Mr. J. Bradley (engineer) and Mr. John Hunt (town clerk) appeared. The companies concerned were represented as follows:—St. James' and Pall Mall Electric Light Co., Messrs. F. J. Walker and S. J. Dobson; London Electric Supply Corporation, Mr. G. W. Partridge; Kensington and Knightsbridge Electric Lighting Co., Messrs. H. W. Miller and S. Erskine; Westminster Electric Supply Corporation, Dr. A. B. W. Kennedy, Messrs. Hordern, C. O. Grimshaw and W. A. Jones; Charing Cross and Strand Electricity Supply Corporation, Messrs. E. W. Seale and W. H. Patchell; Metropolitan Electric Supply Co., Messrs. J. S. Highfield and J. W. Drew; Chelsea Electric Light Co., Mr. P. Still.

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Mr. HUNT, in opening, said the question to be considered was not whether there was to be any or no restriction upon the companies, but the extent of the restriction, one of the conditions on which the companies had been allowed to construct street boxes (thus appropriating a large amount of valuable public property which had been bought by the public at great expense) being that the local authority should have power to prescribe the hours during which they should have access to the boxes, subject only to the approval of the Board of Trade. The opening of these boxes caused enormous obstruction. Many of the openings of the streets, notice of which was given to the Council, were made by the Post Office, the Gas Light and Coke Co. and other companies, but the bulk were made by the electric companies. No notice was given when street boxes were opened, and even if notices were given it would be impossible for the City Council to follow them up unless they had an army of men for the purpose. In the Strand, Piccadilly, Charing Cross, Whitehall, Victoria-street, Regent-street, and Lower Regent-street there were no fewer than 2,700 boxes. These were streets in which the least obstruction caused serious inconvenience to the frontagers and passengers. Each time they were opened an obstruction from 6ft. to 8ft. wide by 8ft. to 10ft. long was caused. It was absolutely impossible to ascertain the number of times the boxes were opened, but the figure could be put at tens of thousands per annum. The restriction proposed would only apply to the streets of importance, there being no claim at present in respect of the by-streets. The underlying principle for which all the companies concerned were contending, with the exception of the Kensington and Knightsbridge Company (who admitted that there must be some restriction on their obstruction of the public streets) was that the whole of the inconvenience caused by the opening of these boxes was to fall on the public and not upon the companies or their customers. Parliament had not intended that the whole of the inconvenience should fall on the travelling public, and apart from any interpretation of an Act of Parliament, it was but common justice that the inconvenience should as far as possible fall upon the companies and their customers, who directly benefited by it, and as little as possible upon the travelling public and the ratepayers.

Mr. BONAR LAW: Are not the customers ratepayers, while a good deal of ordinary traffic is formed of persons who are not ratepayers?

Mr. HUNT: They are all ratepayers, if not in Westminster, then in other parts. The highways are made for the public, and they are public property, and everybody has a right to pass over them. Continuing, Mr. Hunt stated that the bulk of the ratepayers in the streets where the obstruction complained of occurred took electric light. He could not see why the consumer should not give access to the companies in regard to making connections in the early morning, and the rest of the indoor work be done during the day. There was no suggestion that the work should be done at night, and there was no necessity for it. If the schedules of the Council were adopted, the companies would have two safeguards against arbitrary conduct on the part of the Council. First, in case of real urgency, consent to open the boxes during prohibited hours could be obtained immediately from an official of the Council; and, secondly, if the Council summoned a company for opening a box during prohibited hours, and the company made out a case of absolute necessity, the magistrate would have it in his discretion to inflict no penalty. The Post Office had powers in regard to these boxes without restriction, but the Postmaster-General had taken the matter up personally, with the result that an action at law between them had been settled, and the Postmaster-General had voluntarily agreed to considerable restrictions in regard to the opening of these boxes. The risk of explosion arising from taking an artificial light to surface and ventilating boxes, where gas sometimes accumulated, could be obviated by either letting the air in a suspected box out or pumping fresh air in.

Mr. BONAR LAW asked whether the Council had any power with regard to gas or water boxes or sewers.

Mr. HUNT replied that they had not, but such boxes were not opened "once in a blue moon."

Dr. KENNEDY stated that the companies had met and he had been asked to speak for them all. The companies were all desirous as far as possible to minimise the inconvenience alluded to; but that inconvenience they thought inevitable because the thoroughfares where it occurred were the thoroughfares under Act of Parliament for the mains of the electric companies in the same way as they were the thoroughfares for gas pipes, hydraulic and other mains used for the benefit of the public, and particularly for the benefit of the ratepayers of the district. They felt that the question of the safety both of the public and of their own employés, and also the question of efficiency in carrying out their statutory obligations (in which was involved the efficient maintenance of their mains), must come first, and not be sacrificed because of local inconvenience. As to the demands of the Council, he assumed that they applied not to new work (of which notice had to be given) but to renewals and maintenance. While before 9 a.m. there were daylight hours during seven months of the year, there were many months during which there were not daylight hours sufficient for the companies to do anything, and those were just the times when they had most trouble.

Mr. HUNT, in reply to Mr. Bonar Law (who asked whether there was any reason why the companies should not submit to the restrictions accepted by the Postmaster-General), read the portion of the agreement between the Council and the Post Office relating to hours, as follows:—"With regard to the opening of manholes and street boxes and the use of tents and trucks in the streets: (1) The work of drawing-in and jointing main cables in the roadways shall be continuous, and may be begun at any time in all the streets mentioned in the accompanying schedule; (2) other work involving the opening of manholes and the jointing of wires in junction boxes in the whole of the streets will be done as far as possible between the hours of 8 p.m. and 10 a.m., being continued beyond the latter hour only when necessary, in which case a notice marked 'emergency' will be handed to the city engineer." The next clause was only of a temporary character: "(3) The Council will raise no objection to the opening of boxes during the day for drawing-in distributing cables, and will accept a reservation desired by the Post Office in respect of boxes dividing two metropolitan superintending engineers' districts to which access may be required at any time for testing purposes."

Dr. KENNEDY said he had not seen this agreement before, and it took him rather by surprise. He would point out that under it the hours for working were from 8 p.m. to 10 a.m. all the year round, and, secondly, that work must be continuous beyond that hour, at the discretion of the Post Office if they considered it an emergency piece of work. The agreement, also, was in the nature of an experiment to be in force for one year. Apart from that, clause No. 2 was very different from what was proposed to the companies. If a company sent in a notice that a case was one of emergency the Council could say it was not.

Mr. HUNT read the section of the Act of Parliament which provided that undertakers opening boxes during prohibited hours should not be subject to penalties if the Court was "of opinion that the case was one of emergency, and that the undertakers complied with the requirements of this section so far as was reasonable under the circumstances."

Dr. KENNEDY said the difference was that under the agreement the Postmaster-General had the right to say whether it was an emergency or not.

Mr. BONAR LAW suggested that a compromise should be possible on the basis, as an experiment, of the companies accepting what the Postmaster-General had accepted. In the earlier stages the compromise might be temporary. After it had been tried they would be in a better position to see how it would work.

Mr. BRADLEY said that, while the Post Office was a public department, the companies were concerns trading for private gain, and therefore the powers which could be given to the former could not be given to the latter.

Mr. BONAR LAW said he quite understood that, but, at the same time, the Board of Trade were bound to consider the interests of those ratepayers who consumed electricity as well as the interests of those who used the streets. It would facilitate matters if they would agree to the compromise on the definite lines of the hours. They could then discuss the emergency matter.

Mr. HUNT thought there was no power to go beyond the Act of Parliament in relation to the matter of emergency. He added: I consider that you really admit my first contention that there should be some restrictions.

Mr. BONAR LAW: I undoubtedly do if it is in the interests of the district.

After further discussion,

Dr. KENNEDY pointed out some of the differences between the company's boxes and those of the Postmaster-General. The Postmaster-General's boxes, on the whole, contained a very large number of wires, and, practically, one wire served one purpose. If there was a breakdown, practically no harm was done. On the other hand, if the insulation, say, of one of the wires of a company broke down and was undiscovered it might put the whole district in darkness; at any rate, it might cause great inconvenience and possibly danger. In the interests of the consumers also, the mains must be examined continually to find out faults before they occurred. The examination of the mains during the day had probably been the reason there had been so few failures of light, because if anything was wrong it could be rectified during the day. While lights could be used in some boxes, there were others in which they could not, and covered lights would not give sufficient illumination. These boxes, therefore, could not be examined properly except in daylight.

Mr. SEALE, in supplementing Dr. Kennedy's statement, asked if it was fair that freedom of access to the boxes should be restricted and that there should be no corresponding limitation of the liabilities of the companies? At present, if an explosion occurred, the companies were liable. If the department restricted the thorough carrying out of its duties it seemed to him that the question of how far the company was to be liable was raised. It might be possible to reduce the size of the tents and to adopt some method by which less obstruction would be caused. Upon that point they were at one with the Council and would be glad to meet them, but the companies would offer strenuous objection to restriction of inspection or of hours of viewing the boxes.

Mr. BONAR LAW: The Act of Parliament clearly makes it our duty to sanction reasonable restrictions. The whole question, therefore, is: What is a reasonable restriction? In considering that we are bound to consider the interests, not only of the people who walk the streets, but of the consumers of electricity. I would suggest that surely there is some way by which, first of all, the companies could meet together to consider what they would be willing to agree to, and then, that they should have a meeting with the representatives of the City Council of Westminster and try to come to a compromise which, for a time at least, might be used as an experiment. Speaking, not on the authority of the Board of Trade, but giving only my own opinion, I think it would be perfectly unreasonable to make the hours such that the bulk of the work could not be done in the daylight. On the other hand, I do not consider that the fact that the companies would be put to a slight additional expense is to be considered as necessarily conclusive in objecting to the change. There is inconvenience in any case, and it is only reasonable that the companies and their customers should share it. It occurs to me as a possible solution that you might arrange that, in the winter months you should give a slightly longer time in the morning, and a shorter time in the summer, when there is longer daylight to be had. If you frame some rules in that way we shall be delighted to authorise them. If you cannot agree, it will be for us to consider whether the rules laid down by the Westminster City Council are or are not reasonable, and pass them or refuse to pass them accordingly.

Dr. KENNEDY intimated that the companies would consider the suggestion most carefully, and Mr. HUNT stated that the Council would be only too happy to meet the companies again.

The proceedings then terminated.

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ROYAL COMMISSION ON LONDON TRAFFIC.

At the first meeting of the Royal Commission on London Traffic, after the recess, which was held on Friday last week (November 6th),

Mr. W. E. RILEY, superintending architect of the London County Council, gave evidence. He said that the systems of the Metropolitan and Metropolitan District Railways, which had served as a basis for consideration in the evolution of the Paris railway system, now prevented any completely unified scheme being applied to London. The principle of the inner and outer circle railways in London had been adopted and extended in Paris, so that at present the lines formed an ellipse of three irregular curves surrounding the city, with other lines running diametrically north and south, and east and west. An ideal scheme for London would be circumferential lines at various distances apart, with others crossing these diametrically and joining the circumferential lines with the centre points. The existing electric railway lines, however, were a series of irregular lines, which would require some modification to bring them into an approximate unification. Nevertheless, he thought that if all the authorised tube railways were built, a very material improvement in means of communication would be effected. At the same time, it was not to be inferred that the London County Council suggested that tube railways afforded the best means of communication in the direction indicated. For instance, between Marble Arch and Cricklewood (the route of the authorised North-West London Railway) a surface tramway or shallow subway would be a great convenience. He made the following suggestions with regard to the evolution of a system of intercommunication between the numerous railway termini. The City and South London Railway could be extended from its present terminus at Islington down to King's Cross and St. Pancras, so as to form an interchange station with the Baker Street and Waterloo Railway at Portland-place, and interchange stations could also be arranged near that spot with the Great Northern and Strand Railway as well as the Charing Cross, Euston and Hampstead Railway. By this means the following termini could be brought into communication:—London Bridge, Bank, Moorgate-street, King's Cross, St. Pancras, Euston, Waterloo, Charing Cross, Marylebone and Paddington. A further means of such communication would be an extension of the authorised North-West London Railway from Marble Arch to Vauxhall Station. There could be an exchange between such a line and the Baker Street and Waterloo railway in the Edgware-road. This line would thus couple up with Victoria, and leave very few other termini unconnected. An extension of the Great Northern and Strand Railway from its Strand terminus to Waterloo would form an approximate north and south line. Still another line which he considered necessary was one from Piccadilly-circus to the City via Charing Cross, the Law Courts and Ludgate-circus. Witness also suggested that if tramways were not stopped from crossing the bridges, and were allowed to run along the Embankment, the dangerous termini at Westminster and Blackfriars would be abolished. The tramway now terminating at Hampstead-road should be brought nearer the centre of London by an extension down Tottenham Court-road. A further suggested route for a tramway, partly on the surface and partly in a shallow subway, was from Hammersmith Broadway, along Kensington-road via the south side of Kensington Gardens and Hyde Park to Piccadilly, and by a widened thoroughfare to Kingsway.

Outside the central area of London greater railway accommodation was also necessary, and the following suggestions for new tube railways were made:—

1. A route from Highgate, running via Hornsey, Alexandra Palace and Wood Green to Tottenham, where it would join a route from the last-named place to the City.

2. A route starting at Clapham Common and running to Tooting in the direction of Mitcham. The passenger traffic on the City and South London Railway between Kennington and the Bank was so great that any extension of this line would only cause further overcrowding unless relief could be obtained by the construction of the authorised City and Brixton line.

3. A route running through Poplar, crossing the river and continuing via Greenwich and Kidbrooke to Eltham, returning via Lee, Lewisham, New Cross, Deptford and Bermondsey and crossing the river to a point near the Monument.

4. A route from the junction of Sloane-street and Knightsbridge down Sloane-street through Sloane-square along King's-road and crossing the Thames to Putney. This route would be capable of extension towards Kingston, becoming a surface line as soon as possible.

5. An extension to Willesden Junction, and possibly further, as a surface line, of the Baker Street and Waterloo Railway from its present authorised termination at Paddington.

6. A route from Walthamstow, through Leyton, entering the City by Bethnal Green was very necessary, but the exact route required consideration. Relief of the present great congestion at Bethnal Green Junction was much needed.

7. A route beginning at the junction of Queen-street and Cannon-street, passing under the Thames, through Peckham, and ending at or near the Crystal Palace. This line would probably be expensive to construct, but would be very useful.

8. A route from the termination of the authorised North-West London Railway at Marble Arch to Victoria and Vauxhall and in the direction of Camberwell and Peckham.

To complete the systems by connecting one district with another, it was also suggested that certain points on the radial lines should be selected, and locomotion services provided between them. Deep-level tubes should only be constructed where the exigencies of street traffic required, and shallow underground or surface lines should be built as continuations. With a view, also, to providing further relief to rapidly increasing street traffic in and around the central business area, and to provide for the probable increase of traffic in outlying districts, witness suggested that broad avenues should be constructed specially with a view to building shallow subways for tramways underneath them. One such route suggested was on the line of the projected City and Crystal Palace Railway through Camberwell and Peckham. The construction of this line as a tube, owing to the water-bearing nature of the subsoil, would probably be very expensive. A number of similar routes were also suggested running north, south, east and west. At the same time, witness pointed out that the above suggestions were not put forward in any way as definite proposals of the London County Council.

Sir FRANCIS HOPWOOD: What would be the nature of your proposed radiating lines?—They would be on the principle of the shallow subway between Holborn and the Strand, but larger.

Continuing: He would not advocate tube railways where it was possible to put in a shallow subway. It would be possible to construct shallow subways underneath old as well as new streets. Even Oxford-street could be dealt with in this manner, but it would be, in this case, a very costly matter.

Sir FRANCIS HOPWOOD: What would be the dimensions of the proposed subway?—In the new avenues they would be 20ft. high and 13ft. wide, sufficient to take a single-deck car.

I am not convinced that the shallow subway would be preferable to a tube. What are your reasons for this?—The same cars could run upon the surface, the subways are more accessible to the public, and they are safer.

What is the comparative cost of a tube and a subway?—I should put the former at about half the latter.

Witness then put in some figures as to the cost of housing, inside and outside the central area of London.

During the sitting votes of thanks were passed to all who so courteously assisted the sub-commission while in the United States.

The Commission then adjourned until Thursday next, and in future sittings will be held on both Thursdays and Fridays.

Thursday, November 12.

Mr. ANDREW YOUNG, valuer to the London County Council, gave evidence relating mainly to the construction of new streets. In his opinion, the construction of roads having a width of 160ft. (greater than any ever projected in London before) would involve an outlay of great magnitude. At the same time, if, as was put forward by the previous witness, there were to be provided on such thoroughfares special means of locomotion by surface tramways, motors and other fast traffic, and also by tube railways beneath the streets, the possibilities for recoupment would be largely increased, and would also extend over very large areas, inasmuch as the value of property in the remoter districts adjoining the route would be enhanced. From this point of view, he preferred to construct new streets than merely to widen existing ones. If a shallow subway tramway were constructed between Hammersmith and the City, and then on to Stamford Hill, he put the cost of compensation for interference with cellars and vaults beneath the roadway at £1,250,000.

Sir ALEXANDER BRUCE, Assistant Commissioner of Police, dealt with the powers invested in the police by various public acts. With regard to the Tramways Act of 1870 he had no suggestion to make with reference to an amplification of the police powers conferred by it. In giving a list of hindrances to traffic, reference was made to the different rates of speed of different classes of vehicles. The frequent breaking up of streets by electric light and other companies was also mentioned and a remedy was suggested in the form of subways, or, as an alternative, to place such matters in the hands of one authority, which should decide, after consultation with the police, at what hours roads should be disturbed. A complaint which was at present made was that the work of opening the streets by such companies was that the work is not carried out as expeditiously as possible. In his opinion to make a street wider and construct electric tramways would make the congestion worse than before. In a wide street he considered that omnibuses caused less obstruction than electric tramways. He did not propose any change in the police regulations as to the traffic at tramway termini. One great cause of hindrance to traffic was the fact that tramway routes and termini had not been fixed with due regard to the convenience of the public. He proposed looped termini, such as had been adopted at Hammersmith Broadway.

The Commission adjourned until to-day (Friday).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"An Elementary Treatise on Hoisting Machinery." By Joseph Horner. (London: Crosby Lockwood & Son.) 7s. 6d. net.

"Liquid Fuel and its Combustion." By W. H. Booth. (London: Archibald Constable & Co.) 24s. net.

"Hypochlorite und Elektrische Bleiche." By Viktor Engelhardt. No 8 Monographien über angewandte Elektrochemie. (Halle-a-s.: Wilhelm Knapp.) 12m.

"Science Abstracts" for October. Section A: Physics. Section B: Engineering. (London: E. and F. N. Spon.) 1s. 6d. each.

"Telephony." By A. Vaughan Abbott. Vol. IV. The Construction of Aerial Lines. (New York: McGraw Publishing Co.) 7s.

"Theorie und Anwendung des elektrischen Bogenlichtes." By H. Birrenbach. (Hanover: Gebrüder Jänecke.) 9m.

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A CONTINENTAL OVERLAND WIRELESS TELEGRAPH INSTALLATION.

In connection with an industrial exhibition in Aussig (Bohemia) a wireless telegraph installation for transmitting messages between that town and Teplitz was carried out by the Allgemeine Elektricitäts Gesellschaft of Berlin, the system used being that of Slaby-Arco. The following notes regarding this installation are taken from an article contributed by M. Albrecht to the *Zeitschrift für Elektrotechnik*. As will be seen from the profile of the intervening country (Fig. 1) the distance between the two towns is 14km. as the crow flies, and the district, on account of the various hills, is not very favourable to wireless telegraphy. Nevertheless, the reception of communications at both ends was said to be very exact and distinct. The primary current, at a pressure of 200 volts, is interrupted by means of a mercury turbine-interrupter, and the key is provided with a magnetic blow-out. Fig. 2 represents the diagram of connections at the sending station, and it will be noticed that the poles of the secondary winding of the induction coil are connected up to the air-gap, in parallel with which are five Leyden jars and a choking coil for tuning purposes. One of the poles of the air-gap is connected to earth, and the air-wire is connected to the tuning coil by way of a small protective air-gap, the reason for this being to prevent the waves flowing directly to earth through the choking coil whenever the station is receiving messages. Tuning is effected by varying the lengths of the air-wires at the sending and receiving stations by means of adjustable choking coils; the adjustment is varied until the pressure in the air-wire is a maximum—*i.e.*, until the air-wire is equal to one-quarter the length of a wave. Practically, the method of tuning is simplicity itself, and is carried out by placing a hot-wire ammeter in the air-wire circuit of the sending station, and by then adjusting the choking coil until the ammeter indicates a maximum. Several air-wires, in the form of a triangle with its apex near the ground, constitute the antennæ. Altogether there are 16 copper wires, each 30 metres long and 1·5mm. in diameter. The cross-wire, forming the base of the triangle, is suspended between two poles at a height of 35 metres. Wires run from the apex of the triangle to the sending and receiving apparatus. The air-wires are at an angle of between 50 and 60deg. to the horizontal.

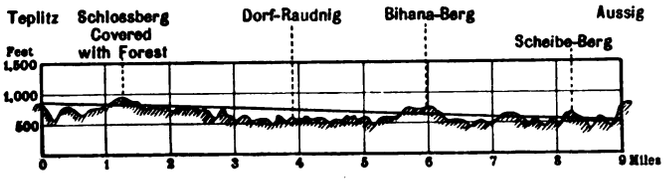

Fig. 1.—Profile of Country between Teplitz and Aussig.

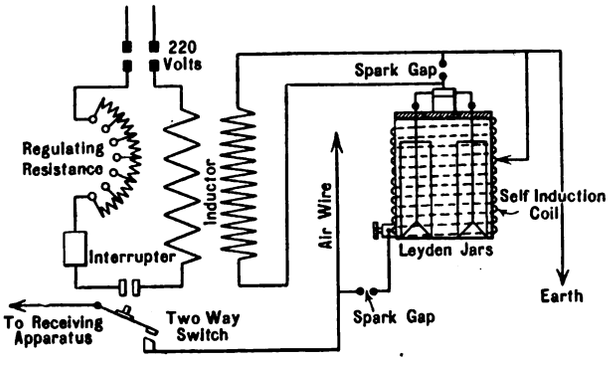

Fig. 2.—Connections at Transmitting Station.

From Fig. 3, which represents the method of connecting up th coherer to the air-wires, it will be gathered that by adjusting th choking coil shown, it is possible to bring the maximum pressure to bear upon the coherer. The method of tuning consists in adjusting the choking coil in the circuit of the air-wire until the pre-arranged signals sent from the other station appear most distinct. Before commencing to tune, however, the coherer and the relay are made as sensitive as possible, the testing in this connection being carried out by means of a simple electric hammer arrangement, which is connected to two small dry cells. Coherer and relay are adjusted until they respond to the minute sparks produced by the hammer device. The metal filings are placed between two wedge-shaped electrodes, so that, by rotating the coherer round its axis, it is possible to alter and adjust the state of looseness of the filings, which also affects the sensitiveness. The coherer is exhausted of air. Regarding the connections of the receiver station, these do not differ in any essential feature from those generally employed.

When an incandescent lamp in the room was switched on or off, the coherer responded; this also took place when the outer of a 2 × 220-volt three-wire circuit was touched with a piece of metal, but not, however, when the outer was touched directly by the person experimenting. Considerable inconvenience was caused by sparking, which occurred when signals were being sent, between wires of the 220-volt lighting system of the exhibition, occasioning thereby many short circuits. To avoid these disturbances, the lighting system is now disconnected during the time wireless telegraphy is proceeding. In Teplitz it is said that sparks of from 5mm. to 10mm. in length could be drawn from the 100-volt lighting supply, this being quite independent of the 220-volt circuit which supplies the primary of the induction coil. During storms, the incoming messages are sometimes unintelligible, but communication can be kept up until the storm is quite near. In very hot weather it occasionally happens that some signals are not recorded. The system works best after storms and on cool days.

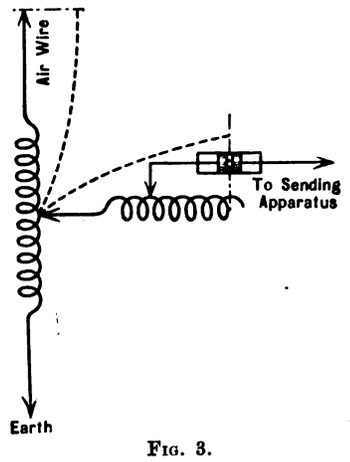

Fig. 3.
Connections at Receiving Station.

CORRESPONDENCE.

STEAM TURBINES *v.* RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: My attention has been called to a letter in your last issue from the well-known engine builders, Messrs. Belliss and Morcom, in which figures given in my Paper recently read before the Leeds Section of the Institution of Electrical Engineers are adversely criticised. In the case of the E.C.C.-Belliss set in the Leeds electricity works—I gave the steam consumption per kilowatt-hour at 19·9lb. (the figure given to me as approximately accurate by the city electrical engineer), whereas Messrs. Belliss put it at 19·49lb., including boiler and steam pipe losses, which correction I accept.

Although no definite statement is actually made, yet the whole letter is cleverly drawn out to convey the impression that reciprocating engine plants are as economical as turbine plants, and complaint is made that I compare the efficiency of reciprocating engines and turbines of about equal sizes but working under different conditions, especially with regard to superheat and vacuum. My reply is that it is quite fair to make comparisons between the plants mentioned in my Paper, because the steam consumptions given are those obtained *under actual daily working conditions*. To the plea that a particular reciprocating plant would give a better efficiency with greater superheat and better vacuum, my reply is, why do you not then provide the greater superheat and better vacuum, and thus obtain the alleged greater economy? Are we to assume that the engineers who have these plants under their charge, or that the engineers who built them and put them down disregard their own fame and the interests of their employers so much that they are content to waste coal and boiler power rather than improve their vacuums and raise the temperature of superheat?

Engineers who have had an extended experience with both reciprocating steam engines and steam turbines know full well that to raise the superheat over, say, 60°F. at the stop valve means with the reciprocating engine: (1) increase in the difficulties and risks of running; (2) increased wear and tear and heavy bills for upkeep and repair; (3) an expensive oil and much of it for cylinder lubrication. In the steam turbine

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none of these difficulties and expenses present themselves, hence, we see in actual everyday work reciprocating engines with little or no superheat and turbines on high superheats.

Messrs. Belliss state that with 237°F. superheat they can reduce the steam consumption in their Leeds plant from 19·49lb. to under 16lb. per kilowatt, then why is not this desirable and valuable economy effected? I trow it is because Messrs. Belliss know, and the city engineers know, that with such high superheat all the difficulties named above would then be at once encountered, and the extra expenses and risks thus brought about would more than counterbalance the temporary economy to be gained. Thus my contention that my comparisons are fair because they are on practical lines is a sound contention, and it applies with equal force to the comparisons drawn between the steam turbine and the Sulzer-Kolben plants named in my Paper. Again, as regards vacuums, engineers with both classes of plant know that by reason of gland and packing leakage it is more difficult to maintain high vacuums with reciprocating engines than with turbines.

Doubtless, Messrs. Belliss would like to prove that reciprocating plants are more economical than steam turbines, but the weight of evidence is against them. It is not to be expected, however, that engine builders will allow the present rapid development of the steam turbine to proceed without making some efforts to stem the tide, futile though it may be. I repudiate Messrs. Belliss's insinuations that I am interested in booming the turbine or that my Paper contains "misleading statements." The figures given are to the best of my knowledge correct, and, moreover, they are not theoretical values, as is the figure of improved economy given for the Leeds plant, but the outcome of everyday practice, which alone is the true standard upon which to found our conclusions.

With reference to the postscript, I would correct it and put it thuswise: It should always be borne in mind that the cost of obtaining the high vacuum necessary for efficiency with *either reciprocating engines or* steam turbines may become a very formidable item in the majority of inland stations.—Yours, &c.,

Harrogate, Nov. 10. GEORGE WILKINSON.

THE INVENTION OF THE DYNAMO-ELECTRIC MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Messrs. Slater, Heelis, Williamson & Co. have written you a letter to which only the briefest reply is necessary.

First, they say that they are instructed by Dr. Wilde to observe that "Dr. Wilde has never designated as magneto-electric machines the dynamo-electric machines described in the specifications of his several patents." I regret to inform them that their observation is faulty. Dr. Wilde never called them dynamo-electric machines at all. In fact, the distinction which Messrs. Slater, Heelis, Williamson & Co. are instructed to "observe" does not exist. You must, Sir, pardon me if I decline their polite invitation to disclose (even after the judgment of the Court of Appeal in my favour) any points in my case. Ample proof exists to substantiate these matters, and will be forthcoming if and when needed.

As to Messrs. Slater, Heelis, Williamson & Co.'s second point, I adhere to my allegation that Dr. Wilde did himself furnish to me in the first instance the statement that the name dynamo-electric machine was first applied in 1867 by Charles Brooke, F.R.S., to the machine of Dr. Wilde's invention.

As to Messrs. Slater, Heelis, Williamson & Co.'s further point, there is nothing in it. They sent me for insertion in one of my books a certain statement which their client believed to be true, and which I believed to be true. In courtesy to their client I signified my willingness to accept it. On investigation, however, it proved to be untrue, and their own client admitted that it was untenable. Nevertheless, though it was known and admitted so far back as July, 1902, to be inaccurate, they, acting for Dr. Wilde, have carried their action against me from Court to Court for 12 months in their endeavour to compel me to insert it in my book. Having failed in their action, they now put forward, apparently in justification of such proceedings, the observation that, at a date a few months previously, I had inserted a somewhat similar statement in another book of mine. How on earth can that circumstance justify them? Would they be surprised to learn that in this case also the information upon which I acted in so inserting the now discredited statement was given me by no other than their own client? He believed it to be true. So did I. In good faith I put it in. Since the date when I found out its inaccuracy I have excised it; for no man would wish to see an elementary text-book marred by a misleading statement. That is all.—Yours, &c., SILVANUS P. THOMPSON.

London, Nov. 10.

THE QUESTION OF THE HOUR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: "H. C. D." misapprehends my argument in several points—the fault, no doubt, being my condensed statement of it. I am well aware of the conditions under which cables are landed at our foreign possessions and protectorates, and was far from implying that as a nation we have "protected" submarine cables. My point was that we possessed ports ("stepping stones") which enabled us to lay cables of practicable length to places where considerable trade existed, and that but for this fact the earlier cables would not have been established by us. I venture also to say that the lines to and on the coasts of South America would not have been constructed by British enterprise but for the commercial success of the connections to the East.

Again, I sought to contrast, from the fiscal point of view, the cable-making industry with the manufacturer of machinery for export, your editorial remarks with reference to the latter having led to this correspondence. Why, then, should "H. C. D." limit my hypothesis of a 25 per cent. duty on "cables" to the shore ends in foreign territorial waters? Obviously, a duty on the entire cost of the cables, with the exception of the shore ends within *our* 3-mile limit, was intended. That, for the purpose of this discussion, it seems to me, is the analogy to foreign tariffs on machinery exported by us. Then he says, certainly the position of our cable enterprise would have been the same even if we had paid duty on the cables, because the rates charged would have been correspondingly increased "at, of course, the expense of the tariff imposers." I fancy they would have had to be increased to the British public too—but that by the way. Does he imagine, however, that the traffic would have grown as it has done, if the rates had been, permanently, 25 per cent. higher? I can only say that is not the general line of argument nor the opinion, judged from practice and results, of the companies.

Again, he asserts, "As soon as public confidence had been established, capital for cable enterprise was easily obtainable in Europe and America." I beg leave to traverse that statement. Cables were a "property" over 25 years ago.

I am quite aware, too, that France and Germany heavily subsidise national cables, but even then, the capital to lay them had to be raised from the public; and, without forgetting the first French Atlantic cable, it is only more recently that there has been any general movement abroad to enter upon world telegraphy. Time was when foreign Governments paid subsidies to British companies for connecting their colonies with the cable net-work, and I still think that foreign cables, and many other of their enterprises, are largely due to capital accumulated from profits on exports to our free markets. He speaks of "imaginary profits" on their exports to us. What does he mean? There is surely no imagination about them.

I quite admit that such free trade as we had was greatly to our advantage for many years, but as foreign tariffs became increasingly prohibitive, it seems to me that the conditions began to alter altogether. I have heard only to-day of a Scotch manufacturing firm which shows enormous profits "under Free Trade," but then they have factories in all the principal European countries and in America in order to get inside the tariff walls. Will not this take place more and more, and with the electric as well as other industries? Capital can easily—too easily, alas!—be so transferred to foreign countries, although it cannot readily be transferred to other industries, but what about the bulk of

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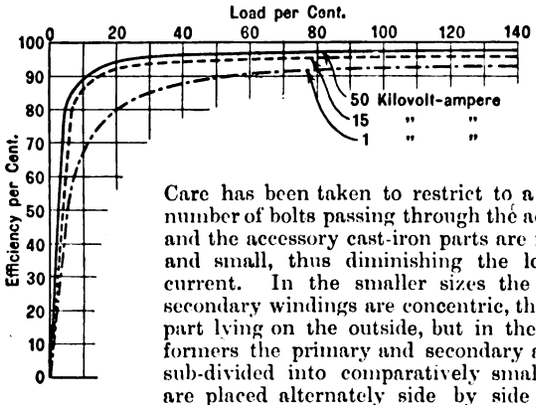
our workmen? It is even more an artisan than a capitalist question. Can we expect them—the majority of the voters—to be content to watch many of their large industries dwindling away or being transferred abroad without any attempt being made to obtain reciprocity?

Can "Free" Traders suggest any other way of abating foreign tariffs than by negotiating with a duty, which can be reduced pari passu, in your hand? We should then have access to their largest foreign customer to offer to most of the nations in return for corresponding access to their people. Even then, at equal duties, we should have a more valuable market to offer them than they would have to offer us. Surely, this is only business. Cobden defined common sense as "a just appreciation of *facts*." *Verb. sap.*—Yours, &c., G. R. N.

London, Nov. 11.

OIL-COOLED TRANSFORMERS.

We have received an interesting pamphlet issued by the Allgemeine Elektricitäts-Gesellschaft dealing with the construction and performance of their smaller types of three-phase oil-cooled transformers. It is pointed out that, in consequence of the rapidity of the abduction of heat and the insulating qualities of the oil, the transformers may be built compacter than air-cooled ones of the same capacity. Then, since the insulating materials do not come into contact with the air, they last longer and are kept from corroding. Also, if from any cause, such as lightning discharges, sparking should momentarily arise between the windings, the oil is said to prevent the working current from being drawn across this path. All the types mentioned in the publication, and ranging in capacity from 1kw. to 50kw., are constructed as core transformers, and the stampings are insulated by paper from one another.



Care has been taken to restrict to a minimum the number of bolts passing through the active material, and the accessory cast-iron parts are few in number and small, thus diminishing the losses by eddy current. In the smaller sizes the primary and secondary windings are concentric, the high-tension part lying on the outside, but in the larger transformers the primary and secondary are, as a rule, sub-divided into comparatively small coils, which are placed alternately side by side on the core. Paper has been found to be most suitable as insulating material, as it successfully withstands the action of oil at high temperatures. It is used in thicknesses of from 0·1mm. to 0·5mm., several layers being employed, according to voltage. A thickness of about 0·2mm., it is stated, will withstand a pressure of 8,000 to 9,000 volts. At ordinary temperatures the oil used in these transformers is comparatively thick, but at the usual working temperatures (60°C. to 80°C.) it becomes very thin. The diagram above represents the efficiency curves, with an assumed power-factor of unity for a 1, 15 and 50 kilo-volt-ampere transformer. The high efficiency of the larger transformers at light load is especially noticeable.

Graphite Resistances.—Mr. Robert Hapfelt communicates to the *Elektrotechnische Zeitschrift* some interesting notes on graphite resistances, in which it is stated that a peculiarity of these resistances, which are built up of graphite powder, lies in the rapid decrease of resistance after they have conducted current for a short time. The rate of diminution of resistance, however, grows smaller and smaller, and eventually its value remains constant for a given current. On connecting a starter for a 6 H.P. motor across a 220-volt supply, it was observed that the initial current was about 5 amperes, corresponding to a resistance of 42 ohms, and that, after 10 and 15 seconds respectively, the figures were found to be 35 amperes, 6·3 ohms and about 100 amperes and 2·2 ohms. Tests proved that the resistance was nearly independent of the temperature. Owing to these peculiar qualities but few stops are required, the starting of motors, it is stated, being nevertheless very even.

LEGAL INTELLIGENCE.

Cole v. Isle of Thanet Electric Tramways and Lighting Co.

On Friday last, before Mr. Justice Bigham and a special jury, Eleanor Cole, a widow, sought to recover damages for the loss of her husband, whose death she alleged to be due to negligence of defendants' driver.

Plaintiff's husband was a carter, and on July 28, 1902, was leading his horse and cart along the Marine Parade, Margate. Plaintiff alleged that before her husband had time to get his cart perfectly clear of the tramway a car came up and struck the wheel. Her husband was thrown down and was run over by his own cart, death ensuing three days later. Defendants denied negligence, and alleged that the accident was due to Mr. Cole's endeavouring to pass between the car and a barrow standing at the kerb.

The jury were unable to agree, and the parties consented to take a verdict of the majority. This was in favour of plaintiff. Damages, £200.

The judge said he considered the verdict was quite wrong. He entered judgment for plaintiff for £200 and costs, but granted a stay of execution.

Lyles v. Southend Corporation.

This case, which came before Mr. Justice Wright on Friday last on points of law, arose out of an accident to plaintiff when a passenger on one of defendants' cars by the trolley rod breaking and falling upon him. Defendants pleaded that, as the action was not brought within six months, as required by the Public Authorities Act, 1893, the claim was barred.

Mr. BRAY, K.C., for Southend Corporation, argued that the case came within the scope of the act, and quoted "Markey v. Tolworth Burial Board" to support his view.

Mr. EVANS, K.C., M.P., for plaintiff, submitted that the act did not apply in the case of a tramway worked by a corporation as part of a municipal enterprise, inasmuch as there was no power to apply any of the profits towards the reduction of the rates. Counsel further contended that the act only applied to actions in tort, and not to contracts, and, therefore, plaintiff was entitled to succeed, as defendants, by reason of the accident, failed to carry out their contract to carry him safely as a passenger.

It was arranged that the latter point, which was raised unexpectedly, should be argued on some future day. On the other points, the learned Judge found in favour of the defendant Corporation. He could not concede that in working the tramways the Corporation were not working in pursuance of any Act of Parliament, public duty or authority. They had obtained a provisional order which empowered them to construct those tramways, and on their undertaking the working of the cars they were under a statutory and public duty, and had a public authority so long as they continued to execute the provisional order.

Speed of Electric Cars.

At the West London Police Court, on Saturday, the presiding magistrate, Mr. Rose, concluded the hearing of summonses against four drivers of the London United Tramways (Ltd.) for driving at excessive speed. (The previous proceedings have been reported in our columns.)

The evidence submitted included that of Prof. SILVANUS P. THOMPSON, who said he had made four speed tests of each of the cars over the measured furlong used in Col. Purcell's tests (referred to in our last issue), and the mean speeds attained by the cars were as follows:—Car No. 272, 14·465 miles per hour; No. 60, 12·487 miles; No. 75, 13·335 miles; No. 173, 14·157 miles. The conditions under which the tests were made were fair, and there had been no tampering with the electrical plant or with the cars.

The MAGISTRATE said, after hearing the scientific evidence, he could have no doubt that the speed of the cars exceeded 10 miles an hour, and, that being the case, there must be a fine, whatever the effect might be upon the public convenience. As to the amount of the fine, motorists would no doubt think that the same fine as they usually had to pay ought to be imposed on this occasion; but he should only impose fines of £2 each, or £8 in all, and costs.

Mr. MUIR said that Mr. Moffat Ford had, in the course of the case, made a deliberate suggestion of fraud against the company in connection with the tests, and he asked the magistrate to express his opinion on that point.

Mr. ROSE said he did not regard the statements made as suggesting fraud.

Mr. MOFFAT FORD said he had not intended to make any such suggestion. If he had done so he desired to withdraw it.

Master and Servant.

At Chertsey County Court on Thursday last the Hon. Arthur Russell heard a case in which an "electrical engineer and engine driver" named Cox sought to recover from Mr. H. Edwards £250 damages for injuries sustained while in his service looking after an engine and electric light machinery at his private residence. While so engaged, the driving belt of the engine flew off and knocked plaintiff down, destroying the sight of one eye. There were no guard rails, or flange to the pulley of the dynamo.

After a long legal argument, his Honour said plaintiff was a domestic servant, and could only claim a maximum of £50. He could not claim under the Employers' Liability Act.

Defendant said he had had the machinery put up by a competent firm, and had no idea it was dangerous. He denied that plaintiff had ever drawn his attention to the necessity of guards being provided.

His Honour said the case rested solely upon the statement that defendant's attention had been called to the dangerous state of the belt. He could see no evidence that defendant had failed to carry out his duty as a master to a servant, and he had employed a competent firm to put up the machinery. Judgment must be for defendant.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Council of the Metropolitan Borough of Poplar invite applications for the position of borough electrical engineer and manager at a salary of £400 per annum. Applications to town clerk (Mr. Leonard Potts) by Nov. 28. See advertisement.

A first-class man is required to act as foreman of stranding shop of dry core telephone cable factory. See advertisement.

Bexhill Council require a mains superintendent with experience of a three-wire low-tension network, paper-insulated cables, street lighting, &c. Applications to chief engineer (Mr. W. T. Le Feuvre), electricity works, Bexhill, by 21st inst. See advertisement.

There is a vacancy for a pupil at an electric motor and engine works in London. See advertisement.

An assistant, with factory experience, is wanted in the electrical engineering department of the City and Guilds of London Central Technical College, Exhibition-road, S.W., to give instruction in the theory and practice of electrical machine design, construction and testing. Salary £150 per annum. Applications to Prof. Ayrton. See advertisement.

Sunderland Corporation require a general manager of their electric tramways. Salary £400, increasing by yearly increments of £25 to £500 per annum. Applications by noon Nov. 17.

Manchester Electricity committee require a mains assistant. Applications by Nov. 16.

Mr. H. M. Atkinson, Ph.D., has been appointed science instructor under the Tipperary Technical Instruction scheme, until July 31, 1904, subject to the approval of the Department of Agriculture and Technical Instruction, Dublin.

Mr. I. Williams, B.Sc., has been appointed a junior assistant in the physics department of Merchant Venturers' Technical College, Bristol. Mr. Williams was educated at University College, Cardiff, where he took the degree of B.Sc. of the University of Wales with honours in physics.

Mr. A. M. Giles has been appointed assistant physics demonstrator at the Northern Polytechnic Institute, Holloway, London, for four evenings per week.

Belfast Gas and Electric committee recommend the appointment of Mr. C. E. Dale as charge engineer.

Mr. Medley of Maidstone has been appointed engineer-in-charge at Darlington.

EDUCATIONAL NOTICE.

Electrical Standardising, Testing and Training Institution — Prof. C. A. Carus-Wilson, M.A., M.I.E.E., commenced a special course of lectures to the senior students of this institution upon direct-current motor construction yesterday (Thursday).

Apprenticeship Premiums.—We have received a communication from "J. S. V.," inquiring as to the position of a young man who has signed on for a term of years at some works as a premium pupil, with the understanding that he is to receive a thorough technical and practical training. Our correspondent states that the young man is learning nothing, and that no attempt is made to teach him anything. He asks if there is any redress, or must the whole of his premium be sacrificed. The answer is that the young man can (through his parents, guardians or next friend) bring an action for damages for breach of contract and for the cancellation of the articles of apprenticeship. If the facts are as stated by "J. S. V.," he is fully justified in taking such action, and he should employ a solicitor.

Ashford (Kent).—The Council have finally decided to transfer their provisional electric lighting order to a company.

Ashton-under-Lyne.—The town hall is to be wired for the electric light.

Batley.—An inquiry has been held into the application of the Town Council for sanction to a loan of £5,000 to extend the electric lighting cables to Batley Carr, Upper Batley, Carlinghow, &c.

Bedford.—From April 1 next the charge for electric current for power, heating, &c., is to be reduced from 2d. to 1½d. per unit.

Belfast.—A special meeting of the Council was held on Tuesday to consider the draft bill for the acquisition and conversion of the tramways, &c. A resolution to strike out all clauses giving the Corporation power to grant a new lease to the present or any other tramway company was defeated by 23 votes to 5, and a clause sanctioned empowering the Corporation to pay compensation to any servants in the regular employment of the tramway company who should not be retained by the Corporation.

Bognor.—The Council will oppose the application of the National Provincial Electricity Corporation for a provisional order.

Bridgend.—The dispute between the Council and the South Wales Electrical Power Distribution Co. as to the supply of electrical energy has been settled:—

In consideration of the Council allowing the company to supply certain firms with energy for lighting and power, the company agree to make no charge for transforming the town supply, for which they have hitherto charged ½d. per unit. As to sums already paid on this account, allowance will be made to the Council. The company is to be free to supply any person or firm within the urban area, to whom power, not lighting, is the chief consideration, with energy for lighting as well as power, on condition that they pay to the Council 2½ per cent. on the receipts. This arrangement is a tentative one, until Dec. 31, 1904.

Brighton.—The Old Steyne extension of the Corporation's electric tramways was opened for traffic on Saturday.

At a special meeting of the Council on Thursday last, Ald. Stafford moved that application be made for a provisional order to authorise the construction of electric tramways in Preston-road from its junction with London-road and Beaconfield-road to the borough boundary near Clermont-road. A debate ensued, during which some members left the meeting with the avowed intention of reducing the number present below the necessary quorum, and the debate was, therefore, adjourned until Monday, when a similar result followed, and the matter stands adjourned.

Brixham.—Owing to dissatisfaction with the present system of gas lighting, the Council have decided to obtain a report from a consulting engineer as to the erection of electricity works. The Council obtained a provisional order in 1903.

Cable Subways.—The Paviors' Company, London, recently invited essays and drawings expounding schemes for subways for water and gas pipes and electric mains to obviate the frequent breaking-up of the roads and pavements. There were 26 competitors. The first prize went to a Mr. Parkinson, Peterborough, who receives 100 guineas, the second (Mr. A. J. Pryce) 30 guineas, and the third (Mr. F. M. Royle) 20 guineas.

Carnarvon.—The Town Council have decided to engage a consulting engineer to report upon the schemes of the National Electric Construction Co. and the North Wales Electric Power Co. for the supply of electricity in the district.

Cheltenham.—A lengthy report has been prepared by the borough electrical engineer (Mr. Hamilton Kilgour) on the present position of the electricity undertaking.

A number of tables and statistics accompany the report, which states that the capital expenditure per kilowatt capacity at Cheltenham was £74·8, the average for high-tension stations in the United Kingdom being about £86, while the revenue cost per unit sold was 1·57d., compared with 2·08d. as the average in this country. In Cheltenham the outside works cost approximately £83,800 out of a total of £148,000, which is (Mr. Kilgour believes) an unusually large proportion. Notwithstanding this the percentage of £74·8 was below the average. The large expenditure upon outside works was due partly to street lighting and partly to the large and scattered area of supply. The expenditure on outside works might be divided as follows: Private supply £48,500, public lighting £32,700, traction £2,625. The revenue-earning capacity (rates of charge being assumed constant) of private supply outside works was much greater than the revenue earned; the revenue earning capacity of the public lighting was more than the revenue earned, but not to a large extent, and the traction was sufficient to supply the contemplated traction extensions in addition to the present line, so that the revenue-earning capacity of traction outside works was about double the revenue at present earned. The output at Cheltenham was 1,287,421 units, and cost per unit 1·569d., which compared favourably with the figures for the six high-pressure stations with outputs between 1,000,000 and 1,500,000 units per annum. At Cheltenham the charges for interest and sinking fund last year were 6·73 per cent. on average capital of year, whereas the average of the corresponding values for 54 high tension stations was 5·70 per cent, and the average value for the total capital was 5·59 per cent. For a 25-year loan the sinking fund rate was £2. 14s. 10d. or £2. 11s. 4d., according as the rate of interest was 3 or 3½ per cent. If they borrowed at 3½ per cent. the total capital charges would be £6·44 per cent. compared with £5·73 per cent. actually charged. At March 31, 1902, the capital raised by loan (other than overdraft) was £44,261, and the average rate of interest was 2·94 per cent.; the corresponding figures for March 31, 1903, were £67,931 and 3·11 per cent. Mr. Kilgour gives the detailed allocation of capital as: Private supply £88,145, public lighting £47,771, traction £12,112, and the gross annual amounts to be paid upon capital and the corresponding values per unit sold for the quantities sold during year ended March 31 were:—

	Capital.	At 6¾ per cent. £	per unit.	At £6. 9s. per cent. £	per unit.
Private supply	£88,145 ..	5,950	3·28d. ..	5,685	3·14d.
Public lighting	47,771 ..	3,225	1·25d. ..	3,081	1·20d.
Traction	12,112 ..	818	0·83d. ..	781	0·80d.

Of the total quantity generated 717,267 units must be allocated to private supply, 687,427 to public lighting, and 249,540 to traction, a total of 1,654,234 units. The actual losses in distribution for public lighting and traction were about 70,000 and 6,000 units respectively. Most of their auxiliary plant was driven by electric motors in order to avoid the use of small and inefficient steam-driven plant as much as possible. Analysis of the works' costs for the two light-load and two heavy-load quarters proved that their stand-by cost was £4,263 for the

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year and that their running cost was 0·23d. per unit generated. The total distribution costs were £651, of which about £322 was on account of private supply and about £329 on that of public lighting; no expenditure was incurred for distribution on account of traction. The total costs for management, rents, rates, taxes, &c., were £1,782. The total stand-by costs (£6,696) allocation was:—Private supply £3,889, public lighting £1,973, traction £843. The total running costs were:—

	Units generated.	Cost at ¼d. per unit generated.
Private Supply	717,267	£747
Public Lighting	687,427	716
Traction	249,540	260

hence the total costs, excluding capital charges were—

		Cost unit sold.
Private Supply	£4,627	2·55d.
Public Lighting	2,689	1·05d.
Traction	1·103	1·12d.

Adding the actual capital charges for the year, the total costs became

		Per unit sold.
Private Supply	£10,429	5·76d.
Public Lighting	5,834	2·27d.
Traction	1,900	1·94d.

The total receipts for energy sold were

		Per unit sold.
Private Supply	£8,428	4·65d.
Public Lighting	4,906	1·91d.
Traction	1,863	1·90d.

hence, the actual losses upon last year's working were:—Private supply £2,001, public lighting £928, traction £37. The total loss on last year's working, excluding interest on deficit, was £2,966, which would have been £1,475 had their capital charges been 5·70, the average for the 54 high-tension stations.

In connection with the annual loss and the accumulated deficit Mr. Kilgour points out that it has been the policy of the Council, and (as he considers, rightly) to do the public lighting at practically cost price and ultimately at less than cost price; that within the last year or two capital charges had increased nearly 1 per cent.; that the cost of coal was now about 35 per cent. higher than when the station started work: that they had supplied the public library from the start at a loss, 29,347 units having been supplied in the last five years for £240 (or 1·96d. per unit), and that their extended network of private supply mains had entailed a large amount of only partially reproductive expenditure. It was clear that, since there was no immediate prospect of a fall in interest and since coal was unlikely to become cheaper, an increased charge should be made for public lighting, an increase of £1,000 per annum would give them a profit and still leave the price per lamp much lower than usual. He did not recommend an increase in the charge for traction supply, because a new agreement would be required directly extensions had been completed. With regard to private supply he recommended that their present sliding scale of charges for energy be changed to the following:—(1) 6d. per unit for any quantity not exceeding that corresponding to 500 hours' supply per annum at the consumer's maximum demand rate, (2) 2d. per unit for any additional quantity up to that corresponding to a further 200 hours' supply per annum at his maximum demand rate, and (3) 1d. per unit for any additional quantity supplied per annum. Mr. Kilgour also recommends that the Corporation use their powers (under their provisional order) of charging 13s. 4d. as a minimum per quarter to all future customers.

Chesterfield-Alfreton Tramway.—Clay Cross Council, through whose district this projected tramway would run, has decided to support the scheme.

Clacton.—The Council have received sanction to a loan of £15,225 for electricity supply.

Dartford.—The electric lighting mains are to be extended to St. Vincent's Industrial School.

Dudley.—The new mayor (Ald. Hughes) announced last week that a report from the electrical engineer stated that extensions must be made to the electricity generating plant. They were already supplying over 1,000,000 units per annum for lighting and traction.

Dunfermline.—The National Electric Construction Co. have notified the Council of their intention to apply for a provisional electric lighting order. The Council are, however, considering whether power shall not be taken in bulk from the Fife Electric Power Co., or whether a company shall be allowed to come in unopposed.

Durham.—Last week the City Council decided to object to any extension of time for constructing the tramways, and representations are to be made to the Board of Trade as to the delay which has occurred in the construction of the authorised lines.

East Dereham.—The Southern District Electricity Corporation are applying for a provisional electric lighting order and the Council have decided to take no steps in opposition.

Edmonton.—The Council is considering proposals as to leasing its electric lighting order from Frank Suter & Co., the Sir Hiram Maxim Electrical and Engineering Co., the Industrial Engineering Co. and the North Metropolitan Electrical Power Distribution Co. The engineer was on Tuesday directed to ascertain whether the Board of Trade would extend the time for the Council to commence putting their order in operation.

Electric Lighting Notices.—Glastonbury Corporation and Walton-le-Dale District Council give notice of intention to apply for provisional electric lighting orders. In both cases it is proposed to insert clauses to empower transfer to a company or any or some of their powers, &c., under the orders.

In the application by Hanwell District Council it is proposed to include a clause "to manufacture, purchase, hire, sell and let on meters, lamps, accumulators, dynamos, fittings, &c."

Electric Power for West Africa.—An article in *West Africa* describes a project for the utilisation of the water power of the Tano river (the second largest river on the Gold Coast) for generating electric power for the mines on the Tarkwa gold belt and the Ivory Coast and in Ashanti.

The Tano has a fall of 75ft. within 1 mile of its course, 40ft. of this being within 100 yards. Power up to 45,000 H.P. would be available. The cost of a 5,000 H.P. transmission plant is estimated at £140,000, and the operating expenses at £28,500. The output of such a plant operating on a mixed load 24 hours per diem for 300 days per annum would be about 21,480,000 units per annum, bringing net cost to less than 2d. per horse-power-hour. The cost per horse-power per annum of steam power in West Africa exceeds £40. The income from the sale of 5,000 electric H.P., estimated at £25 per horse-power, would be £125,000, less working costs £30,000, giving £95,000 profit, or 25 per cent. on £300,000. Over two dozen mines, it is said, are rapidly approaching a stage when the necessity for a cheap power will become necessary, and it is thought that if 20 companies were to take current they would benefit to an extent proportionately higher than the 11 Kolar (India) mines, which are expected to save over £50,000 in working expenses during their 10 years' contract by the use of electrical energy generated at Cauvery Falls.

Electric Railway up Mount Vesuvius.—It is announced that the work of constructing and equipping an electric railway up Mount Vesuvius has been completed, and that a tramway about 4½ miles in length has been constructed for connecting its lower terminus with Naples.

Electric Traction in Victoria.—The report of the Victorian Railways Standing committee recently presented to the Legislative Assembly recommended the conversion of the St. Kilda railway from steam to electric traction. Owing, however, to financial considerations, this recommendation was only carried by the casting vote of the chairman. It is pointed out in the report that the Victorian suburban railways would be at a disadvantage as to earning capacity compared with the Sydney tramways as the trains would not run in the business thoroughfares of Melbourne. Mr. Renwick, the engineer-in-chief to the Victorian railways, estimates the cost of converting the 100 miles of the Victorian suburban railways to electric traction at £2,480,000. The committee also recommended that, wherever a suburban railway line has to be extended, it be converted to electric traction, and that simultaneously with the conversion of the St. Kilda line two extensions be made and worked as overhead trolley tramways. The power house is to be erected near the river Yarra, space being left for future extensions. The cost of the scheme, complete with rolling stock, is not to exceed about £100,000. The committee do not consider the conversion will be a financial success. They further consider that it is not necessary to look outside Australia for a competent electrical engineer to report upon and supervise the works of the character which the Government may decide upon during the next few years.

Electrical Amalgamations and Absorptions.—Amalgamations and absorptions are in the air, and rumours affecting the combination of British, Anglo-German, German and Austrian industrial undertakings are prevalent. In this country report has it that Messrs. Siemens Brothers & Co. and the British Schuckert Electric Co. are likely to work together in the near future, and Vienna reports are to the effect that the amalgamation of Messrs. Siemens and Halske with the Schuckert interests there is now an accomplished fact, and that these businesses will be jointly worked as from Jan. 1 next. There is further rumour that the electro-chemical works of the Bitterfeld Company are amalgamating with the Rheinfelden Electric-Chemical Works. The financial connection between the Rheinfelden enterprise and the Siemens-Schuckert combination is of a very intimate character, while the Bitterfeld undertaking is closely allied financially to the Allgemeine and Union Electricitäts group.

In the incandescent electric lamp branch on the Continent the Verkaufsstelle vereinigter Glühlampen-Fabriken (G.m.b.h.) has been registered in Berlin for buying and selling incandescent lamps, the exploitation of patents, &c. The authorised capital is M.1,000,000. The concern takes supplies of lamps at an agreed price. The Allgemeine Elektricitäts Gesellschaft and Siemens and Halske Aktiengesellschaft undertake to supply 5,000,000 lamps each per annum, and the Vereinigte Elektricitäts-Aktiengesellschaft (Vienna) undertakes to supply 3,100,000 lamps.

As a result of the recent visit of Geheimrath Rathenau and M. E. Thurnauer to America an arrangement has been come to for closer business relations between the General Electric Co. (U.S.A.), the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston, the Compagnie d'Electricité Thomson-Houston de la Mediterranée, the Allgemeine Elektricitäts Gesellschaft, and the Union Elektricitäts Gesellschaft.

The Akkumulatoren Fabrik Berlin-Hagen has acquired the undertaking of the Akkumulatorenwerke System Pollak

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Electricity in Flax Mills.—The Irish Flax Spinning Co., Belfast, have placed a contract with the British Thomson-Houston Co. for the electrical operation of the extensions to their mills now in course of erection. The contract comprises the provision of a 60kw. three-phase generator, switchboard and three motors for driving the machines in the various rooms, which contain the usual flax preparing and spinning machines. We believe this is the pioneer scheme of electrical operation of flax machinery in Ireland.

Eton.—The Rural Council has assented to Maidenhead Corporation supplying electric current in Taplow and Burnham at 6½d. per unit for lighting and 4½d. for power.

Exhibition.—Eastbourne Corporation will hold an exhibition in the large assembly room at the Town Hall from Dec. 2 to Dec. 6 inclusive of fittings, apparatus and novelties for electric lighting or decorative effects, heating, cooking, ventilating, &c., and also of electric power-driven machinery, &c. Spaces for stalls (16ft. 8in. by 6ft.) will be let at £3 per space. A supply of electrical energy can be obtained at 200 volts (frequency 50) at 2½d. per unit, but a minimum fee of £1 will be charged in order to partially cover cost of service. Applications to the borough electrical engineer, Mr. J. K. Brydges.

Farnham.—The Council have applied for an extension of 12 months to comply with the provisions of their electric lighting order, 1900.

Fire.—A fire broke out on the premises of Messrs. Lord and Shand, 29, Westwell-street, Plymouth, on Saturday evening, causing considerable damage. The firm announce that business will be carried on as usual at temporary offices, 12, Princess-square, Plymouth.

Forthcoming Book.—Messrs. George Newnes (Ltd.), publishers, London, announce that No. 1 of a new Technological and Scientific Dictionary will be ready this month. No. 1 will form the first of 15 fortnightly parts of this work, each number being published at 1s. net. The dictionary is edited by Mr. G. F. Goodchild, B.A., B.Sc., Principal of the Wandsworth Technical Institute, and Mr. C. F. Tweney, of Wandsworth Municipal Libraries.

Frome.—At a meeting of the Council on Tuesday, the report of the consulting engineer, Mr. F. H. Medhurst, on the proposed extensions of the electric lighting cables and alteration to the cooling tower was adopted, and sanction to a loan of £7,100 has been applied for.

Gloucester.—The work of reconstructing the permanent way of the old tramways for electric traction was commenced on Monday.

Grimsby.—The Council have taken up a loan of £43,500 for 25 years at 3¾ per cent. for the electricity undertaking.

Ipswich.—Trial trips have been made on the Whitton electric tramway route, which will shortly be opened for traffic.

Indian Telegraphs.—According to the report of the Indian Telegraph Department for 1902-3, the loss arising from the reduction in rates of cablegrams between India and Europe to 2s. 6d. per word has been small in the first year of its operation, owing to increased traffic. The foreign private message revenue only fell off by 3½ lakhs, due mainly to the diversion of the Australian traffic with Europe, formerly transmitted via India, to the direct cable route via South Africa. The total earnings (112½ lakhs of rupees) were slightly in advance of those of previous year, and the net profit represented 4·15 per cent. on a capital expenditure of over 795 lakhs. There are 5,652 telegraph offices, 56,830 miles of lines and over 200,000 miles of wire in India. The Government have also introduced a revised inland tariff.

Kingston.—In a further report on the present condition of the electricity undertaking, the consulting engineers (Messrs. Burstall and Monkhouse) recommend the Council to provide, for the winter load of 1904-5, a new steam alternator, with steam and other pipes, switchgear, &c.

Kingswood.—At a specially-convened meeting of the Council on Wednesday it was decided not to proceed with the application for a provisional electric lighting order.

Light Railway.—The Light Railway Commissioners held an inquiry on Wednesday into the scheme for the construction of an overhead traveller bridge and electric tramway to connect Portsmouth and Hayling Island at an estimated cost of about £63,000. The Commissioners decided to grant an order.

Llandudno.—The District Council decided some time ago to apply for a tramway provisional order, but as the Llandudno and Colwyn Bay Electric Railway Co. have now started the construction of their line the application has been deferred.

London County Council.—At Tuesday's meeting a loan of £3,753 was granted to Islington for 694 electricity meters, repayable within 10 years. The Borough Council asked for a period of repayment of 42 years.

Southern Tramways.—The Highways committee recommended that a special statutory meeting should be held to consider the question of the purchase of the London Southern Tramway Co.'s undertaking.—Decision postponed.

Tramways in Clerkenwell.—The same committee recommended that the conduit system of electric traction be affirmed for the construction of the tramways along St. John-street, St. John-street-road and Rosebery-avenue.—Agreed.

Northern Tramways.—The same committee reported that, in view of the proposal to proceed with the reconstruction to the conduit system of the first 22⅓ miles of the Council's Northern tramways, arrangements be made for the supply of the rails and fastenings required for the work. Tenders should be invited for 12,500 tons of rails, conductor tees, fastenings, &c., at an estimated cost of £90,000. —Consideration adjourned.

The question of the amount to be paid by the North Metropolitan Tramways Co. as rental for the proposed Clerkenwell lines (during the period the lines will be worked by horse traction) was discussed on the report of the Highways committee, and an arrangement was reported by which the company pay a rent of 8 per cent. per annum on £13,175 until electric running is established, when the rental will be on the basis of 8 per cent. on the larger capital expenditure, £30,500.

Tooting Tramway Termini.—It was further recommended that £13,850 be expended in the extension of the existing tramways along Tooting High-street to Defoe-road.—Postponed.

Electricity Station Extensions at Hackney.—The Building Act committee have consented to the proposals of Messrs. R Hammond & Son (on behalf of Hackney Council) for the construction of additions to the Borough Council's electricity generation station at Millfields-road.

Louth.—The Council having decided that it was inadvisable to engage in municipal electricity supply at present, have leased their order to the Sir Hiram Maxim Electrical and Engineering Co., reserving the option of purchasing the undertaking in 14 years or any subsequent period of seven years.

Malta.—The electric lighting works at Valletta, which commenced supply in December, 1896, have now an equivalent of over 18,120 8 c.p. lamp connections, including 30 H.P. for motors but not including fan motors. 140 consumers' names are on the books of the undertaking, current being supplied at 7d. and 6d. for lighting and 3d. for power. 7d. per unit is charged up to 50 8 c.p. lamps and 6d. beyond.

A concession has been granted for electric tramways on the island, and the work of construction is in hand.

There is an opening for increased supplies of incandescent and arc lamps, carbons, lamp holders, fittings, switches, &c., electric fans, yacht and ship lamps, electric bells and batteries. In Malta preference is given to the goods of British firms who can make quick delivery.

Manchester.—The Corporation are promoting three bills, including a bill for the extension of the municipal electric tramways. This authorises the construction of a number of additional tramway lines and further proposes to authorise the Corporation to supply electrical energy beyond the city and to acquire land and execute works in connection therewith.

Market Harborough.—The Council is collecting information as to electric lighting and a consulting engineer is to be engaged to prepare a report.

Marlow.—The offer of a syndicate to erect electricity works and to supply current for public and private lighting is under consideration by a committee of the Council.

Marylebone (London).—Last evening the new Electric Supply committee was elected, and consists of 10 members, with the mayor (Rev. H. Russell Wakefield), and the chairmen of the General Purposes, Works and Finance committees as ex-officio members.

The 10 members are:—E. T. Fowler (52 votes), A. H. Garrould (49), G. Paxton (48), E. R. Debenham and W. Dennis (47 each), Dr. W. Leaf (43), W. Bailey (42), M. A. Blumenthal and A. J. Hopkins (38 each), and J. Anghin (36). The new Council then by resolution decided to inform the London County Council of their adherence to the policy of their predecessors with regard to the proposal to construct a surface tramway along the Edware-road, which the new Council will oppose.

With regard to the deadlock in connection with electric light matters in Marylebone, a motion was on the paper, to be introduced by the new councillor, Mr. Edward White, J.P., L.C.C., "That a committee, consisting of the Mayor and Councillors J. Lea-Smith and Edward White, be appointed to confer with the Metropolitan Electric Supply Co. with a view to an arrangement being arrived at." This motion was not, however, reached, and stands over until the Council's next meeting; as also does a motion (also by Mr. Edward White, J.P., L.C.C.), "That the engagement of Mr. Arthur Wright, the electrical expert, be determined, after notice in accordance with his agreement with the Council."

May-Oatway Fire Detection Appliances.—Some interesting tests between electric automatic fire alarm apparatus and the leading automatic sprinkler system were carried out last week in the offices of the *Glasgow Herald*, Mitchell-street, Glasgow. The apparatus brought into the test comprised 42 sprinkler heads and two May-Oatway detectors, which were arranged in an apartment 12ft. high, 66ft. long and 50ft. wide, the temperature of the room being 60°F. The detectors were set to act at 85deg. whereas the heat had to rise to 155deg. to bring the sprinklers into action. The experiments were

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directed by Mr. W. A. Chamen, chief electrical engineer to Glasgow Corporation; the representatives of two of the leading fire offices (the Liverpool, London and Globe and the North British and Mercantile); the firemasters of Glasgow, Edinburgh and Aberdeen (Messrs. W. Paterson, A. Pordage and W. Inkster); and Dr. Gourlay, representing the *Glasgow Herald*.

Mr. Oatway explained to the persons assembled the working of the May-Oatway instruments, and referred to the considerable number of fires in Glasgow last year (716), which caused a loss of £189,000. He claimed that, had the May-Oatway system been installed in each place where the largest of the fires occurred, not less than £100,000 would have been saved to the community. The installation which had been provided at the *Herald* offices was in no way special or exceptional.

The fire was then lighted in the centre of the room as far away from the detectors as possible. Mr. Oatway poured a large quantity of spirits of wine into two tanks of large capacity and applied a light. The flames at once arose, and in 1 min. 4 sec. after lighting the spirit the alarm bell of the detector arrangement rang, and in 2 min. 46 sec. the brigade arrived, and 30 seconds later were operating upon the fire. The heat brought down the plaster from the roof in two places, but no one present was injured. The 42 sprinklers now became the centre of observation, but it was not until 11 minutes after the arrival of the brigade that these began to act. It was generally conceded that, had the fire occurred in the ordinary course, it would have spread rapidly before the sprinklers came into operation.

The above-mentioned committee subsequently issued their report, which confirmed the above particulars. The demonstration was considered on all hands a strikingly successful one, showing the great advantage of electrically automatic over the mechanically automatic method of fire detection.

Melbourne (Australia).—The *Australian Mining Standard* states that the City Council have decided upon further extensions of their electricity supply undertaking at a cost of £18,507. The additions will include two new boilers, economiser, weighing machine with driving gear, mechanical stokers, &c. When the additions have been completed a saving of £3,000 per annum in working is expected. The Council have reduced the charge for public lighting from £23 to £22 per arc lamp per annum.

Metric System in New Zealand.—An act has been passed by the House of Representatives rendering the proclamation of the metric system of weights and measures legal at any time after Dec. 31, 1905.

New South Wales Tramways.—The Government are about to lay, at a cost of nearly £30,000, three core paper insulated cables from the Ultimo power station to the sub-station at Botany, 12 miles distant.

Newcastle (N.S.W.)—The City Council are about to make extensions to their electricity generating plant, and have decided to adopt the Parsons steam turbine in place of a steam engine.

Overhead Trolley Omnibuses.—Monheim-am-Rhine is introducing a municipal electric omnibus service on the overhead system.

Pacific Cable.—In our issue for Oct. 2 last (p. 983) we gave some particulars of the capital expenditure, &c., in connection with this enterprise up to March 31, 1903. Further particulars to hand show that the expenditure during the period to March, 1903, was £120,000, and the revenue for the three months from the opening of traffic was £18,310, showing a deficiency of £101,690. This deficiency has to be met by the United Kingdom and Canada (£28,055 each), Victoria, New South Wales, Queensland and New Zealand (£11,222 each). The estimated expenditure for next financial year (to March, 1904) is £165,500, estimated receipts £73,400, leaving an estimated deficiency of £92,100, which will be apportioned as follows:—U.K. and Canada, £25,409; Victoria, New South Wales, Queensland and New Zealand, £10,072 each. This is a heavy charge for the Commonwealth to bear.

Penarth.—The Penarth Tramway Syndicate propose to apply for a provisional order to construct an electric tramway between Grangetown Bridge and the Post Office, Penarth.

Plymouth.—A Local Government Board inquiry will be held here on Tuesday into the application of the Council for power to borrow £248,252 for electric lighting and other works. It will be remembered that Plymouth Corporation withdrew their bill last session owing to the conditions as to auditing imposed by a Parliamentary Committee.

Pontypridd.—Mr. J. B. Hamilton has been engaged by the Council, at a fee of 10 guineas per day and travelling expenses, to value the portion of the tramway undertaking owned by the British Electric Traction Co. between the town and Hafod, and the rolling-stock, loose plant, machinery and furniture at Porth.

The Tramways committee had recommended that tenders be invited for six single and six double-deck electric cars, but it transpired that, subsequent to the recommendation, the consulting engineer (Mr. Wilson) wrote stating he was afraid the idea of using double-deck cars on any portion of the route would have to be abandoned as certain bridges were too low to admit of their use. The committee consider it desirable that these cars should be used, and Mr. Wilson is to report further on the matter, and also to submit designs of a workmen's car.

Presentations.—Mr. G. A. Bruce, resident electrical engineer, and Mr. G. W. Steward, superintendent engineer at Lowestoft, have each been presented with a marble clock by the staff of the electricity and tramway departments on their recent marriages.

A gold keyless watch has been presented to Mr. R. E. Fisher, night manager at Messrs. Crompton & Co.'s Arc Works, Chelmsford, by the staff and employés on his departure for Aston,

Proposed North-South Woolwich Underground Electric Railway.—A syndicate, for which Sir James Szlumper is acting as consulting engineer, proposes to apply for powers to construct an underground electric railway between north and south Woolwich. The Bridges committee of the London County Council favour the scheme, which involves frequent service between north and south Woolwich at 1d. fares.

Richmond.—The Tramway committee recommend the Council not to sanction the proposed extension of the system of the London United Tramways over Kew Bridge into Richmond.

St Petersburg.—The Russian branch of the Westinghouse Company has submitted proposals to the Municipal Council for the conversion of the whole of the existing tramways in the city to electric traction. The construction work will be carried out by Russian workmen, but the rolling stock and generating plant will be supplied from the United States.

Seaford.—In three years the units produced by the Council's electricity undertaking have increased four-fold, while six times the number of 8 c.p. lamps are now in use. The cost per unit of production has been reduced from $3\frac{7}{8}$d. to $2\frac{3}{8}$d.

South Africa.—The *British and South African Export Gazette* states that the chief engineer of the Natal Public Works Department advises the adoption of electric lighting in all magistracies and other public offices where a supply is available, and the provision of independent plant when the size of the buildings to be lighted will warrant the expense.

Natal Government estimates for ensuing year include: Telephones, £3,804, and electric bells, £350.

Kroonstad ratepayers have promised to take up, if necessary, the whole of the loan required for the projected public works, including electricity supply.

A supplementary list has been issued specifying "machinery and parts" referred to in para. 63, Class III., of the South African Customs Union tariff, which, in the case of British goods, are subject to $2\frac{1}{2}$ per cent. rebate of duty. The list includes accumulators and accumulator-boxes, plates and glass tubes, armatures, batteries, dynamo brushes, boilers, commutators, dynamos, dynamometers, electric cable, electric pumps, engines (steam and gas), fans, gauges, gauge wire, gongs, lubricators, volt and ampere meters, electric motors, switchboards, transformers, &c.

Lourenço Marques electric tramways will, it is expected, be in operation by Christmas.

In 1901 the imports of electrical goods to Cape Colony and Natal included £97,000 from within the British Empire and £39,000 from foreign countries. In the case of railway and tramway materials, the figures for British and foreign supplies were £416,000 and £263,000 respectively.

Exports from the United States to British and Portuguese Africa during July last included electrical machinery £945 (an increase of £264 over the corresponding month last year), and scientific instruments (including telegraph and telephone apparatus) £9,272 (increase £5,909).

Germany's exports to South Africa in 1902 included electrical machinery £15,050 (increase £11,400 over the previous year), scientific instruments £4,550 (increase £3,100), and telegraph and telephone apparatus £800 (increase £550).

It is reported that the municipal authorities of Port Elizabeth are about to make considerable extensions to the electric lighting of the town, and we learn that tenders are likely to be called for shortly.

Southend.—Sanction to a loan of £20,000 for extensions of the electricity undertaking has been received.

Spain.—At Beasain, in the northern part of Spain, the Soc. Esp. de Construccion Metalicas-Beasain are constructing (under the supervision of their engineer-in-chief, Mr. E. Ph. Jackson) an extensive power transmission undertaking which will, on completion, drive the whole of the machinery of the company's extensive waggon works, now being erected at Beasain. Three units of 500 H.P. three-phase plant will be directly-coupled to horizontal shaft turbines, working at a head of 245 metres. Overhead cables are being erected to conduct the current at 5,200 volts from the power station to the works, a distance of 9,000 metres (about $5\frac{1}{2}$ miles), where step-down transformers reduce the pressure to 200 volts. Provision is at first to be made for lighting 150 arc lamps and 500 incandescents, and a total motor supply of about 1,300 H.P. The electrical portion of this plant is interesting on account of the great variety and size of the motors to be driven. These vary from 5 H.P. to 500 H.P. This latter motor will drive a rolling mill employed in the manufacture of railway car wheels. The hydraulic portion of the scheme is also interesting. Mr. Jackson has, in connection with this scheme, built a reservoir of 10,000 cubic metres capacity at the end of the water-course (4,000 metres in length) in which to store water during the night to provide the works with double power during the daytime.

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Stretford.—The free library, originally built at the expense of Mrs. Rylands, has been altered to make it suitable for technical classes. Electric lighting and heating apparatus have also been introduced at the expense of the same generous donor.

At a special meeting of the District Council on Tuesday a draft bill for the construction of electric tramways, &c., was approved.

Sutton Coldfield.—The General Purposes committee recommend the re-opening of the question of the construction of electric tramways in the district, and the appointment of a sub-committee to meet Mr. J. A. Lycett to discuss the matter.

Telephonic Communication with London Cab Ranks.—The National Telephone Co. propose to put private houses, hotels and clubs in telephonic communication with the nearest cabmen's shelter, provided there are not less than 50 subscribers in the same district. The first experiment is to be made in Portland-place, where already a sufficient number of subscribers has been secured.

Theft of Telegraph Wire.—Four youths were charged at Wimbledon Police-court on Saturday with being concerned in stealing a quantity of telephone and telegraph wire, valued at £9. 4s. 6d., belonging to the London and South-Western Railway Co. Prisoners were also charged with being concerned in unlawfully and maliciously cutting down, removing and destroying a number of telegraph and telephone wires, thus preventing and disturbing communication at Earlsfield on Oct. 26 and other dates. It was stated that on 12 separate occasions, during a period of several months, a quantity of telephone and telegraph wire had been cut with pincers and removed from the posts, no less than 2,636 yds. of wire being thus cut away, preventing communication between the signal boxes and other centres for several hours. Prisoners were committed for trial.

Torquay.—The borough surveyor and the electrical engineer are to carry out the work at the new power station for a commission of 2½ per cent.

The negotiations with the Dolter Electric Traction Co. for the construction of electric tramways have been broken off, and the company will not now apply for tramway powers.

Tramway Rating.—A dispute has arisen between Bradford Corporation and the Councils of Pudsey, Farsley and Calverley as to the rating of the Bradford Corporation tramways, which pass through those districts.

The assessment has been made and has previously been paid on the basis of a tramway, but Bradford Corporation now contend that the lines should be rated on the basis of a light railway, and that they are entitled to an exemption of three-quarters of the district rate. The Councils, on the contrary, urge that the circumstances do not justify the application of this rule, and that the lines are to all intents and purposes tramways, which have been constructed by Bradford under powers obtained in their local act of 1899.

Village Lighting.—Esh Parish Council have accepted the tender of Messrs. Pease and Partners to erect 22 32 c.p. incandescent electric lamps and supply current for £140. 13s. 4d. per annum for lighting the Ushaw Moor district.

Workhouse Lighting.—Bridgend Guardians will take electric current for lighting their workhouse from the Council at 4½d. per unit.

Hackney (London) Guardians have decided, as an experiment, to wire the board and committee rooms for the electric light, with a view to its ultimate adoption for the workhouse premises.

St. George's (London) Guardians have decided to advertise for tenders for lighting their workhouse electrically.

Electro-Harmonic Society.—Our readers are reminded that the "Ladies' Night" concert will be given in the King's Hall of the Holborn Restaurant, London, W.C., this (Friday) evening, at 8 o'clock, under the presidency of Mr. Robert Kaye Gray, president of the Institution of Electrical Engineers.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

London County Council is prepared to receive tenders for the supply, delivery and erection in the electricity generating station to be established by the Council at Greenwich of four 3,000kw. three-phase generators with exciters. Drawings, specifications, &c., from the County Hall, Spring-gardens, S.W. Further particulars are given in an advertisement, and tenders addressed to the clerk of the Council, Mr. G. L. Gomme, by 10 a.m. Dec. 8.

London County Council also invite tenders for wiring and fitting for electric lighting of five sub-stations and three car sheds in connection with the Council's tramways. Drawings can be inspected at the office of the electrical engineer (Mr. J. H. Rider), 303, Camberwell New-road, S.E. Specifiations, &c., from the County Hall, Spring-gardens, S.W. Tenders to Mr. G. L. Gomme, County Hall, Spring-gardens, S.W., by 10 a.m. Dec. 8. See also advertisement.

Kirkcaldy Corporation invite tenders for combined steam engine and dynamo (about 400kw.) for lighting or traction. Forms of tender, &c., from the burgh electrical engineer and tramways manager (Mr. O. F. Francis). Tenders to the town clerk (Mr. Wm. Macindoe) by noon Nov. 23. See advertisement.

Newport (Mon.) Electricity committee invite tenders for three motors of about 50 B.H.P. each, together with switch gear. Specifications, &c., from the borough electrical and tramways engineer, Mr. H. Collings Bishop. Tenders (addressed chairman) to electricity and tramways department, Town Hall, Newport, Mon., by Nov. 23. See advertisement.

Dorchester Council is prepared to negotiate with companies willing to take over and work under lease their provisional electric lighting order, 1901. Offers to town clerk (Mr. A. G. Symonds) by Nov. 26. See advertisement.

The *Dublin* United Tramways Co. invite tenders for the supply of general stores, including electrical supplies, car fittings, iron, steel, castings, oils, paints, ironmongery, &c., for year ending Dec. 31, 1904. Forms of tender, &c., can be obtained and patterns seen at the offices of the secretary (Mr. R. S. Tresilian), 9, Upper Sackville-street, Dublin, up to 23rd inst. Tenders (addressed to chairman) by Nov. 30. See advertisement.

Middlesbrough Electric Lighting committee invite tenders from manufacturers for the supply and erection of one 600kw. steam turbine dynamo, two Lancashire boilers and mechanical stokers and one feed pump, one jet condenser and steam-driven pumps and wood cooling tower. Specifications, &c., may be obtained at the offices of the Corporation electricity department, Snowden-road. Tenders must be addressed to the town clerk (Mr. Alfred Sockett), and delivered by noon of Saturday, Nov. 28. See advertisement.

Preston Corporation invite tenders for the supply and erection at their tramway power station of a traction switchboard and accessories. Tenders to the consulting and resident electrical engineer (Mr. Walter H. Tittensor) by Dec. 12. See advertisement.

Brighton Corporation invite tenders for six water-tube boilers, two separately-fed superheaters, economisers, induced-draught fans and motors, steel chimney stack, feed-pumps and exhaust heater, together with foundations and brickwork for same; a system of steam, exhaust, feed, blow-off and suction pipes, together with their valves; cast-iron storage tanks, hot-well tank and water purifier, and 30 cast-iron circulating water pipes. Tenders to Mr. F. J. Tillstone, Town Hall, Brighton, by 10 a.m. Dec. 7.

The directors of the *Caledonian Railway Co.* invite tenders for stores for six or 12 months from Jan. 1, 1904, including telegraph appliances, telephones, &c., electric lighting materials and fittings, bolts and nuts, copper rivets, &c., drysalteries, hardware, glass, india-rubber and asbestos goods, galvanised wire, wire fencing requisites, locks, oils and grease, tools, screws, &c. Specifications, &c., from stores superintendent, Mr. Thos. Lorimer, Caledonian Railway, Charles-street, St. Rollox, Glasgow, where patterns may be inspected up to Nov. 20. Tenders to secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by 23rd inst.

The directors of the *Great Western Railway Co.* invite tenders for their proposed power station at Park Royal, near Acton, for water-tube boilers, engines, three-phase generators and auxiliary plant. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London, by Dec. 7.

The *Cheshire Lines Committee* invite tenders for stores for 1904, including telegraph materials, electric signals, glass, screws, files, bolts, signal wire, &c. Tenders to secretary, Central Station, Liverpool, by Nov. 27.

Whitehaven Guardians invite tenders for wiring and fitting up their workhouse and infirmary for electric lighting. Tenders to the clerk (Mr. William Henry Atkinson), Union Hall, Whitehaven, by noon Nov. 18.

Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W., are authorised by the Municipal Council of *Sydney* (N.S.W.) to invite tenders by noon Nov. 18 for continuous and alternating-current meters of a pattern approved by the Board of Trade.

Swindon Corporation invite tenders for one complete traction switchboard, tramway feeder cables, pilot wires, arc lamp services, &c. Tenders to the town clerk (Mr. Robert Hilton) by Nov. 23.

Hornsey Urban District Council invite tenders for meters, indicators and consumers' fuse boxes. Tenders to Mr. F. D. Askey, 99, Southwood-lane, Highgate, N., by 4 p.m. Nov. 30.

Kilmarnock Corporation invite tenders for three Lancashire boilers, engines and dynamos, overhead travelling crane, storage battery and switchboard. Tenders to town clerk by Nov. 18.

Kynoch Limited, Witton, Birmingham, invite tenders for stores for six or 12 months, including electrical supplies and engineers' stores. Tenders by Nov. 20.

Tenders are required for heating and ventilating (including electric fans) at *Belfast* Assembly Buildings. Tenders to Messrs. Young and Mackenzie, Scottish Amicable Buildings, Belfast, by Dec. 4.

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Edinburgh Corporation require tenders for wiring and fittings for Gayfield-square police station. Tenders by 21st inst.

Maesteg (Glam.) District Council invite proposals for supplying electricity in the district.

Glasgow Corporation invite tenders by 10 a.m. 17th inst. for wiring Anderston District Library.

King's Norton and Northfield District Council invite tenders by 30th inst. for the erection of tramcar sheds and waiting rooms.

Christchurch (N.Z.) Tramway Board invite tenders for construction and equipment of electric tramways, including steam and electrical plant, car bodies, trucks and motors, permanent way, overhead construction, &c. Copies of drawings, &c., may be obtained from the Agent-General for New Zealand, Victoria-street, London, S.W., by about Dec. 12. Tenders to Tramway Board by March 17, 1904.

The directors of the *Cape Town* Industrial Exhibition (International) invite offers for lighting the grounds, &c. Applications to managers, Palmerston House, London, E.C.

The Municipal Authorities of *Canosa di Puglia* (Bari, Italy) invite tenders until 30th inst. for public and private electric lighting for 50 years.

TENDERS RECEIVED AND ACCEPTED.

Salford Council have accepted the following tenders:—

D. Forth & Son, wiring and fitting up central car shed for arc lighting.

Callender's Company, 2,500yds. high-tension cable, £188. 15s.

British Electric Car Co., "Hit and Miss" car ventilators, £1 per car and covered decks on 17 cars, £92 each.

R. W. Blackwell & Co., constructional tower waggon, £54, and reel waggon, £31.

Westminster City Council are recommended to accept the tender of Mr. A. H. Wood for wiring the Marshall-street public laundry at £228. Four tenders ranging from £228 to £273. 10s. were received.

Messrs. Dick, Kerr & Co. have obtained the contract for two 520kw. direct-current generators for the British Aluminium Co.'s works at Foyers, N.B.

Durban Corporation have accepted the tender of the British Insulated and Helsby Cables (Ltd.) for 5 miles of high-tension cable and that of W. H. Johnson & Co. for 5 miles of low-tension cable.

The tender of R. W. Blackwell & Co. has been accepted for the overhead equipment of Pietermaritzburg electric tramways. Strong and Moore, Durban, have secured the contract for the track-laying.

Bedford Corporation have empowered their electrical engineer (Mr. Phillips) to purchase 18 Ferranti 5-ampere meters at £2. 17s. 6d. each.

The tender of Pratt and Keith has been accepted for the electric lighting of Oldmill Poorhouse, Aberdeen, at £200. Five tenders were submitted, and the lowest was accepted.

Messrs. Belliss and Morcom (Ltd.), have secured the following contracts:—

One engine for coupling direct to General Electric single-phase alternator for Reigate.

One 500 H.P. engine for coupling direct to a Siemens generator for Dewsbury.

One engine for direct-coupling to a Crompton multipolar dynamo for North Riding Asylum, York.

One engine for direct coupling to Westinghouse generator for Gravesend.

Preston Tramways committee recommend for acceptance the tender of Dick, Kerr & Co. for the construction of the permanent way and overhead equipment of the municipal tramways at £80,492.

R. W. Blackwell & Co. have secured the contract for the overhead equipment of the East London (South Africa) tramways.

Messrs. Johnson and Phillips have secured the contract for a 250kw. steam alternator for the Hong Kong electric light station.

St. Helens (Lancs.) Corporation have placed an order with Dick, Kerr & Co. for a 400kw. direct-current generator.

Brierley Hill Council have accepted the tender of Mr. Williams for wiring the new technical schools at £63. 12s.

The tender of the National Electric Construction Co. for wiring the town hall at £29. 18s. 6d. has been accepted by Darlaston Council.

Bromley (Kent) Council has placed an order with the Horsfall Destructor Co. for a three-cell destructor plant at £4,890.

BUSINESS NOTICES.

The Sunbeam Lamp Co. have been appointed sole selling agents for A. Reyrolle & Co. (Ltd.), manufacturers of switchboards, switches, distributing panels, fuse boxes, wall plugs, power and traction accessories, &c.

Mr. Ed. Brand notifies that he has removed his offices from Broad-street House, London, E.C., to 63, Lancaster-avenue, Fennel-street, Manchester.

After 16th inst. the registered address of the Oriental Telephone and Electric Co., the Telephone Company of Egypt and the China and Japan Telephone and Electric Co. will be Alderman's House, Alderman's Walk, Bishopsgate, London, E.C.

Messrs. A. Rosenberg & Co., 21, Southampton-row, W.C., have purchased the business, including plant, stock and goodwill of Mr. J. T. Mill, telegraph engineer, 48, Myddelton-street, Clerkenwell, E.C.

Mr. James C. Boyd, 33, Elm Park Avenue, Ranelagh, Dublin, has been appointed representative in Ireland for the manufactures of the St. Helens Cable Co.

LIQUIDATIONS, BANKRUPTCIES, &c.

The Paisley Tramways Co., whose undertaking is being acquired by Mr. W. M. Murphy with a view to the conversion of the lines to electric traction, is to be wound up voluntarily with Mr. A. R. Mackenzie, Paisley, as liquidator. The purchase price was £14,750, or about £15,500 with interest. After meeting obligations about £5,000 remains for distribution among the shareholders.

At Colchester Bankruptcy Court last week Wm. Frese Greene, inventor, Dovercourt, appeared for examination. Liabilities £1,160' deficiency of £933. Debtor claims to be the original inventor of electrical inkless printing and other patents. He had received over £16,000 in the last seven years for patents. He explained his loss of money by heavy patent and agents' fees, continual litigation, and connection with company promoters. He was a bankrupt in 1891, and was still undischarged. After cross-examination, he was ordered to file in 21 days detailed particulars of receipts and payments during the past seven years.

Claims against the separate estate of J. F. Worthington, electrical engineer (trading, in partnership with G. Nuttall, as J. Worthington & Co.), must be in by 21st inst. to Mr. C. T. Appleby, 26, Corporation-street, Birmingham.

Sale by Auction.—Messrs. James B. Terson & Son, 27, Castle-street, Dover, have been instructed by Messrs. A. Verey & Co. to sell by auction, on Nov. 24, 25 and 26, an extensive stock of electric lighting plant, dynamos, machinery, &c., at London-road, Buckland, Dover. See advertisement.

Plant for Sale.—An E.C.C. shunt-wound dynamo is advertised for sale in another column by Messrs. Elliott Bros., Century Works, Lewisham, London, S.E.

Mr. George Adams, 144, High Holborn, London, W.C., has for sale a small combined electric lighting plant, particulars of which are given in an advertisement.

Tenders are invited for the purchase of nearly new electric lighting plant, some particulars of which are set out in another column. Forms of tenders and all further information from Mr. E. Pennington, auctioneer, Railway Station, Richmond, Surrey, and tenders by 10 am. Dec. 1.

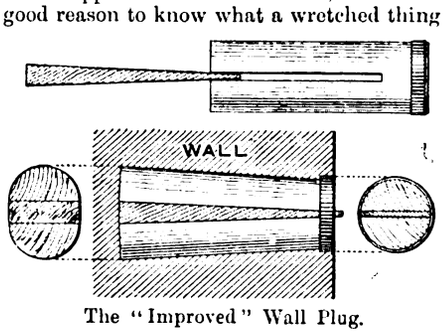
Works Premises for Sale.—Messrs. Farebrother, Ellis & Co., 29, Fleet-street, London, E.C., have extensive manufacturing property, covering 3 acres, for letting or for sale. The property is conveniently situated, with a private siding on the London and North-Western main line; the existing buildings are for the most part of brick construction and readily adaptable for any manufacturing trade. See advertisement.

Land for Sale.—Mr. J. Loder, Hornchurch-road, Romford, has for disposal about 3 acres of land adjoining the Great Eastern goods station, Chadwell Heath, in which sidings could be made. See advertisement.

Factories to Let.—Messrs. Geo. W. Dawes & Co., auctioneers, 11, Basinghall-street, E.C., have large factories to let in London and suburbs, and also in Birmingham, Derby, Cheltenham, Colchester and other leading towns.

A freehold factory is advertised to be let or sold in a S.W. suburb outside the London County Council area. Applications to Messrs. Leopold Farmer & Sons, 46, Gresham-street, Bank, E.C.

Wall Plugs.—We have received from the Improved Wall Plug Co. a pamphlet and a sample wall plug. This plug is of a type which appears to fill a real want, as most electrical engineers have good reason to know what a wretched thing the ordinary wall plug is. Suitable wood has to be found: this has to be cut up, and, after insertion in the wall, it frequently works loose and causes endless trouble. Differing from other plugs on the market, presumably, in using the "Improved" plug, the wedge has to be inserted first and then the plug is driven home upon it. An iron ring holds one end of the plug together, and so a good flat surface is obtained. The illustration, which is drawn to scale and is half full size, shows clearly the construction of the plug.



The "Improved" Wall Plug.

We have received from the Patent Plug Co., 9, Carteret-street, London, S.W., their trade list of patent "Limpet" wall plugs, which are made in a variety of shapes and sizes applicable to all

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classes of work. With these plugs the reverse operation to that above mentioned is necessary, the plug being inserted in the wall and the wedge or block driven in. This company supply tools for preparing walls and other places for the insertion of their plugs. These tools are described as "lightning jumpers."

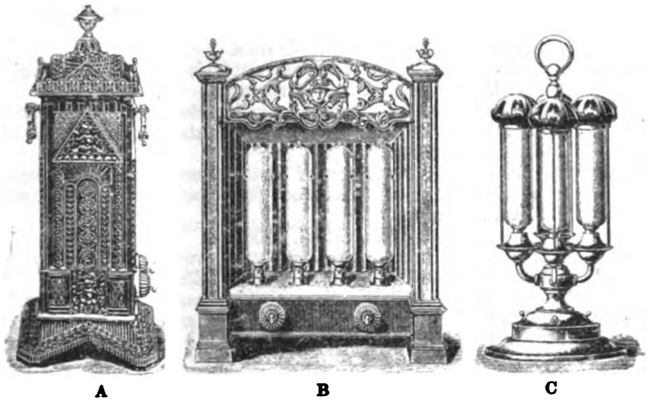
Nernst Lamp Notes —The Electrical Company, 121-125, Charing Cross-road, London, W.C., have investigated certain cases where electrical contractors have not succeeded well with Nernst lamps, and have found that two mistakes are very common :—

Firstly, the voltage of the lamp is not matched properly; the burner voltage, plus the resistance voltage, should be approximately equal to the maximum (not nominal) voltage of the circuit.

Secondly, with direct-current lamps (especially the B type), the polarity is not observed when the lamp is fitted into the holder, and, even worse, the lamp is often taken out of its holder and put back the wrong way, causing the polarity to be reversed and the filament to break very soon. To prevent this the company supplies B type lamps which have a third bayonet pin in the socket. If the holder is altered, by punching a third slot (as shown in the illustration) it will be impossible to put the lamp back into the holder in the wrong way, and the polarity, when once tested, cannot be reversed. With screw-holders the reversing of the polarity is impossible *per se*, and it would be a great advantage therefore if on large installations screw-holders were used.

Arc Lighting in North-West London.—In the description in our last issue of the arc lighting by means of Gilbert arc lamps at Willesden and Hampstead, London, N.W., we omitted to mention that the arc lamp columns for both districts were supplied by Messrs. Rowland Carr & Co., of 6, Lime-street-square, London, E.C.

Catalogues, &c.—New lists dealing respectively with Nernst lamps, electric radiators and Omega "Guarantee" flexible cords are issued by the General Electric Co. The electric radiator list contains particulars of a very large assortment of this apparatus, both plain and



A B C

ornamental. Three of the latest patterns of these radiators are shown in the accompanying illustrations. Fig. A is a pillar pattern radiator suitable for any position where heat is required, and specially designed for centres of rooms, shops, ships' saloons, &c. It can be finished off in colours to match its surroundings. B is the "Jupiter" type of electric glow radiator, consisting of a cast-iron base with sides and back completely enclosed. The reflector is of highly-polished aluminium, with hot-air chamber at back. The four lamps with which this type of radiator is fitted are controlled by two switches. C shows a type of electric glow radiator specially designed for drawing and dining rooms, and constructed completely of polished brass and copper, with suitable reflectors and flush switches. Four lamps are also provided in this type.

A well-arranged catalogue of a large variety of boiler mountings and engine fittings is listed in a catalogue just issued by Messrs. Charles Winn & Co., of Granville-street, Birmingham. This firm's experience in the design and manufacture of work of this description extends over nearly half a century.

The Edison and Swan United Electric Light Co. are issuing leaflets describing improvements in high-voltage accessories including "Ediswan" improved patent knife switches (for circuits up to 550 volts), pear switches and wall sockets.

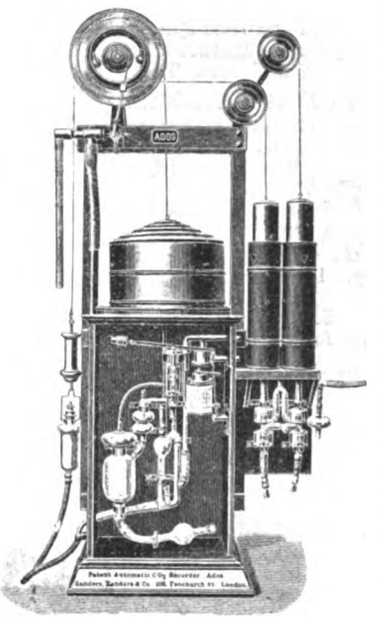
"Finland Asbestos" is the subject of a pamphlet issued by Messrs. Kahler & Co., 29, Fenchurch-street, London, E.C.

"Boiler Feed Purification" is treated in a well-illustrated pamphlet issued by Paterson Engineering Co. (Ltd.) of Glasgow.

Messrs. Alexander Wright & Co. of Westminster have ready a new list of Simmance-Abady patent flicker photometers for testing the illuminating power of electric, gas or oil lights of any colour or intensity.

The British Thomson-Houston Co., in pamphlet No. 159, deal with T.-H. type D.A. continuous-current generators.

Messrs. Sanders, Rehders and Co., in a pamphlet just issued describe their patent automatic CO_2 recorder "Ados," and state that during the past 12 months this apparatus has been installed in a number of electricity supply stations, and other large works, for the purpose of checking combustion in boiler furnaces, with a consequent decrease in coal cost. The illustration shows the apparatus complete, with recording cabinet in front of motor. The height, over all, is 6ft. by 3ft. by 2ft. 6in The object sought in installing this apparatus is the ascertaining and recording of the percentage of CO_2 gas in the flue gases in order that, with such knowledge at command, due watchfulness may be observed to prevent this percentage becoming too low for economical working; and it is claimed for the "Ados" mechanism that it is the most reliable apparatus on the market for the purpose. Its working is based on the well-known fact that a solution of caustic potash absorbs CO_2 gas. A quantity of the flue gases is pumped through the recorder; part of it is bottled up, measured, and passed through a solution of caustic potash, which absorbs all the CO_2 gas; the quantity of gas aborbed, which represents the percentage of CO_2 gas, is determined and recorded on a diagram by means of vertical lines. This process is repeated about every five minutes. The tops of the various lines form a curve, which shows the fluctuation of the percentage of CO_2 in the flue gases during the time the recorder has been working. Where automatic stokers are in use the recorder will, it is claimed, prove a very effective aid in controlling them.



The "Ados" Patent Automatic Fuel-Saving Apparatus.

Imports.—The following are the values of imports to this country during October last :—

Electrical machinery, £37,720; telegraph cables and apparatus, £5,419; other electrical goods and apparatus, £63,661 The respective totals for the 10 months ended Oct. 31 were £467,738, £50,199 and £649,144.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Nov. 4 to 10, with the ports of destination :—

Africa—Alexandria, £246; Cape Town, £403; Delagoa Bay, £157; Durban, £1,194; East London, £706; Port Elizabeth, £224 (including £62 telegraph material). *Argentina*—Buenos Ayres, £155; Rosario, £25. *Australasia*—Fremantle, £189; Melbourne, £703 (including £630 telegraph cable); Perth, £153 (including £124 telegraph material); Sydney, £575 including (£32 telegraph material); Wellington, £813. *Burma*—Rangoon, £12. *Ceylon*—Colombo, £938 (including £887 telegraph material). *China*—Shanghai, £683. *Gibraltar*, £182. *Holland*—Amsterdam, £85; Flushing, £137. *Hong Kong*, £38. *India*—Bombay, £480; Calcutta, £75. *Japan*—Yokohama, £41. *North Sea*, £1,214 (telegraph cable). *Portugal*—Lisbon, £12. *Russia*—St. Petersburg, £108 (telegraph wire). *Siam*—Bangkok, £60. *Straits Settlements*—Penang, £572; Singapore, £81. *Sweden*—Stockholm, £135 (telegraph wire). Total £10,396, against £25,989 in the corresponding week last year (Nov. 5 to 11).

Burglars and Electricity.—The *Western Electrician* of Chicago states that a short time ago a daring attempt was made to rob the safe of a Chicago meat market, and the means used by the burglars were quite unusual. The thieves entered the shop at 10 o'clock at night through a rear window. After turning on three electric lights in the rear of the shop they proceeded to connect a small electric motor, which they carried with them, to the feed wires at the back of the building used to run a laundry next door. A drill was attached to the motor and several holes were drilled through the safe door, enabling them to blow it open with ease. This was all done in view of passers-by, some of whom gave the alarm, and the men were driven away without securing any plunder. They left their motor and also a dozen drills of assorted sizes.

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

July 29, 1903.

16,626 C. HURST. Manchester. Gas dynamos.
16,636 C. H. BRANDRETH. Derby. Insulator brackets for telegraph or telephone.
16,653 J. A. WIRTH and J. BEECH. Soldering armature leads to commutator bars. (Date applied for, Oct. 22, 1902, date of application in U.S.)*
16,661 M. H. SCHOENBERG and J. W. EDWARDS. Electric heating devices.*

July 30, 1903.

3,576A J. T. PEARSON. Burnley. Rail return and utilisation of the current therein. (Date applied for, Feb. 16, 1903.)*
16,711 J. A. DAVENPORT and A. F. GUY. Liverpool. Insulators.
16,740 E. A. CAROLAN. Time-limit circuit-controllers. (G.E. Co., U.S.)
16,741 E. A. CAROLAN. Arc lamps. (G.E. Co., U.S.)
16,742 E. A. CAROLAN. Cutouts. (G.E. Co., U.S.)
16,743 E. A. CAROLAN. Blue-printing machines. (G.E. Co., U.S.)
16,744 E. A. CAROLAN. Controlling switches. (G.E. Co., U.S.)
16,745 E. A. CAROLAN. Controllers for electric motors. (G.E. Co., U.S.)

July 31, 1903.

16,774 G. H. BAILLE. Converting electric currents.
16,788 W. B. DAY. Curragh Camp. Electric integrator.
16,806 J. M. DOUGLAS. Ceiling roses and wall plugs and method of attaching metal terminals*
16,808 G. BREWER. Holding devices for collecting brushes. (E.G. Alioth, Switzerland.)*
16,817 H. M. HOBART. Dynamo electric machines employing commutators.
16,830 W. C. DUNNE and L. LEVITT. Trolley wheels.
16,832 J. S. BEEMAN. Coding or cypher machines.
16,833 J. S. BEEMAN. Machines for printing code or cypher.
16,836 F. SUBATZUS. Lampholders for incandescent lamps.
16,849 SIEMENS BROS. & Co. and A. S. CLIFT. Telphers*
16,852 W. H. K. BOWLEY. Flexible metallic tubing for armouring conductors.
16,855 A. K. HUNTINGTON. Sparking plugs.

August 1, 1903.

16,856 E. W. MARCHANT and G. W. WORRALL. Liverpool. Electrostatic methods of measuring potential differences.
10,868 H. RAMSBOTTOM and J. RICHARDSON. Portable accumulators.
16,878 C. M. STINER. Manchester. Printing telegraph instruments.*
16,902 E. N. BRAY, F. R. MARKHAM, F. E. REISS and BRAY, MARKHAM AND REISS (LTD) Fuses.
16,907 J. BUSH. Controllers for electromotors.

August 4, 1903.

16,960 W. SOUTTER. Balance weights for electroliers, &c.
16,965 J. P. ROBERTSON. Electrical fire alarm apparatus.*
16,975 H. KORTEN. Cutouts.
16,988 P. STEENLET. Diaphragms for electrolytic and electro-plating purposes.*
16,989 P. STEENLET. Obtaining copper by electrolysis from copper-containing solutions.*
16,992 P. A. GAYE. Electrolytic cells.
17,001 B. J. B. MILLS. Automatic electric-stopping apparatus for lace and net machines. (A. Pocheron and F. Cellery, France.)

August 5, 1903.

17,010 T. F. J. TRUSS. Liverpool. Transmitting, receiving, recording and reproducing signals, sounds and scenes.
17,034 E. DUCRETET. Induction transformer for wireless telegraphy stations.*
17,057 T. MATHEWSON and A. J. FIELDING. Steering-gear for motor vehicles.*
17,059 W. P. THOMPSON. Liverpool. Filaments for incandescent lamps. (Bayerische Glühfädenfabrik Augsburg-Lechhausen Georg Luedecke & Co., Germany.)
17,069 G. B. ROSSMAN. Geometric telegraphs.*
17,072 C. R. PAYNE. Syntonising two circuits and apparatus therefor.*
17,073 T. HAMILTON-ADAMS. Arc lamps.

August 6, 1903.

17,082 E. M. MUNRO, H. BRECKNELL and H. I. ROGERS. Bristol. Trolley-poles and connecting them to standards.
17,105 D. BORDONI. Insulating supports for electric traction systems.
17,128 M. ARCHAMBAULT. Electric signalling between trains and between stations and trains.
17,140 F. DE MARE. Electromagnets.

August 7, 1903.

17,149 S. G. BENNETT. Wolverhampton. Electric traction on a shallow conduit system.
17,150 A. SYKES. Huddersfield. Switches for starting electric motors.
18,173 H. F. FOSTER. Epsom. Electrical starting-gate for racecourses
17,179 H. H. LAKE. Electric railway systems. (Morgan Electric Machine Co., U.S.)*
17,184 F. KRÜCKL. Clamps for wires, especially for overhead conductors.*
17,185 G. FINZI and E. KORRODI. Frames for alternating-current motors.*
17,188 G. W. GOLDRING. Fastenings for fuse-boxes.
17,195 O. ROCHEFORT and E. MORS. Wireless telegraphy.
17,207 T. M. DUTTON and THE SANDYCROFT FOUNDRY CO. Liverpool. Dynamo-electric machines.
17,214 W. B. WOODHOUSE. Protecting devices for electric circuits.

August 8, 1903.

17,225 F. J. LOWE. Leeds. Interlocking automatic intercommunication telephone switchboard.
17,229 J. H. LUBY and W. HARRIS. Bristol. Gripping and supporting overhead wires in electric traction.
17,232 C. H. STEVENS. Bristol. Terminal holders.
17,241 J. W. HARROP, T. DICKINSON and H. DICKINSON. Huddersfield. Re-railing tramcars.
17,245 and 17,247 E. A. CAROLAN. Electric light fixtures. (G.E. Co., U.S.)
17,246 E. A. CAROLAN. End play devices for rotary shafts. (G.E. Co., U.S.)
17,248 E. A. CAROLAN. Rheostats. (G.E. Co., U.S.)
17,249 E. A. CAROLAN. Reels for cables. (G.E. Co., U.S.)
17,272 T. GRAINGER. Electrically firing blasting cartridges.

August 10, 1903.

17,307 J. T. PEARSON. Burnley. Electric tramways.
17,367 C. C. VAN DER VALCK. Safety devices for strong current.*
17,374 J. H. LANCASTER. New York. Magneto-electric machines and appurtenances for cooling and pumping.

August 11, 1903.

17,399 G. T. FUERY. Birmingham. Decomposing water by electrolysis. (W. F. M. McCarty and W. S. Beebe, U.S.)*
17,431 S. SAVELSOHN. Electric connections for railway trains.
17,453 J. LOPEZ. Liverpool. Ventilating terminals.

August 12, 1903.

17,460 G. DAVIS. Incandescent lamps.
17,464 P. R. J. WILLIS. Kingston-on-Thames. Electric signalling mechanism. (A. E. Caughey, U.S.)
17,482 W. SQUIRE. Manchester. Arc lamps.
17,488 A. PETZENBURGER. Electric railway vehicles.*
17,497 C. GROOMBRIDGE. Fire alarm applicable as police call.

August 13, 1903.

17,564 E. WHITE and J. WALDRON. Wolverhampton. Inspection boxes and fittings.*
17,568 D. HUNTLEY. Electric heating devices.
17,587 G. W. JOHNSON. Electrodes for electrolytic purposes. (Chemische Fabrik Griesheim Elektron, Germany.)
17,588 G. W. JOHNSON. Treatment of alkali chromates for the production of bichromates and alkali. (Chemische Fabrik Griesheim Elektron, Germany.)
17,589 G. W. JOHNSON. Treatment of chrome ironstone for the production of potassium chromate. (Chemische Fabrik Griesheim Elektron, Germany.)

August 14, 1903.

17,597 H. T. GARVIE. Electric pile-driving apparatus.
17,601 H. LEITNER and R. N. LUCAS. Byfleet. Electric lighting.
17,603 F. W. MANLEY. Byfleet. Reversing machanism for dynamos.
17,605 J. J. CARTER. Dublin. Trolley head and arm
17,630 BULLERS LIMITED and E. J. CHAMBERS. Additions to the socket joints of metallic poles.
17,632 H. T. HARRISON. Electricity meters.
17,640 E. A. ASHCROFT. Production of alkali metals.
17,643 L. CERBOTANI and A. SILBERMANN. Arrangement of steel magnetic armatures for electromagnet pairs.*
17,644 J. PILSATNEEKS. Electrically operating from a distance type-writing machines, type printing telegraphic apparatus and the like.
17,663 B. BECKER. Accumulators.
17,666 G. HOLZKNECHT. Determining action of Röntgen rays.*

August 15, 1903.

17,702 R. H. E. PHILIPPART. Battery.
17,721 F. J. BEAUMONT. Coin-freed electricity meters.

August 17, 1903.

17,744 W. J. STEWART. Glasgow. Shifting points and plough guides on electric tramways.
17,745 A. MORRIS. Stockton-on-Tees. Automatic safety device.
17,767 C. S. MCINTIRE. Electrical propulsion on overhead system.
17,814 R. HADDAN. Safety collision devices for electric tramcars. (R. R. Montparlé, Spain.)*

August 18, 1903.

17,851 G. WESTINGHOUSE. Electric railways.
17,869 E. A. ASHCROFT. Production of alkalies and chlorine by electrolysis.
17,871 C. OLIVER. Flame arc lamps.
17,885 R. F. WOOD-SMITH. Ozonising air and other gases.
17,896 A. ROYLE. Liverpool. Lifeguards for self-propelled vehicles.

August 19, 1903.

17,919 J. IZETT. Glasgow. Automatic emergency brake for electric vehicles.
17,949 C. G. LAMB. Cambridge. Calibrating alternating-current instruments.
17,953 BRITISH ELECTRIC CAR CO. and A. K. BAYLOR. Vehicles for underground railways.
17,967 M. KEMP-WELCH. Insulating compositions.
17,974 R. W. BRAHAM. Electric lamp fittings.

August 20, 1903.

17,994 J. DAWES. Bradford. Clamping broken trolley arm or pole on an electric tramcar.
18,010 L. FIEDLER and F. J. GERARD. Galvanic batteries.
18,036 W. J. DAVY. Arc lamps.

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August 21, 1903.

18,077 J. LAUVERNIER. Germany. Trolleys.
18,080 W. B. LEACHMAN. Preventing electrolysis of water mains.
18,120 R. W. BRAHAM. Electric lamps.
18,121 L. C. H. MENSING. Enclosed or open arc lamps.

August 22, 1903.

18,142 R. F. HALL and ELECTRIC AND ORDNANCE ACCESSORIES Co. Birmingham. Receiver cradles of telephone instruments.
18,143 R. F. HALL and ELECTRIC AND ORDNANCE ACCESSORIES Co. Birmingham. Telephone apparatus.
18,177 W. W. SMITH. Arc lamps.
18,181 Dr. A. FRANKE. Liverpool. Determining length of waves and observing oscillations in electric oscillation systems.*
18,185 SIEMENS BROS. & Co. and G. S. GRIMSTON. Electrically controlled indicator.
18,186 SIEMENS BROS. & Co. and A. S. CLIFT. Telphers.
18,197 A. T. DAWSON. Electric apparatus for motor cars.

August 24, 1903.

18,234 J. SACHS. Fuse blocks.*
18,250 E. A. CAROLAN. Thermal cutouts. (G.E. Co., U.S.)
18,251 E. A. CAROLAN. Processes of insulating coils. (G.E. Co., U.S.)
18,252 E. A. CAROLAN. Speed-regulating devices. (G.E. Co., U.S.)
18,253 E. A. CAROLAN. Magnetic controlling devices. (G.E. Co., U.S.)
18,254 E. A. CAROLAN. Combined socket shell and shade-holder for incandescent lamps. (G.E. Co., U.S.)
18,255 E. A. CAROLAN. Sealing metals into glass or other vitreous material. (G.E. Co., U.S.)
18,256 E. A. CAROLAN. Time-limit controllers for circuit-breakers. (G.E. Co., U.S.)
18,257 E. A. CAROLAN. Switches. (G.E. Co., U.S.)

August 25, 1903.

18,304 A. PHILLIPS. Hartlepool. Water-wheel for generating power.
18,318 G. WALLACE. Incandescent lamp.
18,319 A. F. LLOYD. Brighton. Battery jars.
18,323 F. J. COSTER and SMITH STORAGE BATTERY Co. Glasgow. Machine for making battery grids.*
18,334 H. HUNT, S. ASTON, M. ROSE and J. G. HOWARD. Electrical separation of cream.
18,336 T. J. MURPHY. Electrical interrupting devices for currents, particularly those of high intensity.*
18,343 E. A. CAROLAN. Vapour lamps. (G.E Co., U.S.)
18,344 E. A. CAROLAN. Electric lamps. (G.E. Co., U.S.)
18,354 C. A. WILDE. Electromagnetic rail brakes.
18,376 W. P. THOMPSON. Liverpool. Connection block for conductors. (O. and H. Keller, Germany.)*

COMPANIES' MEETINGS AND REPORTS.

Edison and Swan United Electric Light Co. (Ltd.).

The twentieth annual general meeting was held on Friday last, Mr. HENRY WOLFENDEN in the chair.

The SECRETARY (Mr. H. Charles Gover) read the notice convening the meeting, the auditors' report, &c.

The CHAIRMAN then said: The reason I am addressing you, instead of Mr. Ellice-Clark is that about Christmas last he found the strain of business was affecting his health, and he decided to retire from the chairmanship, retaining his seat on the board. You will notice the accounts are presented in a different form from previous years, the detailed profit and loss account being omitted. The sales of the year show, I regret to say, a decrease in value, but the deficiency under this head has been more than recouped by economies in cost of production and other expenses. Incidentally, I may say the sales since June 30 show an improvement as compared with the corresponding period of 1902. The result of the past year's trading is that we carry to credit of net revenue account this year £30,834. 18s. 5d., against £26,311. 18s. 6d., an increase of £4,522. 19s. 11d. This balance has been arrived at after pricing our stocks upon prudent and conservative lines. We confidently believe that no further reductions in pricing of stocks will be necessary, unless some very unforeseen and unlikely circumstances arise, such as a great reduction in the cost of manufacture, which is not probable, or a fall in the value of raw material, or something of that kind. We have to provide for debenture interest amounting to £18,760. 18s. 4d. We have also appropriated to depreciation on freehold and leasehold property £900. 8s. 6d., or at the rate of 1 per cent. on the book value; to depreciation on plant, £4,789. 15s. 8d., being 6 per cent. on the amount at which it stands in our accounts; and £1,168. 10s. 3d. for reserve on account of bad and doubtful debts. In this connection it is possible that some shareholder may consider that we have appropriated too liberally for depreciation of plant, but having all the circumstances before us we consider this is the right course to adopt. My own experience—no short one—in dealing with works and manufacturing plant has been that liberal appropriations for depreciation have always made for the solidity of the business. In pursuance of the policy we deemed it prudent to adopt last year we have also added £1,000 to reserve for future stock depreciation. Of course, when this reserve attains to a substantial figure, the question of the necessity of adding to it annually will be reconsidered. We have also applied £6,174. 10s. 3d. in reduction of value of stocks after pricing them as previously named. Some portion of this amount represents the ordinary depreciation which necessarily is always going on, to a greater or less extent, from change of fashion, alteration of design, &c., in some of the goods we deal in; but it will be our endeavour to minimise this charge for deterioration by keeping our stocks within reasonable limits, having regard to the necessities of our trade. The remaining and major portion of this £6,174, however, is not a charge arising, strictly speaking, out of the year, though borne by the year. It arises mainly in connection with the stores at our engineering works at Ponder's End. Certain parts of machines and other material in store on June 30, 1903, on which work had been commenced or ordered prior to the present board taking office, were taken into stock in 1902 at the prices of partially finished work, as the intention then was to utilise them to completion. Afterwards it was deemed best not to do so; hence they now appear at "scrap" value only. The result of the net revenue account is to increase our debit balance by £1,959. 4s. 7d.

In the balance-sheet sundry creditors and credit balances figure for only £26,103. 13s. 9d. against £46,045. 14s. 10d. in 1902—a decrease of £19,942. 1s. 1d. On the other side we have owing to us £46,533. 9s. 6d., decrease £12,642. 1s. 11d., which, so far as it may result from our customers paying more promptly, is satisfactory. Our investments are reduced by £7,500, and cash in hand and at bankers is increased by £3,252. 4s. What we may call the cash position is, that we owe £26,103. 13s. 9d. and have £65,012. 19s. 3d. in hand or realisable at short notice to pay with. The sum at which the Altrincham Electric Supply undertaking appears in our balance-sheet is less than last year by £151. 15s. 1d. This is due to the fact that they have paid us in cash during the year a sum equivalent to the year's interest on the debentures and on the sum owing on current account, together with the value of the goods supplied during the financial year, and £151. 15s. 1d. in addition. We expect to continue this process of debt reduction. I am glad to be able to report that this undertaking is making steady progress, the profits for the nine months ended Sept. 30, 1903, showing an increase over the same period of 1902 of about £800. Our balance of special charges is now shown at a higher figure than last year by £748. 7s. This is caused mainly by additional loss in connection with the Parliament-street premises. These premises were closed prior to the present board taking office. Stocks and plant together represent £245,515. 18s. 7d., a reduction of £5,162. 3s. Last year objection was taken that our stocks were disproportionately large when compared with our turnover. I agree with this, and the matter is having close attention. Our stock, however, includes not only finished goods but all stores and work in progress at our factories, both lamps and fittings. Freehold and leasehold property has been brought forward at the figure standing in last year's balance-sheet, less the amount written off for depreciation. The cost of establishing the business, goodwill, &c., is also brought forward at the same figure as before. To deal with this and other balances may involve a writing down of capital; but, as we are not proposing to pay any dividend on the shares this time, it does not appear that any good end will be attained by doing so at the moment. We hope that circumstances may enable us to deal with this matter without unreasonable delay. The board sympathise with the shareholders at the absence of a dividend. Competition is very keen, but we are in a stronger position to meet competition now than ever before. We are making steady progress, and that progress continues. I now move the adoption of the report and accounts.

Mr. E. B. ELLICE-CLARK: I beg to second that.

Mr. LEA-SMITH: The chairman has not told us anything with regard to the lamp or lamps—as to whether we are holding our own. That is a most important matter. We should like to know whether, at the present time, our lamp is absolutely the best, and whether it can be manufactured to sell at a profit. I should like to know more about the stock. We are told the directors have written off a great deal, have provided for future depreciation, and so on; but is the stock now at a bed-rock figure? Have you cleared off all obsolete stock? Then, as to depreciation. Have you provided sufficiently in allowing 6 per cent. for depreciation on machinery. With regard to the Altrincham Electric Supply undertaking, the auditors, in their report, do not seem to care about the way in which you have dealt with the money received. You have taken it into net profit, and no one can tell whether it represents debenture interest or so much paid off the debt. As to the town of Altrincham, I think it is a growing place, and I should like to know whether the electricity undertaking is supplying the large works there are about there. It appears likely to become a large manufacturing centre. Then you have dumped together the stock and plant. But how much is stock and how much is plant? Then there is the item of special charges, £58,472. We know nothing about this large item. As to our debtors, of course as the business has fallen off considerably, it is only natural that the debtors should have fallen off too. Finally, as to reconstruction, nowadays that is so easy a matter that it seems to me rather lagging behind to wait until you can show a profit before dealing with the reconstruction of the company. In my opinion it should be dealt with at once.

Col. AYLMER said he did not think the sale of the telephone shares, by which their investments had been reduced by £7,500, had been sufficiently explained. The board had been getting rid of those shares, but he could not see what had become of the money. He would also like to know whether the checking of the stock and appliances by the departmental managers was in any way counter-checked by the board or general manager. If he remembered rightly the great loss they sustained three years ago was owing to one of the departmental managers giving figures which were eventually found not to be correct.

Mr. LAKE said he hoped they would have been told something about their branches. How many of these were paying? Would it be advisable to close the non-paying branches and conduct the business from London? As to the Altrincham undertaking, was that £900 of profit the result of increased trading, or better done trading, or was it simply the result of the discharge of superfluous employés?

Mr. WEDDELL: I think it is undesirable that our competitors should know how much business we are doing, and by omitting the profit and

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loss account the board are able to suppress the sales which, in the preceding year, had been unproductive, and so have been enabled to apply the pruning knife in that direction. Evidently it has been to the company's benefit, because the balance brought from profit and loss this year is £4,500 larger than it was last year. The directors have, during the last two years, applied the pruning knife very deeply to the stock, &c., and I should like to know whether they have been equally courageous in dealing with the heads of departments, and if the management is as strong in different departments as it ought to be. The debt of the Altrincham undertaking and this balance of special charges are sufficient to call for serious attention. At the same time our financial position has much improved. As to our branches, I do not think it is a question of closing one or two branches because they do not pay. It is a question of general policy which has to be considered—whether one should deal mostly from London, having warehouses in the great centres, and cater more for the goodwill of those who have the selling of the lamps, such as contractors, builders, ironmongers and so forth. So long as the company have retail establishments in the principal streets of our own large cities, which is an expensive manner of selling lamps, they will have the trade against them, and the goodwill of the trade is worth far more than a little extra advertisement in those streets.

The CHAIRMAN: I will take the last speaker's remarks first, and deal with his question as to whether we are prepared to consider the matter of closing the branches entirely. We have given the subject careful consideration, and are not prepared to close the branches unless, of course, the shareholders insist upon its being done. As to the question about the lamp manufacture. I am certain that we can manufacture lamps, quality considered, in competition with anyone, not only in this country, but in the world. The quality of our lamp is A1, and we lead the way, and I think we should continue to do so. As to our stock, I cannot say we have no obsolete stock, but practically it has been got rid of, and prices have been written down to bed-rock absolutely. Mr. Lea-Smith complains of our depreciation of plant as being small. We have had communications from shareholders who take the opposite view, and so we have tried to steer a middle course. At Altrincham we supply the whole of the electric light to the houses, but the manufacturers and works generate their own current. They will only take current from us at the cost of power, which is very small, and our business is a house-lighting business. That business is steadily growing, partly through increase of revenue and partly through decrease of expenses, but not in any way, as one speaker suggested, by discharging workmen and starving the works. As to the writing-down of capital, that, of course, is a matter as to which, if the shareholders give us any mandate, we shall act upon. Our stocks altogether amount to £148,175, but that is not merely stock of saleable goods, it includes work in progress. Plant stands at £97,340, which is the balance of the amount of £245,515. The item of special charges was fully dealt with last year. The proceeds of the sale of the telephone shares have gone into the floating capital. As to the checking of stocks generally, the main items have been gone over by the board. There is no general manager to do this work, so the board have done it. As to the directors remuneration, they are paid the same as in the previous year, £3,000.

The resolution was then carried unanimously.

The retiring director, Mr. H. Wolfenden, was then re-elected, and the auditors (Messrs. Welton, Jones & Co.) were re-appointed. A vote of thanks to the chairman and directors terminated the proceedings.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended June 30 states that the gross receipts amounted to £265,099. 5s. 5d., against £283,856. 2s. for the corresponding half-year of 1902. Working expenses, including £29,613. 8s. 6d. for maintenance of cables, absorb £138,516. 13s. 10d., against £121,237. 17s. 7d., leaving £126,582. 11s. 7d. From this is deducted £5,955. 6s. 9d. for income tax and £11,771. 4s. 9d. for interest, leaving £108,856 as net profit. Adding £37,180. 8s. 2d. from previous half-year, there is available £146,036. 8s. 3d. Two quarterly interim dividends of 1¼ per cent. each (amounting to £75,000) have been paid for the half-year, leaving £71,036. 8s. 3d. to be carried forward. The capital account has been increased during the half-year by £53,192 4 per cent. mortgage debenture stock, making the total issue up to June 30 £588,938. The repairing steamer "Sherard Osborn," being no longer required in the Far East, has been sold to the Eastern Telegraph Co. The contract with the Dutch Government for supplying and laying cables on their behalf between Borneo and the Celebes has been successfully carried out, and a further contract has since been entered into with that Government for supplying and laying additional short cables in the Java seas. These cables have been manufactured, and are now being transported to their destination. The Commercial Pacific Company's cable between San Francisco and Honolulu has been extended to Manila, and an arrangement has been come to with that company by which not only is the United States of America directly connected with the Far East, but the Eastern Extension Company has secured another alternative route to Europe. During the sittings of the International Telegraph Conference recently held in London it was arranged that the tariffs for traffic with Japan, China and Manila should be reduced as follows:—From 7s. 9d. to 5s 8d. per word for Japan, from 5s. 6d. to 4s. 5d. for China, and from 5s. 9d. to 4s. 5d. for Manila. These reductions came into force on July 15 last. The agreement concluded with the Australian Federal Government for extending to Melbourne and Brisbane the privilege enjoyed by the company in other State capitals of Australia of dealing direct with the telegraphing public has been formally approved by the Federal House of Representatives, but the Senate has deferred coming to a definite decision upon it pending the result of a conference to be held between the interested Governments to consider what effect the agreement may have upon the British Pacific cable and other questions. Meanwhile the tentative arrangement come to with the Federal Government by which the company is allowed to work a special wire between Adelaide and Melbourne and to deal direct with the public in the latter city remains undisturbed.

WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended June 30 states that the amount to credit of revenue is £34,903. 10s. 11d., against £28,970. 17s. 9d. for the corresponding half-year of 1902. Expenses have been £23,051. 14s. 2d., against £22,399. 15s. 4d., leaving a balance of £11,851. 16s. 9d., to which is added £2,127. 14s. 4d. interest and £1,914. 2s. brought forward, making £15,893. 13s. 1d. It is proposed to pay 8s. per share on account of arrears of dividend to June 30 on the 1st preference shares (£13,825. 4s.) and to carry forward £2,068. 9s. 1d. This will leave in arrear £3,456. 6s. on 1st preference, and £8,404. 4s. on 2nd preference shares. Expenses of repairing cables amounted to £9,751. 10s. 1d., or £802. 7s. 8d. more than for the corresponding period last year. The company's new cable steamer "Henry Holmes" arrived in the West Indies in June to relieve the "Newington," which was brought back to England and her charter terminated.

WESTERN UNION TELEGRAPH CO.—The annual report of the president for the year ended June 30 states that the capital stock outstanding is unchanged ($97,370,000), of which $29,495.86 is in the treasury of the company, and the bonded debt at close of year was $24,504,000. The revenue for the year was $29,167,686.80, an increase of $1,094,591.70, and the expenses $20,953,215.07, an increase of $172,448.86, compared with last year. Interest on bonds amounted to $1,077,700, an increase of $85,119.65, and $4,868.050 was appropriated for dividends, leaving $2,268,721.73, which, with surplus from 1902, brings the total to $13,019,724.55. The expenses for the year included operating and general expenses, including taxes, $15,553,337.31; rentals of leased lines, $1,567,705.98; maintenance and reconstruction of lines, $3,431,822.21; and equipment of offices and wires, $400,349.57. There were added to the company's system during the year 402 miles of poles and 59,228 miles of wire. Of the newly-constructed wires 47,000 miles were of copper. The number of messages transmitted was 69,790,866, or 415,983 more than in 1901-2. These figures do not include the messages sent over wires leased from the company nor those of railroad companies. The average toll for messages transmitted was 31·4c., the average cost 25·6c. There was expended on construction work during the year $3,351,644.94.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BRITISH L. M. ERICSSON MFG. CO. (LTD.)—Reg. Nov. 6, capital £200,000 in £1 shares, to acquire and carry on the business carried on in Great Britain and Ireland by the National Telephone Co. (Ltd.) and by Aktiebolaget L. M. Ericsson & Co.(under the name of L. M. Ericsson & Co., Ltd.), respectively as manufacturers of and suppliers of machinery, articles, apparatus and appliances in connection with telephones and telegraphs, to adopt agreements between the National Telephone Co. and P. Hammarskjold (on behalf of this company) and between Aktiebolaget L. M. Ericsson & Co. and P. Hammarskjold, and to carry on the business of manufacturers of all kinds of appliances and materials capable of being used in connection with electrical works or with generation, distribution and employment of electricity, manufacturers of and dealers in wires, cables, scientific and other instruments, automatic and general machinery, electricians, electrical and mechanical engineers, suppliers of electricity, &c. The subscribers are A. Bostrom, W. Montelius, H. T. Cedergren, H. Johannson, chief engineer, P. Hammarskjold, electrical engineer, C. S. Agnew, G. H. Robertson, Sir J. Ferguson, Bart., M.P., W. E. L. Gaine and Ald. G. Franklin. P. Hammarskjold is first managing director, and may not be removed without consent of vendors named in the second above-mentioned agreement. Reg. office, Byron House, 82-85, Fleet-street, London, EC.

CANADIAN WESTINGHOUSE CO. (LTD.)—This company has been organised at Hamilton, Ont., with a capital of $2,500,000. The following officers have been elected:—George Westinghouse (president), H. H. Westinghouse and F. H. Taylor (vice-presidents), P. J. B. Myler (general manager and treasurer) and John H. Kerr (secretary). The new company represents a combination of Westinghouse interests in Canada.

FRANK H. CERRITO & CO. (LTD.)—Reg. Oct. 30, capital £5,000 in £1 shares (2,500 preference), to acquire business carried on under the style of Frank H. Cerrito & Co., and to carry on the business of manufacturers of electric, hydraulic, mechanical and other lifts, cranes, hoists, elevators, winding and hauling machinery, gas and steam engines, &c. First directors, R. A. Smith, F. H. Cerrito and F. Barlow. Reg. office, Freeman-street, Birmingham.

ELECTRO PEAT-COAL SYNDICATE (LTD.)—Reg. Nov. 3, capital £500 in £1 shares, to carry on the business of manufacturers of peat-fuel, peat-charcoal and fibrous peat, wherein the raw material is subjected to the influence of electric current with or without the addition of minerals or chemicals, paper and millboard manufacturers, contractors, &c. The subscribers are S. Rowe, T. H. Head, E. J. Johnston, E. Cattanach, A. Russan, S. G. Cole and G. P. Carter.

IMPERIAL ENGINEERING CO. (LTD.)—Registered in Guernsey Oct. 31, capital £1,000,000 in £1 shares, to acquire and turn to account patents, patent rights and inventions, and to carry on the business of engineers, machine makers, metal workers, &c.

ST. ALBANS AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Reg. Nov. 7, capital £25,000 in £1 shares, to carry on business as suppliers of elec-

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tricity, carriers of passengers and goods, electrical engineers, electricians, contractors, manufacturers of and dealers in railway, tramway, electric and other apparatus, &c. The subscribers are J. S. Raworth, C. H. Dade, G. J. Somerville, G. R. Hulme, G. Offor, A. D. Foster and W. L. Madgen. Reg. office, Donington House, Norfolk-street, London, W.C.

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS (LTD.)—Reg. Nov. 5, capital £270,000 in £1 shares, to acquire rights to construct a tramway or tramways in the neighbourhood of Sunderland, together with any tramway or works already constructed thereunder, to adopt an agreement between the Electric Conversion Syndicate (Ltd.) and E. N. Dawe (as trustee for company), to construct, lay down, equip, repair and maintain any tramway or tramways, to work the same by means of electrical or other power, and to carry on the business of tramway, railway, omnibus and motor car proprietors, suppliers of electricity, &c. The subscribers include G. H. Raw and Sir R. Lord, Kt., J.P. (each with 250 shares). First directors, J. S. Barwick, Sir R. Lord, Sir R. D. Monerieffe, G. H. Raw and W. Sutton.

WERNER FRERES (LTD.)—Reg. Nov. 5, capital £120,000 in £1 shares (22,500 7 per cent. cumulative preference), to adopt an agreement for the acquisition of the business carried on as Werner Frères at Paris and Levallois-Penet (Seine), France, and to carry on the business of manufacturers and factors, dealers and agents for the sale of motors, motor cars, cycles, vehicles, batteries, accumulators, and as electricians, engineers, &c. First directors, M. Werner and E. Werner (man.) and others to be appointed by subscribers. Reg. office, 31, Lombard-street, London, E.C.

WESTERN ELECTRIC DISTRIBUTING CORPORATION (LTD.)—Reg. Nov. 5, capital £10,000 in £1 shares, to adopt an agreement with the Bristol Trust (Ltd.), and to carry on the business of suppliers of electric light and power, electricians, electrical, mechanical and chemical engineers, &c. The subscribers are T. Kirkland, C.E. (100 shares), S. Williams (100 shares), E. J. Glyn (550 shares), W. T. Pressland, electrical engineer (150 shares), S. Williams, T. Aucklebridge, A. J. Fippard, electrical engineer, and Prof. D. S. Capper, civil engineer (one share each).

MORTGAGES AND CHARGES.

ELECTRIC DANITE SYNDICATE (LTD.)—Issue on Oct. 29 of £200 debentures, part of series created Feb 6, 1903, to secure £1,000, charged on present and future capital, goodwill and other assets of the company. Holders, R. J. Toleman and R. Drespecker. No trustees. Previously issued of same series, £800.

MANUFACTURING ELECTRIC CO. (LTD.)—Issue on Oct. 15 of £350 debentures, part of series created same date to secure £1,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Also lien reg. Oct. 29, for £350 6 per cent. debentures, part of £1,000 authorised.

WESTON-SUPER-MARE AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Trust deed, dated Oct. 29, 1903, to secure £35,000 debenture stock, has been registered. Property charged, Company's undertaking and property, present and future, including uncalled capital. Trustees, Electric and General Investment Co. Company has power to issue further debenture stock ranking pari passu up to half subscribed capital.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 28 $\frac{3}{16}$d. per oz. (Nov. 12). Consols 87 $\frac{7}{16}$—87 $\frac{5}{8}$ for money, 88$\frac{3}{8}$—88$\frac{1}{2}$ for account; 2$\frac{1}{2}$ per cent. annuities 87$\frac{1}{4}$—87$\frac{3}{4}$ (Nov. 12). Consols Pay Day Dec. 1; Stocks and Shares Continuation Days, Nov. 24 and Dec. 9; Ticket Days, Nov. 25 and Dec. 10; Pay Day, Nov. 26; Mining Share Carry-over Days, Nov. 23 and Dec. 8.

ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.—This company intends to declare a dividend of 8 per cent. for last year.

BERLINER ELEKTRICITATS WERKE.—According to the *Elektrotechnischer Anzieger* the directors at a recent meeting announced that for the past year the units sold amounted to 85,768,679 against 61,405,330 for the previous year. As a result of increased output and increased economy in the generation of current, the net profit was M.3,832,816, compared with M.2,964,211 in the previous year, and at the forthcoming meeting a dividend of 9 per cent. (compared with 7$\frac{3}{4}$ per cent. in the previous year) will be proposed.

CASTNER-KELLNER ALKALI CO. (LTD.)—The directors announce that, though a profit has been made during the half-year ended Sept. 30, they do not feel justified in applying it to the payment of an interim dividend, owing to the unprecedented fall in price of bleaching powder and other chemicals.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The 4 per cent. guaranteed debenture stock transfer books will be closed from 17th to 30th inst. inclusive, preparatory to the payment of interest due Dec. 1.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—At a meeting last week it was resolved to increase the capital of the company to £55,000.

METROPOLITAN DISTRICT RAILWAY CO.—During the week this company invited subscriptions for £500,000 4 per cent. perpetual debenture stock at par.

SIEMENS AND HALSKE AKTIENGESELLSCHAFT.—It is anticipated that this company will declare a dividend at least equal to that of last year (4 per cent.).

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have been asked to appoint special settling days in, and to grant quotations to, 52,000 ordinary £5 fully paid shares, 61,000 cumulative preference £5 fully paid shares and £300,000 4½ per cent. debenture stock of *Dick, Kerr & Co. (Ltd.)* and 15,000 shares of £10 each of the *Havana Electricity Co. (Ltd.)*

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS (LTD.)—This company, which has an authorised share capital of £270,000 and power to create debentures to the amount of £160,000, offered for subscription during the week 750 first debentures of £100 each at par.

UNION ELEKTRICITATS GESELLSCHAFT.—According to the *Berliner Tageblätt* this company will probably pass its dividend for the past year, comparing with a dividend of 4 per cent. last year.

MASCHINENFABRIK OERLIKON.—This company will also, it is stated, pass its dividend for the past year. A dividend of 5 per cent. was paid in the previous year. At the forthcoming general meeting it is proposed to write 291,000fr. off capital account.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Nov. 7	1,109	+ 294	23	29,559	+ 4,790
Ayr Corporation	Oct. 31	184	- 2	25	8,883	+ 42
	Nov. 7	180	+ 6			
Barnsley	Oct. 30	176	...	43½	7,875	...
Bexley District Council	Nov. 6	191	...	5	1,014	...
Birkenhead	,, 8	985	+ 57	...	...	...
*Birmingham Tramways	,, 7	5,067	+ 15	18	93,683	+ 2,743
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 5	3 8	5	§31	85,627	- 210
Blackpool and Fleetwood	,, 7	216	+ 11	19	19,165	- 125
Blackp'l, St. Anne's & Lytham	,, §5	131	+ 45	11	131	+ 45
Bolton Corporation	,, 8	1,687	+ 112	32	59,970	+ 7,457
Bournemouth Corporation	,, 4	894	...	32	34,031	...
*Eradford Corporation	,, 8	3,462	+ 330	32	123,219	+ 17,591
Brighton Corporation	,, 8	866	+ 118	50	44,411	+ 6,248
Brisbane Tramways	Sept. 23	2,136	- 101	12	28,317	+ 376
*Bristol Trams & Carriage	Nov. 6	4,521	- 60	24	128,290	+ 12,892
*Buenos Ayres & Belgrano	Oct. 11	3,338	+ 448	†25	47,471	+ 8,452
Burnley Corporation	Nov. 7	777	+ 90	32	33,775	+ 5,975
Burton Corporation	,, 8	283	...	...	...	...
Calcutta Tramways Co.	,, 7	a37,316	+a7,152	19	a621,871	+a119,922
Camborne-Redruth	,, 9	6,317	...	1	6,317	...
Cardiff Corporation	,, 7	1,963	+ 342	32	64,030	+ 18,038
Carlisle Tramways Co.	,, 9	182	+ 21	¶44	8,616	+ 644
Central London Railway	,, 7	6,859	- 263	19	117,925	- 6,262
Chatham and Dist. Lt. Rys	,, 5	544	+ 158	44	24,012	...
City & South London Rly.	,, 8	2,937	- 552	19	48,767	- 7,662
Cork Electric Trams Co.	,, 5	464	- 99	34	23,432	- 3,438
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	Oct. 30	456	+ 52	43½	19,942	+ 957
Dover Corporation	Nov. 7	177	- 12	†32	7,827	+ 93
Dublin & Lucan Railway	,, 8	105	+ 13	19	2,578	+ 155
Dublin Southern District	,, 7	800	+ 42	¶18	20,363	+ 7,527
Dublin United	,, 7	3,801	+ 48	¶18	75,769	
Dudley—Stourbridge	Oct. 30	821	+ 71	43½	36,620	+ 3,601
Dundee Corporation	Nov. 4	842	+ 73	...	...	...
East Ham Council	,, 7	657	+ 208	†34	22,072	+ 6,534
Gateshead & Dist. Trams	Oct. 30	937	+ 102	43½	38,054	+ 5,096
Glasgow Corporation	Nov. 7	18,719	+ 1,051	23	316,042	+ 33,953
Gravesend—Northfleet	Oct. 30	225	+ 39	43½	10,607	+ 1,013
Greenock & Port Glasgow	,, 20	549	+ 137	43½	23,987	+ 1,960
Halifax Corporation	,, 28	1,209	+ 157	31	44,672	+ 5,122
	Nov. 4	1,337	+ 223			
Hartlepool Tramways	Oct. 30	272	+ 50	43½	11,877	+ 707
Huddersfield	Nov. 7	1,137	+ 120	31	40,490	+ 6,311
Hull Corporation	,, 7	1,899	+ 177	†32	60,112	+ 8,180
Ilkeston Corporation	,, 4	138	...	...	...	...
Isle of Thanet Co.	,, 7	356	+ 4	19	20,597	- 1,025
Kidderminster & District	Oct. 30	108	- 7	43½	5,683	+ 175
Kirkcaldy Corporation	Nov. 4	153	...	26	6,365	...
Lanarkshire Trams Co.	,, 5	594	...	§12	10,045	...
Leeds Corporation	,, 7	4,829	+ 13	32	180,088	+ 10,710
*Liverpool Corporation	Oct. 31	10,226	+ 395	44	444,346	+ 14,527
Liverpool Overhead Rly.	Nov. 8	1,605	+ 140	19	31,958	+ 2,125
*London County Council	Oct. 31	9,731	+ 2,473	†31	310,811	+ 55,161
Lowestoft	Nov. 7	161	...	†16	4,484	...
Manchester Corporation	,, 7	11,174	+ 5,910	21	251,859	+ 135,213
Mersey Railway	,, 7	1,491	+ 514	19	25,331	+ 5,047
Merthyr	Oct. 30	203	+ 24	43½	8,675	- 145
Middleton	,, 30	269	+ 40	43½	14,091	+ 1,739
Newcastle-on-Tyne Corp.	Nov. 7	3,546	+ 454	19	66,574	- 4,233
Newport (Mon.)	,, 7	421	+ 157	6	2,760	+ 1,056
*Oldham, Ashton & Hyde	Oct. 30	549	+ 28	43½	24,925	+ 1,571
Perth (W. A.) Elec. Trams.	Nov. 6	1,362	+ 267	§14	51,234	+ 5,538
Peterborough	Oct. 30	122	...	40	6,507	...
Poole and District	,, 30	258	+ 14	42½	13,460	+ 1,981
Portsmouth Corporation	Nov. 7	1,531	+ 219	...	...	...
*Potteries	Oct. 30	1,831	+ 169	43½	68,066	+ 3,066
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 30	45	+ 1	42½	6,687	+ 1,602
Salford Corporation	Nov. 9	3,768	+ 913	32	123,131	+ 37,169
*Sheerness	Oct. 28	60	...	29	2,043	...
Sheffield Corporation	Nov. 8	4,477	+ 440	19	88,755	+ 6,780
*Southampton Corporat'n	,, 5	967	- 2	...	...	...
Southend Corporation	,, 4	242	+ 45	31	11,119	+ 1,823
Southport Tramways	Oct. 30	276	+ 47	43½	13,923	+ 2,586
S. Staffordshire Trams.	,, 20	1,021	+ 283	43½	39,522	+ 6,260
*Sunderland Corporation	Nov. 8	1,093	+ 71	32	40,685	+ 2,028
*Swansea Trams	Oct. 30	478	+ 2	43½	22,723	+ 1,880
Taunton Trams	,, 30	54	+ 1	43½	2,691	- 193
Tynemouth and District	,, 30	227	- 30	43½	14,009	+ 803
Tyneside Trams Co.	Nov. 4	312	+ 28	44	14,452	...
Wallasey District Council	,, 7	599	+ 61	†32	23,334	+ 2,951
Weston-super-Mare	Oct. 28	39	- 7	43	5,503	- 498
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 30	882	+ 61	43½	17,094	+ 7,497
Wrexham	,, 30	112	...	30	4,350	...
Yorkshire Woollen District	,, 30	536	...	30½	13,765	...

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed. Nov. 11.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS WEEK TO Nov. 11		
				£ s. d.		High-est.	Low-est.	
		ELECTRIC RAILWAYS, TRAMWAYS, &c.						
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅜—4⅝	5 8 1	April, Oct	4⅛	4⅛	
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..	
10	10 0	Barcelona Tramways Ord.	7⅛—8⅛	5 17 8	..	..	..	
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..	
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..	
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..	
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..	
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..	
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —102	4 9 6	..	..	..	
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..	
10	4%	Do. Cum. Pref. (fully paid)	10½—10¾	3 15 11	..	..	..	
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 1	Feb, Aug	..	..	
St.	..	British Columbia Elec. Rlwy. Def. Ord.	83 —86	..	..	..	..	
St.	5%	Do. Pref. Ord. Stock	93 —96	5 6 5	..	..	..	
10	4/2½	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..	
4	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	..	..	
10	10/0	British Electric Traction Ord.	11¼—12	6 13 4	..	11⅞	11⅝	
10	6/0	Do. 6 per Cent. Cum. Pref.	11⅝—11¾	5 4 3	Feb, Aug	11⅞	11¾	
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	122¼	121½	
5	..	Buenos Ayres and Belgrano Ord.	2⅜—2⅝	..	..	..	..	
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5 —5¼	5 9 1	..	5⅝	..	
5	3/0	Do. "B"	4¾—5⅛	5 14 3	..	4⅝	..	
St.	5%	Do. 5 per Cent. Debs.	107 —110	4 12 1	..	107½	..	
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	99 —102	4 18 9	..	..	..	
5	2 6	Calcutta Tramways	6½—7	4 12 10	..	6⅝	6¾	
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —109	4 3 3	..	..	..	
1	1/2½	Cape Electric Tramways Shares	1⅞—2⅛	7 1 2	..	2⅛	1⅞	
St.	4%	Central London Ordinary Stock	93 — 96	4 4 3	June, Dec	95¼	94¼	
St.	4%	Do. 4 per Cent. Pref. Stock	99 —102	3 18 10	..	100½	99½	
St.	4%	Do. Deferred Stock	99 —102	4 0 0	..	..	..	
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 11	..	118¾	118	
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 —5⅛	4 10 11	..	..	..	
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 5	..	..	..	
St.	2½%	City and South London Rly. Con. Ord.	51 —53	5 17 10	Feb, Aug	52	50½	
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	127 —130	3 17 3	Feb, Aug	129	..	
St.	5%	Do. (1896)	125 —128	3 18 10	..	126¼	..	
St.	5%	Do. (1901)	122 —127	3 19 7	..	..	..	
St.	4%	Do. 4 per Cent. Perpetual Debs	110 —115	3 9 7	May, Nov	..	..	
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 0	..	..	..	
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 —13	4 4 7	..	..	..	
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..	
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3¾—4¼	6 13 4	..	..	..	
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 —98	5 2 0	..	..	..	
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7⅛—8⅛	3 10 7	..	7¾	7½	
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9¼—10	..	..	..	..	
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..	
10	6%	‡ Do. 6 per Cent. Pref.	14 —14¼	4 2 10	Mar, Sept	..	..	
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 3 1	Jan, July	..	..	
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾—4⅛	5 17 8	..	..	..	
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 8	..	..	..	
10	1½%	Liverpool Overhead Railway Ord.	4¼—4½	2 14 0	Feb, Aug	..	..	
10	5%	Do. 5 per Cent. Pref.	10¼—10⅝	4 13 0	Feb, Aug	..	..	
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 6	Jan, July	..	..	
10	5/0	London United Trams. 5% Cum. Pref.	11½—12	4 3 4	..	11⅞	11⅝	
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 8	..	105¾	104⅝	
St.	..	Mersey Con. Ord. Stock	8 —11	..	..	..	..	
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	..	..	..	..	
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..	
1	..	Metropolitan Electric Trams Def	⅞—1	..	..	..	..	
1	0/6	Do. 5% Cum. Pref.	1⅛—1⅜	4 8 11	..	..	..	
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —104	4 16 2	..	..	..	
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 4 1	..	..	..	
5	..	New General Traction Ord.	⅛	..	..	..	..	
5	..	Do. 6 per Cent. Cum. Pref.	1¼—2¼	..	May	2⅛	2	
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 —102	4 18 0	..	..	..	
10	10/0	Potteries Electric Traction Ord.	8¼—9¼	5 5 3	..	..	..	
10	5 0	Do. 5 per Cent. Cum. Pref.	8¼—9¼	5 5 3	Feb, Aug	..	..	
St.	4½%	Do. 4½ per Cent. Deb. Stock	104 —107	4 6 10	..	..	..	
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..	
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..	
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..	
St.	3¾%	Waterloo and City Ord.	91 —94	3 9 8	June, Dec	93	92	
		TELEGRAPHS.						
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 0	Jan, July	99	..	
10	..	Amazon Telegraph	2⅞—3⅛	..	Jn, Dec ..	..	..	
100	..	Do. 5 per Cent. Deb.	..	..	..	42½	..	
St.	15/0	Anglo-American	49 — 52	6 1 6	F,My,Ag,N	..	..	
St.	30/0	Do. Preferred	93 — 95	6 7 0	F,My,Ag,N	94½	92½	
St.	1/0	Do. Deferred	8⅛—8⅜	0 11 5	F,My Ag,N	8⅜	7⅝	
100	$2	Commercial Cable Capital Stock	145 —155	5 9 8	Jn,Ap,Jy,O	..	..	
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	Jn Ap,Jy,O	92½	93½	
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	8 1/16	7	
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..	
5	2/0	Direct Spanish Ord.	2¼—3½	5 14 4	April, Oct	..	..	
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..	
50	4½%	Do. 4½ per Cent. Deb.	96⅞—100⅞	4 11 5	Jan, July	..	..	
20	3/0	Direct United States Cable	10¼—10⅝	6 0 11	Ja,Ap,Jy,O	10⅝	..	
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 —102	4 8 10	Jn, Dec ..	..	..	
St.	25/0	Eastern Ordinary	122 —127	5 10 8	Ja,Ap,Jy,O	125	122½	
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 18 8	Ja Ap,Jy,O	87½	86	
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	106½	105	
10	2,6	Eastern Extension	11¼—12	5 16 8	Ja,Ap,Jy,O	11⅞	11⅝	
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 14 9	Feb, Aug	106	..	
100	4%	* Eastern & S. African 4% Mrt. Deb.1909	99 —102	3 18 10	Feb, Aug	..	..	
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	98⅝—101⅝	3 19 3	May, Nov	..	..	
10	5.0	Great Northern of Copenhagen	22½—23½	5 6 5	Jan, July	..	..	
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	99 —102	4 8 4	June, Dec	..	..	
25	12 6	Indo-European	36 —39	6 8 2	May, Nov	38⅜	37½	
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	..	..	
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..	
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..	
2½	..	West Coast of America	1⅛—1⅜	..	..	..	..	
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	97	..	
10	..	West India and Panama	⅝—¾	..	May, Nov	..	..	
10	8/0	Do. 6 per Cent 1st Pref.	6½—6¾	8 18 0	May, Nov	6⅝	6⅜	
10	..	Do. 6 per Cent. 2nd Pref.	3½—4½	..	May, Nov	4¼	..	
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 17 7	Jan, July	103¼	..	
10	3/0	Western Telegraph	12 —12½	5 12 0	Mr,Jn,O,D	12⅜	11⅛	
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 17 1	June, Dec	..	..	
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 8	..	..	..	
		FINANCIAL, INVESTMENT, &c.						
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅜—5⅛	5 14 3	..	..	..	
10	2/0	Globe Telegraph and Trust	8½—9	4 8 11	Ja Ap Jy O	8⅝	8½	
10	3/0	Do. 6 per Cent. Pref.	12½—13	4 12 4	Ja Ap,Jy,O	12⅝	12½	
8	4/0	Reuter's	6¾—7½	5 6 8	April, Oct	..	..	
100	6%	Submarine Cables Trust (Cert.)	116 —121	4 19 7	April, Oct	..	..	

SHARE.	LAST DIVIDEND	NAME.	Price Wed. Nov. 11	RATE PER CENT. YIELDED.	DIVIDEND DUE	BUSINESS WEEK TO Nov. 11.		
				£ s. d.		High-est.	Low-est.	
		TELEPHONES.						
5	6/0	Chili Telephone (fully paid)	4⅜—5⅛	5 14 3	August ..	..	..	
St.	6%	National Co. Pref. Stock	100 —102	5 19 0	..	101¾	99	
St.	5%	Do. Def. Stock	74 —76	6 5 0	..	75½	74	
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	..	..	
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	..	..	
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5⅛	4 15 3	Feb, Aug	5⅛	5	
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	93 —95	3 14 6	June, Dec	94⅛	93¼	
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 —104	3 17 5	..	102¾	102⅜	
1	0/7½	Oriental	1 1/16—1 1/8	7 2 0	April, Oct	..	..	
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..	
5	4/0	United River Plate	5¾—6	5 16 8	July.....	5⅞	..	
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5⅛	4 15 3	June, Dec	5⅛	..	
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 - 107	4 13 9	June, Dec	..	..	
		ELECTRICITY SUPPLY.						
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝—¾	..	..	..	..	
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	116 —119	3 15 7	..	..	..	
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12¾—13⅛	5 18 6	..	..	..	
10	4/6	Do. 4½ per Cent. Cum. Pref	10 —11	4 1 10	..	..	..	
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..	
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 3	..	..	..	
St.	4½%	Bromley (Kent) El. Lt. &Power 1stDebs.	100 —103	4 7 5	..	..	..	
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10¼—10⅜	4 3 9	..	..	..	
5	3/6	Do. 7 per Cent. Pref.	10 —10⅜	3 6 8	Mar, Sept	10⅜	10	
5	3/6	Calcutta Electric Supply Ord.	6¼—7⅛	4 6 8	..	7⅛	7	
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	107 — 110	3 13 2	..	..	..	
5	4/0	Charing Cross & Strand Electric Sup.	9 —9½	5 5 3	Feb, Aug	9⅜	..	
5	2/3	Do. 4½ per Cent. Pref.	5¼—5⅜	3 18 3	Feb, Aug	..	..	
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..	
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 16 2	..	104⅜	104⅛	
5	2 0	Chelsea Electric Supply Ord.	5¼—6	4 3 4	March ..	5⅝	..	
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 —111	4 1 6	Jn, Dec ..	..	..	
10	5/0	City of London Electric Lighting Ord.	9¾—10½	7 6 4	Feb, Aug	10¼	10	
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	13¼	
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 —127	3 18 11	Jn, Dec .	..	..	
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 9 5	..	..	..	
10	4/0	County of London & Brush Prov. Ord.	7¼—8¼	4 14 2	..	8¼	..	
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—12¾	4 16 0	Mar, Sept	11¾	..	
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 2 11	..	108	..	
St.	27 6⅞	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	..	..	
5	2 0	Folkestone Electricity Supply Co. Ord.	5⅜—6⅛	4 0 0	..	..	..	
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..	
5	3 6	Hove Electric Lighting Ord.	7¼—8½	5 0 0	..	..	..	
5	5/0	Kensington & Knightsbridge Ord.	10¼—11¾	4 6 11	..	..	..	
5	6%	Do. 6 per Cent. 1st Pref.	6¼—7	4 5 9	Jan, July	..	..	
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..	
5	..	London Electric Supply Ord.	1⅞—2⅛	..	..	..	..	
5	3/0	Do. 6 per Cent Pref.	5 —5⅛	5 9 1	..	..	..	
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	4 0 6	Mr,Jn,S,D	..	..	
10	8 0	Metropolitan Electric Sup. Ord.	17 —18	4 6 1	April, Oct	17⅝	17	
5	..	Do. 4½ per Cent. Cum. Pref.	4⅛—4⅜	..	..	..	..	
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	110 —114	3 19 8	Jn, Dec ..	..	..	
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 - 99	3 11 7	..	97½	..	
1	6 0	Notting Hill Electric Ord.	12½—13⅛	4 8 11	March....	..	..	
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..	
5	2 6	Oxford Electric Ord.	5¼—5⅞	4 15 8	March ..	..	..	
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 0	..	..	..	
1	..	Rand Electric	1/16—1/8	..	..	..	..	
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	98 —100	4 10 3	April, Oct	..	..	
5	5 0	St. James's and Pall Mall Electric Ord.	14½—15½	4 13 7	Feb, Aug	14⅞	..	
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..	
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 2	..	..	..	
5	2/6	Smithfield Markets Electric Sup. Ord.	3 — 3½	3 11 5	..	..	..	
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	85½	85¼	
1	1,9	South London Electric Supply Ord.	3½ 4	4 7 6	..	..	..	
5	2 6	Urban Electric Supply Ord.	4⅜ 5⅛	4 17 7	..	5	..	
5	2 6	Do. 5% Cum. Pref.	4⅜ — 5	5 0 0	..	5	4⅜	
5	6/6	Westminster Electric Supply Ord.	12 - 13	5 0 0	Mar, Sept	12½	12⅜	
5	2/6	Do. 5 per Cent. Cum. Pref.	6 — 6½	3 16 11	..	6⅜	..	
		ELECTRIC MANUFACTURING, &c.						
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—½	6 13 4	..	..	..	
1	7½d.	Aron Electric Meter 6% Cum. Pref.	1/16—1/8	..	Mar, Sept	..	..	
5	4 0	British Insulated & Helsby Cables Ord.	7⅛—7⅜	7 8 2	July, Feb	6⅝	..	
5	3 0	Do. 6 per Cent. Pref.	5¼—5⅜	5 4 4	Jan, July	..	..	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 5 8	..	..	..	
St.	4½%	British Thoms'n-Houst'n4½%1stMt.Db.	103 —105	4 5 8	..	..	..	
5	3/0	British Westinghouse 6% Pref.	5⅜—5½	5 2 2	..	5⅜	5⅜	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	100 —102	3 18 5	..	101¼	100⅜	
½	..	Brush Electrical Engineering	¾—1⅛	..	March ..	..	..	
½	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1⅛—1⅜	6 17 2	Mar, Sept	..	..	
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	..	..	
St.	4½%	Do. Perpetual 2nd Deb. Stock	85 — 90	5 0 5	Jan, July	..	..	
5	5,0	Callender's Cable Construction Ord.	11 —12	6 5 0	Jan, July	11¼	11	
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 6 11	Jan, July	5⅜	..	
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	106 —110	4 1 10	Nov, May	109	..	
1	7¾d.	Castner-Kellner Alkali Co. (fully paid)	¾—⅞	6 17 2	..	⅞	..	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	89 —94	4 16 9	..	91½	91	
1	0,7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..	
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2	6 13 4	Jan, July	..	..	
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	100⅝—104⅝	4 16 10	Jan, July	..	..	
5	..	Edison & Swan United("A"sh.)(£3 pd.)	½	..	Feb, Aug	..	..	
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 5 3	June, Dec	74	73½	
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 — 81	6 3 5	..	..	..	
5	4/6	Edmundson's Elec. Corp. Ord.	6½—6¾	5 3 8	H'lf-yearly	6⅝	6½	
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6¼	4 12 4	..	.06¼	..	
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 4	..	..	..	
2	1/2½	Electric Construction Co.	1½—1⅜	6 17 2	Jan, July	1⅜	1½	
2	2 9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..	
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 3	Jan, July	..	..	
1	..	Electrolytic Alkali Ord.	⅝—¾	..	..	..	..	
1	7%	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..	
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..	
10	5/0	General Electric (1900) 5% Cum. Pref.	9¾—10½	4 17 7	..	..	..	
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 —99	4 0 10	..	..	..	
5	6/0	Henley's Telegraph Works Ord.	14 —15	6 13 4	Feb, Aug	..	..	
5	2/3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	5	..	
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 — 112	4 0 9	Feb, Aug	..	..	
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 6	Feb, Aug	18⅛	18⅛	
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	100	..	
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 8 11	Mar, Sept	..	..	
12	12/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 8	Mar, July	35⅜	34¼	
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	..	..	
5	3/C	Willans and Robinson Ord.	5 —6	5 8 4	Apr, Oct	5⅜	5¼	
5	3,0	Do. 6 per Cent. Cum. Pref.	6 —6¼	4 12 4	Apr, Oct	6	..	
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 10	May, Nov	..	..	

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THERE appears in another column of this issue an article on the Curtis turbine, which, at a time when the attention of the engineering world is directed towards steam turbines of large capacity, is worthy of careful consideration. It furnishes a more detailed description of the Curtis turbine than has been published hitherto, and the sectional drawing which is included in the article will assist our readers considerably in studying its principle and action. In the near future we hope to publish an article showing the effect of the adoption of the Curtis turbine on the general design of a generating station. Further authoritative tests than have been made at present are much needed, however, but we trust that these will soon be forthcoming.

SIR OLIVER LODGE'S Paper on "Means of Electrifying the Atmosphere on a Large Scale" has excited considerable interest in lay as well as in scientific circles. Sir OLIVER first sketched his method of discharging electricity into the air in times of fog, and described the effects of the operation so far as he had been able to observe them. Unfortunately for his purpose, opportunity for investigation has not been frequent during the past year, since this has been a minimum period for fog. The method consists in supplying high-tension electricity generated by an influence-machine to a well-insulated mast surmounted by discharge points, or, better, by a gas flame. The effect on a mist-laden atmosphere seems surprisingly great. For, as Sir OLIVER'S assistant described the phenomenon, a clear space 200yds. or 300yds. in radius is formed round the mast, into which cumulus-like banks of mist may be seen rolling and vanishing as they enter the charmed circle. Sir OLIVER believes he has thus shown that such a corporation as the Mersey Board would be justified in erecting discharge-masts on either bank of the waterway in an attempt to mitigate the always disastrous river fogs. To drive electricity continuously off points removed to a distance from the earth requires a very high potential.

THE glass influence-machine, so suitable in the experiments, could not be put into the hands of the "practical" man, who would, said Sir OLIVER, soon smash it. And since a unidirectional discharge was here necessary, the alternate-current and a step-up transformer could not be used till a high-tension rectifier had been devised. Thus, when the Cooper-Hewitt lamp was introduced, Sir OLIVER at once welcomed it in this aspect, for it seemed to offer him the possibility of putting his whole scheme into practice. Since then he has adapted the mercury rectifier, with some success, to the end in view; using an alternator with the enormous frequency of 3,000∿ per sec., transforming up by a Ruhmkorff coil, and sifting out the positive and negative impulses by a bridge of rectifiers. On the lecture table he demonstrated the perfection of the process by using the one-sign discharge so obtained to dissipate a cloud of smoke. Sir OLIVER laid considerable stress on the obscure function of a certain detail which he finds contributes to the efficient action of the tubes. This detail is the tinfoil coating outside that portion of the glass bounding the mercury electrode. The coating must be maintained in electrical connection, through an external wire, with the opposite electrode. It was on this detail that the discussion mainly turned, and the speakers did not all share Sir OLIVER'S views, as is shown by the official report which we publish in this issue. Ultimately, however, by the aid of a few striking experiments, Sir OLIVER showed that his contention had a firm basis and that the question was one not easily to be disposed of.

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As a sequel to the report of the tests on Nernst lamps, conducted by the National Electric Lighting Association of America, and published in our last issue, a report on tests of Welsbach gas mantles has been drawn out, and this we publish to-day. Like that of the Nernst lamp, the illuminating power of the Welsbach mantle depends largely on the pressure applied. It may be seen from the curves that the distribution of light in a horizontal plane is almost circular, but it does not follow from this that the spherical candle-power is equal to that obtained in a direction at right angles to the vertical supporting rod. As a matter of fact, the maximum intensity is above the mantle itself, owing to the curvature of the incandescent surface. Another significant point in the report applies to the testing of ordinary bat's-wing nipples, and it was found that the ratio stated by the makers was quite at variance with the observed values. Such facts as these may be borne in mind when comparative figures for gas and electric lighting are brought forward by supporters of the gas interests. The arc lamp, it should be remembered, gives maximum illumination where it is wanted, while the incandescent gas mantle gives maximum illumination in a direction above the horizontal.

ELSEWHERE we print, almost in full, a translation of Mr. GOLDSCHMIDT'S Paper on the electrical smelting of iron. This important document is descriptive rather than critical, and may be cordially welcomed as setting forth a comparative statement of the various processes of smelting iron in the electric furnace which have reached the dignity of practice. The conclusion is what all who have studied the subject have maintained from the first—namely, that the cost of production of crude metallic iron from its ores by electrical means is comparatively large, and that competition with the blast furnace can be successfully undertaken only when the cost of power is unusually low and the supply of pure ore is exceptionally abundant. In those processes which are designed to manufacture steel of high grade comparable with crucible steel, the margin of profit is greater, and it is to these that, in the first instance, the industrialist must look. Though full working details are absent in the description of many of the furnaces, and there is not yet sufficient evidence of the actual running cost, yet the instalment of information which we find is much in advance of previous published accounts, and is worth the impartial consideration of electrical metallurgists.

THE conclusion of our article on "Some Wireless Telegraph Patents" will be found on another page of this issue. It is a noticeable fact that applications for wireless telegraph patents are on the decline, and have been getting gradually less since 1901. What is still more significant, however, is that nearly all the patents which are being issued just now are taken out by foreigners or else by "cranks." At the beginning of the rush, the useful patents were far outnumbered by the useless ones, but now they have become almost a negligible quantity. It is interesting to observe quite a large number of patents for selective and syntonic systems which, alas! have not yet stood the test of ordinary working conditions. There will probably be no renewal of activity until someone makes a great discovery, or until the commercially-minded public can be convinced that money may be made by wireless telegraphy.

IT is gratifying to observe the severity of the punishment meted out to three thieves charged at the Old Bailey on Monday with stealing 340 yards of copper wire from the London and South-Western Railway Co. The practice of cutting and removing telegraph and trolley wires is one of several undesirable importations from America, where opportunities are more frequent than in this country. Magistrates and judges would do well to bear in mind the fact that such thefts ought not to be treated in the ordinary way. The consequences to the plundered are by no means ordinary. It is not merely a question of direct or indirect pecuniary loss to the railway company, but loss of passengers' time owing to delay of trains is an important factor, to say nothing of the risk of injury to life and limb. In the public interest, therefore, these depredations should be put down with a strong hand ere their occurrence becomes so frequent as to render this difficult.

Royal Society.—Among the Papers down for reading yesterday was one by Dr. A. D. Waller, F.R.S., on "Electrometer Records of Secreto-Motor Changes."

Opening of the New Electricity Works at Exeter.—On Monday last the new two-phase electric power station which has been erected by the Exeter Corporation was formally opened by the mayor, although the works will not be actually completed for some few months. When the work of construction is finished, all supply will be given from the new works, and the old station will be shut down.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Guadeloupe—Martinique	May 9, 1902 ..	Nov. 16, 1903
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	—
New York—Hayti	Apr. 18, 1903 ..	—
Trinidad—Demerara	Oct. 23, 1903 ..	Nov. 16, 1903
Tourane—Amoy	Nov. 10, 1903 ..	—
Accra—Lagos	Nov. 14, 1903 ..	—
Lagos—Brass	Nov. 14, 1903 ..	—

New Session of the Institution of Electrical Engineers.—At the meeting of the Institution of Electrical Engineers on Thursday last week, the president announced that the following programme of Papers to be read had been arranged up to the end of the current year:—November 26th, "The Testing of Electric Generators by Air Calorimetry," by R. Threlfall, F.R.S.; "The Edison Accumulators for Automobiles," by W. Hibbert. December 10th, "The Ondograph," by E. Hospitalier (who will come over from Paris to read his Paper); on "The Magnetic Dispersion in Induction Motors and its Influence on the Design of these Machines," by Dr. Hans Behn-Eschenburg. December 17th, "The City and South London Railway: Working Results of the Three-wire System applied to Traction, &c.," by P. V. McMahon.

Society of Arts.—Last Wednesday evening Sir William Abney, K.C.B., F.R.S., delivered, as chairman of the Council of the Society of Arts for the ensuing session, his opening address before a large audience. He traced the history of the Society of Arts back to its foundation, 150 years ago, and dwelt with satisfaction on the fact that its progress had been a steadily progressive one, so that at the present time its influence and importance, as well as its prosperity, were greater than ever. Turning then to the question of education—

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especially that relating to commercial subjects—he first surveyed the results of the examinations and educational work of the Society of Arts, and then discussed this problem on a broader basis. One of his main conclusions was that a sound and general education ought to be given to the rising generation before any attempt is made to specialise.

German Submarine Telegraphs.—The United States Consul-General at Frankfort-on-the-Main has reported upon the submarine cable interests of Germany. He states that during the last seven years no less that 7,375 miles of submarine cable have been laid by Germany, the cost being about £1,250,000. A cable was laid between Sassnitz and Trelleborg, 73 miles apart, in 1898, and in the same year German South-West Africa was connected up with the existing German system by means of a line 154 miles long. In 1900 the Emden–Azores–New York line was laid, a distance of 4,813 miles, and simultaneously the first German cables on the Chinese coast were laid, two of them being between Tsing-tau and Chifu (285 miles), and Tsing-tau and Shanghai (438 miles). A fifth cable between Germany and England was laid in 1901, as well as a telephone cable between Fehmarn and Laland. The Emden–Vigo line, a distance of 1,300 miles, has just been completed, and a second cable to New York, via the Azores, is under construction. Other lines are in contemplation. The opinion of the United States Consul-General is that the increasing importance of German interests, both military and commercial, will require the building of more German cables independent of foreign nations.

British Trade in South Africa.—Some time ago the Board of Trade appointed Mr. Henry Birchenough as its special commissioner to visit South Africa and report upon the present position and future prospects of British trade there. The report has now been issued as a blue book. After an introductory letter, Mr. Birchenough divides his report into two parts, dealing respectively with the conditions existing in South Africa at the present time, and foreign competition. In both of these portions of the report the electrical industry is occasionally referred to briefly. Under the heading "New Openings for Trade," the report states that there are few branches of colonial activity which afford so many opportunities for the expansion of trade as the many necessary and pressing schemes for municipal improvement, including electric lighting, tramways, &c., upon which, it states, there is urgent need for great municipal outlay. Included in a list of those branches of trade in South Africa in which we are actually behind our competitors is electrical engineering, in which at present America, Germany and Switzerland have the bulk of the trade, although signs are not wanting that the British may soon contest this supremacy. Unless this takes place, however, the foreign competition in electrical matters, which is at present very keen, will become still more formidable as the future extent and importance of the market is realised. A better system of representation is asked for in the case of the engineering trades.

The Institution Presidential Address.— After the delivery of the presidential address by Mr. R. K. Gray to the Institution of Electrical Engineers on Thursday last week, Prof. W. E. Ayrton proposed a vote of thanks. In common with the president, he said, he hoped to see a Temple of Engineering arise, but he feared the history of that project would be the history of so many others. England originated the idea, America adopted and developed it, and then later on England re-imported it. More than 20 years ago the late Sir William Siemens proposed that there should be this Temple, a Temple in Westminster for applied science corresponding to Burlington House for pure science, and he was generous enough to offer to start it with a subscription of £10,000. During his (Prof. Ayrton's) visit this year to the United States with the Moseley Educational Commission, he learned that the liberality of Carnegie had made the idea a *fait accompli* in New York. In the days to come England would re-import the idea with the privilege of paying a duty under a Chamberlain protective tariff. The president's reference to submarine telegraphy was to him pathetic, for it brought back to his mind many of the past presidents, now dead, who had sat in the presidential chair—men who had made England distinctly first in the manufacture and laying of submarine cables. Mr. Gavey, who seconded the vote of thanks, referred to the great widening of the possibilities of electrical engineering since the early days of the Institution, when the whole range of the electrical industry was comprised in the one word "telegraphy." The president's address was published in full in our last issue.

Some Water-power Statistics.—In the course of his presidential address to the Liverpool Engineering Society on November 4th, Mr. T. L. Miller said that France used water-power to the extent of 500,000 H.P., the United States 1,500,000 H.P., and it was estimated that in Norway 263,000 H.P. could be supplied by the larger rivers south of Trondhjem without regulation, and by regulation the power could probably be quadrupled; for electro-chemical works alone it had been estimated in 1890 that stations of a capacity of 200,000 H.P. were established. According to Prof. Janet, the cost of water-power development in France varied from £4·28 per horse-power to £30 per horse-power, depending on the head to be dealt with, the lowest expenditure being upon a fall of 140 metres in Haute-Savoie, the horse-power being calculated at the turbine shaft. At Geneva, for the first group of turbines erected, of 840 H.P., and for the river works then completed, the capital cost had amounted to £60 per effective horse-power. The groups of turbines subsequently erected had cost but £19 per horse-power, and the completed works would cost but £27 per horse-power. At the Chlorate works at Vallorbe the capital expenditure upon the development of 3,000 H.P. had amounted to but £3·89 per horse-power. At Niagara the rates charged to ordinary consumers by the Cataract Power and Conduit Co. varied from 1d. per unit for 1,000 units per month or less to 0·32d. per unit for 80,000 to 200,000 units per month. The cost of electrical energy for power purposes from water-power stations in France and Switzerland varied from 1·05d. per unit for small powers to 0·63d. per unit for large powers.

Manchester Section of the Institution of Electrical Engineers.—At the meeting of this local section on Tuesday, Mr. Cowan, the chairman, delivered his inaugural address, an abstract of which appears in another column of this issue. A vote of thanks, proposed by Dr. Bowman, seconded by Mr. C. D. Taite, was carried with acclamation. Dr. A. Schuster, F.R.S., then gave a demonstration of the properties of radium. The first property illustrated was that of increasing the conductivity of air. This was demonstrated by discharging a gold leaf electroscope by the effect of radium and also, at a slower rate, by uranium. An experiment with two spark-gaps illustrated the same property very effectively. It was shown how the presence of radium controlled the spark, taking it from one side to the other. Experiments with radium emanation were also shown, and it was demonstrated that the emanation would pass through cotton wool, paper and like substances, but not through glass and metals. The relative properties of radium, thorium and uranium as radio-active bodies were next discussed, and the different nature and activity of the various rays were demonstrated. The radium emanation was solidified at the temperature of liquid air, and further electroscope experiments were made with a crude Austrian ore containing radium. The lecturer then followed these experiments by a few observations on radium from a commercial standpoint. These are rather discouraging at the present stage. He estimates that 80kg. of radium would yield 1 H.P. for, perhaps, 1,000,000 years, and at the present market value would cost £80,000,000. If some means of acceleration could be found out, say, to increase its activity a million times, and it could be obtained 35 to 50 per cent. cheaper than at present possible, then 10 tons per year would supply the world's power at a figure within the bounds of commercial possibility.

Injuries to Trees by Electricity.—A report has been issued by the Massachusetts Agricultral College by Dr. George E. Stone, State botanist, upon the effects of electricity on trees. Injuries are caused by a mass of wires overhead or by contact with wires or by lightning. Alternating current is less disastrous to plant life than continuous current. Up to a certain point electricity stimulates the growth of a tree, but beyond

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that point it retards. Trolley or electric light wires cause injury at or near the point of contact of the wire to the tree, and in wet weather, when the tree is covered with a film of water, the result is a burning of the limb. Tests made to determine the electrical resistance show a minimum value of about 11,000 ohms for 10ft. of trunk of an elm tree 18in. in diameter. There is no instance in which alternating current caused the complete death of the tree, though it has been shown by laboratory experiments that it is capable of killing small plants. In these experiments the current necessary to kill the plant generated considerable heat, and this probably caused the death. Large trees have been killed by continuous currents from railway circuits. Escaping current has girdled the tree at a distance of 5ft. to 10ft., whereas the point of contact of the feed wire with the limb is 16ft. or 18ft. above the ground, and showed none of the characteristic burning effects. An investigation of these unusual results showed that in these cases the positive 'bus bar of the system was connected to the rails, and the negative to the overhead conductors; and in all instances where trees were killed by electricity this was found to be the case. Lightning, in striking a tree, does not always produce the same results. Trees may be killed outright without exhibiting the common effects of shattering. Quite frequently the tree is girdled by the discharge taking a spiral course to the ground. In a large number of instances lightning strokes cause neither death nor mechanical injury of importance. Hundreds of trees are annually struck by lightning, but this is not recognised except by those who are familiar with the scars which subsequently make their appearance on the trunk.

Lord Kelvin in Wales.—The honorary degree of Doctor of Science of the University of Wales was conferred upon Lord Kelvin last Friday at Cardiff. In replying to the toast of his health at the municipal luncheon, Lord Kelvin said that in the sense of retaliation or protective duties or otherwise, science had no country. Scientific men of one country looked upon scientific men of other countries as their fellow-citizens. In the afternoon, Dr. Thomson, as Dean of the Faculty of Science, University College, Cardiff, presented Lord Kelvin, who was admitted by Vice-Chancellor Griffiths and Senior Deputy-Chancellor Sir Isambard Owen. Lord Kelvin is the first recipient of the honorary D.Sc. of the University of Wales. On the previous day Lord Kelvin received the honorary membership of the South Wales Engineers' Institute. In the absence of the president (Mr. Riches), Mr. E. N. Hann, the vice-president, occupied the chair, among those supporting him being Lord Tredegar, Lord Windsor, the Bishop of Llandaff, Principal Griffiths and Principal Roberts. The chairman briefly welcomed Lord Kelvin, and, on behalf of the South Wales Institute of Engineers, desired his acceptance of the honorary membership. Lord Kelvin, in expressing his thanks for the honour, said he had always had the deepest sympathy with engineering and university training, because engineering was giving one of the most interesting applications of science learned in the university for the benefit of mankind. He remembered with pride that the first chair of engineering in any university in the country was that founded in Glasgow, and he felt that engineers all over the world had still a good deal to learn as to the real value of university training. In the education of foremen in engineering works the Germans had learned how to give them scientific knowledge in a way in which it was not given in England. It was necessary for the young engineer to learn practice as well as theory, and this could only be accomplished satisfactorily by the student's spending half his year at the university and half in the workshop, where he might learn to apply the scientific knowledge which he had acquired in the university. He would suggest this to the Univerity College of South Wales and to the members of the Engineers' Institute, and would ask employers to endeavour to make some arrangement whereby their engineering pupils might be able to do this.

Personal.—We have much pleasure in announcing that Mr. B. Hopkinson, M.A., has been elected to the professorship of Mechanism and Applied Mechanics at Cambridge, in succession to Prof. J. A. Ewing, F.R.S. Mr. Hopkinson was born in January, 1874, and was educated at St. Paul's School, in the Siemens' Laboratory of King's College, and at Trinity College, Cambridge. At Cambridge he took an ægrotat degree in the first part of the Mathematical Tripos of 1895, and was placed in the first division of the first class in the second part of the Tripos of 1896. He is also a Bachelor of Science of the London University, where he held the University Scholarship in Mathematics. From 1896 to August, 1898, he read for the Bar in the chambers of Mr. J. Fletcher Moulton, K.C., Mr. W. H. Upjohn, K.C., Mr. A. J. Walter and Mr. Clavell Salter, and was called to the Bar in 1897. On the death of Dr. John Hopkinson in August 1898, he entered into partnership with Mr. Charles Hopkinson and Mr. Ernest Talbot as consulting engineers. During the five years that this firm have been in practice they have acted as consulting engineers for a number of municipal tramway and lighting undertakings, including Liverpool, Leeds, Newcastle-on-Tyne, &c. Mr. Hopkinson has held a commission in the Corps of Electrical Engineers Volunteers since its formation in 1897. He is also the author of a large number of Papers read before many of the scientific and engineering societies, several of which have appeared in the columns of *The Electrician*.

Mr. George Draper, who has held the position of secretary to the Eastern Telegraph Company since 1872, and of the Eastern and South African Telegraph Company since its inception in 1879, will retire on a pension on December 1st. Prior to 1872 Mr. Draper was assistant-secretary to the associated Anglo-Mediterranean Telegraph and British Indian Submarine Telegraph Companies. The Boards of Directors of the two companies have appointed Mr. A. R. Hardie, who has been accountant to the companies since 1884, to the position of secretary. Mr. Hardie's association with these companies commenced in 1870. Mr. C. W. Adye, late of Messrs. Deloitte, Dever, Griffiths & Co., has been appointed accountant of these companies.

We are glad to learn that Sir William Preece is now considerably improved in health. He is leaving London to-day for Cairo, and proposes to spend the winter in Egypt.

The Recent High-speed Railway Trials.—We are able to give some additional particulars with regard to the equipment and running of the successful cars. According to the *Elektrotechnische Zeitschrift*, it was the car of the Allgemeine Elektricitäts-Gesellschaft which attained, on October 27th, the maximum speed of 210·2km. (130 miles) per hour, the car of Messrs. Siemens and Halske having run at a speed of 206·7km. (128·5 miles) an hour on October 23rd. It appears that this slight difference was due to a somewhat higher frequency of the supply current on October 27th. In order to keep the current increments on starting within practical limits, the Allgemeine Elektricitäts-Gesellschaft, in the course of the trials, adopted the plan of cutting in consecutively (instead of simultaneously, as before) the four stator windings, while the rotors were still on open circuit, and then of starting all the motors at the same time by means of liquid resistances in the rotor circuits. This arrangement also facilitates the switching off of any one of the motors after the train has been accelerated up to full speed. At starting, it appears that the motors were overtaxed to the extent of three times their normal capacity, which was 250 H.P., and that they successfully withstood the strain. A current of slightly compressed air is directed against the end connections of the windings, and this is said to assist materially in keeping the motor temperature down. The liquid starters were a success. By means of pumps the liquid is circulated through a system of pipes located beneath the car and exposed to the draught of air, at the same time some wind shields conduct currents of air also to the surface of the liquid, the temperature of which is kept by these means, it is stated, below 40°C. For marking the time when the various observers on the trial car were to read simultaneously their respective instruments, a clock was provided, which sounded a signal every 10 seconds, this signal being preceded by a short preparatory one. Several devices were adopted of measuring the speed. A small continuous-current dynamo with permanent magnet fields and mounted on the car axle indicated roughly by its voltage the car-speed. A

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more accurate instrument for measuring the speed was a special device made by Messrs. Siemens and Halske, whose principle is briefly as follows:—On a moving paper slip three series of marks are made. One series consists of dots, the distance between any two of which corresponds to one second. Parallel to the first is a second series, the dots of which are marked from the car axle by electrical means, and in such a manner, that the time interval between two dots corresponds to one revolution of the car wheel. Finally, the dots of the third series are made every kilometer. This too, is done electrically by means of a brush fixed to the bogie of the car, making contact with pieces of metal spaced every kilometre. Two instruments were used for determining the air pressure. One consisted of a U-shaped glass tube partly filled with water, and the other of a flat-faced box of a corrugated form, constructed of thin metal and in resemblance similar to the thin metal boxes used in recording barometers. Wind-pressures were measured at various points of the car and also at various distances in advance of the front of the car. Little weather-cocks indicated the direction of the air currents at the different points. The acceleration was measured by Kapp's method, which is based on the unequal distribution of water in a glass tube (placed parallel to the direction of motion and bent up at both ends), whenever any increase or decrease in speed takes place (see *The Electrician*, Vol. XLV., p. 641). An interesting apparatus, which is fitted to the Siemens and Halske car, serves for regulating the brake pressure in such a way that the retardation of the car is kept constant throughout the time of slowing down, and no slipping of the wheels can consequently occur. Another apparatus records the motor torque at any moment. For this purpose oil is compressed into a cylinder by a lever arrangement attached to the stator, the pressure varying in accordance with the torque of the motor. A pressure gauge registers the oil pressure and from its readings the motor torque may be derived. An apparatus is also fitted to the car for recording the extent of the "rolling" motion of the train. The driver of the car is advised 2km. (1·25 miles) in advance by an electric bell if any signal, other than that for free passage, is set. According to our contemporary, the Studiengesellschaft intends at present to investigate, in a minute manner, all conditions and details pertaining to speeds of 140km., 160km. and 180km. (87, 99·5 and 112 miles) an hour.

Glasgow Local Section of the Institution of Electrical Engineers.—Mr. W. A. Chamen delivered his inaugural address as Chairman of the Glasgow Local Section of the Institution of Electrical Engineers on November 10th. After thanking the members for the honour of electing him chairman, and referring briefly to the position and scope of the local section, he took a general survey of the electrical industry at the present time. Referring first to the increased employment of steam turbines, he made mention of the fact that the Clyde Valley Electric Power Co. were putting down this class of plant in their new works. So successful had the larger sizes of steam turbine proved that Mr. Chamen announced there was a likelihood of his adopting this type of plant before long for the Corporation of Glasgow in connection with its general electricity supply. Referring to gas engines, he said that the capital cost of a gas engine, dynamo and producer plant at the present time seemed to be considerably more than the cost of steam dynamos and boilers, and was far greater than that of steam turbo-generators and boilers. This was no doubt partly owing to the comparatively low speed of gas engines, and to the fact that in large sizes it did not seem possible to construct vertical engines. The gas turbine was little more than a dream, though he thought one had actually been made. The difficulty appeared to be that the necessary cooling was so expensive as to rob the machine of any efficiency which might otherwise be expected. When it was borne in mind that the cost of fuel per unit delivered to the consumer on a load like that at Glasgow was only about ¼d., it was obvious that other items to make up the total average cost of 2·94d. per unit were of much more serious proportions. Saving of fuel was useless if it tended to increase the standing charges. Referring to the question of superheating, he said this had not been successful hitherto owing, probably, to the difficulties of keeping the amount of superheat of the steam within the necessary limits and of finding a lubricant for the internal parts of the engine capable of standing high temperature. The whole question, however, was receiving active attention once more, and remarkable results were from time to time reported. The question of electricity distribution had perhaps advanced less than that of production. It was, however, of sufficient importance to warrant the expenditure of much thought. Under the present conditions, the average cost of distribution, per unit delivered to the consumer at Glasgow, was 1·7d. Mr. Chamen then referred to the extension of electric supply for power, heating and cooking, especially emphasising the large field for domestic applications. He also referred in general terms to electric tramways, the electrical equipment of railways, power companies, motor cars and electrochemistry, mentioning in the latter category a recent demonstration of a process of welding metals by means of the oxy-hydrogen blowpipe, in which the oxygen and hydrogen were generated by the electro-deposition of water in a simple and apparently perfect manner.—In proposing a vote of thanks to Mr. Chamen for his address, Mr. H. A. Mavor referred to the gas engine question, and said that the total cost of a complete power equipment of steam plant was from about £10 to £11 per horse-power, whereas the cost of the best gas engines, without the accessory plant, was already about as much as that. He also referred in humourous terms to the question of smoke nuisances, saying that it was interesting to find how the prosecutions for black smoke were converting themselves into an increase of revenue to the electricity department. In one case a manufacturer in the engineering trade, who had been fined frequently for allowing black smoke to issue from his chimney, shut down his boilers and put down an 80 H.P. motor. As soon as he had made this change he found that, not only did he save the fines, but that he had actually lowered his cost of production.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

To-day (FRIDAY), November 20th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Meeting at Storey's-gate, St. James's Park. Papers to be read: (1) "Roofing Existing Shops while Work is Proceeding," by R. H. Fowler. (2) "Experiments on the Efficiency of Centrifugal Pumps," by T. E. Stanton.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "Fires on Shipboard, their Chief Causes and the Method for Prevention and Extinction," by G. Canning.

SATURDAY, November 21st.

JUNIOR INSTITUTION OF ENGINEERS.

2:30 p.m. Visit to Orchard Dock, Blackwall, to witness a demonstration of fire extinguishing, &c., by the Clayton Company.

MONDAY, November 23rd.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture I.: "The Mining of Non-metallic Minerals," by Bennett H. Brough.

WEDNESDAY, November 25th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Universal Exposition at St. Louis, U.S.A., 1904," by G. F. Parker.

THURSDAY, November 26th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Papers to be read:—(1) "The Testing of Electric Generators by Air Calorimetry," by Prof. R. Threlfall, F.R.S.; (2) "The Edison Accumulator for Automobiles," by W. Hibbert.

FRIDAY, November 27th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "An Electrical Thermostat," by H. Darwin; (2) "On the Occurrence of Cavitation in Lubrication," by S. Skinner; (3) "A Lecture Experiment in Electrical Resonance," by Dr. W. Watson.

SATURDAY, November 28th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

Visit to the City-road Works of the County of London and Brush Provincial Electric Lighting Co.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read: "Some Remarks on the Willans Engine," by J. H. Pocock.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

N-Rays.—R. Blondlot has made several further discoveries in connection with his N-rays. Hitherto, the only fact noticed was that they increased the luminosity of a small flame or electric spark. But the author has now found that they also enhance the reflecting power of bodies. He mounted a band of paper vertically and illuminated it with light from a small flame enclosed in a box provided with a vertical slit. An Auer burner was enclosed in a chimney provided with a vertical slit closed with aluminium foil. It was then found that the brightness of the paper was considerably enhanced by allowing the N-rays to fall upon it, and was reduced on cutting them off by means of a lead screen. The same observation was made on viewing the reflection of a luminous slit in a polished steel knitting needle. This shows that regular reflection is also affected by the rays. It was confirmed by observing the reflection in a bronze mirror and in the polished face of a quartz crystal. But in the latter case it was found that the rays had no effect when they fell vertically on the face of the crystal. All these effects require an appreciable time to appear and disappear. Though an effort was made to discover some effect of the rays upon refracted light, no success was achieved in that direction. The author has recently found that the Auer burner may be advantageously replaced by a Nernst lamp without a glass. A 200-watt lamp shows the phenomena with sufficient clearness to be visible even to the untrained eye.

[R. BLONDLOT, *Comptes Rendus*, November 2, 1903.]

Pressure within the Spark.—In the year 1882, Dewar executed some measurements of the pressure within the electric arc by perforating the electrodes and connecting the interior with very delicate manometers. He found that the positive carbon was under a constant pressure of about 2mm. of water, whereas the negative carbon showed sometimes a positive and sometimes a negative variation of pressure. Early this year, Mitkewitsch measured the ratio e/m and v for the electric arc, and found a far-reaching analogy between the arc and the Crookes tube. This analogy has since been extended to the spark by C. Baumgart. He passed sparks between two electrodes enclosed in a glass bulb, one of them being a rod provided with a micrometer screw, while the other was a brass tube mounted in a position facing the rod. The brass tube had an aperture 0·5mm. in diameter. All the results point to two streams of ions, both of which exert a pressure upon the electrode on which they impinge. But the pressure of the positive ions upon the cathode is by far the greater of the two, and sometimes amounts to over a millimetre of water. The longer the spark, the less is the pressure. The ratio e/m appears to be of the order 2×10^5, and would indicate positive ions. The pressure on the electrodes is, of course, independent of the pneumatic pressure within the spark, which, according to Haschek and Mache, lies between 10 and 50 atmospheres.

[C. BAUMGART, *Phys. Zeitschr.*, November 1, 1903.]

Capacity of a Vacuum Tube in a Magnetic Field.—E. Lopuchin and A. Afanasieff have, at the request of J. Borgmann, studied the variation of capacity undergone by a vacuum tube in the magnetic field. They found that there is a close correspondence between the luminosity and the capacity. They used Borgmann's method for the determination of very small capacities, and compensated the capacity of the vacuum tube by means of two burettes containing mercury. They used a string interrupter, which was kept going at a uniform rate by controlling the note emitted by it. The axis of the tube was placed either parallel or perpendicular to the lines of magnetic force. In the first case, the capacity was perceptibly diminished by exciting the magnetic field, whereas in the second case it was strongly increased. The luminosity changes in a corresponding manner. As long as the tube is not luminous the capacity of the tube is constant. The capacity of the electrodes alone is then brought into play. The capacity of the tube is a maximum at a pressure of 1mm. At about 0·05mm. it suddenly falls, and the luminosity disappears at the same time. The magnetic effect is strongest at pressures at which the cathode rays begin to appear. At a pressure of 0·07mm. the magnetic field simply extinguishes the light, if the position of the tube is axial. With an equatorial field, the maximum magnetic effect occurs at a pressure of 5mm. At very high vacua, when the tube remains quite dark, the magnetic field always increases the capacity of the tube.

[LOPUCHIN and AFANASIEFF, *Phys. Zeitschr.*, November 1, 1903.]

Carbon Wool.—MM. Constant and H. Pélabon describe a variety of filamentous carbon obtained in the process of carburising fatty oils for the purpose of manufacturing coke. It is not formed in the recuperative furnaces, but only in the old open furnaces. In these, the admission of the air required for combustion is made in the combustion chamber itself. The gases, therefore, burn within the chamber, and all the flames are concentrated towards an opening in the upper wall. Near that opening, the furnace has a much higher temperature than elsewhere. It is there that the deposits of filamentous carbon are found. Every fibre of the "carbon wool" is attached at one end to a piece of coke, and the general direction of the fibres is that of the blast. Some of the fibres are grey, and others are black. Examined under the microscope, the grey fibres are generally cylindrical, and appear to be covered with a varnish, like the coke to which they are attached. Some of the fibres appear as if made up of a number of cones threaded upon each other, but there is no trace of crystallisation. The black threads are covered with projections often arranged very regularly. They usually appear to be made up of rings. The authors counted six rings on $\frac{1}{10}$mm. The thickness of the fibres varies from $\frac{3}{100}$mm. to $\frac{15}{100}$mm., their length from 5cm. to 8cm. Chemical analysis shows them to be made up of pure carbon.

[CONSTANT and PÉLABON, *Comptes Rendus*, November 2, 1903.]

Conductivity of Selenium.—E. van Aubel has found that besides being subject to variation by light and by Röntgen rays, the conductivity of selenium is also affected by the rays emitted by hydrogen peroxide by essence of turpentine, and by certain bodies after they have been exposed to the action of ozone. A highly sensitive selenium cell was placed in the dark over a porcelain dish containing a 30 per cent. solution of hydrogen peroxide. In three or four minutes, the resistance of the selenium fell from 496,000 ohms to 324,000 ohms. On interposing a brass screen, the original resistance was restored, but very gradually. A similar effect, but somewhat feebler, was observed in the case of essence of turpentine. To test the action of ozone, a leaf of red indiarubber was held for 12 seconds in a stream of dry ozone, and then laid into a porcelain dish. In 15 minutes the resistance of the selenium fell from 599,000 ohms to 556,000 ohms. On interposing the brass screen, the resistance recovered to 563,000 ohms in about an hour, and regained its original resistance in about a day. A stronger effect was obtained on substituting camphor for the indiarubber. This effect may be compared with the effect exerted upon sensitive plates by the same bodies after exposure to ozone. This was first discovered by J. H. Vincent, and was shown to be due to the fact that bodies so exposed contain a small proportion of hydrogen peroxide. Ozone by itself produces no effect. The effect upon selenium is remarkable on account of the slow recovery and the paramount influence of the temperature.

[E. VAN AUBEL, *Phys. Zeitschr.*, November 1, 1903.]

Electric Lighting (London) Bill.—The Board of Trade will again introduce, in the coming session of Parliament, a bill to provide for the alteration and readjustment of the areas of electricity supply within the County of London in order to make the boundaries of these areas, as far as possible, coterminous with the areas of local government fixed by the London Government Act of 1899. A similar bill has already been introduced on two occasions. In 1902 the measure was withdrawn after it had been referred to a Select Committee of the House of Commons, and in 1903, when it came before the House of Lords in the first instance, it was withdrawn after third reading.

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THE WIRELESS TELEGRAPH CONFERENCE.

The official report of the preliminary Wireless Telegraph Conference, which took place in Berlin last August, has now been published. The report, which is in French, fills a blue-book of 81 pages and gives an account of the proceedings at each of the six days of the Conference, together with the text of the final protocol signed by the delegates of the majority of the countries represented.

To assist the deliberations of the Conference the following proposals and subsidiary questions for discussion had been prepared by Germany.

Proposals.	Subsidiary questions.
Article I.	
Wireless telegraph (radio-telegraphic) stations intended for communications with ships at sea shall be subjected to the following regulations:—	Is there need to regulate also the exchange of communications (*a*) between vessels, (*b*) between coast stations?
§ 1. Radio-telegrams coming from, and destined for, ships shall be transmitted without regard to the system employed.	(*a*) Should the proprietor of the station be obliged (*a*) to put himself into communication, on being called, with any person without exception, (*β*) to send by the shortest way the telegram received? (*b*) Can systems be admitted which require subtle syntonisation? (*c*) Or should the duty be imposed of establishing the installation in such a manner that it will adapt itself as much as possible to all systems?
§ 2. The wave-lengths employed by the coast stations for maritime traffic shall be publicly announced. An understanding may be arrived at, however, as to the employment of waves of a special length which is not published.	(*a*) Should specified wave-lengths be prescribed? (*b*) Is there need to require the publication of a technical description of all the stations? (*c*) Or should this publication refer solely to the system employed? (*d*) Should the maximum range of the stations be published?
§ 3. Charges for the exchange of radio telegrams between coast stations and vessels must be reasonable. Half the charges will be credited to the coast stations, the other half to the stations on board the vessels.	(*a*) Or would another method of apportionment be preferable? (*b*) Is it necessary to establish an international clearing house to ensure the payment of these charges?
Article II.	
A concession for the establishment and working of radio-telegraphic stations, intended to exchange messages with vessels at sea shall only be granted to undertakers who are bound by the conditions enumerated in Article I. The charges must be approved by the Government on whose territory the coast station is. Those undertakers will be excluded who, in non-contracting countries, refuse to enter into communication with stations on board vessels equipped on a different system, or who endeavour in any manner to render this communication difficult.	Is it necessary to establish an office of control to see that the conditions imposed on stations are carried out?
Article III.	
A code of regulations shall fix uniform rules for the service between coast stations and stations on board vessels. These stations will be bound to observe the dispositions of this code of regulations.	Should prerogatives be created in favour of vessels in distress?
Article IV.	
The conclusions arrived at by the present Convention shall not be applicable to radio-telegraphic stations destined exclusively for communication with vessels of war.	Nevertheless, would it not be suitable to impose on them the duty of lending, so far as possible, assistance to vessels in danger.
Article V.	
Those countries which have not joined the present Convention shall be admitted at their request.	

The following is a list of the delegates, all of whom were present at the opening meeting on August 4th:—

Germany.—Messrs. Sydow (Under Secretary of State for the Post Office), Prof. Doctor Strecker (Privy Councillor in the Post Office Department), Wachenfeld (Privy Councillor in the Post Office Department), Schrader (Privy Councillor in the Post Office Department), Consul Fluegel (Councillor of Legation), Capt. Rieve (Navy), Lieut.-Capt. Most, Dr. Felisch (Privy Councillor of the Admiralty), Dr. Beggerow (Assistant Physician), Capt. Oschmann, Major Klussmann (Chief of the Battalion of Military Aerostatics).

Messrs. Fuhrken, Lindow and Pfitzner (Superior Inspectors of the Postal Department) and M. Oberlaender (Secretary of the Postal Department) were appointed secretaries to the Convention, and were entrusted with the preparation of the official report.

Austria.—Messrs. Adalbert von Stibral (Councillor of the Section of the Ministry of Commerce), Arthur Linninger (Superior Commissary of Technical Instruction), Capt. Leopold Sellner (of the Navy, delegate for both Austria and Hungary).

Spain.—Messrs. I. C. y Juana (Major of Engineers and Chief of the Squadron of Military Aerostatics), A. P. Campomanes (Chief Lieutenant in the Telegraph Regiment), M. G. de los Reyes (Naval Lieutenant).

United States of America.—Gen. A. W. Greely (Chief of the Military Telegraphic Service), Naval Commander F. M. Barber, J. I. Waterbury (Special Delegate).

France.—Messrs. Bordelongue (Director of Electrical Exploitation at the Ministry of Industry and Posts and Telegraphs), Sins (Telegraph Engineer, Chief of the Office of International Telegraph Correspondence), Lieut.-Col. Boulanger, Capt. Arago (Navy), Commander Houdaille, and Magne (Inspector of Telegraphs).

Great Britain.—Messrs. J. C. Lamb, C.B., C.M.G. (Second Secretary of the Post Office), J. Gavey, C.B. (Engineer-in-Chief), R. J. Mackay (Head of a Department at the Post Office), Col. R. L. Hippisley, R.E., C.B., Capt. H. L. Heath, R.N. (Deputy Director of the Naval Intelligence Department), Lieut. C. R. Payne, R.N.

Hungary.—Messrs. Charles Follért (Chief Director of Posts and Telegraphs), André Kolossváry (Director of Posts and Telegraphs), Joseph Hollós (Engineer-in-Chief), Capt. Leopold Sellner (of the Navy, Delegate for both Austria and Hungary).

Italy.—Rear-Admiral Charles Grillo, Capt. Quintino Bonomo del Casale (Navy), Marquis Luigi Solari (Naval Lieutenant), Commander Fedele Cardarelli (Head of a Department at the Post Office).

Russia.—Capt. Salewsky (Navy), Prof. Osadschy (Chief of the Technical Section of the General Direction of Posts and Telegraphs), Mr. Bilibine (Chief of the International Postal and Telegraphic Relations at the General Direction of Posts and Telegraphs), Prof. Popoff (Professor at Electro-technical Institute Alexander III.).

Mr. Kraetke, Secretary of State of the German Postal Department, welcomed the delegates in cordial terms, and he was thanked on behalf of the delegates by Mr. J. C. Lamb. Mr. Sydow, chief of the German delegates, who was chosen President of the Conference, then invited a general discussion on Article I. of the proposals given above.

Mr. SYDOW pointed out that while wireless telegraphy had not yet gained a considerable importance for traffic overland, nor a generally recognised success for transmissions between distant coasts, its importance and utility were incontestable so far as concerned communications between the coast and vessels at sea, as well as between ships themselves To favour a further development of radiographic telegraphy in this direction, and to overcome as much as possible obstacles which were opposed to its employment seemed, he said, to be a task to the common interest of naval states. The proposal of Article I. was for the purpose of preventing the creation of a monopoly in favour of a single system in the first instance, and in the second, to prevent various systems disturbing one another. By the arrangements which the Wireless Telegraph Co. had concluded with the British Lloyd, the latter agreed to employ the Marconi system exclusively in its stations, and not to allow them to communicate with vessels provided with other systems. It had been ascertained that the Lloyd stations in following out this principle had not replied to the signals from ships equipped with other systems. Such an arrangement limited in an essential manner the utility of radiographic telegraphy. Neither was it to the interest of the technical development of the subject; wireless telegraphy was still too recent for any particular system to be accorded a superiority or preponderance over all others. The German Government was of the opinion that the interests of unification, as well as the interests of technical science, imperiously demanded that communication between coast stations and vessels should be facilitated without regard to existing systems. For the same reason the German Government thought it necessary to seek means to prevent, as far as possible, mutual disburbance between the various systems. The German Government was of opinion that the systematic fight against monopoly in wireless telegraphy, the demand that the various systems should co-operate, and at the same time the fixing of standards to prevent mutual disturbance, were the only means to prevent a war of all against all.

Mr. LAMB (Great Britain), who continued the discussion, said that the Government of Great Britain had accepted the courteous invitation of the German Government to take part in this preliminary conference concerning wireless telegraphy, and it would give the results of their deliberations the most attentive consideration. Nevertheless, he was not in a position to submit definite proposals, and he even thought it would be difficult for him to express definite opinions on the questions which the German Government had formulated. Great Britain was in an exceptional position with regard to the powers of the State. The exclusive privilege of the Postmaster-General was not applicable to communications exchanged by wireless telegraphy with foreign countries nor with vessels outside the limits of the territorial waters. It would, consequently, be necessary for the British Government, before imposing an international control, to ask Parliament for legislative powers, and it would be difficult to have a law voted if the

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control contemplated was of such a nature as to prejudice those who had established an actual service and who were profiting by the facilities accorded them under the existing law. In these circumstances the British delegates thought that they must be content to play the modest part of giving the greatest attention to the views expressed by the representatives of other countries, who would be in a better position to deal with the question.

Mr. BORDELONGUE (France) stated that the French Government associated itself from the first with the views expressed by the German Government as to the necessity of regulating the practical applications of wireless telegraphy, at any rate, so far as the actual state of science permitted it. With regard to Mr. Lamb's remarks as to the position of the British Government and their delegates, he contended that the present laws were not unalterable, and, in fact, he thought that the sooner restrictive legislation were passed the less would be the risk of injuring private interests, as the latter would become more important the longer the delay. Besides, to direct them in a sense favourable to the public interest from the start was not to injure them. It was in this spirit that the French Government expressed its adherence to the present Conference; it was in this same spirit that it supported the views expressed by the German Government, and was disposed to co-operate in the work before them.

Mr. Von STIBRAL (Austria) stated that his Government, while appreciating the difficulties of the case, was disposed to enter the discussion in the same spirit as the French delegates.

Lieut. SOLARI (Italy) here interposed that before discussing §§ 1, 2 and 3 of Article I., they should consider the form taken by the article itself, and he desired to speak on this matter at their next meeting.

Admiral CHARLES GRILLO (Italy) then spoke as the chief of the Italian delegates, and stated that, while accepting the German Government's view as to the necessity of regulating the new system of communication, he must make some reserve as to accepting the first article as it stood, for this might damage private interests. In order to give time to study the matter, he suggested that the discussion should be delayed until the following day.

Capt. SALEWSKY (Russia) said that even if all the problems concerning wireless telegraphy could not be solved at the present Conference, there were some which seemed within their range. He trusted, therefore, that this work would be commenced, for a regulation of this addition to international relations would soon become necessary.

The discussion was then adjourned.

The proceedings of the second day, August 5th, were commenced by the reading of the following explanation by Gen. A. W. Greely, of the United States:—

The delegates from the United States desire to express in general terms their opinions as to the scope and extent of international action now advisable in formulating regulations for wireless telegraphy. Recognising the inchoate state of the science of wireless telegraphy, it is our firm conviction that detailed regulations are impracticable, and that this Conference should confine its action to the formulation of general resolutions. While embodying therein such principles as will ensure the greatest advantages to the commerce and trade of the world, care should be taken to avoid interference with the development of wireless telegraphy.

A broad distinction exists between shore stations, which are entirely within national jurisdiction, and ship stations on the high sea, beyond the plenary exercise of such control. Inasmuch as the interchange of ships' signals under the international code is not obligatory, though recognised as commercially important, it seems to us inadvisable, for the present at least, to insist on the interchange of radiograms between ships on the high sea, especially in view of the impracticability of efficaciously enforcing any such regulations. Finally, we are of the decided opinion that shore stations transacting any paid business should be required to accept from, and deliver to, suitably-equipped ships and stations all wireless telegrams (radiograms) offered for receipt or transmission.

These general statements having been made, the Conference proceeded to discuss the various articles proposed. The Conference met six days in all, and at the final meeting, held on August 13th, the following protocol was agreed upon and signed by the majority of delegates. The English and Italian delegates failed to agree with the delegates of the other countries on certain important points, and signed the declations appended to the protocol:—

FINAL PROTOCOL.

The following delegates to the preliminary Conference concerning wireless telegraphy—viz., those representing Germany, Austria, Spain, United States of America, France, Hungary and Russia—agree to propose, for examination by their Governments, the following general bases of regulations as being capable of forming the object of an International Convention.

Article I.

The exchange of correspondence between ships at sea and shore stations for wireless telegraphy which are open to general telegraphic service shall be subject to the following regulations:—

1. A coast station is to be defined as any fixed station whose field of action extends over the sea.

2. Coast stations are bound to receive and transmit telegrams originating from or destined for ships at sea without distinction of the systems of wireless telegraphy employed by the latter.

3. The Contracting States shall make public all the technical information of a nature to facilitate and accelerate communications between coast stations and ships at sea.

Provided, however, that each of the Contracting Governments may authorise the station situated on its territory, on conditions which it shall judge suitable, to utilise several installations or special arrangements.

4. The Contracting States agree to adopt the following bases for fixing the tariffs applicable to telegraphic traffic exchanged between ships at sea and the international telegraphic network. The total charge to be made for this traffic is to be calculated per word. It includes (*a*) a charge for transmission on the lines of the telegraphic network, the amount of which is fixed by the international telegraphic regulations in force and annexed to the St. Petersburg Convention, and (*b*) a charge for crossing the sea. The latter is, as the former, to be fixed according to the number of words, this number being counted in conformity with the international telegraphic regulations referred to in paragraph (*a*) above. It includes (i.) a charge called the coast station charge (*taxe de la station côtière*), which shall be received by the said station, (ii.) a charge called the ship charge (*taxe du bord*), which shall be received by the station installed on the ship. The charge for the coast station is subordinate to the approval of the State on whose territory this station is established, and that on the ship to the approval of the State whose flag the ship carries. Each of these two charges must be fixed on the basis of an equitable remuneration for the telegraphic work

Article II.

A regulation to be annexed to the Convention which is to take place shall establish the rules applicable to the exchange of communications between coast stations and stations placed upon ships. The prescriptions of this regulation may be modified at any time by common agreement between the administrations of the Contracting States.

Article III.

The dispositions of the Telegraphic Convention of St. Petersburg are applicable to transmissions by wireless telegraphy so far as they are not contrary to those of the Convention which is to take place.

Article IV.

Wireless telegraph stations must, except in the case of material impossibility, accept in priority demands for help which reach them from ships.

Article V.

The working of wireless telegraph stations must be organised, so far as possible, in such a manner as not to trouble the service of other stations.

Article VI.

The Contracting Governments reserve to themselves respectively the right to make among themselves particular arrangements, having for object that of compelling undertakers working wireless telegraph stations on their territory to observe in all their other stations the prescriptions of the Convention which is to take place.

Article VII.

The prescriptions of the Convention which is to take place shall not be applicable to State wireless telegraph stations not open to general telegraphic service, except so far as concerns the clauses of Articles IV. and V.

Article VIII.

Countries which have not adhered to the Convention which is to take place will be admitted at their request.

Made in Berlin August 13, 1903.

The protocol is signed by delegates representing the States mentioned above.

DECLARATION OF THE BRITISH DELEGATES.

While undertaking to submit the above bases for the examination of their Government, the British delegates declare that, in view of the situation of wireless telegraphy in the United Kingdom, the delegates must maintain a general reserve. This reserve refers specially to Article I., paragraph 2, and the application of the dispositions of Article V. to the stations referred to in Article VII.

Made in Berlin, August 13, 1903.

This declaraction is signed by all the British delegates.

DECLARATION OF THE ITALIAN DELEGATES.

The Italian delegates, while agreeing to submit to the examination of their Government the propositions contained in the final protocol of the Conference, are obliged, in accordance with the declarations made by their members at the various sittings, to make the following reserve on behalf of their Government.

Article I., § 2.—They will accept the text proposed only on condition that the following addition is made:—"Provided that all these systems give a recognised guarantee of good working in reciprocal correspondence, so far as range, perfection of organisation and certainty of communication is concerned."

Article I., § 3.—They cannot accept the first paragraph of this section, as in the agreements concluded with Mr. Marconi the Government has agreed to keep secret the details of the installations.

Article VI.—They cannot accept the text of this article and must confine themselves to declare, on the part of their Government, that what is possible will be done to introduce the modifications in the desired direction in the agreements with Mr. Marconi.

This declaration is signed by all the Italian delegates with the exception of Lieut. Solari, who was not present at the last meeting of the Conference.

The discussion was long and discursive. Instead of the proposals being taken in order and each discussed to a conclusion, new points were constantly broached before the previous ones had been settled, and the debate on some topics was adjourned from day to day, allowing other topics to intervene. We will, therefore, not give a summary of each day's proceedings consecutively, as is done in the official report, but will endeavour to give our readers an account of the discussions more or less in the order of their subject-matter.

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The greater part of the deliberations of the Conference centred round Article I. A few of the members desired that the first sentence should be extended to apply to communications between ship and ship and between coast stations, and not merely to communications between ship and shore; but on M. Bordelongue (France) pointing out that this would be an extension of the scope of the Conference indicated originally to the respective Governments, these suggestions were dropped.

The regulation to the effect that no preference should be given to any particular system of wireless telegraphy (§ 1 of the original proposals, and § 2 of the accepted form of Article I.) was not disposed of so quickly, however:—

Lieut. SOLARI (Italy) read a long statement, pointing out that there would be difficulties—technical, administrative, commercial, military and scientific—in carrying out this proposal. The Italian Government had not succeeded in their experiments until one single system had been adopted throughout—viz., the Marconi system of 1901. He thought it would not be to the public interest to adopt the proposal and that it would be better to choose temporarily one single system throughout—Mr. Marconi's, or a better one if it could be found.

The other Italian delegates did not hold such extreme views on this point, but they nevertheless desired an alteration in this clause by the addition of the sentence added in the "declaration" of the Italian delegates above

Seeing that the Italian Government is bound by an agreement to employ none but Marconi apparatus, their arguments did not carry much weight. Questioned by M. Bordelongue, Commander Carderelli said that he would propose that the "recognised guarantee of good working . . ." suggested should be judged by an international commission, which M. Bordelongue considered a useless complication. The precise terms of the agreement between the Italian Government and Mr. Marconi were not disclosed, although it was alluded to frequently during the debates. It appears, however, that the Italian Government is bound not only to employ none but Marconi apparatus for wireless telegraphy for a number of years, but also to maintain strict secrecy in regard to details of the equipment of its stations. This naturally makes more difficult any arrangement for unimpeded intercommunication between the ship and shore stations of other nations and those of Italy. A mysterious announcement was made that "to do homage to the invitation of the German Government [to take part in the Conference], a clause reserving to the Italian Government the right to demand modifications in certain cases was inserted in the contract," but later on it was revealed that this clause does not modify the contract in any essential way. It simply provides that the Italian Government reserves itself the right to modify the contract in some points, but only on condition that these modifications are accepted by Mr. Marconi himself!

The objections of the British delegates to Article I. have already been indicated by Mr. Lamb's preliminary statement, but they are made clearer by his subsequent announcements:—

Other countries are, for the most part, in a position to refuse any concession for working wireless telegraphy, or not to grant such concessions except with the reserve that the concessionaires shall submit to any regulations which may be adopted subsequently by the State; but in our country companies may establish installations without the necessity of submitting to any condition. In consequence, we must consider very seriously any application which could restrain the working of a company already in possession of a number of installations. . . . . Hitherto perfect liberty has been enjoyed to organise a service free of any restriction on the part of the Government, following the methods of commercial competition, and it is now proposed to restrain this liberty by imposing upon the undertakers the obligation to exchange communications with competing installations which have perhaps not attained the same level of development. . . . . It seems to us that one could reasonably insist that every station, as far as possible from the technical point of view, shall exchange communications with ships in distress or with warships of every nation without any regard to the system employed; but, so far as the ordinary service with ships of commerce is concerned, it seems to us equitable that if an obligation is imposed, this should only be done under the condition of safeguarding the legitimate interests of the company in question by means of a special indemnity—for instance, a higher charge for all communications exchanged with a ship provided with an installation on a different system.

Gen. A. W. GREELY (United States) asked if wireless telegraphy is not bound by the laws relating to "common carrier," as the cable companies.

Mr. LAMB replied that, outside the territorial limits, there is no Government monopoly in England. Conditions are imposed on telegraph companies which compel them to accept messages from everybody, because these companies are under the necessity of asking permission to land their cables.

M. BORDELONGUE (France) said that Mr. Lamb's point of view with regard to the existing wireless telegraph companies in England had already been raised in that country with regard to the cable companies. Nevertheless, these companies had been made to observe the rules of the Telegraphic Union. It was even notorious that, in the case of those which had not explicitly adhered to the Telegraphic Union, the Post Office merely awaited the expiration of the present concessions to impose upon them the obligation of such adhesion. What would justify their giving to the wireless telegraph companies—the working of which was at the present moment in such an embryonic state that in reality it did not exist as a public service—more favourable treatment than that accorded to the cable companies? All that they asked was that the Marconi Company, which was the only company to which Mr. Lamb alluded, should be obliged as the cable companies to receive messages from everyone. Moreover, if this question arose, it was solely because this company had signified its intention of refusing telegrams which were not transmitted by its own apparatus. It might be that in this case the Marconi Company feared competition with regard to the apparatus itself, and that it tried to safeguard, not the telegraph system hardly yet constituted, but to compel the use of a single type of apparatus.

Both at this point and at a later stage of the proceedings, when the question of indemnifying a company for having its partial monopoly removed was discussed, this distinction between makers of the instruments and companies working a wireless telegraph system was alluded to. The president (Mr. Sydow, Germany) maintained that no indemnity could be expected by a company working a system, for its operations would be extended if all systems of all nationalities were made free to communicate with one another; while, so far as the manufacture and use of particular instruments was concerned, the owners of these would be able to make their profit or maintain their superior position by their patents. Lieut. Solari (Italy) spoke at great length on the claims of Marconi as an inventor, but the majority of the delegates were of a decided opinion that no indemnity was necessary either in law or equity. Mr. Lamb (Great Britain), while disclaiming any obligation for his country to pay an indemnity properly so-called, considered that a company already at work might possibly be granted some compensation in the form of an extra charge to be levied for messages which it received or transmitted, but this suggestion did not meet with universal approval either. On this matter, and on the question of fixing of charges generally and the apportioning of receipts, there was considerable difference of opinion between the British and Italian delegates on the one side and the remaining foreign delegates on the other; finally § 4 of Article I. was agreed upon, and the framing of a more definite regulation deferred until the next Conference. France, Russia, United States, Spain, Hungary and Germany were of opinion that the maximum charge should be fixed at the next Conference, to prevent the imposition of an excessively high tariff in any case. Gen. Greely (United States) in signing the protocol pointed out, however, that according to the existing law of his country telegraphic tariffs need not be submitted for the approval of the Government.

Article I., § 2, of the original proposals gave rise to a semi-technical discussion before it finally resolved itself into § 3 of the first article of the protocol. A discussion arose as to whether any apparatus existed for measuring the length of electric waves.

Dr. STRECKER (Germany) offered precise descriptions of such apparatus. He also explained the difference between syntony and selective devices, calling the latter "mechanical syntony." He suggested that the information to be published concerning each station should be the wave-length, other elements of syntonisation, if there were any, the system with which the station is provided, and the maximum range. The wave-length should be according to fixed standards—*e.g.*, 100, 200, 300, 400 metres, or 150, 250 350, 450 metres.

No one was very clear, however, as to the meaning of the term "subtle syntonisation" referred to in the "supplementary questions" attached to the draft proposals. The Italian delegates could not promise to publish any particulars as to the technical arrangements of their wireless telegraph stations, owing to the agreement with Mr. Marconi already alluded to. Lieut. Solari stated that the date of this agreement was February 16, 1903, but the agreement as to secrecy had been made in a letter on February 8, 1901.

Mr. GAVEY (Great Britain) differentiated between non-syntonised, partly syntonised and absolutely syntonised stations, the latter, in his opinion, being the stations with "subtle syntonisation." The third category need not be considered. For non-syntonised stations all that was required to be known was the fact that they were not syntonised, and the ordinary range (not the maximum). For partially syntonised stations: the wave length, the ordinary range and the technical particulars necessary to syntonise the receivers. In the interest of the inventors, a more detailed publication should not be given.

The PRESIDENT associated himself with Mr. Gavey's views.

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After this point had been discussed, the President invited the delegates to make statements with regard to the law of their countries in relation to wireless telegraphy.

Mr. BORDELONGUE (France) said that in France wireless telegraphy was a State monopoly, and the Government was in a position to impose such conditions as it might judge useful.

Mr. WACHENFELD (Germany) said that in Germany the telegraph monopoly applied equally to the establishment of radiographic stations. The telegraph law, however, provided for certain exceptions of lesser importance, for instance, in favour of a transport service, and it would possibly be necessary to remove these exceptions for radiographic transmission. With this object a special law was in preparation.

Mr. von STIBRAL (Austria) said that the Austrian law gave the State a monopoly in wireless telegraphy.

Mr. WATERBURY, on behalf of the United States delegates, said that the power of the United States to impose conditions upon the operation of any wireless telegraph system which conveyed messages to or from the United States was absolute. Such transmission had been repeatedly held by the Supreme Court of the United States to be commerce, and, therefore, within the plenary and paramount authority of the Federal Government to regulate, whether such commerce were foreign or inter-state.

Capt. SALEWSKY (Russia) said that in Russia wireless telegraphy was a State monopoly and the Government would not allow any private company to work such a service.

Major I. C. y JUANA (Spain) said that the law in Spain secured only to the Administration of Telegraphs the working of its telegraphic lines. The Spanish Government was quite at liberty to impose on any wireless telegraph companies such charges and conditions as it should consider best, and it had made no convention on this subject with anybody.

Mr. J. HOLLÓS (Hungary) said that in his country wireless telegraph y was also a State monopoly. There was, however, an exception with regard to installations which were not fixtures, but this exception was of less importance for wireless telegraphy, as another regulation prescribed generally that no installation of this nature could be allowed to disturb other telegraphic services.

Mr. J. C. LAMB (England) repeated his former declaration, to the effect that radio-telegraphy is a State monopoly in England, but only so far as the communications do not pass the boundaries of the Kingdom.

(To be concluded.)

Tehran Mar 16, 1904

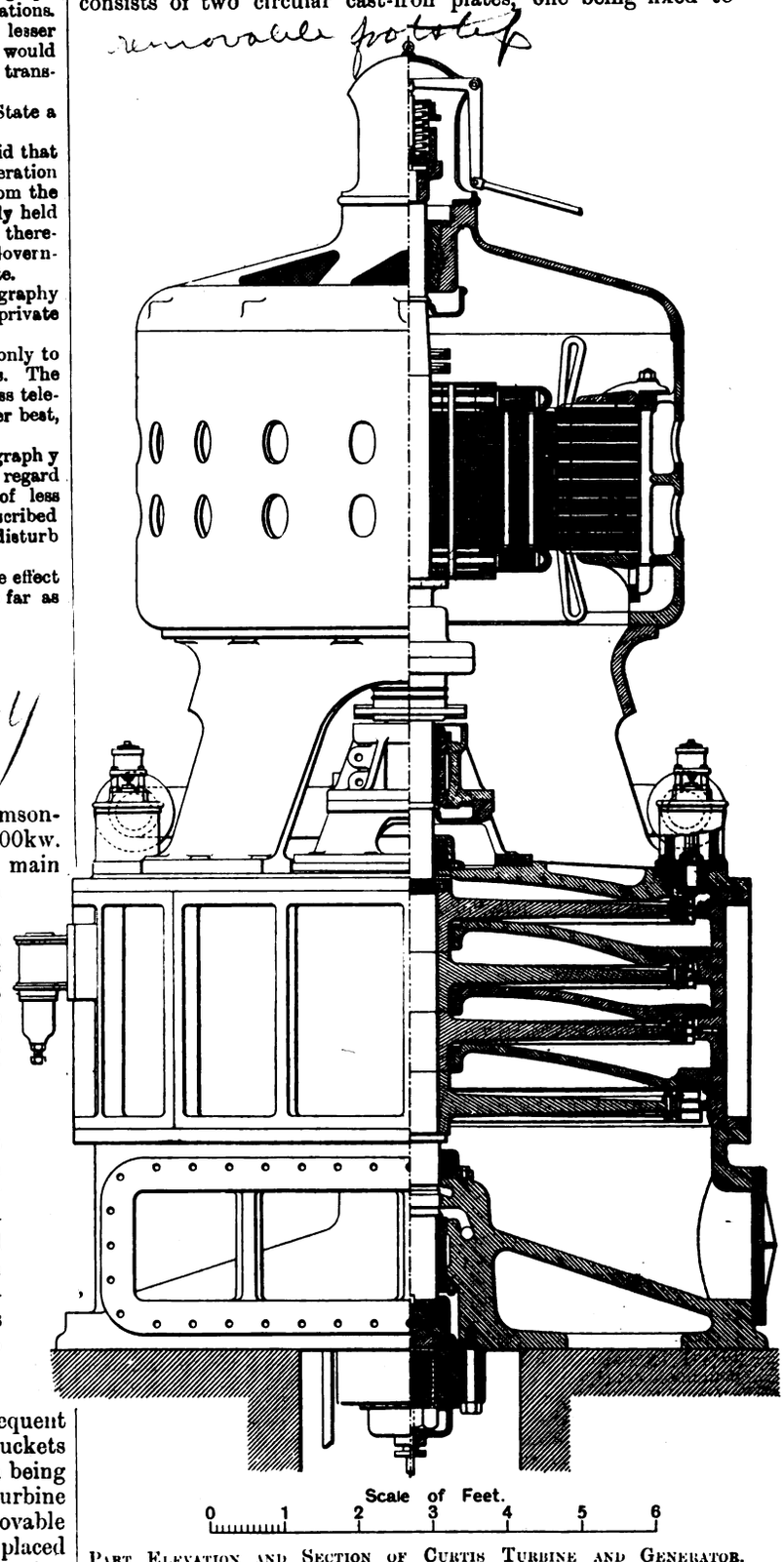
THE CURTIS STEAM TURBINE.

We are enabled, by the courtesy of the British Thomson-Houston Co., to publish a detailed drawing of a 1,500kw. Curtis turbine, together with a description of its main features. The illustration represents a section through the wheel chamber and bearings.

The general features of the Curtis turbine may be briefly described as follows:—Velocity is imparted to the steam in an expanding nozzle, so designed as to convert effectively into kinetic energy the expansive form of the steam between the pressure limits used. After leaving the nozzle, the steam passes successively through two or more lines of buckets on the moving element, which are placed alternately with reversed buckets on the stationary part of the turbine. Thus, the steam is thrown first against the first set of buckets on the moving element, and then re-directed against the second moving set of buckets by passing through the first set of the fixed buckets, rebounding alternately from stationary to movable buckets until the steam is brought to rest. By this means a high steam velocity is made to impart motion efficiently to a comparatively slowly moving element. The nozzle is generally made up of many sections or units adjacent to each other, so that the steam passes to the buckets in a broad belt when all the sections are open.

This process of expansion in the nozzle and subsequent abstraction of velocity by successive impacts against the buckets is generally repeated two or more times, each repetition being generally designated as a "stage." The 1,500kw. turbine shown in Fig. 1 has four stages, with two rows of movable buckets in each stage. A steam-tight diaphragm is placed between adjacent stages, the only outlet for the steam passing to the next stage being through the nozzles in the diaphragm. The leakages in the buckets are, therefore, not total losses except in the last stage, as the steam has to pass through the nozzle in the succeeding diaphragm and do further work.

One of the boldest and most noticeable features in the Curtis turbine is the vertical shaft. This type of construction has been adopted for all sizes from 500kw. upwards, and experience has thoroughly justified its use and demonstrated its desirability. The use of a vertical shaft necessitates a footstep bearing, which is fixed to the bottom of the base, and removable from below, a pit or opening being provided in the foundation for this purpose. The bearing part proper, which supports the rotating elements of the turbine and generator, consists of two circular cast-iron plates, one being fixed to



PART ELEVATION AND SECTION OF CURTIS TURBINE AND GENERATOR, 1,500KW., 1,000 REVS. PER MIN., 11,000 VOLTS, 50~. SCALE: 1:30.

and rotating with the shaft, the other being fixed to the base. Through a hole in the stationary plate oil is forced between the plates, from the centre outwards, in a thin film separating the two plates by about 0·005in. From the footstep bearing, the oil passes upwards and lubricates the guide bearing, which is placed immediately above it.

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The oil is forced between the plates by a pressure pump designed to give, approximately, a constant pressure and a constant flow. The pressure required depends upon the weight of the rotating part and the area of the bearing blocks, and in a small degree on the temperature of the oil. The thrust of the steam jet on the bucket is not noticeable, as the pressure required is exactly the same whether the turbine stands still or rotates. The oil pressure in the step bearing is 350lb. per square inch in the 1,500kw. turbine, and the amount of oil required for the bearings per minute is 2 gallons. A small amount of this oil is passed through a reducing nozzle, and delivered to a tank placed above the level of the turbine, and oil flows by gravity from this tank to the upper and middle bearings, a slight feed arrangement being introduced in each branch. The oil from all three bearings is returned to a common tank, where it is strained and cooled before being put in circulation again. To prevent the turbine being run either by steam or through the generator acting as a motor before oil begins to flow in the step bearing, or in case the flow should cease while the turbine is working, an automatic oil flow switch is placed in the high-pressure oil supply pipe. This switch is actuated by the oil pressure, and opens and closes the electric circuit for the valve magnets in response to the change of pressures in the pipe. If the flow of oil in the bearing falls below the predetermined quantity or pressure, the switch opens the valve circuit, and all the valves close, immediately shutting off the steam from the turbine. When the switch opens a special relay is closed which trips the generator circuit breaker and prevents the generator from running as a motor and driving the turbine. The upper and middle bearings of the vertical shaft have no load to carry save that due to want of balance and to unbalanced magnetic pull in the generator. In an installation of steam turbines the oil pumps are provided in duplicate, and connected so that should one pump fail the other automatically replaces it.

All the bearings can be taken out without disturbing the turbine and generator. The foot-step blocks and the guide bearing are lowered into the pit below, the middle bearing is split and can be removed sideways, and the upper bearing is lifted out, it being necessary to first remove the governor. As the step bearing works under atmospheric pressure, it is necessary to provide a packing round the shaft at this point to prevent air entering the exhaust base when the turbine is working under vacuum, or steam escaping when the shell pressure in the turbine is higher than the atmospheric pressure. For the same reason, packing is provided where the upper end of the shaft passes through the turbine cover. The clearance between stationary and rotating parts is about 0·05in. in the 1,500kw. turbine. This is the clearance between the outer shrouding of the buckets and the rings of metal from which the buckets are cut, which present broad smooth surfaces to one another. The buckets are made a little narrower than the rings, so that they cannot possibly come into contact with each other. Adjustment of the clearance is made by means of a heavy screw bolt at the bottom of the step bearing which supports the foot step blocks. Inspection holes are provided in the casing, so that the clearances between the buckets can be readily seen.

The governor is of the centrifugal spring loaded type, and is generally set for a speed regulation of 2 per cent. between full and no load with a maximum momentary variation of 4 per cent. For the purpose of synchronising, and to make the turbine take its proportional share of the load, a supplementary spring is introduced which acts in conjunction with the main governor spring and allows the speed of the turbine to be varied 2½ per cent. on each side of the normal speed. In the 1,500kw. turbine, this adjustment is made by a small motor which actuates the spring. The motor is controlled by a double-pole double-throw switch placed on the switchboard or at any other convenient position. The governor operates a controller opening or closing the electrical circuits of magnets which operate pilot valves, these in turn admitting steam or exhausting it from the spaces behind the pistons of the main valves, one of which is provided for each nozzle or group of nozzles; the governor thus opens and closes these valves and varies the number of nozzles in service in proportion to the load. Since each nozzle represents a comparatively large proportion of the whole power at light loads, one of these valves would be called upon to open and close alternately in rapid succession in order to keep the speed constant. To avoid this a balanced throttle valve is placed in series in the steam path of the first valve and corresponding nozzle, and so connected to the governor that it must be fully opened before the governor can open the next valve and again fully closed before the controller moves backwards and closes the valve last opened. The result is that the turbine can run at a constant speed at any load, although only a small part of the whole steam throw is throttled. Thus the disadvantages of admitting steam in puffs, with the consequent tendencies to variation in speed at light loads making the parallel running of the generators difficult, or of throttling the whole steam throw, are avoided.

A sufficient number of nozzles are provided in the first stage to run the turbine at full load non-condensing. Hence the turbine has an overload capacity of about 100 per cent. when operating condensing with a 28in. vacuum. In addition to the speed-regulating governor, which will always hold the no-load speed of the turbine within about 2 per cent. of the full-load speed, an emergency governor is provided, whose function is to trip a trigger should the speed of the turbine increase 15 per cent. above normal, and thus permit a weight to fall and give a hammer blow to a butterfly or damper valve in the main steam pipe, closing the valve instantaneously. This governor is located on the shaft between the turbine and the generator, and consists of an ordinary centrifugal device balanced against a spring. The governor restores itself to normal position when the speed is reduced to normal, so that it is not necessary to stop the turbine, but the butterfly valve and weight must be brought to their normal position by hand. Such a precautionary device is rarely called upon to act, but experience with large engines has shown it to be desirable.

All the vertical turbines are so designed that the exhaust base on which the turbine stands can be substituted for a condenser base. Placing the condenser directly under the turbine makes a very compact and efficient arrangement. Its simplicity and economy in floor space and foundations are at once evident. A better vacuum is obtained due to reduction in air leakages and to the shorter and more direct path of the exhaust steam. It is safe to prophesy that most of the future turbines installed will be of the condenser base type. The condensing types of the Curtis turbines are designed for a normal steam pressure of 150lb. and a vacuum of 28in., or 93¼ per cent. of the barometric pressure. The steam pressure may be varied about 15 per cent. from normal without affecting the economy much. With the lower pressures, however, the overload must be reduced as each nozzle discharges a fixed quantity of steam depending upon the pressure. As already indicated, the overload capacity is about 100 per cent., so that a reduction here of 15 to 20 per cent. of the turbine's capacity is not of very great importance, as long as the generators are designed for an overload of only 50 per cent. Any considerable excess of the normal pressure does not tend towards economical working, as the ratio of expansion of the nozzles is then too small to render available the additional energy due to the higher pressure, so that in general, when the pressures vary more than 15 per cent. from the normal, the designs of the turbine will have to be adapted to suit the pressure. The high economy of turbines in general must be to a great extent attributed to the very high degree of expansion of the steam which can be effectively obtained and utilised in the turbine. In ordinary steam engines, a high degree of expansion is practically impossible. As the exhaust pressure approaches a perfect vacuum, the volume of the steam increases very rapidly, being twice as great at 29in. vacuum as at 28in. To handle higher degrees of vacuum in an engine, it would, therefore, be necessary to make the cylinders very large, and this increase in size and weight of parts, as well as the increased frictional losses, fixes a practicable limit which cannot be passed without excessive cost and complication. In the turbine, the highest degrees of steam expansion are easily provided for, and consequently a much larger proportion of the total energy in the steam can be utilised by the turbine than by the reciprocating engines;

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 132.)

The most instructive property of a charged particle moving with great velocity is its power of being deviated out of a straight line by the action of electric and of magnetic forces, since, by a study of these deviations, we can arrive at the determination of the velocity of the particle and of the ratio e/m of the charge of the particle to its mass.

These considerations are of great importance in radio-activity, for by aid of them knowledge has been obtained of the mass and velocity of the projected particles from radio-active substances.

If the charged particle is projected with uniform velocity at right angles to the lines of magnetic force, no electrical forces acting, its path is changed to that of a circle whose radius of curvature, ρ, is given by

$$\rho = \frac{mv}{He},$$

where m is the mass of the ion, e its charge, and H the magnetic force. This enables us to determine the value of e/mv. If an electrostatic force is made to act simultaneously on the moving ion, so that the lines of electric force are at right angles to the lines of magnetic force and at right angles also to the direction of motion of the ion, the electric force can be made either to neutralise or assist the deviation produced by the magnetic force according as the sign of the P.D. is in the one direction or in the other. If it is adjusted so as to oppose the magnetic deviation, a point can be reached, by the suitable variation of one of the forces, the other remaining constant, at which the projected particle is not deviated. At this point the force Fe,

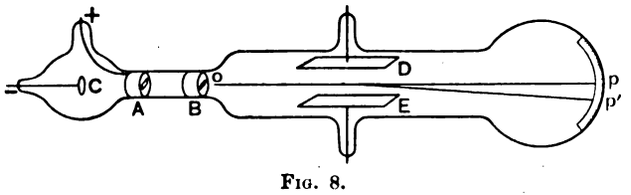

Fig. 8.

where F is the electric force and e the charge on the ion, is balanced by the force Hev. $Fe = Hev$. Therefore, $v = F/H$, and the velocity of the ion can be determined. If v is known the ratio e/m can also be determined from the ratio e/mv.

In this way Prof. Thomson, in 1897, succeeded in determining the value of e/m and of v for the negatively charged particle which constitutes the cathode ray of the Crookes tube. The apparatus used is shown in Fig. 8. Cathode rays starting from C are projected through the diaphragms A, B, which consists of fine horizontal slits in metal discs; they then pass between the two horizontal plates E, D, maintained at a constant P.D., and fall upon the phosphorescent screen at the end of the tube. The vacuum in the tube must be of the highest, or otherwise the ionised gas, being a conductor, screens the rays from the action of the electrostatic field ED. The value e/mv was determined by measuring the deviation of the spot of light on the screen pp under the action of a known magnetic field. An electric field of known intensity is then applied at ED, so as to bring back the spot of light to its original position, and the value of v and of e/m thus found. Prof. Thomson obtained $v = 2{\cdot}8 \times 10^9$ cm. per second and $e/m = 7{\cdot}7 \times 10^6$ as the mean result of his determinations. The velocity of light is about 3×10^{10} cm. per second, so that the cathode rays consist of streams of particles travelling with one-tenth of the velocity of light. From the direction of the deviation it follows that the particles must be negatively charged. The value e/m for the hydrogen ion in electrolysis is only 10^4, so that the value for the cathode ray particle is 770 times greater than for the hydrogen ion. This value was found to be independent of the nature of the gas in the tube, although a wide range of gases, represented by the extremes of hydrogen and methyl iodide, was experimented on, and it has been proved to be the same whatever the nature of the metal of which the cathode is made. Lenard investigated the values of v and e/m for the rays from an exhausted tube that escaped through a window of very thin aluminium foil, and found that while e/m was in good agreement with Thomson's value the value of v was much higher—viz., 7×10^9, indicating that the aluminium foil had sorted out the more rapidly moving particles, but that the value e/m was independent of the velocity.

The theoretical reasoning on which these determinations are based has been confirmed in the most brilliant manner by the direct determination of v by Wiechert (*Wied. Ann.* 1899, p. 739). The principle of the method was to send a Leyden-jar discharge through two circuits at different positions along the tube through which the cathode rays passed. The Leyden-jar discharge consists of very rapidly alternating currents whose frequency can be accurately determined. If the distance between the two circuits is so arranged that the cathode ray takes the time of a complete oscillation to traverse it, the deflection produced by the first circuit will be augmented by the second circuit. If, however, the distance is so arranged that by the time the cathode ray leaves the first circuit to the time it reaches the second circuit only half a period of oscillation has elapsed, then the deflections produced will neutralise one another, and the path of the ray will appear straight. The value of v found by Wiechert in this way was, for one experiment, 5×10^9. From the magnetic deviation of the same rays, the value mv/e was determined, and combining this with the direct experimental value of v the value e/m = from $1{\cdot}5$ to $1{\cdot}0 \times 10^7$ was obtained. Considering the difficulty of the experiments, this value is in good agreement with the others, and supports the general argument in the strongest possible manner.

The case of the negative ions produced by the incidence of ultra-violet light on metals in vacuo is of especial interest as they resemble in their properties the cathode rays of the vacuum tube. The values of v and of e/m have been determined by Prof. Thomson (*Phil. Mag.*, 1899, p. 547) and by Lenard (*Drudes Annalen*, 1900, p. 359). The former found for e/m the value $7{\cdot}3 \times 10^6$, which is in very good agreement with the value for the cathode-ray particle—viz., $7{\cdot}7 \times 10^6$. Now, when ultra-violet light acts upon metals, especially, for example, a polished sheet of zinc, only negative ions are produced, so that the gas is rendered a conductor, but only in the one direction of the E.M.F. These negative ions have been very carefully studied, and they have been shown to be identical with the negative ions produced by other agencies (as, for example, the X-rays) in their coefficient of diffusion and their velocity under unit potential gradient and, therefore, in the value of e, the charge carried. Moreover, a direct determination of the value of e has been accomplished by Prof. Thomson by the condensation method, and found to be the same as that carried by the hydrogen ion in electrolysis. Yet this same ion, when the air is removed and it travels free from entanglement, then resembles the cathode ray in all its properties and is found to possess a value of e/m 700 times greater than that possessed by the hydrogen ion in electrolysis. The conclusion is thus reached that the negative ion, when it travels free, possesses a mass $\frac{1}{700}$th of the mass of the hydrogen atom. Since the value of e/m agrees for all negative ions for which it has been determined, it follows that this ion possesses an invariable mass about $\frac{1}{1000}$th of that possessed by the lightest atom known, and that negative electrification in high vacua, when but little ordinary matter is present, consists of an assemblage of discrete charges or "corpuscles" of far smaller size than anything before observed.

The presence of positive ions in the electric discharge in vacuo is manifested in a type of radiation discovered by Goldstein, called by him "Canalstrahlen" (Canal Rays), but which may be termed the positive rays. They are deflected by electric and magnetic fields in the opposite sense to the deflection produced in the path of the cathode rays, but only with very much greater difficulty. Wein showed the value of e/m for these rays to be 3×10^3, while $v = 3{\cdot}6 \times 10^7$ cm. per second. The subject has

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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since been investigated by J. J. Thomson for the positive ions emitted from heated wires in vacuo, and he found a similar value, $e/m = 4 \times 10^2$. Thus this value is only about $\frac{1}{30000}$th part of that shown by the negative ion, and is of the same order as in the case of electrolysis for heavy ions like those of oxygen or the metals. Since the value e/m of the positive ion has never been observed to be greater than that observed for the hydrogen ion in electrolysis, it follows that the positive ion, unlike the negative, is never dissociated from the atom which carries it. On this view Prof. Thomson has developed the "corpuscular theory of electricity" which supposes that the negative charges are discrete particles or *corpuscles* (called *electrons* by other investigators), and that the absence of one of these corpuscles from the atom of matter produces the positive ion.

Prof. Thomson as early as 1881 showed mathematically that an electric charge concentrated on a sphere of sufficiently minute radius, would possess inertia or mass by virtue of the electromagnetic field of force it creates in the surrounding ether. One of the consequences of this is that the speed of the charge cannot exceed a certain limited value, represented by the velocity of light, because at this value the inertia, and therefore the mass, of the particle would be infinite. For values of v below one-half the velocity of light m is approximately constant, but above that speed the mass increases rapidly. Sir Oliver Lodge (*Nature*, June 11, 1903, p. 129) has given some calculations of the ratio of the mass m_0 for slow motions to the mass m when the velocity of light is approached. At half the speed of light $m = 1{\cdot}12m_0$; at three-quarters $m = 1{\cdot}37m_0$; at nine-tenths $m = 1{\cdot}8m_0$; when the speed is 99 per cent. of that of light $m = 3{\cdot}28m_0$, for 99·9 per cent. $m = 5m_0$, whereas between this last value and that of light the mass increases to infinity. It is to be remarked how nearly the velocity of light must be approached before the action becomes pronounced. How far these calculations possess a real meaning I am not in a position to say; but one of the most remarkable facts of radio-activity has been the discovery that radium projects negative corpuscles, whose speed falls within the limits between which an increase of mass is to be theoretically expected, *if this mass is electrical in origin*. This increase has been looked for and found by Kaufmann and we shall have to consider his work when the rays from radium are studied.

It will be seen that the tendency of these developments has been to replace the attributes of matter by those of electricity, and to look upon the atom as a very complex system made up of much smaller units of electricity, or corpuscles. If one excludes the minute and unexplained effect of gravitation, which is only so prominent to us on account of the nearness of the overwhelming mass of the earth, the main attribute of matter is inertia. If the corpuscles possess inertia equal to one thousanth of the mass of the hydrogen atom, it follows that an assembleage of a thousand corpuscles might represent in inertia and other properties the hydrogen atom as we know it. This point of view at once accounts for the behaviour of matter towards X-rays, cathode rays and the rays from radio-active substances. For if the corpuscle rather than the chemical atom were incidental in causing the absorption, the latter would depend on the number of the corpuscles in the path of the ray, and would be independent of the nature of the complexes—chemical atoms or molecules—into which these corpuscles were grouped. This view of the constitution of matter is, of course, far from established, and mainly doubtful points require further elucidation. These cannot be here considered, but the nature of positive as opposed to negative electrification may be mentioned as one of the most fundamental. However, our knowledge of the internal structure of the chemical atom has been advanced so far by these researches on the electrical properties of gases by a similar movement that has been proceeding in spectroscopy; and, lastly, by the discoveries in radio-activity we are shortly to consider, that unless one prefers to be entirely without hypothesis, such theory as the above is necessary to assist the mind in forming concrete mental pictures of the various relations between matter and electricity.

(*To be continued.*)

PRODUCTION OF IRON AND STEEL IN THE ELECTRIC FURNACE.*

BY DR. H. GOLDSCHMIDT.

The following are some particulars and figures relating to the manufacture of iron and steel in electric furnaces of different inventors. The dates quoted in Table I. merely refer to the time of the appearance of publications or patent specifications bearing on the subject. In this connection I should like to mention that Dr. Héroult has made me a definite statement to the effect that he delivered his first car load of steel, consisting of bars weighing 400kg. each, and amounting in all to 8,890kg., to Messrs. Schneider & Co., Creusot, as far back as December 28, 1900. This metal had been produced in the electrical furnace of Froges. Further particulars as to the process employed by him may be gleaned from the patent specifications, which, however, do not contain very many details. But I am able to give a very complete account of the process of the Italian captain, Stassano, since—two years ago—I was requested by the German Patent Office to inspect Mr. Stassano's works in Darfo, near the Lago d'Isco, and to report in particular if the commercial production of soft iron (with less than 0·2 per cent. carbon) directly from the ores had been accomplished. This, I may remark at the outset, is actually the case. Stassano employs the very pure ores that are to be found in the north of Italy, and which have so far been very little utilised. He is favoured, too, by the cheap water power available in those districts. A comparison between the ordinary methods and the electric process gives the following figures:—Coal,

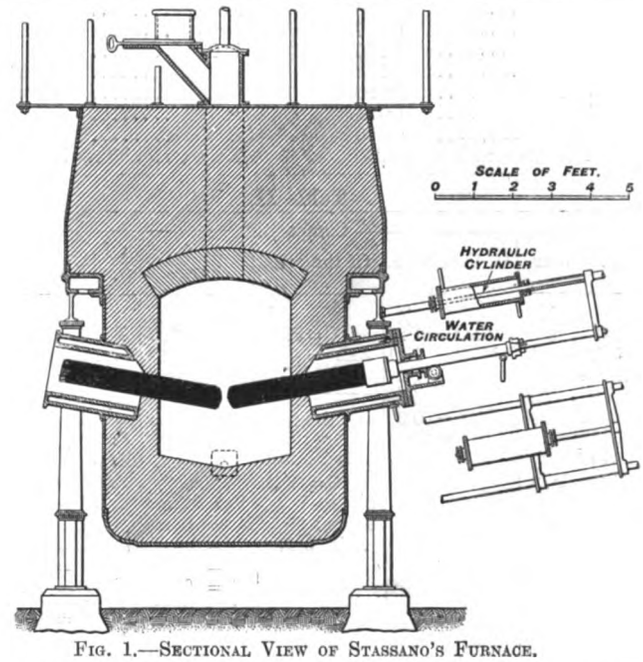

FIG. 1.—SECTIONAL VIEW OF STASSANO'S FURNACE.

7,500 calories, and, if the efficiency be taken as 20 per cent., 1,500 calories. One H.P.-hour corresponds to 635·3 calories, or, with an efficiency of 80 per cent., 508·24 calories. This means that, with the efficiencies given, the heat produced by 1kg. of coal equals that equivalent to 3 H.P.-hours. Cost of installation per electric horse-power, £12; annual costs—10 per cent. for interest and depreciation, £1. 4s., maintenance, 8s. = £1. 12s. Cost of 1 H.P.-hour, on the basis of 7,000 working hours per annum, therefore 0·055d. Fig. 1 is a diagrammatic sketch of the Stassano furnace. The heating of the charge is effected solely by radiation, the arc being produced by an alternating current of 2,000 amperes at a pressure of 170 volts. After the furnace has been in operation for some time and has attained a constant temperature, the arc has a length of nearly 1 metre and emits a loud rattling noise. Great care is bestowed by Stassano on the composition of his charges, so as to obtain complete reduction and a maximum of production (see Table II.). The ores are mixed with charcoal and fluxes in appropriate quantities, and, in order to maintain the uniformity of the mixture, the compound is worked into briquettes with tar as binding material. It appears likely, however, that this precaution may be omitted without interfering with the satisfactory working of the process. In order to obtain a fluid slag and especially to flux the silica, which forms part of the gangue, Stassano endeavours to obtain a slag of the form $SiO_2 + 4$(base). He takes into account the bases already contained in the ore, such as magnesia, lime, alumina and manganese oxide, which he supplements by adding carbonate of lime.

Stassano possesses also a smaller furnace in Darfo, working with 1,000 amperes at 80 volts and used chiefly for experimental purposes.

* Abstract from the *Zeitschrift für Elektrochemie*.

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Table I.—*Various Processes for Producing Steel in the Electric Furnace.*

Name.	Year.	Type of furnace.	Charge consists of:	Energy required per ton of steel (H.P.-hours).	Costs of production per ton of steel.
Gin-Leleux.....	1897	Furnace with carbon electrodes	Cast iron and scrap iron	..	..
Stassano.....	1898	Furnace with carbon electrodes, 500 H.P. ..	Italian ores with a high percentage of metal	3,800 to 4,000	75s.
Gysinge*	1900	Furnace without carbon electrodes, 225 H.P.	Cast iron and wrought iron..	1,320	172s.
Froges-Héroult ..	1901	Furnace with carbon electrodes, 400 H.P. ..	Cast iron and scrap iron	1,200	..
Keller	1901	Furnace with carbon electrodes, 1,200 H.P.	Iron ores and cast iron	3,800	72s.—80s.
Harmet	1901	Furnace with carbon electrodes	Iron ores	3,600	24s. (not total costs)
Schneider	1901	Furnace without carbon electrodes.....	....	..	..
Ruthenberg	1901	Furnace with carbon electrodes	Iron ores	..	..
Conley	1902	Furnace with carbon electrodes	Iron ores	1,000	48s.
			Cast and scrap iron	1,042	114s.

* Quality of crucible steel.

Chemical Compositions of Italian Ores.

Magnetite.	Per cent.	Red Hæmatite.	Per cent.
Fe_3O_4	78·400	Fe_2O_3	88·850
MnO	0·700	MnO	0·470
SiO_2	8·650	SiO_2	2·960
Al_2O_2	7·330	Al_2O_3	3·420
CaO	2·100	CaO	0·870
MgO	1·030	S	0·078
S	0·055	P	0·093
P	0·008	Loss on ignition	2·561
Limonite.		**Limonite.**	
Fe_2O_3	80·930	Fe_2O_3	73·840
MnO	0·567	MnO	0·567
SiO_2	1·970	SiO_2	1·970
Al_2O_3	2·152	Al_2O_3	2·152
CaO	0·590	CaO	0·590
P	0·124	P	0·124
S	0·070	S	0·070
Loss on ignition	12·630	Loss on ignition	15·550

Table II.

Composition				
Of the ores.	Of the fluxes.	Of the coal.	Of the charge.	Of the charge for every 100kg. of ores.
%	%	%	kg.	kg.
Fe_2O_3 = 93·02	CaO = 51·21	C = 90·42	Ores 100	Fe_2O_3 = 93·02
MnO = 0·619	MgO = 3·11	Ash = 3·88	coal 23	MnO = 0·619
SiO_2 = 3·79	Al_2O_3 / Fe_2O_3 = 0·5	H_2O = 5·70	fluxes 12·5	SiO_2 = 3·79
S = 0·058				S = 0·058
P = 0·056	SiO_2 = 0·9	Of the tar	Of the iron produced.	P = 0·056
CaO / MgO = 0·5	CO_2 = 43·43	%		CaO / MgO = 0·5
H_2O = 1·72		C = 59·2	%	H_2O = 1·72
		Hydrocarbons 40·5	Fe = 99·764	C = 20·9
		Ash 0·27	Mn = 0·092	Ash = 0·892
			Si = trace	H_2O = 1·21
			S = 0·059	CaO = 6·401
			P = 0·009	MgO = 0·389
			C = 0·090	Al_2O_3 / Fe_2O_3 = 0·062
				SiO_2 = 1·125
				CO_2 = 5·429

(Ore. / Coal. / Fluxes.)

As basis for the calculations, the following figures, which refer to the calories required for the different chemical and physical changes, may be quoted:—

	Calories.
For the reduction of 1 gramme-molecule of Fe_2O_3	192·000
For the conversion of 1kg. of water of 100°C. into steam of the same temperature	637·000
For raising the temperature of 1kg. of steam at 100°C. by 1°C.	0·480
For calcining 1kg. of flux.....	425·000
For raising the temperature of 1 gramme-molecule of CO_2 1°C.	0·016
For raising the temperature of 1 gramme-molecule of CO 1°C.	0·0068
For fusing 1kg. of iron	350·000
For fusing 1kg. of slag	600·000
The combustion of 1kg. of C to CO generates	2175·000
Required for the decomposition of ferric oxide $\frac{92·02 \times 192}{0·16}$	111,552·000
For the evaporation of the water contained in the ore and coal (1·72+1·21) 637	1,866·41
Required to superheat the steam to 500°C. $2·93 \times 0·048 \times 400$	562·56
Required for calcining the flux $12·5 \times 425$	5,312·5
Required for raising the temperature of the CO_2 to 500°C. $\frac{5·429 \times 0·016 \times 500}{0·044}$	987·09
Required for heating the CO generated $\frac{20·9}{0·012} \times 0·0068 \times 500$ ..	5,921·667
Required for fusing the iron produced 65×350	22,775·2
Required for fusing the slag $13·89 \times 600$	8,334·0
Total	157,311·427
The oxidation of C to CO produces $20·9 \times 2,175$	45,457·500
Balance.....	111,853·927

Assuming an efficiency of 80 per cent., 111,853·927 calories correspond to $\frac{111,853·927}{635·3 \times 0·80} = 219·08$ H.P.-hours, or, since 65·114kg. of iron are produced, 1kg. of this metal corresponds to $\frac{219·08}{65·114} = 3·364$ H.P.-hours. Electric energy, at the rate of 0·055d. per horse-power hour, would, therefore, cost 15s. 5d. per ton of iron produced. An example of how the process is carried out in the small furnace is given in the following:—

Charge 70·25kg. { Iron ores 1,000. Limestone 125. Carbon 160. Other materials (tar, &c.) 120. } Produced 30·8kg. of wrought iron.

Charge contained (*a*) in the ores:—46·51kg. Fe_2O_3, 0·309kg. MnO, 1·895kg. SiO_2, 0·25kg. CaO + MgO, 0·86H_2O.

(*b*) In the fluxes 3·263kg. CaO, 0·194kg. MgO, 0·056kg. SiO_2, 0·031kg. $Al_2O_3 + Fe_2O_3$, 2,714kg. CO_2.

(*c*) In the coal 7·234kg. C, 0·310 ash, 0·456 H_2O.

(*d*) In the other materials (tar, &c.) 2·43kg. hydrocarbons, 0·016kg. ash.

Qualities and Quantities of the Materials.

	Charged.		Produced.
Fe	32,557·28gr.	.....	30,727·312gr.
Mn.....	239·745gr.	.....	28·336gr.
Si	910·448gr.	.....	trace.
S	29·000gr.	.....	15·172gr.
P	28·000gr.	.....	2·772gr.

At 8:15 the charging was commenced and the current was switched on. At 9:15 the charging was stopped, and at 10:15 the iron was tapped. The supply of current was regulated in such a manner that after 20 minutes its value was 800 amperes at 80 volts; after another 20 minutes the figures were 1,000 amperes and 100 volts; 30 minutes after this the current was reduced to 600 amperes, the voltage being 70. After another 30 minutes the current was diminished to 500 amperes, the supply pressure then being 50 volts, and finally, during the last 20 minutes, a current of 1,000 amperes at 100 volts was employed. The total energy consumed amounted to 7,290,000 volt-ampere-minutes, which is equivalent, taking a power-factor of cos $\phi = 0·8$, to 132·24 H.P.-hours.

Thermally, the final result is:—

	Calories.
Expended in the reduction of the Fe contained in the final product $\frac{30,727·312}{112} \times 192$	52,730·262
Expended in the reduction of the Mn contained in the final product $\frac{28·336}{55} \times 94·6$	48·719
Required for fusing the metal $30·8 \times 350$	10,780·000
Required for fusing the slag $6·3 \times 600$	3,780·000
Required for the conversion of the water to steam of 100°C. $1·316 \times 637$	838·292
Required for burning the lime $6·25 \times 475$	2,968·75
Required for superheating the steam to 500°C. $1·316 \times 400 \times 0·48$	252·672
Required for heating the CO_2 $2·714 \times 500 \times 0·016 \div 0·044$ ..	493·554
Required for heating hydrocarbons $2·43 \times 500 \times 0·27$	328·05
Required for heating the CO which is produced in the process of reduction of Fe and Mn $\left(3 \times \frac{30,727·312}{112} \times \frac{28·336}{55}\right) \times 500 \times 0·0068$.....	2,800·131
Total.....	75,000·330
From this total is to be deducted:— The heat produced by the oxidation of C to CO during the process $9·883 \times 2,175$	21,495,525
Balance	53,524·805

Since the heat introduced into the process was $132·24 \times 635·3$ calories = 84,012·072 calories, the thermal efficiency is, $\frac{53,524·805 \times 100}{84,012·072} = 61·33$ per cent.

As will be noticed from the actual example given, the input of heat was not constant throughout the time of operation, and

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Stassano intends to employ several furnaces side by side, each fitted with a number of pairs of carbons (about three), and to arrange the process in such a way that the cutting out of one pair of carbons in any one furnace occurs simultaneously with the switching on of a pair of carbons in another furnace, thereby utilising to the utmost the source of energy. At the present Stassano's process is being carried out in Turin on behalf of the Italian Government, the works in Darfo having been discontinued now for some time. According to the inventor, the costs of production of 1,000kg. of iron are as given below, it being postulated that the power available amounts to 5,000 H.P., that 30 tons of steel are produced per diem, and that the thermal efficiency is about 66⅔ per cent.:—

	s.	d.
1,600kg. of ores at 12s. per ton	19	2½
For pulverisation of same at 2s. 5d. per ton	3	10
200kg. flux at 4s. per ton	0	10
For 250kg. of coke at 36s. per ton	9	0
For the crushing of same at 1s. 7d. per ton	0	5
For 190kg. of other materials (tar, &c.) at 56s. per ton	10	8
For producing the mixtures, 2s. 5d. per ton	5	5
Wear of electrodes, 12kg.	2	10½
Maintenance of the furnace	9	7
Labour	4	9½
Accessories	2	5
For electric energy, 4,000 H.P.-hours at 0·055d. per H.P. hour	18	3
Other costs	2	4½
Total	89	8
Less the value of inflammable gases, 900 cubic metres at 0·192 per cubic metre	14	5
Actual expenditure	75	3

The item "Other Costs" appears to be underrated.

Let me, finally, give a few analyses of some grades of iron and steel produced in Stassano's furnace and examined in my laboratory in Essen:—

C = 0·04% Mn = 0·05%	C = 0·04% Mn = 0·12%	C = 0·17% Mn = 0·07% Si = trace P = 0·029% S = 0·05%
C = 0·09% Mn = 0·18% Si = trace	C = 0·77% Mn = 0·65% S = 0·04%	Chrome steel: C = 1·51% Mn = 0·26% Cr = 1·22%

As a rule, Stassano employs ores in his process, but he also uses pig iron and scrap; often, too, the charges are of a mixed nature, and quite correspond to those used in connection with the Martin process. Naturally, the power consumption is considerably reduced if only cast iron and scrap have to be melted in the steel process. Samples from Stassano's furnace are analogous to those obtained by the Martin process. To obtain a quality comparable to crucible steel Stassano's process would have to be further perfected, but there seems no reason why this improvement should not be obtained.

Another worker in this field is Conley, whose figures relating to the cost of production vary, of course, according to the charge being made up of ores or of raw metal. His figures for both cases are as follows:—

1. *Steel Production from Ores, 100 tons daily.*

Electric energy	£50 0
30 tons of coke at 8s. per ton	12 0
200 tons of ore, containing 65% of metal, at 14s. per ton	140 0
Repairs and maintenance	10 0
Labour	25 0
	£237 0

i.e., £2. 7s. 5d. per ton.

2. *Steel Production from Pig Iron and Scrap, 24 tons daily.*

Electric energy	£12 10
12 tons of wrought-iron at 112s. per ton	67 4
12 tons of cast-iron scrap at 64s. per ton	38 8
Repairs and maintenance	5 0
Labour	13 0
	£136 2

i.e., £5. 13s. 6d. per ton.

It does not appear that this process, so far, has been used practically to any extent.

Keller's process, recently expounded by the inventor before the Iron and Steel Institute of London, merits special mention. Contrary to Stassano, Keller (see *The Electrician*, Vol. LI., p. 283) divides his process into two parts when working with ores; he employs two furnaces, one on top of the other. In the first and top one the electrodes come into direct contact with the charge, and here it is where the raw iron is produced. In the lower furnace, then, this raw material is refined and decarbonised (if necessary, with the aid of an addition of ores, scrap iron and fluxes), and the electrodes are here not in direct contact with the metal to be refined. Similar is the process of Harmet, which, however, was subsequent to that of Héroult. Keller's figures as to cost of production do not differ much on the whole from those given by Stassano; his data regarding the amount of power required for the reduction from ores also coincides nearly with Stassano's data. All figures, however, are based on cheapness of ores and electric energy. For Germany different figures would have to be taken: Electric power would cost, even in the most advantageous cases, about three times as much as the figures quoted, and the ores could not well be bought for less than double the price which is put down in the tables reproduced above. In the case of Germany the costs of production per ton of steel would, therefore, amount to 150 to 170 marks (£7. 10s. to £8. 10s.), and it is apparent that the Martin process is much cheaper. Different conclusions might, however, be arrived at if the quality of the steel produced would be equivalent to that of crucible steel, the cost of production of which is, on the whole, hardly less than 300 marks (£15) per ton.

Mr. Héroult has informed me that he produces in his electric furnace a tool steel of the best quality from a mixture of cast iron and steel scrap. About 3 tons are smelted at a time, the electrodes being placed above the charge. An alternating current of 4,000 amperes at 60 volts is used for forming the arc. Several charges, it is said, can be dealt with daily. The composition of the refined steel is given by Mr. Héroult as follows:—

S = 0·007% Mn = 0·15% P = 0·003%.
Si = 0·003% C = 0·60 to 1·80%.

An ingenious process for producing crucible steel of the best quality is that invented by the Swede, Kjellin. As will be gathered from the sectional drawing (Fig. 2), the furnace constitutes a transformer, the secondary of which is formed by the charge itself, electrodes being totally avoided. Pure charcoal iron (about 25 per cent.) and soft iron are smelted together. This process was introduced into the Gysinge works as long ago as 1900, and, as is the case also with the invention of Héroult, it appears to be at present perfectly practicable technically, and extensions to the existing plant are contemplated. In the following are quoted some figures relating to the costs of production and based on data emanating from the works referred to:—

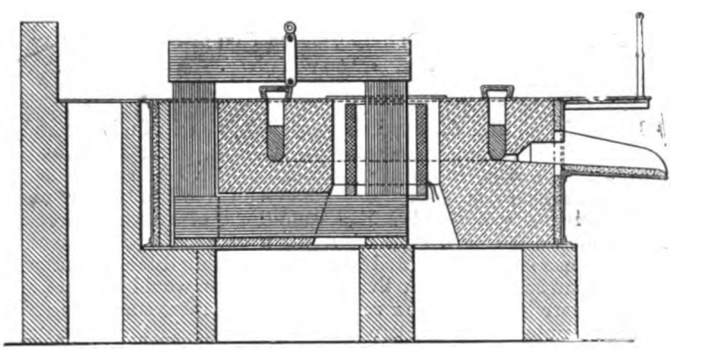

FIG. 2. SECTIONAL VIEW OF KJELLIN'S FURNA

4,100kg. of steel are produced in 24 hours with an expenditure of energy of 225 × 24 H.P.-hours; 1,000kg. require, therefore, 1,320 H.P.-hours. Expenditure in energy, assuming 1 H.P.-hour to cost 0·18d., gas engines	£1 0 0
Charge (pure charcoal cast iron and wrought iron)	6 10 0
Repairs and lining	0 9 8½
Depreciation and interest	0 2 3
Labour	0 10 0
Expenditure, excepting royalties, business charges, &c.	£8 11 6½

Especially pure charcoal iron, as also the addition of such metals as chromium, tungsten or molybdenum would increase the cost of the charge not inconsiderably. A special feature of the process is that furnace gases do not come into contact with the steel. Another advantage is that the receptacles may be lined with either acid or basic bricks, and that the charges are not confined to small quantities (30kg. to 50kg.) at a time. In Gysinge, in fact, about 1 ton is smelted per charge. According to information received from these works, the initial cost of an installation of the size indicated in the table given amounts to 15,000 kronen (£832). The following table contains some analyses obtained in Gysinge:—

	I. (%)	II. (%)	III. (%)
Carbon	1·45	1·20	0·95
Silicium	0·47	0·74	0·35
Mangan	0 49	0·46	0·33
Phosphorus	0·011	0·013	0·014
Sulphur	0·010	0·010	0·015

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CANDLE-POWER TESTS OF WELSBACH BURNERS.*

Below is an abtract of that part of the fourth progress report of the N.E.L.A. Committee for Investigating the Photometric Value of Arc Lamps, which deals with tests of mantle gas burners and of the naked gas flame. With a view of getting representative results on gas mantles of the Welsbach type, a variety of mantles were purchased in the open market. These mantles were classified according to their retail price as follows:—Class A, retail price, 35 to 60 cents; class B, retail price, 20 to 30 cents; class C, retail price, below 20 cents.

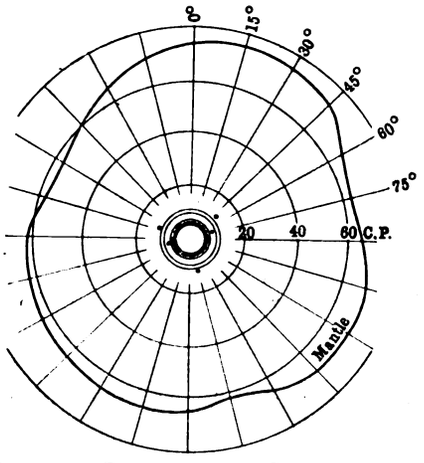

Fig. 1.—Horizontal Distribution of Candle-power about an Incandescent Mantle.

It was found that the candle-power of a gas mantle is dependent in a marked degree upon the gas pressure. The report contains data on the relations of these two magnitudes. So important is this relation that comparative measurements on mantles become meaningless unless conducted under conditions of constant pressure. Fig. 1 shows the horizontal distribution of candle-power about an ordinary gas mantle mounted in a burner having three side supports for the mantle. It is clear that the distribution would be practically a circle were it not for the screening effects of these supporting rods. It will be noted that there are three depressions in the curve corresponding to the positions of the rods. The minimum horizontal candle-power in this instance is about 57, the maximum about 76. The position of the supporting rods is indicated in the middle of the figure.

In Fig. 2 is shown the mean vertical distribution of candle-power from each of the three grades of mantles tested. This winged-shape distribution of candle-power in a vertical plane is characteristic of the ordinary gas mantle. The maximum candle-power is found at about 15deg. above the horizontal, because from this point of view the visible area on incandescent surface is probably a maximum.

On account of the position of the maximum candle-power in these curves the mean hemispherical candle-power is uniformly larger above than below the horizontal. The mean gas consumption for Class A mantles working under a pressure of 2in. of water is 3·79 cubic ft. per hour. The values of gas consumption for grades B and C are, respectively, 3·66, 3·99 cubic ft. per hour. The mean

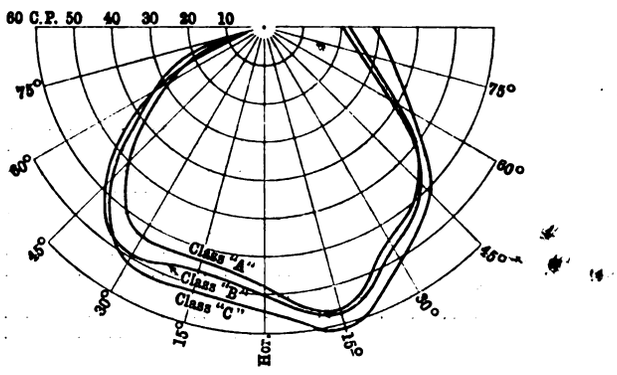

Fig. 2.—Mean Distribution of Candle-power about an Incandescent Gas Mantle.

spherical candle-power for the three grades is tabulated as 55·8, 58·8, 62·2. This means a gas consumption per candle-power of 0·068, 0·062 and 0·064 cubic ft. It is seen that the more expensive mantles give the least candle-power. Whether this is a general conclusion or not cannot be said without a larger number of tests than is here described. In point of gas used per mean spherical candle-power,

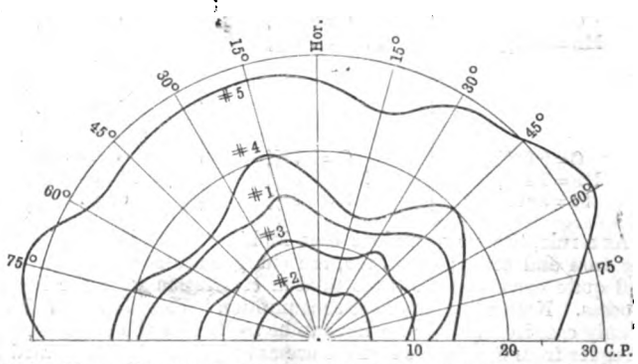

Fig. 4.—Mean Distribution of Candle-power for various Open Gas Flames.

class B leads classes C and A, following in the order named. The real economy of one grade of mantles over another cannot be told without a life test. Time was not available for such a test in connection with this work.

Fig. 3 exhibits the illumination on a plane normal to the ray produced by the mantle burner, placed at a height of 12ft. above the street. The illumination varies from the maximum of 0·187 candle-ft. at a distance of 10ft. to 0·0105 candle-ft. at a distance of 80ft. Changing the height of the burner has but little effect on the illumination at points beyond 50ft. from the lamp, but changes in a marked degree the illumination at points near by. The illumination at a distance 80ft. from the lamp is practically 0·01 candle-ft. for all heights of lamp between 8ft. and 20ft. However, as the lamp is raised between these limits, the mean normal illumination will fall from 0·039 to 0·029 candle-ft.

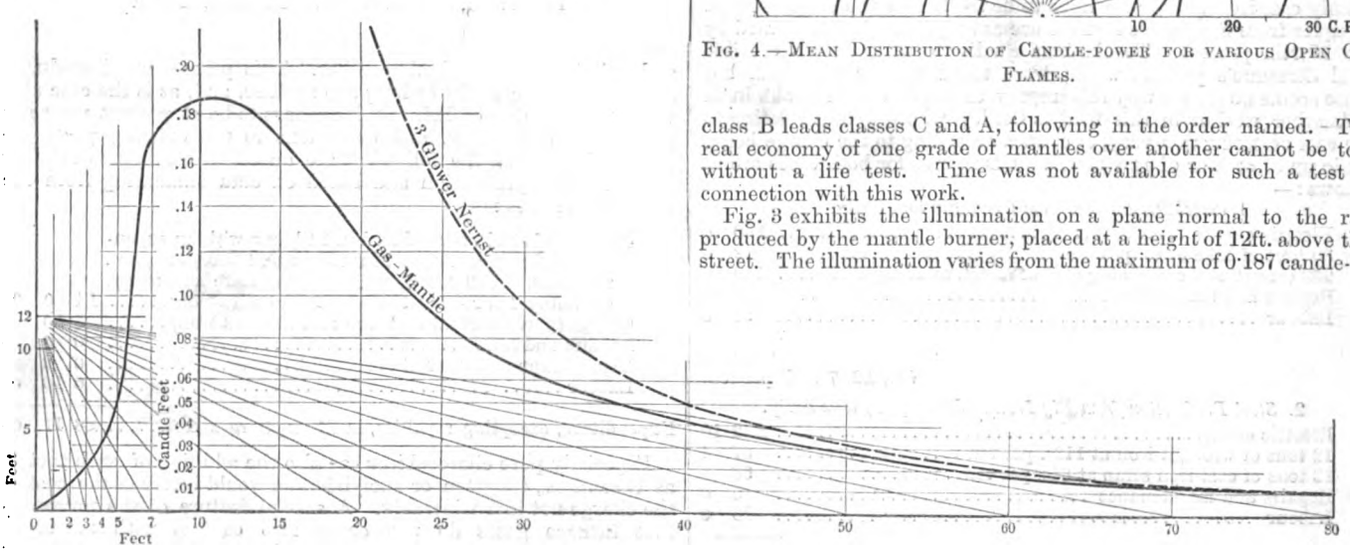

Fig. 3.—Normal Illumination Curves from Incandescent Gas Mantle.

The report concludes with a short series of tests of the candle-power and gas consumption of the ordinary open gas flame. An assortment of tips was secured from different dealers conveniently at hand. In seeking to test these it was soon found that the nominal

* From the *Electrical World* of New York.

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Table I.—*Open Gas Flame.* (*Pressure 1·2in. of Water.*) *Candle-power.*

Angle.	Tip No. 1.			Tip No. 2.			Tip No. 3.			Tip No. 4.			Tip No. 5.		
	0°	90°	Mean 0° and 90°	0°	90°	Mean 0° and 90°	0°	90°	Mean 0° and 90°	0°	90°	Mean 0° and 90°	0	90°	Mean 0° and 90°
75deg. A.	15·77	19·30	17·54	6·02	6·70	6·36	13·38	10·73	12·06	20·85	20·35	20·60	30·6	33·6	32·1
60deg. A.	13·38	17·27	15·33	6·90	5·23	6·07	10·40	10·80	10·60	15·12	17·68	16·40	26·2	29·4	27·8
45deg. A.	15·37	14·40	14·89	6·27	5·07	5·67	9·82	10·52	10·17	14·90	16·43	15·67	28·6	29·4	28·1
30deg. A.	13·90	14·45	14·18	5·96	6·49	6·23	11·21	10·86	11·04	17·02	19·15	18·09	26·4	29·8	28·1
15deg. A.	15·00	16·09	15·55	6·16	6·03	6·10	11·01	10·92	10·97	19·10	21·00	20·05	26·3	31·3	28·3
Hor.	12·00	14·85	13·43	5·46	4·99	5·23	9·85	9·55	9·70	15·20	18·00	16·50	25·1	29·7	27·4
15deg. B.	11·51	12·27	11·89	4·44	4·76	4·60	9·11	8·94	9·03	13·22	13·73	13·48	22·9	27·1	25·0
30deg. B.	12·82	12·96	12·98	5·99	5·30	5·65	10·20	11·67	10·94	15·15	16·40	15·78	26·6	30·8	28·7
45deg. B.	13·82	17·46	15·64	5·26	6·33	5·80	9·04	11·22	10·13	18·02	21·73	19·88	29·7	36·3	30·0
60deg. B.	13·43	17·80	15·62	5·24	6·49	5·87	8·95	11·92	10·44	16·90	18·20	17·55	28·0	38·5	33·3
75deg. B.	12·42	15·85	14·14	4·41	7·41	5·91	7·59	12·63	10·11	11·80	19·18	15·49	27·4	29·2	28·6
Cu. ft. gas used per hour	..	5·75	..	..	3·64	..	..	4·45	..	..	6·20	..	..	9·7	..
Mean hemispher. c.p., upper	..	15·00	..	..	6·00	..	..	10·67	..	..	17·96	..	..	28·60	..
Mean hemispher. c.p., lower	..	13·88	..	..	5·42	..	..	9·93	..	..	16·38	..	..	29·20	..
Mean spher. c.p.	..	14·44	..	..	5·71	..	..	10·30	..	..	17·17	..	..	28·90	..
Cu. ft. gas per mn. h.s.c.p., upper	..	0·384	..	..	0·607	..	..	0·417	..	..	0·345	..	..	0·339	..
Cu. ft. gas per mn. h.s.c.p., lower	..	0·414	..	..	0·672	..	..	0·448	..	..	0·378	..	..	0·332	..
Cu. ft. gas per mean sph. c.p.	..	0·399	..	..	..	..	..	0·422	..	..	0·362	..	..	0·336	..

rating of the tip had scarcely any significance, either as regards the gas consumption or candle-power.

Table I. and Fig. 4 summarise the tests on the open gas flame. It is evident from these tests that the candle-power of gas as found in ordinary commercial service can be determined only by means of a very large number of tests.

Chemical analyses of the gas used in this work show a very considerable variation in the composition of the gas at different times. An analysis made under the supervision of the department of chemistry of Purdue University on April 23, 1903, concludes with the statement that "The gas is supposed to be a mixture of coal gas and water gas (enriched), but evidently contains a large quantity of natural gas."

Mr. W. E. THRIFT'S INAUGURAL ADDRESS TO THE DUBLIN SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

After acknowledging in suitable terms the honour conferred upon him by being elected chairman of the section for the coming session, and after complimenting the section on the all-round success of last year, Prof. W. E. Thrift first gave a general *résumé* of recent industrial progress. He alluded especially to improvements made in connection with electric lighting, electric motors and generators, as well as to steam turbines and gas engines. Electric traction was also touched upon, and the speaker was of opinion that in only few and special cases would the advantages accruing from the use of electricity on existing steam lines be sufficient to compensate for the double capital expenditure involved.

The second part of his address was dedicated to a review of the chief achievements of pure science during the year. The speaker believed that the past year would probably prove to have been epoch-making in the modifying, or perhaps revolutionising, of our views on electricity and matter. After referring to M. Blondlot's newly-discovered N-rays, he went on to describe the Cooper-Hewitt type of mercury lamp. He pointed out a new use for this. As its initial resistance is high and breaks down with great suddenness, it will, if placed as a shunt across a condenser, allow a single discharge of definite character to pass when the pressure of the condenser rises to a certain value. The oscillatory discharge of the condenser is limited to a single discharge, because the current cannot pass through the lamp in the opposite direction and the resistance of the tube is immediately re-established. He continued: That a train of waves of definite character and frequency, depending on the time required by the condenser to charge itself up to a definite pressure, can thus be obtained, and that with increased power, is an important scientific advance and may have invaluable applications in wireless telegraphy.

But pre-eminent in interest and importance have been the researches on radio-active bodies and the opening up of what must be regarded as a new sphere of analysis and investigation.

After referring to the earlier discoveries with regard to these bodies, Prof. Thrift proceeded: A step of fundamental importance was the separation from thorium and uranium, by chemical means, of constituents called Th.X and Ur.X, by Rutherford and Soddy, and Crookes respectively, which removed from thorium and uranium their power of emitting β-rays, though they retained the power of emitting α-rays. The Th.X gives out α and β-rays and a radio-active emanation, while the radiation from Ur X consists mainly of β-rays. The energy emitted in α-rays is much greater than that in β-rays. While the Th.X and Ur.X decay in their powers, the thorium and uranium from which they have been separated recover their original power at precisely the same rate, so that the sum total of the activity of the two constituents remains constant.

* Delivered November 12th. Abstract.

It seems hard to avoid concluding that the thorium atoms or molecules, while it is giving out α-rays, are breaking up; that the product of disintegration is itself unstable, and in breaking up gives off α and β-rays and a radio-active emanation; that this is again unstable and breaks up, shooting out matter which is deposited on other bodies and which in turn is disintegrated with the emission of radiation, the new product, again, being radio-active at the cost of its own organic existence. The constant radio-activity of thorium is thus maintained by the constant production of Th.X: the activity of the Th.X is added on to that of the Th. and the whole activity increases until a steady state is reached in which the decay of activity of the Th.X balances the gain due to the production of fresh disintegrated products. Ordinary chemical processes can be checked or modified by variation in the physical and chemical conditions to which the changing substances are subject; but no such variations have any influence on the history of these new substances. At low temperatures or at high, with absolute independence of their environment, subject to an inexorable fatalism beside which the laws of the Medes and Persians are but the type of inconstancy; in splendid isolation they are born, live their allotted span, and die in giving birth to their successors.

Investigation of the radio-activity excited in other bodies by radium and thorium showed that it is due to the deposit of radio-active matter transmitted by positive carriers produced from the emanations, perhaps by the expulsion of negative bodies from its molecules, for in that it emits β-rays we have evidence of such expulsion occurring. The rapid increase of the absorption of α-rays with the thickness of the matter traversed, pointed to their being projected particles, and Rutherford and Becquerel proved that they are deviated by a magnetic field in the opposite direction to the deviation of the β-rays, but to a smaller extent, according with an estimate of the mass of the particles as of the order of the mass of the hydrogen atom, about twice as great, and of their velocity as equal to one-tenth of the velocity of light.

Examination of the emanations showed that they behave like inert gases, diffusing through gases like gases of considerable molecular weight, and as indifferent to chemical wiles and blandishments as any member of the argon family. The activity of radium is largely due to its emanation and the excited radio-activity caused by it, the activity of fresh emanation increasing for a time because the excited radio-activity matter manufactures out of itself the fresh active matter which causes the excited radio-activity. The emanation is continually being produced and is occluded like a gas in solid radium compounds, a sudden evolution of the emanation resulting when the solid is dissolved. The radio-activity of fresh radium, therefore, gradually increases with increase in the amount of occluded emanation; and with the loss of the occluded emanation, when it is dissolved, it retains the excited radio-activity, and therefore its activity at first diminishes and then increases to its normal maximum. The emanation gives out α-rays at first, β-rays afterwards from the excited radio-activity. The emanations can be condensed by liquid air, regaining the gaseous condition on rise of temperature. They volatilise at fairly definite temperatures, that from radium at about $-150°$C. and that from thorium at about $-120°$C., and they appear to exert a real vapour pressure. So the excited radio-activity due to thorium is volatilised at a definite high temperature and re-deposited on neighbouring bodies.

Besides having the power of emitting α and β-rays and a gaseous emanation, radium was found to emit a third kind of rays not deflected by a magnet and of an exceedingly penetrating nature, but this was not all. M. Curie found that it possessed the power of maintaining itself constantly at a higher temperature than its surroundings, and to an extent involving the continual emission from 1 gramme of radium of approximately 100 calories per hour, and Dewar proved that this power was (if anything) increased rather than diminished at the temperature of liquid hydrogen.

The excess of temperature of freshly prepared radium is not so great as in that which has been some time prepared, but it gradually rises to its maximum in about a month, appearing in this way to be intimately connected with the gradual occlusion of the emanation, and with the destruction of the emanation as its cause. This, along with the fact that helium is generally found in the mineral sources of radio-active bodies,

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and Rutherford's measurement of the mass of the α particles as equal to that of the helium atom, as contrasted with the mass of the β particles approximately the same as that of the corpuscles in the cathode rays as determined by J. J. Thomson, drew attention to the products of the disintegration of the emanation. Ramsay and Soddy investigated its spectrum, found it of a new type, and non-permanent in character; after standing for four days the characteristic lines of helium appeared, along with certain new lines, and Rutherford's suggestion that helium might be one of the ultimate products of the disintegration seems to have been thus triumphantly verified.

Strutt, McLennon and others have found that the ionisation of air depends upon the material of the containing vessel, a radio-active emanation has been detected in air, probably due to the radio-activity of the earth's surface; Strutt has obtained an intensely radio-active gas or emanation by bubbling air through mercury (and by drawing it over hot copper); C. T. R. Wilson has obtained a radio-active residue by evaporating rain and snow; J. J. Thomson finds that air bubbled through solutions of lead becomes radio-active, that the water from deep wells contains a radio-active gas, and that the air expelled by boiling tap water contains a radio-active constituent which can be frozen out by means of liquid air; while Rutherford has demonstrated the radio-active powers of wood, brick and earth, as well as the fact that metal exposed to air is more radio-active than cleaned metal. Much of this may be due to the wide diffusion of minute quantities of the more intensely radio-active bodies (Strutt has shown that 1 part of radium in 300,000,000 would account for his observed effects due to the materials of the walls of vessels on contained air) but the effects have been observed in materials obtained far from any known sources of the radio-active bodies, and it is probable that the difference between them and all matter is one of degree rather than of kind.

We cannot fail to be struck by the ease with which the disintegration theory co-ordinates and accounts for all the effects produced by the radio-active bodies that have hitherto been observed. To recapitulate, the theory supposes that the atom of a radio-active body is in an unstable state, or rather that certain of its atoms are continually becoming unstable; whether from internal processes, such as that suggested by Lodge in that, on the electron theory, the atom must be radiating, because of the radial acceleration of the revolving charge, and, therefore, the charge must be approaching the centre of the atom and its velocity be ultimately increasing, until when it approaches the velocity of light an unstable state of things must ensue (though, on this theory alone, apparently, one might expect all the atoms to become unstable together and an explosion ultimately to occur; perhaps, indeed, all substances are thus doomed to destruction or resolution into the primordial electrons); or whether, amid the vicissitudes of a varied career, from collisions with their fellows occurring at times, in such a way as to increase the velocities of some of the atoms beyond the ordinary limits at which their state is stable, and thus, instead of committing suicide or dying from internal complaints, they are slain in the shock of battle; or whether from a concurrence of both causes, or whether, in some way not yet understood, somehow or other the state of instability is reached.

The unstable atom disintegrates with the ejection of at least one positively-charged particle of the mass of the helium atom; the residue, itself unstable, breaks up further, and as the decomposition proceeds, now with the emission of an α-ray, now with that of a β-ray—the negative electron—now with that of a γ-ray, without electric charge, so far as external bodies are concerned, and small enough to find its way through the internal avenues of other bodies with small risk of being obstructed, because not attracted by the matter of which those bodies are composed, until the last product of decomposition is reached, a stable product and, therefore, one never to be detected by the methods specially applicable to radio-active bodies, because radio-activity is a mark of instability. Thus arise, at different stages in the process, Th.X, Ur.X, the emanations, the excited radio-activities; thus the various radiations occur simultaneously with the coming into being of the new products; thus are explained the rise in activity with its age of newly prepared radium up to a maximum, when the gain in activity due to the secondary fresh products is counterbalanced by the loss due to the decay of those products; thus the initial fall in activity of radium, from which the occluded emanation has been removed, followed by a rise as before, due to the occlusion of fresh emanation; thus the general law that the proportionate amount of radio-active matter that changes in unit time is constant for each substance, and thus the thousand and one details that have so far been brought to light. Even the fact that the radio-active bodies are all bodies of the highest known atomic weight is, perhaps, accounted for, since it is likely that any arrangement of electrons forming an atom will be less stable the more electrons it contains. The evidence in favour of the view that the changes that occur are changes in the atom is very strong. They are independent of the state of chemical combination in which the radio-active body finds itself; they are independent, both in character and velocity, of temperature within the wide limits of observation; physically and chemically they are beyond our power, either to cause them or prevent them. (Our very notions of what is meant by chemical change would have to be altered so as to bring them within its sphere.) They take place with the evolution of energy of quite a different order of magnitude from the energy set free in any known chemical change. The kinetic energy of the particles emitted in the α-rays during the breaking up of 1 gramme of radium calculable from the measured mass and velocity of the particles is, at the lowest estimate, as great as the energy set free in the chemical union of the hydrogen and oxygen required to produce 25,000 grammes of water, perhaps 100 times as great, and, weight for weight, no other known chemical reaction liberates more energy than this. The energy ultimately being used by 1 gramme of radium in ionising the surrounding air would suffice to boil 150 grammes of water a year, while the heat continually being emitted by 1 gramme of radium would boil 1 gramme of water in an hour. Indeed, any attempt to regard the changes causing radio-activity as chemical changes, appears to me as likely to involve more revolutionary changes in accepted chemical doctrines than the recognition that chemical laws—the atomic theory itself—apply to reactions between atoms and atoms, limit our powers of dealing with matter, hedge the atom round with a screen impenetrable to our weapons of attack, but are themselves limited, in that they only apply to the more stable products towards which all atoms are inevitably tending of their own inherent nature, or perhaps in that they are only approximations—generally very close approximations—to the truth, because nearly all the atoms of a special kind are stable, and it is only a comparatively rare occurrence for one of the 10, 20 or so atoms of which 1 cubic cm. of matter consists to be perturbed beyond its limits of stability. In this way I regard the new theory as an extension of the atomic theory, as confirming it rather than throwing doubt on it; for instance, it shows that the internal energy of the atom is extremely great, and, so far, explains our inability to do anything which may break up into its constituent parts an entity in which the connecting ties are of such enormous strength. In passing, I cannot refrain from remarking on the extraordinary sensitiveness of the new method of investigation in comparison with even the most refined methods of chemical investigation.

Rutherford has shown that 1 gramme of uranium emits something like 2,000 α particles a second, and as the α radiation from a milligramme is probably within the limits of observation, it follows that the emission of two α particles a second can be detected, and that we are actually within range of observing the effects of the disintegration of a single atom of uranium. The chemical balance might weigh 10^{14} atoms of uranium.

It is easy to account on the theory for the continuous emission of heat from radium; in fact, one might almost expect it to occur to a much greater degree. The α particles are easily absorbed by solid bodies and, therefore, most of those projected from atoms not near the surface of the radium will be stopped by collisions with the internal atoms, and, therefore, a considerable development of heat will come.

Sufficient data indeed seem to be available to enable us to estimate, at any rate, the maximum amount of heat which could be thus developed. Rutherford has shown that the α radiation emitted probably comes from a layer not more than 0·0001cm. in thickness. If we suppose 1 gramme of radium in the form of a sphere, the radius of the sphere would be about 0·3cm., and, therefore, the area of its surface would be about 1·1 sq. cm., and the quantity of radium which succeeds in emitting the α-rays would be about $\frac{1}{10000}$th gramme, or all but the $\frac{1}{10000}$th part of the α radiation of the 1 gramme of radium is absorbed in the radium itself. Now the energy actually emitted externally in the α-rays from 1 gramme is 2×10^4 ergs per second, and, therefore, the energy of the whole α radiation of the gramme is 2×10^7 ergs per second, or 72×10^9 ergs per hour, equivalent to 1,800 calories per hour. Thus, if the whole of the energy of the α-rays were converted into heat by impact within the mass, it might account for the development of 18 times as much heat as that actually observed. This estimate only gives a major limit to the amount, because the thickness 0·0001cm. of the externally active layer may be only a very approximate estimate, and also because it is very likely that many of the α particles within the mass, instead of having their energy converted into heat by impact within the mass, simply fill up the gaps in atoms which have lost an α particle and so restore certain of the disintegrated atoms to their original state.

We naturally ask how long can such evolution of energy continue, and calculation sets a limit of a few thousand years to the "life" of radium. It has been thought that this raises a difficulty, for if its life is so short it should long ago have lost its powers in being resolved into the products of its disintegration. However, it is possible that the radiation and disintegration occur at different rates when it is in its mineral sources owing to the extreme tenuity of its distribution throughout their mass, and even without resorting to this assumption, which may not be in accord with the theory that the disintegration is atomic and independent of physical conditions, particularly if the instability of the atom arises from internal causes, there is the possibility, or probability, that radium is itself a product of the disintegration of another radio-active body, perhaps in existence or perhaps disintegrated some thousands of years ago. No radium X has yet been discovered, perhaps because what we call radium is really the R.X of the original radium.

However, naturally the disintegration theory has not by any means met with universal acceptance. The atomic theory, as hitherto received, has been too useful a weapon to be lightly cast aside, and even though the new theory were to involve nought but a modification of the old, of course it ought not to be accepted whilst the original theory has even a fair chance of adequately accounting for the newly-observed facts. At present, as I have said, it does not appear to me to be able to do so without undue straining; though decision on this point may be largely a matter of weighing of evidence, and will perhaps be much influenced by predisposition as determined by individual work and training.

On the other hand, the disintegration theory seems to many to demand too great an assumption for the internal energy of the atom, and they feel constrained to hypothesise the ability of radium to draw in some way upon supplies of energy contained in cosmic radiation previously unknown. And it is certainly time that distinct evidence has been found of the existence of such radiation of a very penetrating character. Messrs. Lennan and Burton, in their investigations on the electrical conductivity of atmospheric air, found that they could diminish the conductivity of enclosed air by about 37 per cent. by surrounding the vessel containing it with a thick layer of water. But even though such radiation be existent, it is hard to see why radium and allied bodies should be so especially able to make use of its energy. The general law of absorption of such radiation is that it is proportional to

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density, and so the absorption of it by radium ought to be on the same scale as that by lead or gold. The difficulty at best is only pushed back a step, and it must be admitted that radio-active bodies are of a peculiar constitution. Indeed, this theory, perhaps, isolates them more than its rival.

Whatever may be the fate of the various theories, it is at least suggestive that, as a genius is often but the impersonation of the Zeit-geist, as the discovery of radium and other radio-active bodies has synchronised with the development of the electron theory of electricity and matter, verified some of its predictions and enabled some of its logical consequences to be put to the test of experiment. In 1898 J. J. Thomson demonstrated experimentally the existence in the cathode rays of masses smaller than atoms; they carry the ionic charge, so far undivided and indivisible, but their mass is about the $\frac{1}{1000}$th of that of the atom of hydrogen; it is mathematically demonstrable, and was then known, that a charge of electricity possessed inertia; it tends to continue in its state of rest or uniform motion in a straight line; being accelerated or retarded, it radiates energy; and the mass of inertia of a given charge (moving at a velocity small compared with that of light) depends on the size of the charge and can be easily calculated if it be assumed that the charge is spread over a sphere of known radius; a part of the mass moving in the cathode ray was thus clearly of electrical origin. A possible hypothesis to make was that the whole of its mass might be accounted for in this way. On this hypothesis the radius of the electron—the ionic charge moving in the cathode ray, without mass of any other than electrical origin—that is, without mass derived from any assumed "material" source, but nevertheless with a mass equal to the $\frac{1}{1000}$th of the mass of the H atom—proved to be of the order 10^{-13}cm., very small compared with the size of the atom. No doubt the penetrating power of such rays was thus inexplicable, particularly if the further assumption were made that the whole mass of the atom had a similar origin, the atom consisting of an agglomeration of electrons. But the hypothesis was a hypothesis, scientific in that it avoided the necessity for postulating matter as distinct from electricity, but without anything like proof for it being adduced, and even without much likelihood of proof for it being forthcoming. However, it was also a consequence of the theory that the mass of the electron should depend upon its velocity, the charge being quite inappreciable at ordinary velocities, but becoming of importance as the velocity approached the velocity of light, the charge being about 1 per cent. at a velocity one-tenth of that of light and rapidly increasing for higher speeds; and the discovery of radium and the emission by it of electrons with enormous velocities, greater even than those of the electrons in the cathode rays, made it possible to put the increase of mass to the test of experiment. Kauffman succeeded in measuring the velocities and the ratio of charge to mass of the particles emitted by radium for a considerable range of velocity, found an unmistakable increase of mass with velocity, and showed that the electrical part of the mass was comparable with the material part. The assumption that the charge is distributed in the same way as over a conducting sphere led to one-third as the value of the ratio of the two. By assuming the electric field due to a corpuscle to coincide with the field outside a small sphere due to a point charge at the centre of the sphere, Thomson finds that Kaufmann's results agree, within 10 per cent., with the whole of the mass being electrical. Moreover, further investigation of the electron theory by Abraham led him to discriminate between the longitudinal mass—meaning the opposition to acceleration in the line of motion and the transverse mass, meaning the opposition to acceleration in a direction perpendicular to the line of motion—and adopting this theory Kaufmann found that, within the limits of experimental error, if the whole of the mass of the electron were electrical, his results agreed with the theoretical values. We are thus within reach of, if we have not already attained it, a demonstration of the electrical nature of matter. If the electron has its mass as a consequence of its being a moving charge, may we not well ask whether all matter does not consist of electrons; are not atoms agglomerations of electrons, grouped in different numbers and in different ways, and held together by their mutual electrical attractions—astronomical systems in miniature, in which the bodies are held bound by their own electrical forces and kept apart by the kinetic energies of their orbital motions? Is it not probable that the atomic theory of matter may come to be a deduction from the atomic theory of electricity—the old hypothesis of the unity of matter be verified in a manner unexpected by its originator, the dream of the alchemist be theoretically fulfilled, though in practice we be unable to separate the atom into its constituent parts; the law of parcimony, so often appealed to by chemists at present, be obeyed, but at a stage earlier in theory than that where they invoke its aid?

The discovery of radium and its properties gives rise to many other speculations of extreme interest, and has an important bearing on theories of the most varied nature, but within the limits of the time at my disposal this evening I cannot do more than refer to them in the briefest way. It suggests a new source for the energy of the sun and widely extends the previously-estimated limits for the ages of the sun and earth, thus affording a new way of harmonising geological and physical theories. The emission of electrons from the sun may explain the electrification of the earth, the aurora borealis, the connection between magnetic storms and sun-spots, the photosphere and the corona. On similar lines may come the explanation of comet tails and their repulsion by the sun, and of the nebular light. Radium may have the power of exciting luminous vibrations in the atoms of matter (when its emanation is mixed with air the spectrum of N has been observed), and it may give us information as to how these vibrations may be directly excited. In radium there may be found the long sought-for cures for cancer and consumption, it certainly appears to have a beneficial effect when used in the treatment of certain forms of external cancer. We are but on the threshold of discovery as to its applications to practice and theory. So the electron theory is little more than in the initial stage of its mathematical development; it opens up fresh avenues for research and offers problems to the mathematician to solve of almost infinite variety and complexity, whether with regard to its own nature and properties, the explanation of gravitation and the proportionality of mass and weight, or in reference to the part which it plays in the structure of the atom. Surely there is no need to fear that in its unification of matter and electricity it may beget any unphilosophic contentment; rather will it spur experimentalist and theorist alike to fresh efforts, climb further up the hill of knowledge, whose peak is hidden in the lands of heaven, and on whose lower slopes men are yet struggling,

MR. GERALD STONEY'S INAUGURAL ADDRESS TO THE NEWCASTLE SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.*

This branch of the Institution of Electrical Engineers has now been in existence for four years, and the membership has risen steadily from 93 at the time of its inauguration to 152 at the present time. A subject in which great interest is being taken is the education of engineers, and most diverse opinions have been expressed. All, however, are practically unanimous that it is necessary to combine practice with theory, but as to the best way of doing this there is much difference of opinion. The best way, however, seems to be the "sandwich" system, in which the theoretical and practical training are carried on concurrently. Stress should be laid on the importance of letting a boy early in life learn the use of tools, and this can, as a rule, be best accomplished by letting him have an amateur workshop in which the average boy will, with a little encouragement, spend a part of his spare time.

Modern languages also are of great use to an engineer, and he should be taught both to read and speak them. Latin and Greek may well be left out, and it is maintained that the German grammar is as good an education for the mind as the Latin grammar, besides being of practical use to an engineer. Mathematics also should be taught from a practical point of view, so as to enable the student to make use of them in the actual problems which occur in practice. In thus urging a practical education for an engineer, however, no one more than an engineer is aware how much is owing to those who pursue science for itself apart from mere monetary gain. Without the investigations of the immortal Faraday, out of which he deliberately refused to make any monetary gain, where would the whole of our modern electrical engineering be? Without the investigations of Faraday, Maxwell, Hertz, FitzGerald, Lodge, and many others, Marconi could not have made wireless telegraphy the brilliant success it has been. In almost all cases the way has been paved for the engineer and the commercial man by seekers after knowledge, the results of whose investigations have been given to the world freely and without stint, and it is hard to say what bearing investigations in pure science may have in the future. Such discoveries as the fixation of atmospheric nitrogen and the formation of nitrogenous manures may be of great importance to agriculture, while the formation by electrolysis of many of the organic compounds found in plants may eventually give us a clue to the mystery of life.

The distribution of electricity for power, lighting and traction has made enormous advances, and there is no sign of the rate of progress slackening. In this district we have the first of the great power stations at Neptune Bank, Wallsend-on-Tyne, and soon a second one at Carville will be at work. During the past 15 years the size of engines and dynamos used has steadily risen from about 100kw. to from 4,000kw. to 5,000kw. at the present date. In this connection the Parsons steam turbine has taken a notable part. This machine was invented by the Hon. C. A Parsons, F.R.S., in 1884, and the first engine was of about 10 H.P., while now turbines up to 8,000 H.P. and 10,000 H.P. are being made. The low first cost, small steam consumption, absence of reciprocating parts and small foundations, as well as reduced attendance and upkeep, have caused this type of engine to be largely adopted for driving dynamos, as well as for the propulsion of ships and other purposes.

A great field is opened up by the discovery of cathode and other rays in which we seem to be dealing with individual electrons instead of with masses of them. Recently there is the marvellous discovery of radium, which not only gives forth three distinct sorts of rays, but also is warmer than objects surrounding it, and is, therefore, constantly giving out energy, the exact source of which is still in dispute. These researches in molecular physics may some day enable us to deal with individual molecules instead of with masses of them, and thus it may be possible to tap the great source of energy existing in the atmosphere by the help of the "Sorting Demon" pictured by Clerk Maxwell, thus utilising for the service of man the energy of the atmosphere without the consumption of coal or other fuel. And looking back on the advance made in the last 100 years, who will say it is impossible? Fancy our grandparents in the "Flying Scotchman" at 60 miles an hour! What would they think of telephone, telegraph or gramaphone? What would the effect be on a stage coach if it met a bicycle or motor car? Some of these things would have been declared impossible even within the memory of many of those here present.

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THE WIRELESS TELEGRAPH CONFERENCE.

Although we were enabled two months ago to give our readers a summary of the results of the preliminary Wireless Telegraph Conference held in Berlin last August, the fuller report, which we publish to-day, will, doubtless, be perused with interest. One point is brought home with particular clearness—namely, the weak position of our own Government with regard to its telegraph monopoly as compared with the Governments of other countries. In France, in spite of the much-vaunted liberty of the subject, the Government can order the removal of any private wireless telegraph station that may offend it, and in other European countries the telegraph monopoly of the Government is absolute and applies to any wireless telegraph station erected in its territory or under its flag. In the United States, the Government has a right to impose conditions upon wireless telegraph stations conveying commercial messages to or from the country, and in some of our own colonies even the construction of wireless telegraph apparatus is illegal except under licence. Under the present state of the law in Great Britain, however, the Government has no right to interfere with any wireless telegraph company unless the company is sending commercial messages between two stations both within the boundaries of the kingdom.

It has always been the policy of this country to allow the utmost freedom to private trade and enterprise, but in the case of telegraphy it has been shown repeatedly that this industry can only be carried out to the greatest advantage if it be a State monopoly. This was realised in the case of the ordinary telegraph system 34 years ago, when the old telegraph companies were taken over by the State, and it is difficult to see to what extent the present situation differs. It has been the custom to compare the wireless telegraph companies rather with the existing submarine cable companies than with the old inland telegraph companies, probably because of the fact that the wireless telegraph traffic between coast stations and ships at sea is also more or less of an international service. It may be pointed out, however, that cable companies, whether British or Foreign, have always been obliged to comply with certain conditions imposed by the State; for although telegraphy to other countries is not included in the telegraph monopoly of the British Government, the observance of certain regulations can be made the condition on which landing rights are granted. Hence the Government has always been in a position to impose regulations upon the submarine cable companies without any special Act of Parliament; and the position of the present wireless telegraph companies is, therefore, more nearly parallel to the case of the original telegraph companies than to that of the companies working submarine cables. An actual

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Government ownership of the wireless telegraph business of the country is not needed at present, but the imposition of a clearly-defined State control. Not only would this make the benefits of wireless telegraphy more available to the general public, but it would also assist development by preventing, in the future, interference between different wireless telegraph companies. Surely the passing of an Act of Parliament giving the Government this control should be easier and not more difficult than the passing of the fundamental Telegraph Act of 1869. There can be little doubt that the necessity exists for international agreement with regard to the working of wireless telegraphy, and international agreement can only be effected in such a case through State control.

The position of reserve taken up by the British delegates to the Conference was regrettable, but nevertheless it could not be avoided in view of the present condition of the law of the land. The delegates could only point out that the Government had no power to impose the regulations and restrictions agreed upon by the other nations (with the exception of Italy), and they could naturally not pledge their Government to do what can only be done with the consent of Parliament. We trust that there will now be no reluctance in bringing in a Government measure of the nature indicated in the next session of Parliament. So far the Post Office has done everything in its power to assist Mr. MARCONI and his company in the execution of their experiments. When first Mr. MARCONI came over with crude ideas and limited experimental means at his disposal, Sir WILLIAM PREECE and the other engineers at the Post Office gave him every facility and opportunity for pursuing his investigations. At a more recent date the Government erected a private line for him from Falmouth to Poldhu to assist him in collecting the numerous messages he hoped to transmit to America from the latter station. The Department even offered to consider the question of acting as receiving agents for "wireless" telegrams to America if the Marconi Wireless Telegraph Co. would give them guarantees that these should be promptly and accurately transmitted; and yet this reasonable demand for guarantees before the Department would act as an agent between the Company and the general public was made a pretext for attacks on the Post Office both in the Press and in Parliament. Surely the Government cannot be justly accused of want of consideration to the claims of Mr. MARCONI and his associates, and it might now fairly turn its attention to the question of widening the field of wireless telegraphy by an acquisition and judicious use of a beneficient State control.

OBITUARY.

JAMES HOOKEY.

We regret to announce the death of Mr. James Hookey, which took place in London last Saturday. Mr. Hookey succeeded Sir William Preece as chief engineer of the General Post Office in February, 1899, and retired through ill-health in March, 1902. Hence, he has enjoyed little more than 18 months' rest from active service. On the last day that he spent at St. Martin's-le-Grand he was the victim of a slight paralytic seizure, a recurrence taking place about a month ago, during a visit to London, and from this he never properly recovered.

Born at Bristol in 1839, Mr. Hookey was educated at Bath, and entered the service of the Electric Telegraph Co. in 1855. Six years later he was appointed engineering inspector and assistant superintendent of the company's West Midland section, and in 1862 he was transferred to London to work as chief officer under the late Cromwell F. Varley and his successor, Richard S. Culley. Then came the transference of the telegraphs to State control, and, although Mr. Hookey was offered the position of superintendent of the telegraph system of a great railway, he decided to enter the country's service as principal technical officer under the late Mr. Graves and Sir William (then Mr.) Preece. On the death of Mr. Graves in 1892, the two positions of engineer-in-chief and electrician were filled by Sir William Preece, and Mr. Hookey became chief assistant. He continued in this position until 1899, when he was appointed to the post of chief engineer, rendered vacant by the retirement of Sir William Preece.

Mr. Hookey not only had an extensive knowledge of engineering matters, but his business and administrative capacities were very remarkable, and his untiring energy, both as chief assistant engineer and as engineer-in-chief, have materially assisted in raising the department to its present state of high efficiency.

SOME WIRELESS TELEGRAPH PATENTS.

(Concluded from page 87.)

The claims appended to Specification No, 10,181 of 1902 are as follows :—

1. In systems of Hertzian-wave telegraphy, the combination with the two capacity areas, of a condenser in series with each of the capacity areas, and an adjustable self-induction coil inserted between the two condensers, substantially as described.
2. In systems of Hertzian-wave telegraphy, a sending circuit substantially as described with reference to, and as illustrated by way of example in, Figs. 4, 5, 6 and 7 of the accompanying drawings.
3. In systems of Hertzian-wave telegraphy, the use of an automatic transmitter, substantially as described.
4. In systems of Hertzian-wave telegraphy, the combination of an automatic transmitter and a transmitter inserted in the local circuit thereof, substantially as described.
5. In systems of Hertzian-wave telegraphy, a transmitter designed to open and close, at a definite rate, the primary circuit of the induction coil in the sending circuit, substantially as described.
6. In systems of Hertzian-wave telegraphy, a transmitter constituted and arranged substantially as, and for the purpose, described with reference to Figs. 8 and 9 of the accompanying drawings.
7. In systems of Hertzian-wave telegraphy, a receiving circuit, substantially as described with reference to, and as illustrated by way of example in, Fig. 13 of the accompanying drawings.
8. In systems of Hertzian-wave telegraphy, arranging the sending circuit relatively to the receiving circuit at a station in a differential manner.
9. In systems of Hertzian-wave telegraphy, the differential arrangement of the capacity areas in a station receiving circuit, relatively to the capacity areas in the sending circuit thereof.
10. In systems of Hertzian-wave telegraphy, the arrangement for the purpose of duplex transmission, substantially as described with reference to Fig. 14 of the accompanying drawings.

Now that the De Forest system has come so prominently before the public in this country, patent No. 10,452 of 1902, granted to the De Forest Wireless Telegraph Co. of New York, is of considerable interest.

Referring to Fig. 15, the signal receiving device may be an ordinary telephone receiver or a telephone sounder placed in a secondary local circuit controlled by a relay. The device will operate without the condenser S, but its use will tend to increase the efficiency of the device.

Referring now more particularly to the responsive device or detector of my invention, I have found that when two metallic electrodes are slightly separated and included in series in a circuit containing a source of current, and a suitable medium is interposed in series between their opposed surfaces, minute metallic particles are apparently torn off from the anode and carried across the gap separating the electrodes to the cathode, where they build up little trees and bridges which extend out towards and soon reach the anode, thus bridging the gap. As long as these bridges continue between the electrodes the resistance of the device is comparatively low. But if it is subjected to the influence of an electrical impulse or oscillation, such as results when a spark passes between the terminals of an induction coil, the metallic bridges between the electrodes are instantly disrupted and the resistance of the device increases greatly. If a signal receiving device be included in the local circuit with the detector, this change in resistance is made manifest and the passage of the impulsed is signalled. Between each spark at the apparatus employed in the production or generation of the oscillations these bridges between the electrodes are again built up, or rather on the cessation of the impulse or oscillation the metallic particles again form into chains across the gap, and so automatically restore the conductivity of the device. I have used as the medium between the electrodes various materials and combinations of materials, including water, glycerine, oils, viscous semi-solids as vaseline, porous solids, non-conducting or poorly conducting powders as sulphur and the oxides of lead, fibres and fabrics, and combinations of the above as fibres or fabrics saturated with glycerine or allied unguents and a mixture of the oxide of lead or litharge with

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glycerine or allied unguents. I have also used collodion and gelatine. The action of such media seems to be to support the chains of metallic particles and retain them in operative relation with the electrodes and each other, and to limit the number of chains. When a few such chains are formed the surrounding fluid seems to prevent further increase in numbers and also supports the particles of which they are composed, so that when the chains are broken up by the passage of the signalling wave they are not scattered but remain in proximity, so that the chains are immediately and fully restored upon the cessation of the signal waves. The electrolytic action of the electric current upon the fluid tends to cause the collection upon the cathode of hydrogen bubbles and upon the anode of oxygen bubbles, which, if not corrected, would eventually surround the particles with a gaseous instead of a fluid medium, and the automatic restoring feature would be seriously interfered with. By the use in the responder of lead peroxide or other depolarising agent this action is prevented, and the permanency of the automatic restoring feature is secured. Different forms of electrodes are shown in Figs. 17 to 19 inclusive. In these e represents one electrode and e^1 the other. In Fig. 16 one of these electrodes, as e^1, is threaded in its support so that it may be adjusted toward and from the other electrode. Between the two is placed a small piece of fabric, e^2, which may have been charged with substances such as previously mentioned. In Fig. 19 a tube is used, within which are placed the two electrodes, and between these electrodes or between plugs which fill the tube and upon the face of which the electrodes are placed is placed the substance e^7 chosen for this purpose. The electrodes may be either flat, of coiled wire with a smooth or roughened surface and more or less separated from each other, the distance being, however, in no case very great. It is sometimes advantageous to make the exposed or juxtaposed surface of one of the electrodes, as e of Fig. 18, preferably the

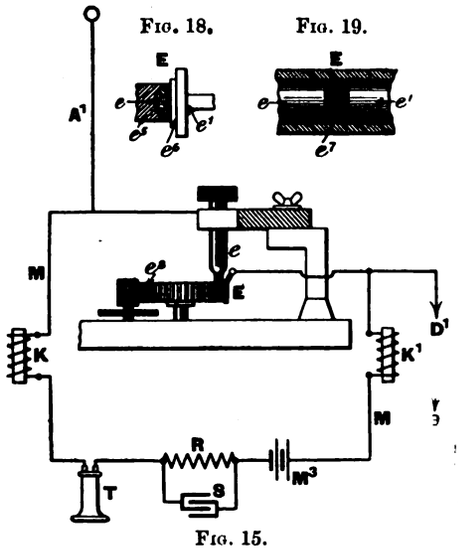

Fig. 15.

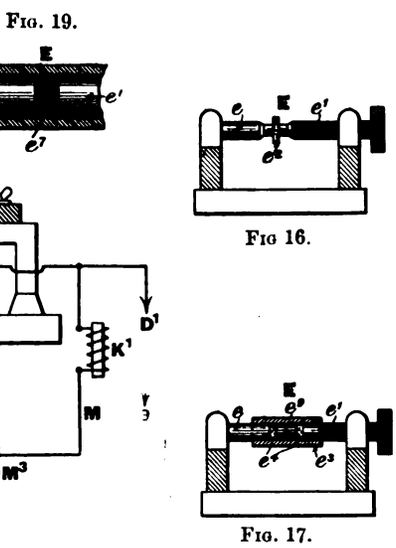

Fig. 18.

Fig 16.

Fig. 17.

Fig. 19.

negative one, cup-shaped, having a narrow edge surrounding the cup or recess and opposed to the plane surface of the other electrode e^1. The cup or recess is filled with a mass, e^5, of lead oxide and glycerine to a point flush with the surface of the surrounding edge. The breaking of the chains connecting the electrode may be mechanically accomplished by making them relatively movable either by turning on their axis, as shown in Fig. 16, or by a longitudinal movement. In Fig. 16 one of the electrodes is in the form of a plate attached to a wheel, e^8, which is turned by clockwork or otherwise, while the other electrode remains stationary. I have sometimes found it advantageous to employ a number of sensitive elements in series-multiple arrangement. Such a form is shown in Fig. 17, which comprises an insulating tube e^4 into the ends of which the primary electrodes e and e^1 project, and one or more auxiliary pieces or electrodes e^9 placed in said tube, and between the primary electrodes, being separated from said primary electrodes by spaces e^4 of from $\frac{1}{16}$in. to $\frac{1}{8}$in. In these spaces I place a mixture of rather coarse metal filings and a powder, such as litharge, in about equal proportions by bulk. This mixture is made into a rather fluid paste by means of glycerine or vaseline with a slight amount of an electrically decomposable body, such as water or alcohol. If desired, however, the auxiliary electrode or piece may be omitted. In that case the same effect of a series-multiple arrangement is secured, the metallic fragments or filings in both cases forming, substantially, auxiliary or secondary electrodes. The most satisfactory metals, both for the electrodes and for the conducting particles or fragments to be interposed between the electrodes, at present appear to be tin, silver and nickel, in the order named; but I do not desire to be limited to the use of any particular metals, as others may be found equally suitable. The current employed in the local battery circuit is preferably small, say from $\frac{1}{16}$th to 1 milampere. I have found the most satisfactory electrolytes, or decomposable bodies employed in connection with the interposed medium, to be water, alcohol and ammonia, or a mixture of these. It is obvious, however, that other bodies may be found equally satisfactory. I do not desire, therefore, to be limited in this respect. Commercial glycerine and alcohol ordinarily contain water in sufficient amount to make it suitable for my purpose, or, if desired, water or alcohol or both may be mixed with the glycerine. Alcohol and ammonia especially aid the action by apparently facilitating the formation of the conducting bridges or chains connecting the poles. A detector or receiver of Hertz oscillations, such as above described, is instantly responsive and instantly and automatically restored to its normal condition at the cessation of an impulse. In the use of the apparatus when a telephone receiver is employed in connection therewith, the listening operator hears a distinct and separate click for every spark produced at the transmitting end or station. If a long series of such sparks be made at the sending instrument the receiving operator hears a similar series of sounds or clicks in the telephone, which may represent a dash, for instance, of the Morse code. A short series of sparks at the transmitting or generating station may represent a dot of the Morse code, and hence the speed of transmission and receipt of the message is limited only by the ability of the operators to send and receive signals. . . . . In a signalling, telegraphing or telephoning system such as above set forth, it is desirable to provide means whereby the receiving instrument or signal, telegraph or telephone device, in the operation thereof bears a definite relation to the rate of discharge of the transmitting or radiating conductor. In other words, the rate at which the sparks are produced between the terminals should bear a definite relation to the responsive action and operation of the receiving instrument. Or, to state the idea in another way, it is desirable that the receiving instrument be attuned to a definite relation with respect to the rate of discharge of the transmitting or radiating conductor, or, rather, to the rate of spark discharge. When this condition obtains, it will be evident that the receiving signal device will be influenced only when a certain and predetermined rate of spark discharge occurs. In this manner the receiving signal device will record or give response only to certain energy waves, and will not respond to energy waves of different characteristics. Therefore, by suitably and properly controlling the rate of spark discharge at the transmitting station so as to tune such discharge to a certain pitch, so to speak, and arranging the receiving signal device to be acted upon or to be responsive to that same pitch, a pseudo-syntonism is produced, which renders the receiving part of the apparatus selective as to the character and quality of energy waves to which it is responsive. This result may be attained in different ways, as, for instance, through the proper actuation of a commutator, or other circuit-changing device, through which the number of makes and breaks per second of the spark-producing circuit may be controlled or determined. In a system such as above described, it is evident that by arranging a number of receiving signal devices in the local battery circuit at a receiving station, each containing a member attuned to vibrate under impulses received at a certain frequency similar to the vibrations induced in a tuning fork when its note is sounded, and unresponsive to impulses received at a different frequency, the same receiving station and apparatus when provided with different selective vibrating members may be utilised to receive simultaneously signals or messages from different transmitting or radiating stations, it being understood that each receiving signal device or instrument responds to energy waves sent out or radiated from the particular transmitting or sending station at which the periodicity of the spark discharge corresponds to the tuning of that particular receiving signal instrument or device. This may be secured by the use of a vibrating member which is attracted by the electrical impulses received, whereby the cumulative effect of a series of impulses corresponding in frequency with the time of vibration of said member, will cause it to actuate the signal, while impulses of other rates will have no effect thereon. The frequency or periodicity of spark discharge referred to above is not the periodicity or frequency periodicity corresponding to the time between successive sparks, said time being determined by the rapidity of operation of the spark controlling and producing device. The receiving instrument of such syntonic device may be a relay having its armature supported on a reed adjusted or adjustable to vibrate at the proper rate and serving as the support for the armature, or a sound producing instrument which is sensitive only to vibrations of a definite rate, such, for instance, as what is known as the Mercadier mono-tonic telephone.

The patentee concludes with a list of no less than 58 claims, all relating to Dr. De Forest's anti-coherer.

The next specification of importance is No 16,550 of 1902, granted to Prof. S. P. Thompson, for "Improvements in Controlling Alternating Electric Currents for Signalling."

My improvements relate to the use of alternating currents for signalling and consist in novel methods of breaking up an alternating current into long and short signals, by which methods I reduce the difficulties occasioned by sparks at the key or switch on the make or break of circuit. Into the alternating-current circuit between the generator and the apparatus which is to be operated by the said alternating current I introduce a suitable self-induction coil in combination with a condenser of suitable capacity. These two are chosen of such relative proportions that when in series with one another they will constitute together a resonating system such as will allow the alternating current to pass. As an example, if the generator works with a frequency of about 50 periods per second, a suitable capacity will be 10mfd. and a suitable self-induction about 1 henry; it being advisable that the self-induction coil be provided, in some known way, for example, by the introduction of a sliding core, with a means of adjustment. This arrangement being introduced into the circuit, then the means for breaking up the alternating current into long and short signals or impulses for producing signals corresponding to dots and dashes is constituted by combining the above described resonating system with one of the following arrangements:—(*a*) A conductor to short-circuit the condenser, a key being placed in the said conductor; (*b*) a low resistance to shunt the condenser, a key being placed in the said resistance; (*c*) a device for changing the capacity of the said condenser by inserting additional capacity, or removing part of the capacity by the operation of a key in the well-known manner; or by mechanically changing its capacity by varying the

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distance between its plates if the construction of the condenser permits. (*d*) a conductor to short-circuit the self-induction coil, a key being placed in the said conductor; (*e*) a low resistance to shunt the self-induction coil, a key being placed in the said resistance; (*f*) a device for varying at will the inductance of the self-induction coil, by inserting additional impedance, or removing part of the impedance, by the operation of a key, in the well-known manner; or by mechanically changing the inductance, as, for example, by varying the position of a movable core should the construction of the coil so permit. The advantage of the method above described is that when either the condenser or the self-induction coil is short-circuited or shunted, the current through the system immediately falls to a very low quantity, so that on removing the shunt or short circuit by opening the key the spark is unimportant. It is preferable for signalling that the condenser should at times of repose remain short-circuited, the key which closes the short-circuit being opened for a short time to signal a dot, or for a longer time to signal a dash. Or, instead of using the condenser directly in the circuit of the generator, I apply it in an auxiliary circuit containing the secondary coil of a mutual induction coil or transformer, the primary of which is in the generator circuit. If into this second or auxiliary circuit the condenser and self-induction coil are inserted, with the means of varying the capacity or the self-induction as above described, then I may vary the effective self-induction of the primary of the first coil through the mutual inductance by manipulating the key or keys which control the apparatus aforesaid which has been inserted into the secondary circuit. Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is: (1) In an apparatus for signalling by means of alternating electric currents, controlling the current by means of a resonating system constituted of a condenser or its equivalent, combined with a self-induction coil or its equivalent, the two being of such proportions as to resonate to the frequency of the alternate current. (2) In an apparatus for signalling by means of alternating currents, the combination of a condenser and a self-induction coil, together constituting a resonating system, with means for short-circuiting either part of the said resonating system. (3) In an apparatus for signalling by means of alternating currents, the combination of a condenser and a self-induction coil, together constituting a resonating system, with means for shunting either part of the said resonating system with a shunt of a sufficient resistance to prevent the system from resonating. (4) In an apparatus for signalling by means of alternating currents, having the combination mentioned in claim 2 or that mentioned in claim 3, the method of operation by a key which short-circuits or shunts either part of which removes the short-circuit or shunt from either part. (5) In an apparatus for signalling by means of alternating currents, the combination of a condenser and a self-induction coil, together constituting a resonating system, with a device or devices for varying either the capacity or the self-induction, substantially as described. (6) In an apparatus for signalling by means of alternating currents, the arrangement of a transformer or mutual induction coil having its primary coil inserted in the circuit of the generator, and having its secondary coil inserted in an auxiliary circuit containing a resonating system, substantially as described, together with means for controlling or operating the same, all substantially as described.

Patent Specification No. 17,111 of 1902, granted to L. H. Walten, relates to coherers of the mercury type. Figs. 20 and

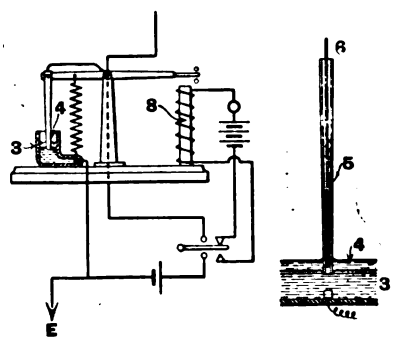

Fig. 20.

Fig. 21.

21 represent the device employed. In the latter, 3 is mercury, floating on which is a film of pure water 4, acting as an insulator. A wire of platinum or other suitable substance is represented by 6 and a capillary tube covering it by 5. The end of the wire does not reach the end of its sheath by a very minute fraction of an inch—about $\frac{1}{64}$in. or $\frac{1}{100}$in. Under normal conditions the tube is pressed down into the mercury, but owing to surface tension no mercury enters the tube, and thus there is no metallic contact between the wire and the mercury. Should a Hertzian wave strike the device, however, the surface tension of the mercury is broken down, and as the mercury flows up the capillary contact is established and a circuit completed. On receipt of a signal current flows through a relay, 8 (Fig. 20), attracting the armature, on the other end of which is the tube and wire. This attraction is only momentary, and the next instant the spring pulls back the lever to its original position, and the coherer is once more in a sensitive condition.

From about this period applications for patents relating to wireless telegraphy have been getting gradually less, and there are very few more of any importance. La Compagnie Française des Télégraphes et Téléphones Sans Fil has been granted patent No. 17,896 of 1902, which relates to a coherer of a novel form. Briefly, it consists of three rods of polished steel, each of which has one end rounded off to more or less of a point and then oxidised. These three points rest on a plate of polished steel and, under ordinary conditions, the resistance between points and plate is sufficient to prevent any current passing. If, however, a Hertzian wave should strike the device this resistance is broken down and a current flows. Sensitiveness is restored by the application of a slight tap, and this is effected automatically by means of an electromagnetic tapper. Of course, one rod with an oxidised point would probably work satisfactorily, but three are employed, in order that the apparatus may be more nearly perfect.

Patents No. 17,703 and 17,705 of 1902 were granted to Prof. Fessenden of America, and relate to his "wave-chute" arrangement described in *The Electrician*, Vol. XLIX., p. 944. No. 17,704 of 1902 was also granted to Prof. Fessenden, and relates to an arrangement by means of which it is claimed that selective working can be achieved. In Fig. 22 A is the sending station and B the receiving station. One end of the secondary winding of the induction coil 3 is connected to the aerial wire and the other to earth. The aerial wire really consists of two separate wires, 1 and 2, which have different natural periodic

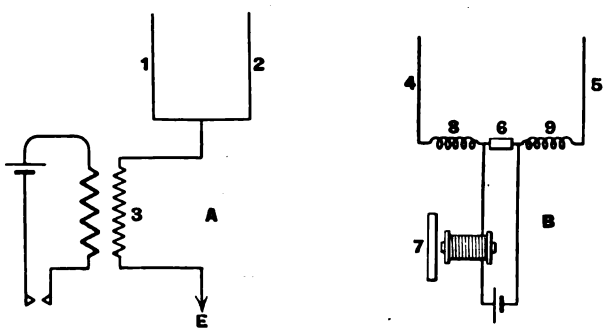

Fig. 22.

times. At B, neither end of the coherer 6 is connected to earth, but one end is connected to one air wire, 4, and the other end to another air wire, 5. The signal receiving or recording device is shown at 7, while 8 and 9 are inductances. By varying 8 and 9 the air wires 4 and 5 are brought into time with 1 and 2 respectively, and hence, the patentee maintains that 4 will receive only the waves emitted by 1, and 5 the waves emitted by 2. If both 4 and 5 receive waves of the same frequency, there will be no difference of potential between the two ends of the coherer, and nothing will happen. But if they receive waves of different frequencies as sent out by the transmitting station, then a difference of potential will be set up across the coherer and a signal will be recorded. The patentee, therefore, claims that an outside instrument sending waves of only one frequency will not interfere with B.

PHYSICAL SOCIETY.

At a meeting of the Physical Society, held on November 13, Dr. R. T. Glazebrook, F.R.S., President, in the chair, Sir Oliver Lodge read a Paper entitled

"Means for Electrifying the Atmosphere on a Large Scale."

Twenty years ago the author was engaged with Mr. J. W. Clark on an investigation of the dark spaces seen near hot bodies placed in illuminated smoke. The existence of these dust-free spaces was discovered by Tyndall, and the phenomenon had been investigated by Lord Rayleigh. Tyndall worked with high temperatures, and attributed the effect to the burning of the dust near the hot body. Such, however, cannot be the case, as the spaces exist when inorganic dust, such as oxide of magnesium, is used. The conclu-

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sion at which Messrs. Lodge and Clark arrived (see *Phil. Mag.*, 1884) was that the result was due to an aerial bombardment from the hot wire, which drove the particles away, and they tried the effect of electrifying the hot body to see if there was any modification of the dark space. A new phenomenon was discovered, the whole of the dust being driven to the sides of the containing vessel. This experiment was shown by the author at the British Association meeting in Montreal in 1884, and subsequently, on a larger scale, at the Royal Institution. In the latter experiment two pieces of wire gauze, connected to the terminals of an electric machine, were placed opposite each other in a smoke-filled chamber, through which a current of smoke was slowly passing. Upon electrifying the plates the smoke ceased passing, the dust particles cohered, hovered in the air, and were either driven to the sides of the chamber or fell to the bottom. In the case of mist electrification of steam in a bell jar converted it into fine rain. It seems, therefore, possible that rain might be produced by the electrification of a cloud. Sir Oliver Lodge has tried at Liverpool to disperse fogs by discharging electricity into them. For this purpose a large mast was erected on the roof of the University College buildings. It terminated in a bundle of points, to which electricity was conveyed from a Wimshurst machine by a wire supported by specially-constructed insulators. In order to drive electricity from a point far removed from a surface a high potential is necessary, and sometimes a large gas flame was used to supplement the points. Upon one occasion the discharge of electricity from the flame was sufficient to keep a clear space of 50yds. or 60yds. radius in a dense fog. The author had hoped to induce the Mersey Dock Board to try the principle on a large scale, having a series of positive discharges on one side of the river and a series of negative discharges on the other; but he felt a certain reluctance in recommending the method to practical men so long as it was necessary to derive the current from a Wimshurst machine. A dynamo would be a more suitable generator if it were possible to get a sufficiently high potential. The way out of the difficulty is to rectify a high-tension alternating current, and Sir Oliver Lodge has for some time been considering the possibility of doing this by utilising Cooper-Hewitt mercury lamps. A study of these lamps has led him to believe that their rectifying power is much assisted by the outside metallic coating which surrounds the mercury electrode, and which is connected to the positive terminal of the lamp. In order to rectify an alternating discharge, four lamps are so arranged in the form of a quadrilateral that, when the leads from the terminals of an alternating transformer are connected to two opposite corners, two unidirectional currents are obtained from the other corners. Experiments have been made at Birmingham by sending the current from a high-frequency alternator (3,000~per sec.) through the primary of an induction-coil and connecting the terminals of the secondary to the rectifiers. The length of the rectified spark can be increased by putting a number of lamps in series in each arm of the quadrilateral arrangement. Sir Oliver Lodge performed an experiment at the meeting to show the dissipation of fog by electrification. The current from an alternator was passed through the primary of a coil, and the terminals of the secondary connected to the rectifiers, 12 lamps in all, three in series in each arm. This arrangement is capable of giving a rectified spark 2in. or 3in. long, the unidirectional nature of which can be proved by passing it through a Crookes or a Röntgen tube. Some magnesium wire having been burnt under a large bell-jar to fill it with a cloud of magnesium oxide, the jar was then illuminated by the light from an electric lamp. Passing through the base-piece upon which the bell-jar was placed was a conductor which terminated in a point inside the jar. When the terminals between which the rectified discharge was passing were separated and the other end of this conductor was joined to one of them, the electricity streaming from the point into the clouded atmosphere caused an immediate deposition of the magnesium oxide.

Prof. W. E. AYRTON congratulated the author and expressed his interest in the experiment showing the deposition of magnesium oxide. He pointed out that the combination of four Nodon valves for obtaining a continuous current from an alternating one had been used before. Dealing with the rectifier itself, he said his feeling was that the rectification was due to a difference in the electrodes and not to any special proximity of two electrodes through the glass as suggested by Sir Oliver Lodge. There were many cases of rectification—a metal-carbon arc for instance. In this case the explanation of the phenomon was probably connected with the fact that one electrode was metallic and the other carbon. In the mercury lamp both electrodes were metallic but the metals were very different from each other. Prof. Ayrton said that Prof. Steinmetz had recently shown him some interesting experiments with mercury arc-lamps, resembling in some details the Cooper-Hewitt lamp. There was, however, no choking coil, the starting being effected by an electromagnet capable of separating two tags within the tube, and causing a small arc which started the lamp. There was also no branch lead from the positive electrode to the mercury end of the lamp. In his opinion this connection was only a starting device in the Cooper-Hewitt lamp. Prof. Ayrton concluded by expressing his pleasure that the administrative duties of Sir Oliver Lodge had not interfered with his keen interest in scientific research.

Prof. H. L. CALLENDAR expressed his interest in the paper and in the experiments shown. In connection with the rectification he pointed out that under certain conditions any vacuum-tube would act as a rectifier, illustrating the point by an experiment with an X-ray tube. The phenomenon was noticed by Hittorf 30 years ago, and attributed by him to the constriction around the negative electrode.

Mr. W. DUDDELL said he should like to discuss the rectifying power of mercury lamps. Any two different electrodes in air will rectify to some extent. In the case of two carbons the diameters of which are as two to one, the resistance between them varies by 5 or 6 per cent., according as the current is passed one way or the other. With a metal carbon arc it is possible to stop the current altogether. A point and plate will also act as a rectifier. He thought that the condenser arrangement was to facilitate starting, and expressed the opinion that the rectification was due to the temperature of the electrodes and the temperature gradients near them. The temperatures of the mercury and iron in a mercury lamp were very different, and in the case of a point and plane there was a difference of temperature because of the cooling of the plane by radiation. He had also found that the best rectification takes place between electrodes having a high potential difference, and that when using the lamp for practical purposes the presence of impurities improved it by facilitating starting.

Dr. C. CHREE pointed out that there was a potential gradient in the atmosphere from the ground upwards which sometimes amounted to 1,000 volts per metre and was often 150 volts per metre. He asked if this difference of potential between the ground and the tops of high trees would have any effect upon the dissipation of fog.

Sir OLIVER LODGE, replying to Dr. Chree, said it had occurred to him that atmospheric electricity must be taken into account, and said it was quite feasible that point discharges from trees might have some effect upon fogs, but not enough. Replying to Mr. Duddell, he said they had found that for high tension rectification it was necessary to have as good a vacuum as possible, but for lamps working on low voltages it was beneficial to permit a residue of impurities. He said he was still of the opinion that the outside connection assisted the rectification in some tubes by throwing a great strain on the gas near the cathode.

Sir OLIVER LODGE then described

"An Arrangement for driving Mercury Pumps,"

designed by himself and Mr. B. Davies. The apparatus was constructed because the work necessary to make large numbers of vacuum-tubes renders it essential to drive the pump hydraulically. The preliminary exhaustion is effected with an ordinary Fleuss pump and the work completed by using a Töpler mercury pump. The reservoir of the pump is suspended from the rim of a six-inch wheel, and is almost counterbalanced by a water-vessel suspended from the rim of a two-foot wheel fixed upon the same axle. The water-vessel is capable of moving up and down between vertical guides, and mechanism is so arranged that when it reaches the top of the guides a tap is turned and it is filled with water. The increase in weight causes it to descend and raises the pump reservoir. When it reaches the bottom of the guides a valve in the bottom of the vessel is opened automatically and the water is discharged. The vessel then rises again and the process is repeated. Keyed to the axle carrying the two wheels referred to, there is a third wheel, one foot in diameter, over the rim of which passes a friction band. The function of this arrangement is to control the upward and downward motion of the water vessel, bringing it to rest quietly at each end of the journey, and yet allowing it to move quickly. There is also a device at the bottom of the guides for keeping the valve of the vessel open until the whole of the water has been discharged. The mercury which overflows from the pump is conducted back to the reservoir, thus giving a circulation of mercury and automatically replenishing the reservoir.

ROYAL COMMISSION ON LONDON TRAFFIC.

On Friday last, November 13,

Sir ALEXANDER BRUCE, Assistant Commissioner of the Metropolitan Police, continued his evidence, which, however, did not contain much of electrical interest. Amongst his suggestions as to a more efficient police control of the street traffic was one that the police authorities should be consulted as to the location of tramway routes and termini. At present this was not so. He then enumerated certain streets which, he said, were entirely unsuitable for tramways. These were as follows:—High-street, Brentford; High-street, Whitechapel; High-street, Shoreditch; Hackney-road; Newington Butts; Walworth-road; London-road; Southwark Park-road; Old Kent-road; King street, Hammersmith. He was particularly emphatic as to the disadvantages of the tramway termini at Shepherds Bush and Kew Bridge.

Superintendent BANTICK, of the D division of the Metropolitan Police, also gave evidence. He was of the opinion that tramways came too near the centre of London, and, contrary to the views of the London County Council, advocated the removal of the present Hampstead-road terminus to a point further away from the City. Tramways undoubtedly hampered the general traffic of a street, although congestion caused by electric tramways was probably less than with horse trams.

The Commission adjourned until to-day (Friday).

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SOME HINDRANCES TO THE DEVELOPMENT OF THE ELECTRICAL MANUFACTURING INDUSTRY IN THIS COUNTRY.*

Mr. E. W. Cowan, who, as chairman of the Manchester Local Section of the Institution of Electrical Engineers, delivered his inaugural address on Tuesday, devoted himself largely to a discussion of fiscal questions. He commenced, however, with an expression of his appreciation of the confidence shown in him in electing him chairman of the Manchester Section, the sincerity of which, he said, he would endeavour to show by rendering such service to the working of the section as he was capable of. He trusted, therefore, that he would not be considered ungracious if he began by finding some fault with the members. A circular letter had been sent round by the secretary inviting offers of Papers, a number of subjects being suggested as suitable. The only response to that communication was one solitary offer. In consequence, a heavy burden was thrown upon the shoulders of their hard-worked and able hon. secretary in arranging, with the assistance of other members of the committee, a suitable programme. If a similar procedure was adopted next year he feared that the 1904-5 session would commence without either a programme or a secretary.

Another local matter he wished to touch upon at once was the establishment of a joint meeting place and library for the technical and scientific societies of Manchester, a subject dealt with by Mr. Wordingham in his address to the section in 1900. Upon the invitation of Mr. Wordingham, other societies were approached, and a joint committee was formed to consider this question. The chairman of this committee was Sir James Hoy, the vice-chairmen Prof. Boyd Dawkins, Dr. E. Hopkinson, Mr. C. H. Wordingham, Mr. S. B. Wells and Mr. Reynolds, with a large and representative committee, including the chairmen and vice-chairmen of about a dozen local societies. This committee met on several occasions, and at the last meeting he (Mr. Cowan) was instructed, as hon. secretary, to bring their report before all the societies interested, and to ascertain what support might be forthcoming. He should be shortly bringing this matter before the committee of the Manchester Local Section, but it would depend more upon the practical interest taken by individual members of each society whether the suggested scheme or any modification of it would be put into practice. Still dealing with local matters, Mr. Cowan made reference to the loss of Mr. Wordingham from the Manchester district, and also to the fact that, on the initiative of Prof. Swartz, another effort was to be made to inaugurate a student's section in Manchester.

Coming then to the subject of his address, he said that they had heard a great deal lately about our foreign trade and the conditions which hamper its progress, but in that our home trade was vastly greater than our foreign, we should not overlook considerations which affect its welfare owing to our attention being engrossed by international questions. The published share lists of our electrical manufacturing companies pointed to one conclusion—viz., that our industry is sick. Nearly one-half of the capital invested in the undertakings listed in the electrical press was bearing no interest whatever. The investing public in this country had not forgotten the £12,000,000 which was lost in the early days of the boom in electric lighting. If we could not now offer a better return, we could not expect to restore the lost confidence. Ordinary share capital in manufacturing companies should bear an interest of not less than 10 per cent. to justify its being rated at par value. The influences which had injured trade in all or nearly all its branches recently in this country were the South African war, the over-production of Germany and America, the financial juggling of those men who lived by their wits and aggregated to themselves a vast unearned capital, with the consequent impoverishment of the worker, whose loss was often the financier's gain. But there was another aspect of the question.

It was a common experience to hear in this country manufacturers of electrical apparatus say: "Municipal contracts are not worth having." This was a very serious charge to make, and his own opinion was that, allowing for certain contributory faults on the manufacturer's part, the essence of the unprofitable nature of these contracts lay in the introduction of an element of *risk* or *chance* without the corresponding chance of increased remuneration which should accompany all contracts in which there is the element of a gambling risk. This element of risk came into these contracts under many headings. There was, first, the wording of the specification and of the general conditions, which declare on the face of them a one-sided bargain. Again, there was the delayed payment which increased largely the working capital locked up in this business. Further, there was the risk that the delayed payments would not be punctually paid.

Another point injurious to the home manufacturer was that he was hindered in standardisation, owing to the demand for alterations in designs, according to the opinion of the engineer. Whereas the home manufacturer's designs were overhauled and a number of small or large alterations demanded, the foreigners' standard apparatus, if accepted, was accepted generally without alteration. Generally speaking, a consulting engineer did, in his opinion, too much and too little. He would declaim against English manufacturers neglecting to standardise, and yet in his own work make standardisation impossible. Resident engineers, too, were frequently selected solely by reason of their technical experience, with the consequence that grave injustice had often been done to contractors, as from the word of the resident engineer there was practically often no appeal. The business incapacity of resident engineers had also an indirect effect damaging to the contractor who was executing work to the specification of the consulting engineer to the municipality. According to his own views, the manufacturer in this country should be able to look to the consulting engineers (or resident engineers when they take the consulting engineer's place) to protect the manufacturer's interests as well as the interests of their own clients. The consulting engineers could, in his opinion, have done much that they have not done in preventing municipal contracts from being brought into discredit. It was a primary condition of prosperity that the producers should be treated with justice. It might be contended that it was within the power of manufacturers to protect themselves by refusing to sign one-sided contracts, &c. To do so required that they should be in a strong financial position, which at present was not the case. Many firms were obliged to book orders at cost price or below cost price, as such a course involved less loss than doing nothing. And this was not a condition favourable to united action of a kind which would have a tendency to send more work into the hands of our foreign competitors than they were receiving now. At present no collective bargaining was possible on the part of the home manufacturer in the face of the alternative foreign market for the home buyer. It was not even worth while to attempt it. In concluding this portion of his address Mr. Cowan admitted that the faults of the manufacturer had in some measure contributed to the present condition of affairs. He then passed to the question of foreign competition as affected by Free Trade or Protection.

He started from the point that, though Protection might be proved to be unscientific, it might, nevertheless, be desirable. When, or if, any foreign trust or firm attempted to cripple or destroy an industry in this country by importation below cost price in order to gain a monopoly with a view to ultimate raising of prices, it would also be only a policy of common sense to provide that a Government department should be empowered, without reference to Parliament, to impose such prohibitions as might be found necessary to nip such an enterprise in the bud. We learned, on the authority of the Board of Trade blue book, however, that there was at present little or no evidence of such practice on the part of our foreign rivals. None the less, we should be prepared with a means of defence against that kind of attack. It did not seem to him that there was any force in the argument that because England had prospered under Free Trade, therefore Free Trade must be a right policy. Nor, on the other hand, that because Germany and America had increased in prosperity at a greater rate than we had under Protection, that Protection must be a right policy. In analysing this question from the economic standpoint, however, and also from the standpoint of a member of the electrical industry, the relation between imports and exports should first come under notice. The value of our imports had exceeded that of our visible exports for the last 46 years, and yet we had during that time grown immensely richer. That condition of affairs was, as far as it went, satisfactory, but equality of the value of imports and exports must of necessity be the normal condition of every country. Whether this was actually the case or not in Great Britain to-day was a controversial question. He took the following hypothetical case, however, and applied it to real conditions. Suppose that the consumers in a country decide to buy only imports from a foreign country, and to give no orders to home producers for anything that they consume. What would then be the position of the home producers? They would not be idle, as some seemed to think; they would be engaged in making exports of equal value to the imports. At *equal value*, but not necessarily at *equal profit*. They were in the postion of a shop, the goods in which must be sold by a certain date, and they would have to sell them at what they could get for them, making up in quantity what was lacking in value. It was not difficult to see in which of the two countries there would be prosperity under such conditions, especially if there was a hostile tariff in the foreign country. The problem was, of course, different under real conditions, but it appeared to him that, at a time when the demand for our exports was weak, it was in the nature of a *percentage difference* rather than a neutralising one. When the demand was strong the case was altogether different, and he could conceive that, in times when there was a large demand for our exports, the placing of orders abroad would add to our prosperity. The more the better.

"Dumping" was a trick of international commerce, and was due to three things: 1. Depression in trade, resulting in over-production. 2. The element of fixed capital in manufacturing business, involving fixed charges. 3. The loss due to temporary reduction of output. He had called dumping a trick, but it was a perfectly business-like operation in certain circumstances. It appeared to him that there was and had been a great deal of internal dumping in our home trade, especially in the electrical manufacturing industry. The improving of the load-factor of a central station by a below-cost price supply of electric current to the daylight consumer was on all fours with dumping. The contribution to fixed charges justified it on economic grounds. It did not pay, however, to over-produce in order to employ greater division of labour in manufacture, unless the surplus, when sold, contributed something to fixed charges.

In considering the broad question, however, we should distinguish between steady or continuous dumping and intermittent dumping. The former only needed a certain amount of adaptation on the part of the manufacturer. If the commodities dumped were not sufficient in quantity to supply the whole demand, there would arise apparently the extraordinary condition of two prices in one market. The home manufacturer could, however, adapt his selling arrangements to this condition and obtain his normal profit without any great difficulty. It would be some trouble to him, but the gain to the consumer is so considerable that he must take that trouble in the general interest.

The case with intermittent dumping was different, even though it were periodic, which it generally was. It was a question as to whether the quantity dumped was sufficient to result in the ruin of the corresponding industry in the home country.

* Chairman's address to Manchester Local Section of the Institution of Electrical Engineers. Abstract.

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The essence of the whole of this question, then, lay in the home producer's power of adaptability.

It was a question of how far this adaptability was commercially practicable to the manufacturer. So far as the electrical industry was concerned, he did not think that it was commercially practicable. Was it possible to efficiently adapt a factory laid out for dynamos and motor manufacture to any other branch of the industry, or was it possible with a lamp or a carbon factory? Assuming that it was not, there was still left the question whether the injury done to the home producer was not balanced or more than balanced by the gain to the consumer? But an analysis of the result to the home manufacturer was that the nature of his business might be such that he could not be driven from pillar to post in the choice of articles to manufacture. So far as the electrical industry was concerned, he thought that it was in the ultimate interests of the country that the consumer should be deprived of the advantage to him of dumping in cases where the vested interests of the manufacturers suffered.

Mr. Cowan then considered at some length the question of "Protection," using the word according to its usually accepted meaning. In this, he put forward a certain number of "postulates" which he summed up as follows:—

1. That Protection may be desirable, though economically unsound.
2. That Retaliation causes injury to our foreign trade, and results in economic loss unless effective in lowering foreign tariffs.
3. That temporary dumping for the purpose of destroying a home industry should be summarily dealt with.
4. That, in case of steady importation at prices below cost price of any commodity, the home producer must adapt or change his trade.
5. That intermittent dumping is detrimental to the development of our own manufacturing industry, and should be checked or stopped.
6. That placing orders abroad does not in times of normal trade involve loss of money to the country, loss of wages to the workman, or loss of profit to the home producers.
7. That when the demand for our exports is weak, loss may occur to the home producer when orders are placed abroad.
8. That the imposition of tariffs causes a check to the import and export trade, and that the consumer suffers loss.
9. That if our country is freely importing commodities from countries where the standard of well being of the people is below that of our own, it may result in the dragging down of our standard nearer to that of the foreign country.
10. That if the people in this country are out-distanced by the people abroad, owing to their increased facilities for cheap production or by high tariffs, weakening the demand for our exports to an extent which rendered exportation with advantage impossible, protective tariffs will become a necessity.

On the point that a flourishing export trade is regarded as an index of prosperity, Mr. Cowan said that some in the electrical industry began to wonder when that prosperity was coming their way. There had been undoubtedly an arrest in the progress of the value of electrical exports, but when we remembered the fall in prices of commodities, and corrected for that, it would be found that there had been a considerable increase in the quantity or volume of our foreign trade.

Scientific Protection, however, represented a means of applying a control to international trade, according to the dictates of reason, based upon a study of economic science and of economic facts and experience, which, while giving free play to the natural course of the laws of trade, mitigated the evils which must accompany a syseem dominated by individual self-interest. It was a system which recognises that as the buyer of imports and the seller of the corresponding exports had a common interest, they should be brought into touch with each other through a controlling centre. It was a policy which failed not in the principle, but in the difficulty of putting it into practice. Germany had faced these difficulties, with what measure of success or failure he left it to others to judge. The German people had a different temperament to ours; they were accustomed to paternalism. It should be remembered that there were many protectionists in Germany who fully appreciated the arguments in favour of Free Trade and understood the losses which a protective tariff involves.

In America he suspected that the power and organisation of the great trade combinations had exercised a dominating influence over the consumer, and that their fiscal system was adapted to the producers' requirements rather than to those of the consumers.

The practicability of a scientific protective system depended on whether a department of State could interfere, with a sufficiently full knowledge of the far-reaching and ultimate results of its action, to avoid doing more harm than good. And also whether the people of this country were sufficiently enlightened to be capable of framing the principles under which such a State department might act. Such a department would need to be one very different to our present Board of Trade, and it would be necessary that it should be represented in every centre of industry in the kingdom. It must be worked by men capable of giving a judicial decision with the impartiality of our English judges, and their action must be, in all cases, in strict accordance with the principles committed to their care by Parliament, It must not be governed by political economy experts nor by practical business men, but by a combination of both, with some added qualities which are peculiarly those of the statesman. Making yet another assumption, he said that, allowing for the impress of human weakness, such a department was a practical possibility. That, as we spent great sums of money on an army and a navy to protect our country, it might be worth while to spend something on a department to guard some of the principles referred to in connection with our trade, upon which our greatness and supremacy depends. It must be remembered that it was only by tariffs, prohibition, bounties, &c., such a department could exercise any control; and we should keep steadily before us the fact that these weapons must involve economic sacrifice to the country adopting them, as a primary result of their operation. The advantages to be gained were ulterior and secondary. Therefore, the legitimate objects which justified the sacrifice might be summarised as follows:—

1. The maintaining, as far as is consistent with the other principles enumerated, the natural and free course of international trade, so that all exchange, with a balance in favour of this country, shall continue unchecked.
2. The protection of home industries when foreign competition results in such a depreciation of prices as to put an injurious strain upon the home producer in providing the corresponding exports.
3. The protecting the standard of well-being of the people of this country from being dragged down to that of another country employing much low paid labour.
4. The mitigation of the suffering consequent upon the unrestricted working of individual self-interest.
5. The fostering of new industries well adapted to the resources of the country until they have had time to develop sufficiently to hold their own without assistance.
6. The checking of intermittent dumping and stopping dumping, which has been resorted to with the specific object of destroying an industry.

Whatever steps might be taken he trusted that in our own business the advantages which could only be gained by severe competition would not be lost. He referred in particular to keeping the home manufacturer up to the mark in the matter of design in respect to both cheapness and efficiency. Much had been learned from our foreign friends in this direction; we had only to look back upon the history of the development of electrical machinery to realise this. It was due to the impulse of foreign competition that our home manufacturers replaced the two-pole with the multipolar dynamo. The long delay in the development of the high-voltage incandescent lamp would certainly have been much increased but for the stress of Continental competition. Even in the old days of the Paddington Station, 180-volt lamps were in use; but, until the monopoly expired, the improvement in the manufacture of filament and the vacuum in the globe which rendered the high-voltage lamp a commercial article were not forthcoming. He thought that the temperament of the English manufacturer was such that he needed to be kept up to the mark, and when he was roused he would hold his own.

CORRESPONDENCE.

THE EDISON SECONDARY CELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in last week's *Electrician* a report of the presidential address of Mr. R. Kaye Gray to the Institution of Electrical Engineers on the 12th inst. Referring to the Edison nickel-iron cell, which, according to Mr. Gray, "appears to be on the verge of adoption on a commercial scale," he goes on to say: "There seems to be no question that the cells have fulfilled the claims made for them, and that their introduction in quantity will give an immense impetus to the electric automobile industry, and even to accumulator traction in general."

Might I ask Mr. Gray to what claims he refers? Is it to the claims with which we have grown familiar in the daily press during the past two or three years, such as that the new batteries can be put into half the space of the lead battery, or that they give as large an output as the latter, with half the weight? Such claims have been repeatedly advanced, and if this is what Mr. Gray means, it would be interesting to learn the nature of the evidence on which his assertion is based.

It is exceedingly difficult to ascertain what are Mr. Edison's own claims for his battery, and if, as one would seem justified in inferring from his remarks, Mr. Gray has any special or definite information on the subject, I think the public would be glad to learn its exact nature. Such figures as have been published by the Edison Company appear to show that the new battery—at any rate, as manufactured at present—developes less power weight for weight than the best lead batteries in use for automobile purposes, and requires at least 50 per cent. more space than the latter, besides being much more expensive.

We have heard so often and for such a long time that the battery is "on the verge of adoption on a commercial scale," that one may be excused for receiving the latest report *cum grano salis*, even though it emanates from such a distinguished source as the President of the Institution of Electrical Engineers.—Yours, &c.,

DAVID SMITH,
Secretary of the Electrical Power Storage Co. (Ltd)
London, Nov. 18th.

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STEAM TURBINES v. RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Permit us to assure Mr. Wilkinson that we have not intended to insinuate anything beyond what we have said in our letter. We called the statements extracted from his Paper misleading because these incorrect statements were largely used in his argument. As he does not in his reply dispute the inaccuracies, the remarks in our previous letter still apply to the facts. Mr. Wilkinson is evidently not aware of the extent to which superheated steam is being used with reciprocating engines in central stations. Hundreds of our engines working under superheat, some for four or five years, show that the troubles Mr. Wilkinson anticipates are purely imaginary.

Our triple expansion engines, expressly built to use superheat without risk, have shown benefits so great that nearly all up-to-date central station engineers have insisted on superheat for some time past in their specifications. The difficulty with the turbine under superheat is due to the expansion, which necessitates a considerable increase of the usual clearance to avoid the risk of stripping the blades when the maximum possible superheat comes on. This might be arranged for if the superheat could be kept constant, but as this is impossible, there must, on account of the excessive clearance, be a large increase of leakage under the normal working conditions.

As Mr. Wilkinson prefers to compare results "under actual daily working conditions" and to have "the outcome of every-day practice," we submit the following table giving the results of a year's working of all the provincial central stations we know of where steam turbines are used to any extent for electric lighting.

	Station.	Kw. capacity.	Total units sold.	Coal and other fuel.	Oil, waste & stores.	Works costs.	Total costs.
				Pence per unit sold.			
Steam turbines.	Blackpool	3,050	2,169,463	0·91	0·10	1·52	1·76
	Newcastle Dist...	2,500	1,619,671	0·69	0·12	1·22	1·63
	Cambridge	1,500	419,005	0·66	0·14	1·57	2·40
	Scarborough ..	1,085	431,777	0·85	0·08	1·61	2·65
	West Bromwich	650	295,848	0·55	0·11	1·10	1·79
	Morecambe	700	202,967	1·28	0·14	2·61	3·31
	Melton Mowbray	150	43,742	0·93	0·12	2·19	3·05
				Average 0·84	Average 0·11	Average 1·7	Average 2·37
High-speed reciprocating steam engines.	Leeds	8,740	4,448,650	0·28	0·03	0·62	0·89
	Halifax....	3,000	2,557,548	0·48	0·10	1·09	1·47
	Bootle	850	1,619,129	0·41	0·03	0·70	0·88
	Taunton ..	1,080	646,273	0·70	0·06	1·05	1·54
	Darwen ..	900	545,856	0·65	0·10	1·10	1·34
	Kings Lynn.	520	286,678	0·59	0·09	1·26	1·75
	Salisbury ..	200	150,222	0·46	0·07	1·21	1 80
				Average 0·51	Average 0·07	Average 1·0	Average 1·3

The figures are taken from the latest official returns published in the electrical papers, and for comparison we give from the same official returns an equal number of stations with reciprocating engines under approximately similar circumstances as to costs of labour, fuel, output, &c. The results are interesting, and show that the steam turbine stations on the average are quite 50 per cent. worse than the reciprocating engine stations, not only in the fuel used, but in the total cost per unit of electricity produced.

These official returns, if brought up to date, might possibly modify the results in favour of the reciprocating engine or otherwise by a decimal point or so, but the superiority shown by the reciprocating engine is too large to enable steam turbine advocates to quibble it away at present. We may say that the reciprocating engine stations have been chosen by us with as much absence of bias as possible, and we might have selected for example 38 stations showing an average of 0·41 for fuel cost instead of the 0·51 we have accepted for comparison sake. These figures are the only official ones at present published, and they should, in our opinion at least, give pause to the enthusiasts who want to rush the steam turbine for central station work.

Turbine enthusiasts appear to lose sight of the fact that the steam engine has not been standing still during the last few years, but has been largely improved by the judicious use of superheated steam in specially-designed engines. The reciprocating steam engine, in fact, is still far ahead of either gas engines or turbines for economy of fuel on the average station loads, and for comfort and reliability of running, on which the reputation of the station more immediately depends, there is no question as to the superiority of the steam engine.—Yours, &c.,

ALFRED MORCOM, Managing Director.
(For Belliss and Morcom, Ltd.)

Birmingham, Nov. 18.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Geo. Wilkinson's experience with reciprocating steam engines, as I gather from his letter published in your last issue, appears to have been unhappy. While one can be sorry for him, his conclusions are really too hasty to be passed without remark. There is at least one electricity works where steam superheated very considerably more than 60°F. has been in regular use for the past five years in quick revolution reciprocating engines. The engineers running the plant are quite happy about it, and would be glad to get the steam at a higher temperature if the superheaters would only give it. There has not been an accident in the five years due to the use of superheated steam other than the failure of a copper bend inadvertently left in the main steam pipe when the use of saturated steam was discarded. Valve faces, cylinder liners, piston rods, &c., that have been subjected to superheated steam for five years are still in excellent condition, and the cost of engine repairs will compare favourably with that of most undertakings using the same type of plant. During the whole of this period the cylinder oil used has not cost more than 1s. 10d. per gallon delivered at the works, and the quantity used is strictly moderate. There seems generally to be considerably more fear of superheated steam among engineers in charge of steam engines than there is any occasion for.—Yours, &c.,

Bournemouth, Nov. 14. E. LL. I.

THE INVENTION OF THE DYNAMO-ELECTRIC MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Our client, Dr. Henry Wilde, F.R.S., has seen us with reference to the letter from Prof. Thompson, which appeared in your issue of the 13th inst. We are instructed by him to correct—and must ask you to be good enough to give us the opportunity of doing so—an assertion made by Prof. Thompson in that letter and in his previous letter of October 30th, which amounts to this—that we sent to him for insertion in one of his books the statement that the name dynamo-electric machine was first applied in 1867 by Charles Brooke to the machine of Dr. Wilde's invention.

This statement was furnished in the first instance on April 12, 1902, by Prof. Thompson himself to our client, and was merely embodied in a document which we, at a later date, as Dr. Wilde's solicitors, sent to Prof. Thompson for signature. The assertion, therefore, that the statement was sent by us is misleading, as it suggests that it was an original statement made by us on behalf of our client, when, in fact, it was Prof. Thompson's own.

Our client considers that it was due to your readers that Prof. Thompson should have pointed out that the information on which this statement was based was not obtained from our client—either in conversation or by correspondence. It was to be found in (amongst other places) the *Journal* of the Institution of Electrical Engineers, Vol. XXIX., in the year 1900 (which was the year of Prof. Thompson's presidency of the Institution), and in our client's printed correspondence with the Society of Arts in the same year, on the award to him of the Albert medal (as set out in the *Journal* of the Society of that year), "for the discovery and practical demonstration of the indefinite increase of the magnetic and electric forces from quantities indefinitely small, *a discovery now used in all dynamo machines*, and for its application to the production of the electric search-light and to the electro-deposition of metals from their solutions."

Prof. Thompson no doubt obtained his information from one of these sources, and it is worthy of note that in the correspondence (copies of which were widely distributed, one of them being sent to Prof. Thompson) the application by Brooke

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of the term "dynamo electric machine" both to static and dynamic generators of electricity is fully and fairly dealt with, and references are freely given.

Our client considers it a matter for regret that Prof. Thompson is again bringing forward the claims of Werner Siemens to the invention of the term "dynamo-electric machine," after it has been clearly demonstrated (as appears from the quotation with which we close this letter) that the name was not employed by Siemens in his communication of January 17, 1867, to the Berlin Academy, as Prof. Thompson has repeatedly alleged in his book on dynamo-electric machinery. We have before us Prof. Thompson's letter to our client of April 12, 1902, in which he says:—"In making the former statement that this word" (*i.e.*, dynamo-electric machine) "was first used by Werner Siemens in his Paper at the Berlin Academy of Science, I was misled by Siemens' own subsequent allegation that he had done so. As, however, in the printed Paper the word does not appear, and as (on inquiry in Berlin) no one remembers that he did so when communicating the Paper, it is clear that his statement cannot be accepted as historic."—Yours, &c.,

SLATER, HEELIS, WILLIAMSON & Co.

Manchester, Nov. 17.

CAPACITIES AS MULTIPLIERS FOR ELECTROSTATIC VOLTMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The principle of the method for determining voltages by means of capacities and static voltmeters, described in *The Electrician* of October 9th, has been expounded by Herr W. Peukert already in 1898 (see the *Elektrotechnische Zeitschrift*, 1898, No. 39).

In 1901 I exhibited such apparatus before the Elektrotechnische Verein in Berlin (*Elektrotechnische Zeitschrift*, 1901, No. 12). Since that time they have been manufactured by the Allgemeine Elektricitäts-Gesellschaft for voltages up to 40,000 volts, as is evidenced by a prospectus and the English edition of the price list of measuring instruments which I send you herewith. The diagram given therein is the same as Fig. 1 in the article in your paper; with higher voltages, however, not only two, but three or four condensers in series are employed.—Yours, &c, DR. G. BENISCHKE.

Berlin, Nov. 16.

[Herr Peukert's just claim to priority was alluded to by Dr. E. W. Marchant in his letter published in *The Electrician* of October 16th.—ED. *E.*]

THE QUESTION OF THE HOUR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps you would kindly permit me to notice "G. R. N.'s" further lengthy letter, in which he opines that his "condensed" statement has caused me to misapprehend his argument.

There is a certain confusion and lack of sequence in the ideas of this correspondent. Take, for example, his remarks upon the shore ends of submarine cables. In his first letter he points out (very justly) that "no country can impose duties on conductors lying at the bottom of the *high* seas." Now, however, he takes me to task for following him in this plain statement of fact, and asks why should I limit his hypothetical duty on submarine cables to their shore ends, inasmuch as "obviously, a duty on the entire cost of the cables, *with the exception of the shore ends* . . . . was intended."

I cannot reconcile these two statements on his part, nor do I understand, in common, I think, with others, his further contention that cable rates cannot be increased except at the expense of the British public. As to his remaining statements in the same paragraph, should "G. R. N." happen to have any practical acquaintance with submarine telegraphy he will know to what extent the cable companies have really benefited by any 25 per cent. reduction of rates, and also, he will be able to judge what useful analogy can, at present, be drawn between the receipts from cable traffics and those of say, the penny postage system.

"G. R. N." now states that cables were a property over 25 years ago; quite so. But who disputes the fact; and, fact or no fact, what logical bearing has the circumstance upon his own prior statements and my "assertions" on this point, as contained in my first letter?

"G. R. N." is aware that two Continental Governments heavily subsidised national cables. He adds, "but even then the capital to lay them had to be raised from the public." Here again he speaks without his book. Before seeking to correct me and instruct your readers, ought he not to know the facts. In at least one of those two countries whose system of Protection and State subsidies so arouses his admiration the money for laying such cables is not subscribed for by the public. The procedure is very different. First of all, the subsidy is secured by certain individuals from the Government, and then it is hypothecated to some financial group, who find the money wherewith not only to lay, but to make the cable. Eventually and gradually the highly patriotic and protected public in that country are admitted to this "National" enterprise, but with results to themselves which even "G. R. N.," with his strange reasoning, might hesitate before suggesting to British investors for imitation.

There are notable omissions in "G. R. N.'s" letters. For example, he does not mention that, while in France and Germany submarine telegraphy has been heavily protected and subsidised for some years now, yet, notwithstanding the absence of these supposed advantages with ourselves, never has the cable industry been more active and more prosperous in Great Britain than during this period.

In my first letter I quoted the cable industry as a fair example of innumerable others in this country in which our continued success as the world's traders depends upon excellence of work and cheapness of output, the latter conditions being due to our system of free imports of raw material and articles required, both in manufacturing industries and for the comfort and well-being of the workers.—Yours, &c.,

H. C. D.

DESTRUCTOR AND ELECTRICITY STATIONS IN SMALL TOWNS.

In a Paper on this subject read before the Leeds Local Section of the Institution of Electrical Engineers yesterday, Mr. S. D. Schofield stated that: The destruction of refuse was a purely sanitary matter, and in no circumstances should that work be jeopardised for the sake of power production. However, the modern high temperature destructor might be used for steam raising without any fear as to that use being a cause of nuisance. The higher the temperature of the furnace, the less would be the risk of any noxious gases escaping into the atmosphere, and the higher would be the duty of the plant. Any of the leading makers would erect plant capable of destroying the refuse of a town without any nuisance, and without any dust being allowed to escape from the chimney, giving a guaranteed evaporation of 1lb. to 1½lb. of water for each pound of refuse destroyed, according to the value of the refuse. The results of a three weeks' test of the steam-raising plant at Shipley are given in the following table, the first week with the destructor in use supplemented with a coal-fired boiler, the second week with the destructor off, the coal boiler alone being used, and the third week with the destructor in use again. As all the boilers fed into one common pipe-range, it was not possible to run the destructor straight on to one steam dynamo and meter the output in that manner.

Taking the five days September 21st to 25th inclusive, the units generated were 12,961, and 41·35 tons of coal were used; this gave an average of 313 units generated per ton of coal used, and 7·1lb. of coal per unit. At an average price of 7s. per ton of coal, delivered, this equalled 0·266d. per unit generated. Taking the figures from September 14th to 20th, and September 26th to October 2nd, each inclusive, it would be found that 36,196 units were generated for the destruction of 265,075 tons of refuse, with the aid of 73·8 tons of coal. Taking a basis of 313 units per ton of coal, 23,100 units were

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generated by coal, leaving 13,096 units generated by refuse, being an average of 49·8 units per ton of refuse. No doubt these figures were well above the average for a destructor, but the exceptionally good daily load-factor assisted materially to produce this result. During the 12 months ending March, 1903, 6,525 tons of refuse were destroyed, the six stokers' wages amounted to £486. 13s. 8d., including labour in stoking 1,502 tons 7 cwts. of coal. This was equal to a cost for labour alone of 1s. 5·89d. per ton of refuse, and included all cleaning of boilers, flues, economisers, &c. Without a destructor, two stokers would be required for coal firing, and, on the other hand, at least five men were required for the furnaces. If 4½ men were taken for the furnaces, and 1½ for the coal boilers, the cost of labour would be 1s. 1½d. per ton of refuse destroyed. Thus, for an expenditure of 1s. 1½d., we get 49·8 units from each ton of refuse, which, if generated from coal, with the same plant and all other conditions equal, would have cost 1s. 1d. (49·8 × 0·266), so that, as far as an electricity department was concerned, is at least no gain but a slight loss. The figures of the tests were better than those which would be obtained over a whole year's working, but the writer was of opinion that it would be perfectly safe to assume that 40 units per ton of refuse would be the figure for the year ending March, 1904. Six thousand tons of refuse would then give 240,000 units, and at a cost of 0·266d. for fuel, per unit generated, would reduce the coal bill by £270, as a set-off against £332. 10s. (6,000 × 1s. 1½d.), the cost of destroying the refuse under the most favourable conditions. This was a clear gain of £270, as destruction by fire was the only possible way, and this was the saving if arrangements were made to utilise the power obtained from destruction. But to an electricity department this steam was not worth the £270 mentioned; against that must be set the unreliability of the refuse, the quality and quantity varying from day to day; the supervision to be given to a destructor steam-raising plant as compared with a coal steam-raising plant was far more, and necessitated a larger staff. It was impossible to keep out of the engine room all the dust incidental to works of this description, and these, and other disadvantages, reduced the pecuniary value of the steam thus generated. From the health committee standpoint, the reduction of management expenses, and the fact that a skilled staff at the electricity station was available for repairs and attention to the destructor plant were obvious advantages. The results given above showed that it was possible to combine the two undertakings, but the advantage to the electricity department was questionable. No engineer would prefer a destructor if he could turn his generators without one. The calorific value of the refuse varied almost directly as the price of coal in that district; if the coal was cheap the refuse was good, and if the coal was costly, the refuse was of less value. The Shipley destructor was of the Meldrum regenerative type, consisting of furnace, combustion chamber, Lancashire boiler and regenerator, the maximum capacity with average ashpit refuse being 50 to 55 tons per 24 hours. At Shipley there was not more than an average daily supply of 25 tons, which was easily disposed of. Mr. Schofield says nothing of interest on capital cost, depreciation, sinking fund, &c., which would give a more unfavourable appearance to the figures than they even now possess. If Mr. Schofield had worked these items out and included them in his Paper, its value would have been considerably enhanced.

Date.	Refuse destroyed.	Coal used.	Coal used.	Units generated.	Daily load-f'ctors	
					Traction.	Light & Power.
1903.	T. c. q.	T. c. q.	T. c. q.		Per cent	Per cent
Sept. 14	21 6 1	5 19 3	..	2,289 ..	23·2	54·8
,, 15	26 16 2	3 1 2	..	2,320 ..	21·5	61·9
,, 16	23 3 2	3 8 1	..	2,481 ..	17·2	62·5
,, 17	19 8 2	4 5 2	..	2,486 ..	18·2	55·7
,, 18	20 7 3	4 1 1	..	2,789 ..	18·5	45·1
,, 19	23 1 2	5 4 1	..	3,059 ..	27·1	68 6
,, 20	..	5 4 1	..	1,610 ..	31·4	17·6
,, 21	..	..	9 6 1	.. 2,434	24·0	63·0
,, 22	..	..	7 3 3	.. 2,411	21·8	66·8
,, 23	..	..	7 8 1	.. 2,663	21·0	48·1
,, 24	..	..	7 15 3	.. 2,482	23·3	63·7
,, 25	..	..	9 13 0	.. 2,971	22·3	53·3
,, 26	14 4 3	7 18 3	..	3,310 ..	26·8	50·2
,, 27	..	7 18 3	..	1,921 ..	22·3	38·4
,, 28	19 4 1	6 1 1	..	2,767 ..	22 4	48·5
,, 29	28 17 0	6 0 1	..	2,582 ..	19 6	40·6
,, 30	23 2 2	4 4 2	..	2,917 ..	19·9	53·3
Oct. 1	21 1 1	4 4 4	..	2,800 ..	17·2	56·0
,, 2	24 7 3	6 3 2	..	2,865 ..	18·4	35·4
..	265 1 2	73 16 3	41 7 0	36,196 12,961	..	..

LEGAL INTELLIGENCE.

Jandus Arc Lamp and Electric Co. (Ltd.) v. Arc Lamps Limited.

This case came before Mr. Justice Kekewich on Wednesday.

Mr. WILLIAM GRAHAM, for plaintiffs, said the action was brought to restrain the infringement of two patents of the Jandus Company by defendants. Plaintiffs had been advised that neither of their patents in the form in which they now were could be safely litigated upon, and the motion before his lordship was for plaintiffs to be allowed to amend their specification and the pleadings.

Mr. BOUSFIELD, K.C., for defendants, submitted that as plaintiffs could not win on their present materials the action ought to be dismissed, and defendants receive all costs so far incurred in this matter.

HIS LORDSHIP granted the application in the form of an order made in the well-known Ruddington case, with costs as asked by Mr. Bousfield. It was also directed that the action should stand over formally, no advertisements to be issued meantime by either party threatening penalties for infringement.

Ferranti Limited.

In the Chancery Division, on Tuesday, Mr. Justice Buckley heard a petition by Estler Bros. for the compulsory winding-up of Ferranti Limited.

Mr. BUCKMASTER, K.C., said the company carried on a large business, and had issued debentures for £100,000. The debenture-holders had appointed receivers and managers, who were carrying on the works, and a meeting of creditors had been called to consider a proposal for reconstruction. He asked that the petition might stand over for a fortnight.

His lordship assented, and ordered accordingly.

Re Automobile Supply Co. (Ltd.)

In the Chancery Division on Tuesday, Mr. Justice Buckley made, on the petition of C. Hoare & Co., an order for the compulsory winding-up of the above company.

Greenhouse v. South Lancashire Electric Traction and Power Co. (Ltd.).

In the Chancery of Lancaster on Monday, before Sir Charles Hall, K.C., plaintiff sought (on behalf of himself and other first debenture-holders in defendant company) for a declaration that certain extraordinary resolutions passed at a meeting of debenture-holders on Oct. 7 were not within the provisions of a certain indenture; also for an injunction restraining defendants from giving effect to such resolutions, and for the appointment of a receiver and manager.

For plaintiff it was stated defendant company was formed to acquire the undertakings of two subsidiary companies and extending the electric tramways in South Lancashire. The original capital named in the prospectus was £750,000 first mortgage debentures and £400,000 cumulative preference shares, but the subscription was only £51,132 preference shares and £521,602 first debenture stock. On that amount the directors embarked on their vast undertaking. Practically the only assets the company had were the two concessions from the subsidiary companies. The additional lines proposed had not even been begun, and it soon became apparent that the company could not carry out their Parliamentary powers with the money subscribed. The directors, however, went to allotment, and paid the promoters £50,000 in cash and allotted to them £50,000 in preference and £250,000 in ordinary shares. The directors were then in the position that their capital came to an end with their system still incomplete. It was proposed that the original debentures should be made second debentures, and that further debentures, to be classed as first debentures, should be issued to the amount of £600,000. That proposal was submitted to a meeting of debenture-holders and approved.

The VICE-CHANCELLOR, without calling on defendants, said the application failed. The company was formed substantially for the acquisition of shares in certain companies with the view of completing an undertaking, which included the South Lancashire Tramways, the Liverpool and Prescot Light Railway, and various other tramways either in existence or contemplated. The prospectus mentioned that the trust deed for the debenture stock could be inspected. From this trust deed it was quite clear that the majority were able to sanction any scheme of arrangement, although it deprived the debenture-holders of their security in part. It appeared that there were holders of £151,000 of debentures solely who voted in support of the proposed new issue as against holders of £26,500 who voted against. There was, therefore, an ample majority, and it was also easy to understand that they might readily support such a proposal in the hope that it might lead to the company being made a paying concern and so securing their interests.

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Tramway Rating.

At Bradford, on Thursday last week, before the West Riding magistrates, Bradford Corporation were summoned by Pudsey Corporation and Calverley and Farsley District Councils for general district rates, amounting to £31. The rates referred to the tramway lines between Thornbury and Stanningley. The extension of the tramways was made under a Bradford Corporation act, and this Corporation took over the powers contained in a light railway order applicable to the same route. Plaintiffs urged that the local act was in itself sufficient, and that the line had always been regarded as a tramway both in accounts and communications. Bradford Corporation maintained that the line was constructed under the light railway order, and that being so, they could only be rated to the extent of one-fourth the total value.

Mr. HARRISON, for complainants, contended that the line ought to be rated at its full value, as it was a tramway. If that was not so, one section (from Thornbury to Woodhall End) would be half a light railway and the other half a tramway.

For Bradford, the DEPUTY TOWN CLERK (Mr. Wardle) said the Corporation had powers to lay either a tramway or a light railway. A light railway was laid because they had the right of a double track, whereas, if they had constructed a tramway, they could have had only a single line with passing places. There could be no physical difference between tramways and light railways as now laid. He submitted that the line in question was a light railway, and he put in the certificate of the Board of Trade given when the line had been inspected and passed, which described it as a light railway. The powers of a light railway order applied to the whole length of the line between the boundaries of Leeds and Bradford. Under these powers it was not necessary for Leeds Corporation to obtain the consent of the local authorities to construct a line. If their consent had been necessary, then the local authorities interested could have raised their objections before a line was constructed. The money for the construction of the line had been borrowed under a light railway order. He admitted that the Corporation could not get rid of their responsibilities, even if the light railway proved to be an inconvenience.

The Bench decided that the line might be a light railway; but, even if it were, it would not be entitled to the reduced rating. They, therefore, made an order for the payment of the amount claimed.

Notice of appeal was given.

Tramcar Passengers and their Tickets.

At the Liverpool County Court, last week, before Judge Collier and a jury, Mr. Hughes claimed damages from the Liverpool Corporation for wrongful arrest.

For plaintiff it was stated that on Aug. 28 plaintiff boarded a tramcar and paid his fare (1d.). On the journey an inspector asked him to show his ticket, which he had thrown away. The inspector informed him he must pay again. When asked for his name and address plaintiff refused to give it, as he contended it could not be legally demanded when he had paid his fare. The inspector gave plaintiff into custody, and he was detained at the police station until he gave his name and address, which he did under protest.

For the defence it was submitted that there was no case for the jury, as it had not been proved that the inspector did anything more than he was entitled in law to do. If plaintiff did not produce his ticket, he was bound to pay, and as he refused and would not give his name and address, the inspector had the legal right to detain him. If he had given his name and address he would have been proceeded against by summons.

For Plaintiff it was urged that the bye-law under which the inspector acted was only intended to meet fraud or attempted fraud.

Judge COLLIER: On demand a passenger must show his ticket or pay his fare. If a man throws away his ticket he does it at his own risk.

Eventually plaintiff was non-suited.

Tramway Track Repair.

At the West Hartlepool Police Court on Monday, the General Electric Tramway Co. were summoned by the Corporation for failing to keep certain portions of the track on their West Hartlepool to Hartlepool section in proper repair.

The BOROUGH ENGINEER (Mr. J. W. Brown) said he inspected the track on Nov. 2 and 3, and found that parts of the granite pavement were 1½in. above the rails, whilst at others the rails were considerably below the pavement. The condition of the track was dangerous.

Mr. TYLDESLEY JONES, for defendant company, submitted that that Court had no jurisdiction. He quoted sec. 33 of the Tramways Act, 1870, which provided that in any case of difference between a tramway company and the local road authority as to the construction of track the matter should be referred to the Board of Trade.

The TOWN CLERK said it was not a question of construction, but of maintenance and repair, and the Board of Trade had directed the Corporation to that Court to enforce the order.

The Bench found the case proved, and imposed fines amounting to £4, and costs.

M'Kechnie, jun., v. Lowdon Bros. & Co.

This action, for the recovery of damages for personal injuries, has been settled by the payment of £100 to the pursuer. On April 10 last, pursuer, while in the employment of defenders as an apprentice electrician, fell 35ft. from a new building in Glasgow.

Peculiar Compensation Case.

Judge Parry heard at Salford County Court on Friday last a claim by a night watchman named O'Brien against the British Westinghouse Co. for compensation for injuries received in May last during a struggle with a man whom he had found on the company's premises masquerading as a ghost. For defendants it was contended that the injuries were not received in the course of plaintiff's employment, but his Honour granted compensation of 14s. 4d. per week, as he held that it was the duty of plaintiff to repel or capture trespassers, and that he could not have been expected to know that the intruder was not on the premises for dishonest purposes.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Sheffield Corporation desire applications for the post of general manager to take the control and management of the working of their tramways. Applications to the town clerk (Mr. Henry Sayer) Town Hall, Sheffield, by noon Dec. 1. See also advertisement.

The Sanitary Commissioners of Gibraltar require an assistant electrical engineer. Salary £200, increasing by annual increments of £10 to £250 per annum. Applications by Dec. 16 to Mr. William Wallace Copland, secretary and engineer, Sanitary Commissioners' office, Gibraltar. See also advertisement.

A manager is required for the development aud extension of a leading electric power supply company's businesss. Further particulars in an advertisement.

An assistant, with factory experience, is wanted in the electrical engineering department of the City and Guilds of London Central Technical College, Exhibition-road, S.W., to give instruction in the theory and practice of electrical machine design, construction and testing. Salary £150 per annum. Applications to Prof. Ayrton. See advertisement.

An under foreman is wanted to take charge of electric repair shop, comprising armature winding, bench and machine work. Applications to Messrs. Harland and Wolff, Belfast. See advertisement.

Poplar (London) Borough Council invite applications for the position of borough electrical engineer and manager at £400 per annum. Applications to town clerk (Mr. Leonard Potts) by Nov. 28.

A resident tutor in physics, with mathematics or chemistry, is required for Trinity College, University of Melbourne. Salary £300 per annum, with board and residence. Applications to Mr. P. V. Bevan, Trinity College, Cambridge.

Mr. J. B. Gibbons, Engineer, City District National Telephone Co., has been appointed engineer to the Oriental Telephone and Electric Co., and will shortly proceed to the East for the purpose of conferring with the local managers and advising the board as to what system of underground cabling should be adopted for their exchanges in India, China, Burmah and the Straits Settlements.

Dr. J. Donald Pollock has been appointed radiographer and superintendent of the electrical department of the Cancer Hospital, Fulham-road, London, S.W.

Mr. Sidney H. Rhodes of Morecambe has been appointed assistant electrical engineer at Oldham.

Mr. J. G. Longbottom, lecturer in mechanics, has been appointed professor of mechanics at Glasgow and West of Scotland Technical College, in succession to Prof. Rowden, resigned.

Mr. Holme, assistant manager and accountant of Portsmouth municipal telephone department, has been appointed telephone engineer to Hull Corporation.

Mr. R. C. Coxon of Sunderland has been appointed general clerk and Mr. H. Atkinson, York, switchboard attendant at Bermondsey (London) electricity department.

Mr. John Lincoln, telegraph inspector for the northern district of London, has been appointed postmaster at the House of Commons.

Acton.—The Council have engaged Mr. W. H. Trentham as consulting electrical engineer for three years, and the question of the erection of combined electricity supply and refuse destructor works has been referred to him for further report. It has also been decided to employ steam-driven plant.

An "Infant" Company.—An amusing case was heard before Judge Emden at Lambeth (London) County Court on Wednesday, H. W. Branley was sued by the Imperial Motor Co., Brixton, to recover nearly £5 for repairs to a bicycle. Defendant pleaded infancy, and when asked his age, said it was 17. Counsel for the prosecuting company said defendant, although only 17, was trading as "H. W. Branley & Co., electrical engineers." This announcement gave Judge Emden an opportunity of administering a severe reprimand to the defendant, and the "company" was ordered to pay the plaintiffs' claim and costs at "short notice."

Antony.—The consulting engineer (Mr. J. Enright) has submitted his report upon electricity supply. It is estimated that the cost of erecting works will be about £7,000.

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Argentina.—The *Review of the River Plate* states that Rojas Municipal Council is open to receive proposals for erecting electricity works.

Las Flores Council are about to arrange with Senor Lombardi, a local millowner, for the supply by the latter of electricity for public lighting.

There is a probability that a municipal electricity station will be established shortly at Azul.

The Postmaster-General has drawn up proposals for the joining up of the telegraph land lines with those of the other South American States, and for joint working.

The Corporacion Comercial Sud Americana, which was recently registered with a capital of $100,000 gold (increasing to $1,000,000), has offered, it is stated, on behalf of London bankers, to construct and work for 26 years the projected Buenos Ayres municipal electricity works. It is proposed that the capital expenditure (estimated at something like $13,600,000 gold) should be repayable in 26 years, and the company signify their willingness to take a portion of the bonds at 85 per cent.

It is reported that Buenos Ayres Grand National Tramways Co. has refused the terms of the Municipality for the concession for the adoption of electric traction on their system. The company asked for 99 years and the Municipality offered 55.

Messrs. E. E. Clèrice & Co. have obtained a concession to construct a system of electric tramways from La Bahia de Sans Blas, on the Atlantic coast, to Carmen de Patagones. Further particulars are given in the *Boletin Officiale* of Oct. 14, which can be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

Asylum Lighting.—Wilts. County Council have sanctioned expenditure of £6,150 upon electric lighting and other works at the county asylum.

Bath.—The accounts of the electric lighting department for September quarter show a gross profit of £635, against £469 in the corresponding period last year. Owing to increased charges for interest and sinking fund, the deficit is £928, compared with £859.

Bermondsey (London).—The Surrey Commercial Dock Co. have consented to electric cables being carried through their premises and across the Surrey and Lavender docks. In a report by the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson) submitted to the Council on Tuesday, it was stated that since the Thames Ironworks Co. completed the re-winding of the generator armatures the machines at the station had been entirely satisfactory, and the sparking and tendency to flash over which was noticeable with the armature winding originally put in had entirely disappeared. They had, therefore, issued a final certificate which closed the accounts under the contract. Included in the amount due to the Thames Ironworks Co. was £243. 12s., which represents the bonus due to the contractors on account of the steam consumption of the engines being below that guaranteed. The report was adopted and the bonus of £243. 12s. passed for payment.

Brierley Hill.—Application has been made to the Board of Trade for an extension of two years in which to comply with the terms of the Council's electric lighting order, 1900.

Caerphilly.—Owing to the satisfactory nature of the recent canvass of ratepayers, applications for the equivalent of 2,720 8 c.p. lamps having been received, the Council have decided to proceed with their application for an electric lighting order.

City of London.—At the meeting of the Court of Common Council last week the Streets committee submitted a recommendation in favour of new gas lamps fitted with incandescent burners being fixed in several thoroughfares within the City.

Mr. Painter, in moving an amendment that the question be referred back, asked the Court to hesitate before spending any more money in the direction proposed. He referred to the investigations of the Westminster City Council, who had found incandescent electric lighting much cheaper than incandescent gas. The recommendations were, however, agreed to.

Companies Struck off Register.—The following have been struck off the Register of Joint Stock Companies:—

Automatic Fog-Signalling and Railway Appliances Syndicate.	Electric Arms and Ammunition Syndicate.
British Volta Electric Glow-Lamp Co.	International Electric Storage.
Collier-Marr Telephone and Electrical Manufacturing Co.	Lithanode Electric Storage Co.
General Traction Co.	Merthyr Tramway Co.
	Monte Video Tramways Co.
	Universal Electric Lighting Co.

Darlington.—The charge for electric current supplied to the tramways has been fixed at 1¾d. per unit.

Dartford.—The Electric Lighting committee have been instructed to consider and report upon the best method of exercising the powers of the Council for the construction of electric tramways.

Dundee.—The Tramways committee are considering the possibility of utilising the water power available at the city reservoir at Lintrathen in the generation of electric energy.

Durham.—The County Council has resolved to re-elect the special committee appointed some time ago to investigate and report upon the feasibility of a county scheme of electricity supply.

East Ham.—Sanction has been received to a loan of £2,700 for the purchase of five additional tramcars.

Wanstead Council have been asked to consent to the extension of the tramways in that district. Inquiries are being made as to the running of motor omnibuses, and certain members of East Ham Council are to visit Hastings, to inspect a type of omnibus used in that town.

Edmonton.—At the half-yearly audit of the District Council's accounts on Wednesday, objection was raised by ratepayers to expenditure in connection with the opposition to the bill promoted by the North Metropolitan Electrical Power Distribution Co., and at the efforts of the Council to establish municipal electricity supply.

In 1900 the Tottenham, Edmonton, Wood Green and Southgate local authorities were successful in excluding the company from their districts, and then promoted a bill for enabling the Councils to jointly undertake electricity supply. This bill had, however, to be dropped in consequence of an adverse vote of ratepayers in two of the districts, and then the Edmonton Council applied for and obtained a provisional electric lighting order, and incurred further expenditure in engaging electrical experts. The auditor was, therefore, asked to surcharge amounts exceeding £1,000, which, it was contended, the Council had expended without mandate from a majority of the electors. The auditor, however, held that the Council were entitled to expend money in opposition to private bills where the interests of the Council were affected, and so far as expenditure in other directions referred to was concerned, he deferred decision in the matter until the adjourned audit.

Electric Driving in Mills.—A large order has recently been obtained by the British Westinghouse Co. for two turbo-generators and auxiliary plant, which will form the first introduction of the large modern steam turbine for factory driving in India. The plant will supply electric power to drive the jute mill of Messrs. Birkmyre Brothers on the River Hugli, near Calcutta.

The turbo-generators will each be of 1,300kw. capacity, furnishing three-phase current at 440 volts and 25 periods. Each turbine will exhaust into a vertical surface condenser having 4,800 sq. ft. of cooling surface, and the exciter generators of 20kw. each will be mounted direct on extensions of the turbine shaft. The turbines are to be of the multiple expansion parallel-flow type, running at 1,500 revs. per min. With steam at 1,175lb. per sq. in., 27½in. vacuum and 200° F. superheat, a low steam consumption will be attained. There will be eight Economic boilers employed, supplied by Messrs. Davey, Paxman & Co., of Colchester. The various departments of the mill will be driven by Westinghouse polyphase induction motors, type C, varying in size up to 700 H.P. The three 700 H.P. motors will run at 290 revs. per min. and will be direct-coupled by solid flange couplings at each end of the spindle to 350ft. lengths of shafting. A large number of slow-speed motors will also be used for direct-coupling to shafting. The contract includes switchboard and auxiliary apparatus, transformers, and two jib cranes.

The saw mills of Mr. F. G. Minter, at Putney, London, have been equipped with sawing, planing, moulding, &c., machines, by J. Sagar & Co., Halifax, the whole of which are driven by electric motors supplied by the Electromotor and Dynamo Co. Each machine (there are 14 in all) is belt-driven from a separate motor, two phase current being supplied at 200 volts by the County of London Company.

Electric Hauling in Australian Mines.—The *Australian Mining Standard* reports that underground electric haulage plants have recently been installed at the Berry Consols Extended Gold Mining Co.'s mines at Creswick, Victoria. The plant was erected by the Austral Otis Co. on behalf of the Ganz Co., and includes a belt-driven Ganz dynamo by a Buffalo horizontal engine. Electrical energy is also supplied for lighting and for two 9 B.H.P. locomotives.

Electric Lighting Notices.—The following additional notices of intention to apply for electric lighting provisional orders have been given:—

Clitheroe Corporation, Walmer District Council, Northampton Electric Light and Power Co. (extension of area) and Mr. E. P. Harvey (for Hexham, Acomb, Sandhoe, Hexhamshire, West Quarter and Warden in Northamptonshire). In the Clitheroe and Walmer orders clauses are to be inserted to enable the Councils to purchase, sell and let fittings, &c., and for the transfer of the powers to a company.

Electric Power in Cheshire.—A syndicate has been formed for the promotion of a bill to authorise the generation and supply of electricity for lighting and power throughout Cheshire. It is proposed to erect stations at Neston, Middlewich, Frodsham, Timperley, Bollington, and Dukinfield. The area to be served is to a large extent industrial, and contains several manufacturing districts.

Electric Traction Notices.—West Ham Corporation are applying for a provisional order to extend their tramway system.

Crompton and Royton District Councils are also applying for provisional orders to revive and extend the powers granted by their 1901 tramway orders, &c.

Electricity in Bakehouses.—The Home Secretary has issued an order modifying the proportion of cubic feet of space to each person employed in underground bakehouses:—

(1) As regards underground bakehouses by substituting 500 for 250 cubic ft. of space to every person; and (2) as regards bakehouses where work is carried on at night by artificial light *other than electric light* by substituting in respect of the period between nine in the evening

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and six in the succeeding morning, 400 for 250 cubic ft. of space to every person.

Engineering Standards Committee.—The committee have appointed Messrs. Crosby Lockwood & Son, Stationers' Hall-court, London, E.C., official publishers to the committee. Reports and specifications published by the committee may be had either from Messrs. Crosby Lockwood or direct from the offices of the committee.

Exhibition.—Eastbourne Corporation propose to hold an electrical exhibition in the Town Hall from Tuesday, Dec. 1, till Saturday, Dec. 5, inclusive. Electrical or manufacturing firms desirous of exhibiting can obtain particulars from the borough electrical engineer, Mr. J. K. Brydges, electricity works, Eastbourne.

Fair Contracts Clause.—Cheshire County Council, by 21 votes to 17, have rejected a resolution to include in future conditions of contracts a clause to compel all contractors when competing for work to undertake to pay the standard rate of wages, work the recognised number of hours and observe the accepted conditions of employment in operation in the district in which the work is to be carried out.

Faversham.—The following scale of charges for electricity supply has been adopted by the Council:—Private lighting 6d, small motors 6d., motors over 2 H.P. 3d, meter rents 1s. per quarter up to 25 8 c.p, 1s. 6d. per quarter up to 50 8 c p.

Festiniog.—At a meeting of the Council last Friday it was decided to employ a competent adviser on electric lighting matters. There appears to be same friction between the Council and the Yale Electric Power Co.

Finchley.—The Electricity committee recently received a communication from the North Middlesex Gas Co. complaining that a cable had been laid in dangerous juxtaposition to the gas mains, and requesting that the same be removed; further, that in case of accident they would hold the Council responsible.

The electrical engineer reported that, in his opinion, there was no danger in consequence of the position in which the electric mains had been laid, and the clerk has been instructed to state that the Council do not consider that there is any danger as alleged, but that if the company were still of opinion that there is, the Council would be prepared to alter the position of the main at the expense of the company, or refer the matter to the Board of Trade for arbitration.

Foreign Competition.—There has been considerable adverse criticism of the recent action of Brighton Corporation in rejecting the tender of the Brush Electrical Engineering Co. for the supply of tramway cars and trucks, and this criticism has culminated in a mass meeting of the men employed at Loughborough works, who passed resolutions of protest. There are 2,000 men engaged in these works, and Mr. E. E. Cook, the rolling stock superintendent of the Brush Company, was recently interviewed. He pointed out how seriously the action of the local authorisies in sending their contracts abroad affected that section of the artisan class engaged in tramway truck and car construction. Mr. Cook stated that at least £25 per ton of trucks is spent in labour alone, and as 2,000 trucks weighing 2 tons each are built in Great Britain every year, this represents a wages bill of £100,000 per annum. This sum is depleted by any orders passed to foreign competitors. Mr. Cook is of opinion that "a tariff against foreign-made trucks would enable the Brush Co. to forge ahead, and to double or treble their works to meet the demand." Needless to say, Mr. Cook enters very heartily into the spirit of Mr. Chamberlain's proposals.

Frome.—The Council have accepted the offer of the Urban Electric Supply Co. for the electric lighting of the streets at £845 per annum. Application has been made for sanction to a loan of £8,500 for extensions of the electricity works, which will bring the total capital expenditure to £28,500.

Glasgow.—The Electricity committee submitted to the Corporation yesterday (Thursday) recommendations that the extension of the Port Dundas electricity station be proceeded with, and that the committee be authorised to appoint a deputation to visit Sunderland or any other English town where steam turbines are in use at electricity works, before submitting recommendations with regard to new plant for Port Dundas and Pollokshaws-road stations.

Harrogate.—The Council have abolished electricity meter rents.

Ipswich.—The Board of Trade inspection of the new municipal electric tramways takes place to-day.

King's Lynn.—The Council have rejected a proposal to apply for a provisional order to supply electricity in West Lynn, Gaywood, &c.

Leek.—The District Council have taken up a loan of £9,261 at £3. 15s. per cent. for electricity supply.

The Electricity committee received 70 applications for the appointment of resident electrical engineer. This number has been reduced to the following four:—Mr. J. R. W. Grainge (London), Mr. A. France (London), Mr. F. M. Carr (Maidstone), and Mr. J. W. Hame (Wigan).

Light Railways.—The Board of Trade have confirmed the Bere Alston and Calstock (extension of time) and the Totton, Hythe and Fawley orders.

Llandudno.—On the recommendation of the Light Railways committee, the Council have agreed with the Light Railway Co. (in the event of the Colwyn Bay Council obtaining an injunction restraining Llandudno Council from supplying electricity to the company outside Llandudno) to accept £750 instead of £1,000 as the minimum sum to be paid by the company in any one year for current for traction.

London County Council.—At Tuesday's meeting the Highways committee recommended that a special meeting of the Council should be held to consider the question of purchasing the undertaking of the London Southern Tramways Co., and that the local authorities in whose district the tramways run be asked whether they would object to the overhead system of electric traction being adopted, and would pay a contribution to the cost of the necessary street widening.

In the course of a long discussion on this proposal, Lord Welby and other members warned the Council against further increasing its commitments for the purchase of tramway undertakings.

Eventually, however, the recommendation was agreed to with only four dissentients.

Tramways.—The same committee recommended that an expenditure not exceeding £90,000 be authorised for the purchase of 12,500 tons of rails, conductor tees, fastenings, &c., required for the electrification of portions of the northern system of tramways, and the reconstruction of the cable tramways between Kennington and Streatham.—Agreed to.

It was decided that the following suggested tramway routes be not proceeded with:—Southwark-street, via Stamford-street and York-road, to Lambeth Palace-road; Shepherd's Bush-road, via Richmond-road, High-street, Notting-hill and Bayswater-road, to Marble Arch; Battersea Park-road to King's-road, Chelsea; and Tooting High-street to the county boundary.

This decision is due either to the refusal of the local authority concerned to give consent or to the refusal of the local authority to contribute to the cost of street widening.

It was decided that the offer of Messrs. J. G. White & Co. be accepted to carry out the road work for the St. John-street and St. John-street-road (Northern) Tramways at a price 15 per cent. above that of their contract for the reconstruction of the New Cross and Greenwich tramways.

The question of spending £35,000 on the rebuilding of the car sheds at Streatham to suit the altered condition of electrical traction was adjourned.

The extension of the existing tramways in Tooting High-street and the construction of new termini there at a cost of £13,850 was approved.

Deptford Fire Station.—It was agreed to take from the London Electric Supply Corporation a supply of electric current for the new Deptford fire station for a period of two years, the Council guaranteeing a minimum payment of £50.

Littleborough.—Sanction to a loan of £1,370 for electric lighting has been obtained by the Council.

Loughborough.—The Council on Monday considered the revised estimate of their consulting engineer (Mr. C. H. Gadsby) for the erection of electricity works, and it was decided to proceed and apply for sanction to a loan of £30,000. The total cost of the revised scheme (which involves the erection of electricity works of a capacity of 600kw.) is £28,408.

Lowestoft.—The proposal to introduce a system of free or assisted wiring has been postponed. In future consumers are to have the option of taking current either on the present maximum demand system of 7d. and 3d., or at a flat rate of 6d. per unit on signing an agreement for 12 months.

Market Lighting.—Since Friday last the wholesale market at Smithfield, Birmingham, has been lighted electrically.

Monmouth.—The borough electrical engineer (Mr. Blake) has reported to the Council upon the recent interruptions in the supply of current owing to the failure of the high-tension cables. Mr. Blake attributes the fault to bad jointing.

Municipal Incandescent Lamp Works.—It is stated that the Vienna Municipal Council have accepted an offer for the erection of a municipal incandescent electric lamp factory. The Council also proposes to issue stringent rules as to the testing of lamps, &c.

Municipal Telephony.—Following is an extract from a letter sent by Mr. W. E. L. Gaine, general manager of the National Telephone Co., to the Mayor of Brighton, under date Nov. 16:—

Sir:—I am directed to call the attention of the Town Council of Brighton to the methods adopted by its Telephone committee in conducting its competition with the National Telephone Co. I enclose copy of a letter addressed by the chairman of the Telephone committee to the managing director of Messrs. Hoadleys, Limited, Burgess Hill, who have signed a contract for telephone service with the National Telephone Co. This company has evidence that similar letters have been addressed to each of the persons and firms at Burgess Hill who have signed similar contracts, and that, in the case of the Tradesmen's Association of that place, a cheque for £100 was sent with the object of inducing its members to support the Corporation in preference to the com-

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pany. The cheques sent to the Burgess Hill people are the personal cheques of the chairman, and, unless the chairman is to be credited with unusual philanthropy and zeal, it must be assumed that he will eventually be indemnified by the Corporation, in which event the Corporation will be a party to an illegal expenditure of public money.

In addition to this, a distinct promise is made to the effect that no rental will be charged by the Corporation for telephone service until these persons are able to speak to 750 Corporation subscribers. This promise constitutes a distinct breach of the provisions contained in the Corporation licence against the giving of favour or preference, and the Company has therefore felt it its duty to call the attention of the Postmaster-General to the matter.

The main object of the Company in this correspondence is to suggest for the consideration of the Town Council whether these methods of conducting a competitive service which the Corporation has perfectly legitimately set up, are such as ought to be resorted to by a great public authority, and I am directed to say that they will not be followed or adopted by the Company, as they do not, in the opinion of its Board, constitute legitimate and proper methods of doing business.

The letter referred to by Mr. Gaine as having been addressed to the managing director of Hoadleys Limited:—

Dear Sir: Referring to my call upon you the other day, I hope your firm will see their way to support the Brighton Corporation telephone system at Burgess Hill. Mr. A. P. Serase, Mr. S. T. Maynard, Mr. Davies, Mr. Thornton and a large number of very influential Burgess Hill gentlemen are supporting our system. The St. George's Retreat, Hayward's Heath Asylum, and several other important institutions will be connected with our system, and we are particularly anxious to secure the support of your influential firm. There is no doubt that the fact that Burgess Hill is about to enjoy a cheap telephone service is entirely due to the enterprise of Brighton Corporation, and I would point out that the limited service of 1,800 calls for £5 offered by the National Telephone Co. is only equal to about five calls a day, which you will be sure to exceed as as the system extends. Brighton Corporation have obtained the support of 1,200 of the leading firms in Brighton, and there can be no doubt that the great majority of subscribers in Brighton are joining the Corporation system. I am aware that you had signed an application to join the National Telephone Co's system before you realised that we should be at Burgess Hill, and I accordingly enclose you a cheque for £5 to enable you to pay off the National, as your liability to them is merely for one year's subscription. I send you this cheque on condition that you will not join the National Telephone Co. for this year, and that you become a subscriber to the Corporation system. We will undertake to give you a service with Brighton within a fortnight, and no rental will be charged until you can speak to 750 subscribers. You will admit that two systems at Burgess Hill will be a very great nuisance, and now is the time to prevent the establishment of the National Telephone Co. at Burgess Hill. I am glad to see the Burgess Hill Council are supporting our system and we also have the support of the County Council and every local council in the Brighton area. Subscribers to the Brighton Corporation system can speak to all the National Telephone Co's subscribers in London, Eastbourne, Seaford, Worthing, Lewes, and in every town in England except Brighton, on payment of the Post Office fee for trunking. All terminal fees charged by the National will be paid by Brighton Corporation.—H. Carden.

The telephone exchange system of the Brighton Corporation was brought into use on the 13th inst.

At Tuesday's meeting of Glasgow Telephone committee the general manager (Mr. A. R. Bennett) reported that the number of telephones subscribed for had reached 10,322.

Newcastle-on-Tyne.—The Corporation resolved on Wednesday to promote a bill for various improvements, including the construction of additional tramways.

Newfoundland Telegraphs.—Mr. R. G. Reid has sent in a claim against the Government for $3,000,000 for losses sustained by him through the Government taking back from him in 1901 the control of the Newfoundland telegraph system.

Obituaries.—Mr. James Buchanan Mirrlees, a partner in the well-know Scottish firm of Mirrlees Watson Co., died at his residence at Kelvinside, Glasgow, on Monday in his 82nd year.

An inquest was held last week into the circumstances attending the sudden death of Mr. L. Page, electrician at the Middlewich Electrolytic Alkali Works. Mr. Page had only gone to the works two days previous to his death, which occurred very suddenly following a fit, and before medical aid could be obtained.

Ormesby.—The Board of Trade have notified the Council of intention to revoke their provisional electric lighting order. A sub-committee has been deputed to confer with Redcar Corporation as to engaging an electrical expert.

Paignton.—The Council on Monday discussed in detail and approved an agreement with the National Electric Construction Co. for the erection of electricity works.

Paisley.—Sheriff Cheyne having recalled the interdict recently issued against Mr. W. M. Murphy from proceeding with the reconstruction of the Paisley tramways, the Paisley Corporation have applied to the Board of Trade to appoint an arbitrator to settle the question as to the use of foreign as opposed to Scotch granite for the construction of the permanent way.

Peking.—It is reported that a Hamburg firm has secured an order for the electric lighting of "the Chinese Emperor's palace at Peking."

Pembroke (Ireland).—Application has been made for sanction to a further loan of £20,000 for extensions of the electricity undertaking. The electrical engineer (Mr. Price) has reported to the Council that the demand for current continues to increase and that the net revenue is increasing in a satisfactory manner.

Penzance.—The Electric Lighting committee recommended the Council to support the application of the Penzance and District Electric Supply Co. for a provisional electric lighting order.

Plymouth.—A Local Government Board inquiry was held on Tuesday, Wednesday and Thursday this week into the application of the Corporation for sanction to borrow £248,252 for capital expenditure incurred for electricity supply and other works, and £6,700 for future extensions to the electric lighting.

The town clerk (Mr. J. H. Ellis) gave information as to population, rateable value, &c., and said Plymouth's capital indebtedness had grown from £255,537 in 1902 to £1,722,324 at present. He gave the causes for this great increase, which included the construction of electric tramways and the erection of electricity works. The amount they now sought to borrow included sums spent to March 31, 1903—sums spent since and money unspent. The first item was £41,465 for extension of electricity buildings and also for the supplementary sum of £6,700, the estimated capital expenditure for the current year. The electricity station was a combined one, for lighting and tramways. So far as the expenditure was for tramways, it was a municipal purpose, and so far as it was for lighting it was a sanitary purpose. The original estimate was for £46,000, and that was sanctioned except £400, in February, 1897. The next sanction applied for in October, 1899, was for £20,000 to the Board of Trade for tramways, and was granted in June, 1900. The next sanction was for £29,000, by the Board of Trade in July, 1902. In December, 1899, it was shown that they wanted £38,000 additional, and in January, 1902, a further report showed that they wanted an additional £19,000. Now they were asking for the actual expenditure and for the estimated expenditure on capital account for the current year. But that would not exhaust the money they would require in the next three or four years. He mentioned that because it might occur to them that the large sum of £105,400 which the Council put in their bill for electricity was hardly justifiable. But that amount would have given them £48,000 in addition to what they had already spent and what they required for the current year, and would have been sufficient to cover the capital expenditure on electricity account for the next seven years.

Mr. E. Pearse Burd (one of the inspectors): But you are asking now only for such sum as will carry you to March, 1904.

Mr. Ellis: Yes, and that is all I dare ask you for, because of the limitation of borrowing power, because the first thing we have to consider is the main drainage, and I do not think you can grant all we want for electricity for another four or five years.

For the opposition, Mr. Greenway said they did not so much oppose the application of the Corporation to borrow money to put their house in in order, but his clients realised that the Corporation were not even asking for enough to do that, and that when the sum had been granted the same troubles, irregularities and difficulties would be experienced unless there was attached to the sanction some condition which should put the town under an audit and at the same time provide a personal liability in the case of those who committed the irregularities. He did not necessarily suggest a Government audit, but there might be some method by which personal liability could be established, because without it it was absolutely impossible to stop these irregularities. It was shown conclusively by the report of the borough surveyor and the electrical engineer that over 30,000 would, within a comparatively short period of years, be required for reconstructing the electrical system. With a bank prepared to grant overdrafts of hundreds of thousands of pounds, there was no check whatever for the ratepayers.

The Borough Electrical Engineer (Mr. Okell) said, in reference to depreciation on the electricity account, in the first two years the loss sustained in the sense of sums which ought to have been charged on the rates were carried to a suspense account. They had turned the corner, and the whole of that suspense account had been cleared off, and they had a small reserve. Up to March 31 the sum spent on capital account which the Corporation had no authority to borrow was £41,465.

The Town Clerk explained the sums spent for traction and for lighting purposes, and the inspector suggested that these accounts need not be kept separate. On the one account there were balances remaining of sums already sanctioned, and the inspector said these might reasonably be put against the sums they had technically spent without sanction.

Cross-examined by Mr. Greenway, Mr. Okell agreed as to the necessity of a depreciation account. He considered the life of the machinery at about 25 years. He would also allow for obsolescence in addition to depreciation. The life of electric mains and cables was a debatable point, but not less than 15 years. No part of the £41,465 spent on the electricity undertaking was included in any of the previous sanctions. Current was supplied to the Corporation tramways at 2d. per unit, and to private consumers for power at 3d., and in certain instances at night for 2½d.

Mr. Burd called attention to two sums entered in the electricity account, one in revenue and the other in capital account, both referring to a reserve fund, and said he had not been able to find any reserve fund anywhere.

The Borough Treasurer explained that last year the whole of the profits were kept back, with the result that the balance of suspense account was wiped out, and a reserve of £409 created

Where is that reserve fund? Where is the cash?—There is no reserve fund. It is simply a statement in the balance-sheet. The cash has gone into the Corporation account.

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Is it merely a paper reserve fund, or can you put your hand on that £409, and take it out of the reserve fund at any moment and use it?—It is in the same category as the balance unspent at the depot. It is all in the one banking account.

Then all you can say is that there is cash, but that cash is really in the banker's hands as against the over-draft?—Yes.

Now you have got cash due to bankers £3,501. Yet you are are able to carry to reserve fund £409. Why should that be?—Because on the other side we have sundry debts £5.321.

These sundry debts enable you to put in the sum of £409. It is really a balance to make up your balance-sheet. You never have any cash, but you have debts outstanding, and you call this a reserve fund, when it really is not cash or anything of the sort?—That is so.

Then it is merely a paper entry, and is the balance of your income and expenditure account?—For the year, yes.

Mr. Okell, re-examined by the Town Clerk, said current was supplied to the Plymouth, Devonport and Stonehouse Tramways Co. up to a limit of 80,000 units for a fixed sum of £1,000. This worked out at 3d. per unit.

Presentation.—On the occasion of the marriage, on the 10th inst., of Mr. E. A. Barker (borough electrical engineer at Barnsley) and Miss A. Blackwell (second daughter of Mr. J. Blackwell, Walsall), the staff of Barnsley Corporation presented to Mr. Barker a barometer, and also a time-piece from the public lighting staff.

Rotherham.—The council are promoting a bill to enable them (inter alia) to supply electric motors and fittings and to wire consumers' premises.

St. Pancras (London).—The new Borough Council have rescinded a resolution passed by their predecessor against the construction of electric tramways in Tottenham Court-road. The scheme for widening the southern end of Hampstead-road and for the construction of a tramway across Euston-road and along Tottenham Court-road to a point opposite the Horse Shoe Hotel will, therefore, be proceeded with.

St. Petersburg.—The population of the district served by the various electricity supply undertakings in this city is about 1,000,000. There are four of these undertakings, one owned by the Russian Helios Co., the second by the Russian Electrical Company, the third by a Russo-Belgian Co., and a fourth by the Smirnoff Co. The latter company was the first in the field, followed by the Russian Company, followed again by the Helios Co., and, lastly, by the Russo-Belgian Co. The total connections represent the equivalent of 300,000 8 c.p. lamps to about 10,000 consumers. The price of current per kilowatt-hour for lighting is 7½d. and for power 3d.

St. Petersburg Municipality are about to construct nearly 200 miles of electric tramways, and have under consideration several schemes for the utilisation of adjacent water-power.

This city is supplied by a municipal telephone system, which has a total subscription of 15,000, the rate to private subscribers being 50 roubles per annum.

St. Vincent.—The telephone service on the island of St. Vincent realised a revenue of £419 in 1902, compared with £330 in 1901. Communication is established between Kingstown, Chateaubelair (on the Leeward side) to Georgetown (on the Windward side) of St. Vincent, about 24 miles either way. The service is said to be a most useful one, and to be increasing in public favour. Slowly but surely this distressful isle is recovering from the recent disaster.

Shrewsbury.—The salary of the borough electrical engineer (Mr. C. M. Johnston) has been increased from £300 to £350 per annum.

Speed of Electric Tramcars.—At the South-Western Police Court (London) on Monday, Mr. Garrett, on the application of Mr. Moffat Ford, granted 10 summonses against the London County Council for driving certain of their electric tramcars at a speed in excess of the legal limit. The speed of the cars was (applicant stated) far greater than that of the cars of the London United Tramways, whose drivers were fined last week for a similar offence.

Stirling.—A report by Prof. Kennedy on the conversion of the tramway system to electric traction has been presented to the Council.

Swanage.—The Council, who have before them a proposal by the Southern District Electricity Corporation, have also received a communication from Messrs. Pressland and Fippard on the subject of electricity supply. The firm offered to supply current for public lighting at a price not exceeding 8d. per unit. The Finance committee is considering these offers.

Sydney (N.S.W.)—On the recommendation of their consulting engineer, Mr. T. Rooke, the Lighting committee have instructed Messrs. Preece and Cardew to ascertain from Dick, Kerr & Co. their terms for supplying an additional 1,000 H.P. steam alternator, with condensing plant, switchboards, &c., and 1,000 H.P. additional sub-station machinery, with necessary additions to switchboards, &c., and also their terms for two additional steam alternators of 1,000 H.P. each.

Theft of Telegraph Wire.—At the Central Criminal Court, London, on Monday, four youths pleaded guilty to an indictment charging them with stealing a large quantity of copper wire, the property of the L. and S.W. Railway Co. The facts were stated in our last issue, and the Recorder sentenced one of the prisoners to 15, another to 10, and a third to six months' imprisonment with hard labour. The fourth was bound in his own recognisances in £20 to come up for judgment. The Recorder characterised the theft as a most mischievous offence which might have brought about a terrible calamity.

Thibet.—Col. Younghusband's force, which is about to operate in Thibet, has already erected in that country over 100 miles of telegraph line at an altitude of 15,000ft., which is said to constitute a record as to height.

Todmorden.—An inquiry was held last week into the application of the Council to borrow £21,274 for electricity supply and £6,500 for refuse destructor works. There was no opposition.

The town clerk (Mr. D. Sutcliffe) asked the inspector to allow 40 years for repayment of the loans. The necessity for an electric lighting scheme had practically been forced upon the Council by applications and suggestions made by a large number of ratepayers. Several firms had begun to put in independent installations, and there seemed little doubt that the municipal undertaking could be made a paying concern. The site for the station was adjoining the gasworks.

The consulting engineer (Mr. H. Waring) said a canvass had been made of the district, and there were applications for the equivalent of 4,800 8 c.p. lights, principally by shopkeepers for lighting, and another 2,000 for motive power for mills and workshops.

The Mayor said it was not proposed to go in for electric tramways at present, but he thought something might be done in the near future in an experiment in electric 'busses.

Tramways in Cheshire.—A syndicate is promoting a scheme for constructing an electric tramway to connect the Manchester Ashton-under-Lyne, Oldham, Stalybridge, Mossley, Dukinfield Denton, Hyde and Stockport electric tramways with the Glossop and Hadfield electric tramways, and with the Great Central Railway Co.'s main line at Mottram. Application will be made for a light railway order. The line will have a total length of about seven miles, and will provide intercommunication between Stalybridge, Hyde, Mottram, Broadbottom, Glossop (at Woolley Bridge), Hollingworth and Tintwistle. Parcels, light goods and minerals will also be carried.

Transvaal.—The imports of electric cables, wire and fittings into the Transvaal for the eight months ended Aug. 1903, were valued at £49,000, compared with £29,000 in 1902. Tramway material imports were valued at £57,000 in 1903, compared with £12,000.

Trowbridge.—The Electricity committee have been instructed to report upon the proposed application of the Western Electric Distribution Corporation for a provisional electric lighting order, and also as to the desirability of carrying out the terms of the Council's electric lighting order (1901).

Whitley Upper.—Negotiations are proceeding with the Yorkshire Electric Power Co. for a supply of electricity in bulk to the District Council.

Willesden.—It was announced by the electrical engineer (Mr. E. T. Ruthven-Murray) at the last meeting of the Council that, although the electricity works had not yet been in operation six months, the equivalent of 8 c.p. lamps connected was 16,965, and 3,290 awaited connection, the total being 2,000 in excess of the demand originally anticipated at the end of the first year's working.

Wishaw.—Terms have been arranged between the Council and the Clyde Valley Electrical Power Co. for the supply of electricity in the district, and a provisional order is to be applied for.

Workmen's Compensation Acts.—A departmental committee, recently appointed by the Home Secretary, is engaged in considering what amendments in the law relating to compensation for injuries to workmen are necessary or desirable, and to what classes of employments not now included in the Workmen's Compensation Acts those acts can properly be extended, with or without modification. The committee consists of Sir Kenelm Digby, his Honour Judge Lumley Smith, K.C., Sir Benjamin Browne, Capt. A. J. G. Chalmers, and Mr. George N. Barnes (secretary of the Amalgamated Society of Engineers). Mr. R. R. Bannatyne, of the Home Office, is secretary.

Yorkshire Electric Power Co.—The first generating station of this company is in course of erection at Thornhill, and the arrangements for the buildings, plant and mains, now completed enable the directors to state that a supply of electricity to power users within a reasonable distance of the station will be available on Dec. 1, 1904.

The directors have appointed Mr. W. B. Woodhouse, A.M.I.M.E., A.M.I.E.E., formerly engineer to the Newcastle Electric Supply Co. (Ltd.) as resident engineer in charge of their business in Yorkshire. Mr. Woodhouse has permanently taken up his duties, and is in charge of the company's interests at Central Bank Chambers, Infirmary-street, Leeds.

The directors are prepared to enter into contracts with local authorities, colliery owners, manufacturers and others in the district for the supply of electricity, and Mr. Woodhouse is ready to furnish full information as to the cost and application of the power to be distributed by the company.

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Cricket.—The second annual tea and social in connection with Leeds Corporation Electricity Works Cricket Club took place on Saturday, Nov. 7. The city electrical engineer (Mr. H. Dickinson), president of the club occupied the chair, and urged all members of the works establishment to take up physical and mental culture, reading, &c., during the winter months. After the programme was finished Mr. Dickinson presented numerous prizes, W. Merritt taking first for batting, T. Merritt second for batting, R. Rowntree first for bowling, W. Merritt second for bowling and G. Newby the fielding prize.

TRADE NOTES AND NOTICES.

[Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.]

TENDERS INVITED.

Preston Corporation invite tenders for the supply and erection at their tramway power station of a traction switchboard and accessories. Tenders to the consulting and resident electrical engineer (Mr. Walter H. Tittensor) by Dec. 12. See advertisement.

Crewe Corporation invite tenders for wiring the new municipal buildings. Specifications, &c., from the borough electrical engineer (Mr. H. H. Denton), Electricity Works, Crewe. Plans can also be inspected at the offices of the architect (Mr. H. T. Hare), 13, Hart-street, London, W.C. Tenders to Mr. Denton by Dec. 4. See also advertisement.

Brighton Corporation invite tenders for six water-tube boilers, two separately-fad superheaters, economisers, induced-draught fans and motors, steel chimney stack, feed-pumps and exhaust heater, together with foundations and brickwork for same; a system of steam, exhaust, feed, blow-off and suction pipes, together with their valves; cast-iron storage tanks, hot-well tank and water purifier, and 30 cast-iron circulating water pipes. Tenders to Mr. F. J. Tillstone, Town Hall, Brighton, by 10 a.m. Dec. 7.

The directors of the *North-Eastern Railway Co.* are prepared to receive tenders for telegraph apparatus, wire, and line stores for six months ending June 30, 1904. Forms of tender from the company's telegraph superintendent (Mr. C. H. Ellison) and tenders to the secretary (Mr. C. N. Wilkinson), York, by noon Dec. 7. See advertisement.

London County Council invite tenders for supply, delivery and erection in the Greenwich electricity generating station of four 3,000kw. three-phase generators with exciters. Tenders to the clerk (Mr. G. L. Gomme) by 10 a.m. Dec. 8.

London County Council also invite tenders for wiring and fitting for electric lighting of five sub-stations and three car sheds in connection with the Council's tramways. Tenders to Mr. G. L. Gomme, County Hall, Spring-gardens, S.W., by 10 a.m. Dec. 8.

Middlesbrough Electric Lighting committee invite tenders from manufacturers for one 600kw. steam turbine dynamo, two Lancashire boilers and mechanical stokers and one feed pump, one jet condenser and steam-driven pumps and wood cooling tower. Tenders to town clerk (Mr. Alfred Sockett) by noon of Saturday, Nov. 28.

Newport (Mon.) Electricity committee invite tenders for three motors of about 50 B.H.P. each, together with switch gear. Tenders to chairman of Electricity and Tramways committee, Town Hall, Newport, Mon., by Nov. 23.

Dorchester Council is prepared to negotiate with companies willing to take over and work under lease their provisional electric lighting order, 1901. Offers to town clerk (Mr. A. G. Symonds) by Nov. 26.

Dublin United Tramways Co. invite tenders for stores, including electrical supplies, car fittings, iron, steel, castings, oils, paints, ironmongery, &c., for year ending Dec. 31, 1904. Tenders (addressed to chairman) by Nov. 30.

The directors of the *Caledonian Railway Co.* invite tenders for stores for six or 12 months from Jan. 1, 1904, including telegraph appliances, telephones, &c., electric lighting materials and fittings, bolts and nuts, copper rivets, &c., drysalteries, hardware, glass, india-rubber and asbestos goods, galvanised wire, wire fencing requisites, locks, oils and grease, tools, screws, &c. Tenders to secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by 23rd inst.

The directors of the *Great Western Railway Co.* invite tenders for their proposed power station at Park Royal, near Acton, for water-tube boilers, engines, three-phase generators and auxiliary plant. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London, by Dec. 7.

The *Cheshire Lines Committee* invite tenders for stores for 1904, including telegraph materials, electric signals, glass, screws, files, bolts, signal wire, &c. Tenders to secretary, Central Station, Liverpool, by Nov. 27.

Kirkcaldy Corporation invite tenders for combined steam engine and dynamo (about 400kw.) for lighting or traction. Tenders to the town clerk (Mr. Wm. Macindoe) by noon Nov. 23.

Hornsey Urban District Council invite tenders for meters, indicators and consumers' fuse boxes. Tenders to Mr. F. D. Askey, 99, Southwood-lane, Highgate, N., by 4 p.m. Nov. 30.

Tenders are required for heating and ventilating (including electric fans) at *Belfast* Assembly Buildings. Tenders to Messrs. Young and Mackenzie, Scottish Amicable Buildings, Belfast, by Dec. 4.

Kilmarnock Corporation invite tenders by 27th inst. for work required in erection of electricity station and tramcar shed.

The Directorates-General of the Royal Italian arsenals at Spezia, Naples and Venice, invite tenders for the supply of electric lamps for the lighting of Italian warships to the value of about £1,500. The *Gazetta Ufficiale* of Nov. 10 contains further particulars.

TENDERS RECEIVED AND ACCEPTED.

Mather and Platt have secured (through their local agents, J. F. Macadam & Co.) the contract for supplying the whole of the electrical machinery required by the La Plata (Argentina) Cold Storage Co., comprising three 200kw. and two 60kw. steam dynamos, surface condensing plant with motor-driven circulating and air pumps, &c. There are to be 45 motors installed ranging from 1½ B.H.P. to 42 B.H.P.

London County Council have selected the following firms to supply engineers' goods for electrical stores during 1904:—A. Wilson & Co., Buck and Hickman, Mosers Limited, Jukes, Coulson, Stokes & Co., P. and W. MacLellan, J. Gibb & Co., M. Wilson & Co., G. Braulik, and Stewarts and Lloyds.

Since the contract was placed with Messrs. Hadfield's Steel Foundry Co., Tinsley, Sheffield, for special work for the Johannesburg tramways, a further order has been placed with the firm for the special work for the car sheds for the sum of about £2,000.

The contract for the electrical equipment of Messrs. Tolhurst & Sons cement works at Northfleet, Kent, including a complete installation for electric lighting and power, arc lamps, pumping plant, &c., with wiring, has been awarded to the British Westinghouse Co.

Whitehaven Council have accepted the tender of the British Insulated and Helsby Cables Limited for armoured cable, and that of Callender's Co. for 2,500 yds. of cable.

Tunbridge Wells Council have accepted the offer of the Aron Meter Co. for cleaning Aron electricity meters at 2s. per meter per annum.

The steel rails and fishplates for the Sunderland and District Tramway Co's. system will be supplied by the North-Eastern Steel Co., Middlesbrough.

Colchester Corporation have accepted the tender of Siemens Brothers & Co. for cables at £393.

Ashton-under-Lyne Council have placed an order with De Grelle, Houdret & Co. for arc lamp carbons.

Kingston-on-Thames Town Council have accepted the tender of the Schattner Electricity Co. for 500 demand indicators at £800.

BUSINESS NOTICES.

Messrs. A. Higgins and S. Griffiths have entered into partnership to carry on the business of electrical engineers and contractors at 4, Albany-street, Regent's Park, London, N.W., under the name of Higgins and Griffiths.

The City address of Mr. E. Kilburn Scott, M.I.E.E., A.M.Inst.C.E., is 18, St. Helen's-place, London, E.C., where he is associated with Messrs. Harper Bros. & Co. in the engineering work of the North Wales Power and Traction Co., the Bath and the Sunderland District Electric Tramways, &c.

Messrs. E. T., E. S, and W. H. Mackrill (trading as E. T. Mackrill & Sons), electrical engineers, Aylesbury, have dissolved partnership. Debts by Messrs. E. S. and W. H. Mackrill, who continue.

Mr. A. Lester Taylor has retired from the firm of Lester Taylor, Kelly and Hide, electrical engineers, 36, Dale-street, Liverpool, and the business will be continued by the remaining partners as Kelly and Hide.

Mr. F. S. Pillan has retired from the firm of Haydn Harrison & Co., 11, Victoria-street, London, S.W. Messrs. H. T. Harrison and P. J. Brewer continue.

LIQUIDATIONS, BANKRUPTCIES, &c.

A well-attended meeting of the creditors of Ferranti Limited was held in London on Wednesday under the presidency of Mr. W. D. Davidson, secretary of the company. The petitioning creditors (Messrs. Estler Bros.) were present with their legal representative. Messrs. Ferranti were represented by the official receivers and managers (Messrs. A. W. Tait and Arthur Whittaker) and by Mr. Ferranti:—

The CHAIRMAN said the object of the meeting was to fully explain the financial position of the company, and, if thought desirable, to appoint a committee of the largest creditors to investigate the affairs of the company

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and to decide upon the best means of bringing about a reconstruction or reorganisation. He explained that in 1891 Mr. Ferranti was the sole owner of the business. In that year there was every appearance of its profitable development, and it was decided to form a company with a capital of £100,000 in debenture stock, £120,000 in preference shares, and £100,000 in ordinary shares. The flotation was not successful, but the capital was underwritten. About £60,000 was, however, subscribed, and the directors went to allotment. Later on the company found that their available capital was not sufficient to meet the strain of outgoing expenses on a number of large contracts in hand for municipalities and other bodies requiring long credit and making part payments at infrequent intervals. This brought the company to its first crisiss and fresh capital had to be found. £60,000 was raised, and with this a portion of the liability of the company to the bankers was extinguished. The company, however, still found it impossible to continue for any length of time with its limited resources, and was compelled to again obtain temporary loans from the bankers. Subsequently, a further £50,000 capital was raised, about £30,000 of which was paid to reduce bankers' claims, leaving £20,000 available as working capital. The company's financial position was not, however, materially improved by this comparatively small addition to its capital, and it was this year considered advisable to place the position of affairs before the Court, who appointed receivers and managers to conduct the business until such time as the creditors had met and decided what was to be done. The work of the officials appointed by the Court (continued Mr. Davidson) was an earnest endeavour to carry out existing contracts, and to keep the business moving in the interest of all concerned. This had so far been very successfully done. Messrs. Tait and Whittaker had ascertained the exact position of affairs up to Sept. 2 last, and had issued a printed statement to the creditors in October. It would be seen that the receivers and managers had decided, after careful investigation, to discontinue the engine and dynamo department of the company and to confine their operations at present to continuing and developing the electric meter and switch gear manufacturing departments. Owing to the keen competition in all work relating to engines and dynamos, it was found that these departments could not be continued profitably, whereas the departments dealing with meters and switch gear could, under efficient control and good management, give satisfactory pecuniary results. The chairman pointed out that the receivers and managers represented the secured creditors, but they desired to work amicably with all creditors, so that the business might go on. They urged that a forced liquidation would disadvantageously affect the prospects of all the creditors, as Mr. Ferranti's valuable services, the interest and goodwill of the business, and the patents, drawings and stock would be depreciated or disappear in such a forced liquidation. He (the chairman) represented the preference shareholders for upwards of £100,000 cash capital. He thought it desirable that the meeting should appoint a committee to co-operate with the directors in devising a scheme of reconstruction. He referred to the fact that the petition for a compulsory liquidation presented by Messrs. Estler Bros. had that day been adjourned for a fortnight.

Messrs. Estler Bros.' solicitor said he had agreed to the adjournment referred to in order to enable this meeting to decide upon some definite action on the lines indicated by the chairman.

The CHAIRMAN, replying to questions, said the unsecured creditors were for £56,000, the bankers being secured by a second mortgage, which was to be reduced to £20,000. But if the Court found that the meter and switch gear departments of the company's business could not be carried on at a profit, the bankers would not consent to the proposed scheme of reconstruction. But, of course, time would be given, so that the experiment might have a fair chance. This was especially desirable as the company had an improved form of electric meter which he (the chairman) was assured would be a profitable asset. The company's type of switch-gear had also been improved in many ways, and he was further assured that a profitable business awaited the development of this branch.

Mr. HENDERSON (representing Messrs. Thomas Bolton & Sons) said his firm were among the largest creditors, their debt amounting to £3,500, Messrs. Estler Bros. being only for £910. He had found out that creditors who had pressed for payment had been paid their accounts, and he complained of this action, and said all creditors should have received equal treatment. He urged that the creditors should have been called together as soon as the directors had ascertained the condition of affairs. He strongly urged the meeting not to force a compulsory liquidation, and proposed the appointment of a committee of not more than 10 creditors to confer with the directors, receivers and managers to prepare a scheme of reconstruction or reorganisation and submit this to a subsequent meeting.

This proposal having been duly seconded, and the chairman having replied to various questions, a resolution drafted on the lines of Mr. Henderson's proposal was carried.

Messrs. Estler Bros.' representative agreed to a further adjournment of the hearing of their petition for six weeks, in order to enable the committee chosen to submit their scheme, but without prejudice to their legal position. The following committee were then chosen:—

Mr. Nalder (Messrs. Nalder Bros. and Thompson, creditors for £1,136).
Mr. Henderson (Messrs. Bolton & Sons, creditors for £3,750).
The London Electric Wire Co. (creditors for £3,000).
Messrs. Estler Bros. (creditors for £910).
Mr. Coles (Messrs. Babcock and Wilcox, creditors for £1,397).
The Great Central Railway Co. (creditors for £2,074).
Mr. Taylor (creditor for £907).
Mr. George Schultz (creditor for £200).
Mr. Brotherton (New Brotherton Tube Co.).
Mr. Bergtheil (Messrs. Bergtheil and Young, creditors for £600).
The Carron Company (creditors for £4,000).

A receiving order has been made against Geo. Neale, electrician, 2, Fulham Palace-road, London, S.W., formerly trading with another as the South Western Electrical Contracting and Maintenance Co.

A second dividend (2s. 8d.) will be payable on Nov. 23, at the liquidator's office, 7, Lothbury, E.C., in the liquidation of Harry South & Co. (Ltd.).

A meeting of the Electric Royalties Syndicate (Ltd.), will be held at 82, Victoria-street, London, S.W., on Dec. 18, to receive an account of the winding up.

Sales by Auction.—Messrs. Weatherall and Green will sell by auction at Brunswick-buildings, Brunswick-place, City-road, London, on Nov. 30 and following day, at 12 for 1 o'clock, the whole of the valuable plant and stock of the Renewable Electric Lamp Co. (Ltd.) (in liquidation), comprising the complete equipment of an incandescent electric lamp factory. Further particulars are set out in an advertisement. Catalogues from the auctioneers, 22, Chancery-lane, London, W.C.

Messrs. James B. Terson & Son, 27, Castle-street, Dover, have been instructed by Messrs. A. Verey & Co. to sell by auction, on Nov. 24, 25 and 26, an extensive stock of electric lighting plant, dynamos, machinery, &c., at London-road, Buckland, Dover. See advertisement.

Plant for Sale.—Mr. George Adams, 144, High Holborn, London, W.C., has for sale a small combined electric lighting plant, particulars of which are given in an advertisement.

The Newcastle-upon-Tyne Electric Supply Co. (Ltd.), owing to removal of their new power station, have for sale several Ferranti modern high-tension switch gear panels complete with latest type oil-break switches and fuses, 'bus bars, synchronising gear, high-tension voltmeters and synchronisers. Further particulars are given in an advertisement. Communications to the manager, 50, New Bridge-street, Newcastle-on-Tyne.

New Insulation Testing Set, &c.—The accompanying illustration (Fig. 1) shows an ohmmeter and generator recently placed on the market by Messrs. Everett, Edgcumbe & Co. The chief advantages claimed are that it is direct-reading, has an extremely open scale (about 12in. long), ensuring accurate readings, the indications are independent of the testing voltage and unaffected by the strongest magnetic fields (so that it can be used close to dynamos or motors), and that it is compact and light. The set works on the Wheatstone bridge principle, but is constructed so that the insulation is read off directly on the dial, no plugs or switches being employed. For ordinary insulation testing the set can be used to

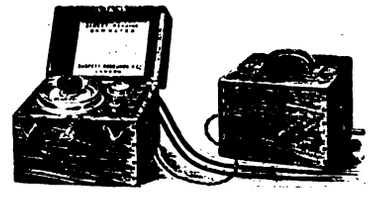

FIG. 1.
New Insulation Testing Set.

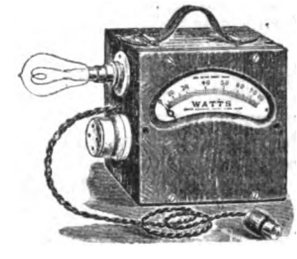

FIG. 2.
Lamp-testing Wattmeter.

read from 1,000 ohms to 20 or 50 megohms, while for mains testing an additional range can be added, so that measurements up to, say, 200 megohms can be measured. The ordinary generator can be used with it instead of the portable battery. The makers have adapted the insulation set to copper resistance measurements, so that a complete set can be obtained 8½in. by 6½in. by 6in., by means of which resistances of from $\frac{1}{10}$th of an ohm up to 200 megohms can be measured without any alteration of connections or any manipulation whatever. Either a generator or a battery can be used, or, of course, current from supply mains. For the copper resistances a few Leclanché cells are all that are required.

Fig. 2 shows a new lamp-testing wattmeter by the same makers. This indicates at a glance the actual watts consumed by a lamp. The instrument is accurate with continuous or alternating current of any frequency, and can be used to measure the power consumed by any other apparatus—small fan-motors, for example. The range most generally useful is found to be from 0 to 130 watts, but any other range can be supplied.

Automatic Time Switches.—As their name implies, automatic time switches are intended to perform at given times specific duties, which may consist in switching in or switching off a circuit, changing over from one circuit to another, &c. A number of varieties of such automatic time switches are listed by Messrs. Vandam, Marsh & Co. in a pamphlet dealing with these instruments just to hand. For small and medium currents and voltages, mercury is used

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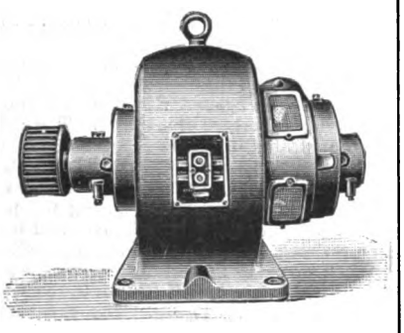
as a rule for making and breaking electrical contact, but the types designed with the usual metallic switches are equally well suited for this purpose, although intended chiefly for larger currents or high voltages or both. The operations are obtained by simple mechanical means, set in motion by strong clockwork, and the switch mechanism is said to be such that it does not effect the time-keeping qualities of the clock. One dial only is employed to set and effect all actuations. The instrument is wound up once a week. In the list under notice there are one or two switches for particular purposes, including a change-over switch suitable for switching "on" arc lamps at any desired time, to "change over" to incandescent lights at a fixed hour (say midnight), or to switch "off" all lamps at daybreak. Another example, similar to the one just mentioned, has an additional arrangement by means of which incandescent lamps are switched on whenever and as long as the arc lamps (during their intended time of burning) fail. Similar in conception is a design for a three-wire system. In this case, one of the outers is switched off at a certain time, and the number of incandescent lamps which remain burning is accordingly reduced. We may also mention the "variable-rate meter type," which varies the recording rate of shunt meters by means of a resistance inserted in the shunt during pre-determined hours by the time switch.

Ends of Electric Motor Shafts.—"Manager, Levenshulme," writes us as follows:—

Designers of electric motors seem to have a tendency for skimping the projecting shaft ends which are required for the fixing on of the toothed pinion on the driving pulley. In my opinion it would be well to have ample shaft ends (as shown in my illustration). A user of an electric motor made by one of the leading electrical engineering firms of this country complained to me recently that he was in a difficulty through not being able to fix a wide noiseless pinion on his motor because of the small amount of shaft projection. Possibly motor makers will only need to have their attention called to this matter to slightly amend their designs.



"Cylinder Oil and Cylinder Lubrication"—This is the title of a work on lubrication and lubricating oils by Messrs. H. M. Wells and W. Scott Taggart which has been issued by the Henry Wells Oil Co. of Manchester. It forms Part I. of a more exhaustive general work on the subject. The object of this book is to present a scientific treatise on the general subject of oils and lubrication, and Prof. Hele-Shaw has written an interesting introduction to the book. Much information is given as to the processes through which the crude oil passes to the finished product. Analyses of various oils are given which will prove of service to those who are studying this important branch of work in connection with machine design, manufacture and use, and the deductions made by the authors from these analyses with regard to the lubricating qualities of various oils, and the information and advice which accompany their investigations and researches, make the work of more than usual interest. Numerous illustrations of British, Continental and American makes of steam engines and combined generating sets are shown, together with examples of the more general types of cylinder lubricators. Perhaps the most important feature in the book is the evidence presented that improvement would not be difficult in the methods adopted in ascertaining the lubricating values of various kinds of lubricating oils for the more exacting classes of work which these oils are called upon to perform.

Prepayment Meters.—We are informed by Messrs. Geipel and Lange that they have adapted their Vulcan prepayment meter, hitherto used as a penny-in-the-slot meter, for use for 1s. prepayments. The shilling-in-the-slot meter differs only from the penny-in-the-slot form in the size of the coin slot and in the reduction of the numerator train. 8s. in all can be received. These meters are made in 2 and 3-ampere sizes, suitable for pressures between 50 and 250 volts, and the price per unit can be varied with these meters to suit any limit in this country.

"Banks and their Customers" is the title of a useful work of which a copy has been sent us by the author, Mr. H. Warren. This is the seventh edition of a book which will be found very serviceable by business men, and especially those whose businesses necessitate banking operations of a more or less intricate character. The book is published at 2s. net by Effingham Wilson, London.

Catalogues, &c—The Union Electric Co., 151, Queen Victoria-street, London, E.C., have ready a new pamphlet (No. 1,021) relating to eight-polar dynamos and motors ranging in capacity from 100 H.P. to 500 H.P. at the usual standard voltages, and with a large range in speed to suit the various requirements of dynamos and motors of such large power. In connection with these machines it is stated that each size of magnet-frame and armature is made in five different patterns, to suit various styles of drive.

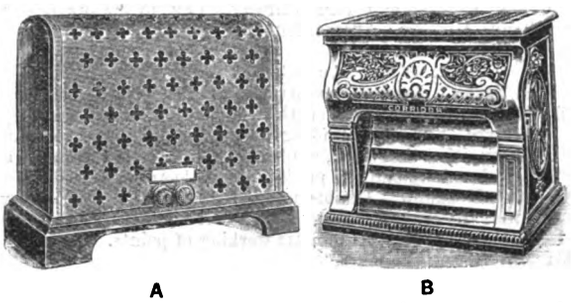
Pamphlets Nos. 160 and 161 issued by the British Thomson-Houston Co. are concerned with electrical measuring instruments and single-phase integrating induction watt-meters. Our illustration shows the Thomson inclined coil pocket ammeter with top removed. This is designed to permit of it being carried in a side pocket of the coat. The construction is very strong so that it will withstand comparatively rough usage without loss of accuracy. Attention is drawn by the makers to the great length of the scale as compared with the size of the instrument. These pocket ammeters may be used upon continuous or alternating-current circuits, and are made of capacities from 0=10 to 0=25 amps.

Thomson Inclined Coil Pocket Ammeter, with cover removed.

The Westinghouse Brake Co., from the London office, have issued an interesting pamphlet of over 80 pages of matter and illustrations relating to the Westinghouse system of electro-pneumatic signalling, dealing with the principles and practice of this system. Five illustrations show the extensive installation of Westinghouse pneumatic signals at the Tyne Dock for the North-Eastern Railway Co., and the intricate service at Bishopsgate goods depot, London, of the Great Eastern Railway is also shown. Many other illustrations, pourtraying intricate networks of railway lines governed by this system of signalling, are given.

Mr. F. Winter, 8, Redcross-street, London, E.C., is well-known in the electrical industry as the energetic agent of Dr. Heinr. Traun & Sons for all kinds of ebonite or vulcanite goods. Mr. Winter forwards us examples of a new vulcanite combined pen-holder and envelope opener, and it may be some satisfaction to him to know that these articles are in use and appreciated. The pen-holder does not offer much room for improvement, but such as it does, Mr. Winter's firm has accomplished.

The Electric Heating Corporation, 34, Leadenhall-street, London, E.C., have ready a new list of "Phœnix" electric heaters of artistic design. Also electric car heaters for railways, tramways, motor vehicles, ships' cabins, &c.; and a special type of heater for corridor



A B

work are listed. The accompanying figures show two examples of the Phœnix heater made expressly for corridors, narrow halls, &c. The size of A is about 24in. by 18in. by 6in., and of B 15in. by 9½in. by 14in. B is provided with large copper reflecting lamps.

A new list of "Miniature" arc lamps for continuous currents is issued by the Union Electric Co., 151, Queen Victoria-street, London, E.C.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Nov. 11 to 17, with the ports of destination:—

Aden, £60 (telegraph material). *Africa*—Alexandria, £157; Beira, £252; Cape Town, £1,205; Delagoa Bay, £6,022 (including £5,844 telegraph material); Durban, £1,709; East London, £155; Port Elizabeth, £60. *Argentina*—Buenos Ayres, £60. *Australasia*—Adelaide, £87; Brisbane, £12; Melbourne, £339; Otago, £52; Sydney, £2,033 (including £230 telegraph material); Wellington, £395. *Belgium*—Brussels, £327. *Canada*—Halifax, £60 (telegraph material). *Ceylon*—Colombo, £153. *China*—Shanghai, £26; Tientsin, £85. *Germany*—Hamburg, £326 (telegraph material). *Gibraltar*, £828 (including £742 telegraph cable). *Holland*—Amsterdam, £25. *Hong Kong*, £348. *India*—Bombay, £36; Calcutta, £614; Madras, £173. *Straits Settlements*—Singapore, £34. *Sweden*—Carlskrona £128 (telegraph cable). *West Indies*—Trinidad, £40. Total, £15,741, against £34,361 in the corresponding week last year (Nov. 12 to 18).

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

August 26, 1903.

18,383 W. RHODES. Leeds. Pulleys to facilitate finding trolley wire.
18,390 A. E. MITTON, R. WHITEHOUSE and E. BLAKEMORE. Birmingham. Construction of insulators.
18,393 T. A. B. CARVER. Glasgow. Electrical indicating instruments.
18,398 H. HAWTHORN. Automatic electric signalling.
18,411 J. F. MASON. Steps of electric vehicles.

August 27, 1903.

18,453 C. MACKU. Manchester. Dynamo electric machines.*
18,485 H. WADE. Secondary batteries. (Hugh Rodman, U.S.)*
18,508 H. C. FOLGER. Sparking plugs for explosive engines.*
18,513 B.T.-H. Co. and F. HOLDEN. Determining magnetic properties of metals.
18,536 O. IMRAY. Controlling electric motors. (Bullock Electric Mfg. Co., U.S.)

August 28, 1903.

18,550 J. MACLEAN. Glasgow. Commutator for dynamos and motors.
18,551 J. MACLEAN. Glasgow. Brush-holders for commutators.
18,555 J. H. LUBY, W. HARRIS and J. J. BALLARD. Bristol. Section insulator.
18,556 J. H. LUBY, W. HARRIS and J. J. BALLARD. Bristol. Adjustable crossing for overhead systems.
18,557 J. H. LUBY, W. HARRIS and J. J. BALLARD. Bristol. Points for overhead wire systems.
18,558 J. H. LUBY, W. HARRIS and J. J. BALLARD. Bristol. Clip for clamping wires to fittings in overhead systems.
18,581 H. LEITNER and R. N. LUCAS. Byfleet. Electric lighting of railway trains.
18,586 W. E. LANGDON, J. C. FULLER and G. FULLER. Insulators.*
18,598 J. E. SPAGNOLETTI. Automatic electro-mechanical cutout.
18,602 E. TAYLOR. Carrier for an incandescent lamp.

August 29, 1903.

18,624 C. O. BASTIAN and A. E. SALISBURY. Electric vapour lamps.
18,625 T. W. BULLOCK. Prescot. Incandescent of variable candle power.
18,631 J. EAGLES and J. EAGLES. Salford. Trolley heads.
18,648 W. J. E. HILL. Grapnels for raising submarine cables.
18,653 H. J. READ. St. Albans. Switchboards and fuseboards.
18,680 H. L. ERIKSEN and THE COMPANY KOEFOED HANBERG MARSTRAND and HELWEG AKTIESELSKABET TITAN. Controlling electric elevators.*

August 31, 1903.

18,705 E. FERRY. Intensifier sparking plug for petrol motors.
18,710 D. COOK. Chambers for the combustion of fuel under pressure, valves, purifiers, loading apparatus and air compressors in connection therewith, applying the gaseous products to smelting, steel making and the production of electricity.
18,712 A. C. HOLBROW. Double point for rails of the conduit system so that the car can always pick up current.
18,713 A. C. HOLBROW. Automatic working of points.
18,731 H. CROWE. Switches.
18,740 W. E. EVANS. Actuating switches. (A.E.G., Germany.)*
18,745 L. B. ATKINSON. Excess indicators for current.
18,754 E. A. FALLER. Semi-automatic telephone systems.*
18,755 H. BLENDER. Electrical indicating apparatus.*
18,758 C. BAXTER. Automatically indicating and recording at a distance.
18,763 P. J. SAVELSBERG, G. WANNSCHAFF and ALLGEMEINE METALLURGISCHE GESELLSCHAFT M.B. H. Extraction of heavy metals by chlorine.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

14,112 PRESTED. Miners' electric lamps.
20,355 DUCRETET. Morse telegraphs.
20,571 and 20,572 FYNN. Alternate-current motors.
20,887 SHEEHY. Signalling apparatus for electric railways.
21,346 JANDUS ARC LAMP AND ELECTRIC CO. and JONES. Arc lamps.
21,473 CREED. Perforating telegraphic tape for automatic transmission.
22,152 HALL. Telephone call boxes.
23,021 and 23,022 BEST and ACKROYD AND BEST (LTD.) Apparatus for electrically igniting miners' safety lamps.
23,231 BAIRD. Signal devices for telephone systems.
23,255 JACOBS and NICHOLSON. Apparatus for telegraphy.
23,387 EWART. Main and branch switches.
23,594 TEERS. Overhead life-guards for trolley cars.
23,933 BENTLEY. Supports for overhead wires.
24,212 CAROLAN (G.E. Co., U.S.). Brush-holders for dynamos.
24,634 BOUSFIELD (Gerdes). Driving mechanism for use with electric train lighting systems and for other purposes.
24,705 CAROLAN (G.E. Co., U.S.). Contact clamps for conductors.
24,712 CAROLAN (G.E. Co., U.S.). Alternating-current motors also applicable to induction meters.
24,713 CAROLAN (G.E. Co., U.S.). Induction electro-motors.
24,715 CAROLAN (G.E. Co., U.S.). Systems of distribution.
24,756 JOHNSON and PATERSON. Insulating material for cables.
24,820 SOWDEN. Disconnecting and junction boxes for underground cables and manhole covers and frames for same.
24,865 PILKINGTON and ORMANDY. Insulating substances for cables, &c.
25,794 MIDDLETON and SMITH. Controllers.
25,904 CAROLAN (G.E. Co., U.S.). Systems of distribution.
25,949 GILLARD. Electric light brackets for bakers' ovens.
26,032 CAROLAN (G.E. Co., U.S.) Controlling speed of electric motors.
26,033 and 26,384 CAROLAN (G.E. Co., U.S.). Relieving bearing pressure of revolving shafts.
26,035 CAROLAN (G.E. Co., U.S.). Automatically stopping an electric railway car or train.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension Australasia and China Telegraph Co. (Ltd.).

The sixtieth half-yearly general meeting was held on Wednesday, Sir JOHN WOLFE BARRY, K.C.B., presiding.

The GENERAL MANAGER (Mr. F. E. Hesse) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: It will be seen from the accounts issued with the report that the gross revenue for the half-year has amounted to £265,099, as against £283,856 for the corresponding period of 1902, showing a decrease of £18,757. The actual falling off in receipts from the Australasian traffic alone amounted to considerably more than this decrease, or to, roundly, £31,000; but, fortunately, many of the local traffics show substantial increases, and the loss on exchange incurred last year was not experienced during the past half-year, owing to the satisfactory rise in the value of silver and the introduction of our new system of revising the rates of collection in silver countries every three months. When we come to working expenses, we find that they have amounted to £138,516, against £121,237 for the corresponding period of 1902, showing an increase of £17,279. The expenses attending the maintenance of cables account for over £2,000 of this increase, and the stations opened last year in the north of China account for a further £1,400, but the bulk of the increase—like the decrease in revenue—is due to the keen. and, what I think I may without qualification call, the unfair competition which we are experiencing at the hands of the British Government, the Canadian Government and the Australasian Governments for the Australasian traffic. In order to meet this competition by being in a position to fulfil every telegraphic need of Australasia, and in order to obtain a more central position in Australia, this Company, in conjunction with the Eastern Company, laid a few years ago, as the shareholders know, at heavy cost, the Cape-Australian cable, which not only gives us direct telegraphic connection with the cities of Perth and Adelaide, but, as part of the consideration for our expenditure, obtained for us direct dealings with the public in those and other State capitals of Australia, together with the use of Government wires between Adelaide, Sydney and Melbourne for the transmission of the traffic by our own employes. Although the privilege of dealing with the public is readily granted to private telegraph companies—both foreign and British—in Great Britain, Canada and many other countries, the Governments of Canada, New Zealand and Queensland have strongly objected to our enjoying it in Australia, and have protested against the Federal Government's decision to extend the Company's privilege to the cities of Melbourne and Brisbane. As a result of these protests our new agreement with the Federal Government, though ratified by the House of Representatives without a division, still awaits the decision of the Senate, which is delayed until after a conference has been held of the partners in the Pacific cable enterprise. This conference is expected to take place either in London or Australia very shortly. Meanwhile the competition between our cable and the Government cable is being conducted as actively and keenly as possible on both sides, and although we have had to complain, as I have said, of unfair treatment by the British as well as by some of the Colonial Governments, we have, so far, been successful in retaining quite as large a proportion of the traffic as we expected to do under the circumstances. Only yesterday a statement appeared in the London newspapers representing the working of the Pacific cable to be much quicker than that of the Eastern group of cables, messages having taken only 25 minutes via the Pacific, against three hours by our route. By selecting the most favourable conditions for the Pacific route and the most unfavourable conditions for ours, it is, of course, very easy to show this striking result; but had Adelaide and Perth been selected as the Australian termini instead of Christchurch and Brisbane, as was evidently the case, the result would probably have been extremely different. Many of our messages are transmitted to our cable termini at Perth and Adelaide from London in a few minutes. The message announcing the result of the first race for the American Cup took only 4 minutes between London and Adelaide by our route against 3 hours by the Pacific route. (Applause.) A later Cup telegram took only 2 minutes to reach Adelaide by our route. But I am bound to say that all these comparisons are more or less misleading, and the only fair comparison of any real value is to take the average time of the whole traffic by each route spread over a given period. (Hear, hear.) The best test is the attitude of the telegraphing public, who would not con-

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tinue to give us the bulk of their traffic unless our route were perfectly satisfactory—(hear, hear)—especially in face of the sentimental and other appeals made to them by some of the Governments interested in the Pacific cable. This competition, of course, involves considerable expenditure, and accounts for the increase to which I have already referred in our working expenses for the past half-year. Whilst seriously injuring our interests, the Pacific cable has not benefited the British or Australasian public, or even its promoters. The rates charged by the Pacific route between Australia and Great Britain are no lower than those agreed to be charged by the Eastern Companies in connection with the new cable via the Cape. It is true the Pacific cable transmits traffic between Australasia and America at a lower rate than formerly, as the route for that traffic is very much shorter than via Europe. As a consequence of this the chief—indeed, one may almost say the only—benefit from the Pacific Cable accrues to the United States, as the traffic with Canada is very small. According to a recently published official return, there will be a deficit on the working of the Pacific line for the current year of nearly £100,000, which will have to be borne by the taxpayers of this country, among whom you, gentlemen, are numbered, and by the taxpayers of Canada, Australia and New Zealand. This goes to prove what I have often stated before—that the Australasian traffic is insufficient to support all the existing cables, and that the Pacific cable was never needed for any traffic requirements; indeed, the cable connections with Australasia are far in excess of any traffic likely to be developed for some years to come. I have already said that you are losing as taxpayers of this country, but those of the public who are shareholders in our companies are losing also in dividend, or are likely to lose in dividend, so that we lose on both sides—both as taxpayers and as shareholders—and it does seem to me a most unfortunate thing that a commercial Company like ours should be exposed to a Government competition conducted with public money and to the great detriment and discouragement of private enterprise. (Hear, hear.) The more one thinks of these matters the more one sees that all great developments have always been due to private enterprise, and if Governments are to embark upon a policy of systematically discouraging private enterprise, they will not only be doing no good to the taxpayers but they will be doing serious harm to the country at large. It cannot be a sound policy, and never will be. (Hear, hear.) A short time ago we were unfortunate enough to have our Cocos-Perth cable interrupted and although the break was only a few miles from Fremantle and our repairing ship was very quickly on the spot, it took over a fortnight to restore the communication, owing to bad weather prevailing at the time. The traffic, however, I am glad to say, was not seriously affected, because we were able to transmit it by our other cables; but I need not say it would be a very different matter if the Pacific cable were interrupted, because with their single line they would have no resources to fall back upon except those provided by our enterprise. Happily the severe drought from which Australia so long suffered has now passed away, but it will naturally take a considerable time before the country fully recovers from the ill-effects of such a terrible visitation. This, and the competition, make the possibility of any further reduction of tariff under our standard revenue arrangement a very remote contingency. You will quite understand, therefore, that you at the present time suffer from two causes in Australia—first the Government competition, and secondly the fact that the country has been suffering year after year from these terrible droughts, which have seriously reduced the volume of business because it has seriously interfered with the prosperity of the country at large. We are, therefore, suffering this half-year from two causes, one of which, I am afraid, will remain—namely, the Government competition—while the other we have every reason to hope will pass away, and that our traffics may be expected to increase. (Hear, hear.) After meeting the increased expenditure to which I have just referred, and adding the credit balance of £37,180 brought forward from the previous half-yearly account, the net profits for the half-year amounted to £146,036. The usual interim dividends at the rate of 5 per cent. per annum have been paid for the half-year, absorbing £75,000, and the balance remaining of £71,036 is carried forward to the next account. The cables which the Company contracted to supply and lay for the Dutch Government between Borneo and the Celebes were successfully completed during the half-year, and a further contract has since been made with that Government for supplying and laying some additional short cables in Netherlands-Indian waters. These cables have been manufactured, and are now being conveyed to their destination by the steamship "Scotia," which has been chartered for the purpose; and shareholders will, I am sure, be glad to know that we have received letters of satisfaction from the Dutch Government for the way in which these contracts have been carried out. (Applause.) The necessity of the United States having direct telegraphic communication with their new Philippine colonies will have prepared the shareholders for the establishment of an American cable between the United States and the Far East. As you are aware, the first section—namely, between San Francisco and Honolulu—was laid and opened for traffic last year, and in July last it was extended from Honolulu to Manilla. The American cable was thus brought into direct connection with our system in the Philippines, and we are now exchanging traffic at Manilla with the Commercial Pacific Co., and through them with the Commercial Cable Co. of New York, under an arrangement come to with those companies after prolonged negotiations. Thus, not only is the United States given direct telegraphic communication with Hong Kong, China and other parts of the Far East over our cables and over those of the Great Northern Telegraph Co., but we have been able to secure, on our side, another alternative route to Europe for our traffic to and from the Far East, and, consequently, by this means to extend the network of international cables, making it almost impossible during political complications for telegraphic communication to be entirely suspended. This arrangement, though good for all parties, and especially for the public, has involved some financial sacrifice on the part of the Eastern Extension and Associated Companies, besides involving a reduction of the tariffs for China, Japan and Manilla traffic, as detailed in the printed report. These reductions, and the direct American connection with the Far East ought, however, to lead to a substantial development of the traffic in time to come. The only other matter to which I wish to draw attention is with regard to the International Telegraph Conference. The decision arrived at during the sittings of that Conference, recently held in London, not to make the "Official Vocabulary" compulsory ought to put an end, once and for all, to the constant disputes between the telegraphing public and the cable companies as to the admissibility, or otherwise, of doubtful code words. Under the new arrangement such words, which may be real or artificial, must be composed of syllables capable of pronunciation according to the eight authorised languages, and the words must not exceed 10 letters of the Morse alphabet. Combinations not fulfilling these conditions will be considered as letter ciphers, and will be charged accordingly—namely, at the rate of five letters per word. I now move the adoption of the report and accounts.

The Marquess of TWEEDDALE, K.T., seconded the motion.

Mr. MOUNTCASTLE: I should like to ask if there is any prospect of further reductions being made in our tariff? We have had a good many of them, and I should like to know if any more are likely to come.

There being no further questions asked, the CHAIRMAN said: As far as we can see, casting our eyes as far forward as possible, we think we have now made every reduction which can be contemplated, and I think it is perfectly obvious that our telegraph companies cannot do much more in this direction. We think, and indeed feel sure, that we have met almost every requirement of the public in the matter of reductions; and the general body of shareholders will, I daresay, recollect that in the report of the Departmental Committee appointed by the British Government to go into the question of telegraphic communication in the most exhaustive way—and I think almost every department of Government was officially represented—it was stated that the telegraphic rates charged by our Eastern Companies were all of the most reasonable kind, except, I believe, in two or three unimportant matters which it is scarcely worth my troubling you with. At any rate, they do not affect our Company. It should also be borne in mind that the same committee stated deliberately as the result of their investigations and deliberations that the telegraphic enterprises of this Company deserve the powerful support of the Government. I think that this view, coming from such an important committee will be borne in mind in the future, particularly having regard to the fact that the Pacific Cable has been established and worked under the conditions to which I have alluded.

The resolution was carried unanimously.

Mr. JOHN NEWTON: Before we separate, I should like to move a vote of thanks to the Chairman and Directors, who have, evidently, at the present time, considerable labours to perform in order to protect our property, and I trust they will be as vigorous as they possibly can be in combating the methods by which the Government are treating cable enterprise. Of course, it is only the same old story as to how the authorities have always treated private enterprises—as, for instance, the electricity supply undertakings. Electric lighting in this country has long been behind what it is in others, and that is largely because of the neglect of Government patronage or support. (Hear, hear.) The fact of their having dumped the Pacific cable on what are practically our preserves shows how little consideration they have for private enterprise, and that they are more or less regardless of the damage they may do to our property. The only comfort we have is, and that is somewhat mitigated by the fact of our being taxpayers as well as shareholders, that this cable is costing them a lot. (Applause.) I see by this morning's paper that there is estimated to be a loss of £150,000 for the two years' working. I can only say it serves them right. This Company, from the time I have been connected with it, now approaching 30 years, has made one continuous series of reductions in its tariff. I do not remember any increase. When anything like prosperity or a tendency to increase the dividend was apparent something has come along to rob us of the accruing benefit. I think that you, gentlemen, are entitled to the confidence and support of the shareholders, and I trust you will be successful in your efforts to protect our interests in the future and to resist all attempts to damage our property. I have great pleasure in moving a vote of thanks to you and your colleagues for your services.

Mr. MOUNTCASTLE seconded, and the proposition was unanimously agreed to.

The CHAIRMAN having returned thanks, the proceedings terminated.

West India and Panama Telegraph Co. (Ltd.).

The fifty-third half-yearly general meeting was held on Wednesday, Mr. WALTER B. KINGSFORD presiding.

The MANAGER AND SECRETARY (Mr. R. T. Brown) read the notice convening the meeting, and the auditors' report.

The CHAIRMAN said: Gentlemen, the total receipts for the half-year under review are £34,903, as compared with £28,970 for the corresponding period of 1902—an increase of £5,933. This is almost entirely due to a windfall of abnormal traffic which came upon our line in consequence of the interruption of two of the French West Indian Company's cables. Those two cables have now been repaired, and since the middle of October this extra source of revenue has ceased. We all of us have read with interest of the startling and important political events which are taking place on the Isthmus of Panama. As one result of these events a certain amount of additional traffic is at present passing over our Colon cable and this may perhaps compensate, in some measure, for the loss of the French traffic to which I have just referred. The expenses amoun to £23,051, against £22.309,

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representing a net increase of £652. This is arrived at by the increased cost of repairing cables, which amounts to £802, and also the setting aside of £281 for depreciation of our new repairing ship. There are also sundry other increases at stations and in London amounting to £319. This increase amounts in all to £1,402. From the total there has to be deducted a saving of £750. That is an expense which was incurred in the corresponding half-year in connection with the disasters at Martinque, but as that expense does not recur in the half-year under review the net increase is £652, as already stated. It will be seen from the report that although the Directors are again able to recommend the payment of 8s. per share on account of the arrears of dividend on the first preference shares, there still remain arrears of 2s. per share, representing £3,456, accrued on the first preference shares, and of 36s. per share, representing £8,404, accrued on the second preference shares. The policy of the Board, gentlemen, will, of course, be to pay off those arrears when the available profits enable them to do so. I much regret to have to report to you that on Aug. 11 a great cyclone struck the island of Jamaica. Happily the loss of life was small, but the damage done to the buildings and other property was enormous. Great tracts of fruit plantations were utterly laid waste, and the valuable and important banana crop was almost utterly ruined. The Jamaica Government telegraph land lines were completely wrecked, and our own land lines between Kingston and Holland Bay, a distance of 52 miles, were also blown down, and in some places altogether disappeared. At Holland Bay itself, where the full force of the hurricane was felt, the roof of our office and of the dwelling house of the staff was blown off. The cable hut was entirely carried away, and the cables leading into it were dislodged and disconnected. On the following day Mr. Demeza, our clerk in charge there, with great energy managed to clear the cables, and succeeded in restoring communication by the smart device of joining them up on the beach. Four days afterwards the "Henry Holmes" arrived at the spot, and at once set to work to repair the damage done to the cables. At the same time, our Kingston clerk-in-charge, Mr. McLeod, was very actively engaged in restoring the land lines. I cannot speak too highly of the zeal, energy, promptitude and presence of mind displayed by the members of our staff in the very alarming and most deplorable circumstances in which they found themselves so suddenly involved. With 21 stations to be maintained, with 24 sections of cable having a total length of 4,600 miles, and with nearly 400 miles of landlines, our system is vulnerable over a very large area, and at very many points. Consequently, in any disastrous convulsion of Nature which takes place in the West Indies we are invariably found to be in the list of those who suffer. To take, for example, only quite recent years, it was so in 1898, when a great hurricane swept over the Windward Islands. It was so in the year following, when a hurricane struck the Leeward Islands. Last year we had to deplore the terrible disasters at Martinique and at St. Vincent. In the present year this destructive hurricane at Jamaica has to be added to the catalogue. It is, gentlemen, by such events as these that we are continually and painfully reminded that the maintenance of telegraphic communication throughout the West Indian colonies is, in Falstaff's phrase, "No boys' play," but a most arduous and anxious business. At the very best—that is to say, under its normal conditions—our work is at all times beset with difficulties, and too frequently those difficulties are enormously increased by the sudden occurrence of some grave disaster which, with the utmost care, energy and foresight, it is utterly impossible either to guard against or to prevent. Taking into due account all the difficulties, hindrances and discouragements which our Company all through its career has had to face and overcome, I feel that it most assuredly deserves great commendation and no little credit for the resolute persistence with which for more than 30 years its burdensome and ill-requited task has been performed. I am sorry to say, gentlemen, that we have lately had considerable trouble with the section between Trinidad and Demerara, the southern terminus of our system. I may remind you that, in fact, two cables are lying in those waters. One of them has been down for 32 years. We have spent very large sums in repairing it from time to time. We are a most hopeful Company and always try to take a cheery view of things, but really, I feel a time may come when the Board will have seriously to consider whether, in our poor financial position, we should be justified in spending further money in endeavouring to put that cable into good working order. The second cable was laid, you may recollect, upon a new route that was specially and most carefully selected in the hope that we should find a better sea bottom upon which it might rest in greater security. Most unfortunately the new route, which, by the way, is longer and, therefore, more expensive than the other, has proved to be little or no better than the old one. It is quite evident that the mud in which a portion of the cable has of necessity to be laid contains some destructive property which, by chemical action, corrodes the iron armour of the cable, and so weakens it that a break not unfrequently occurs. In order to do everything that is possible to mitigate the mischief by renewing portions of the cable systematically from time to time, we some little while ago gave instructions to our cable staff in the West Indies that all weak places in the cable met with during repairing operations are to be cut out and replaced by entirely new cable. Within the last few days one such operation has, in fact, been carried out, 9 knots of weak cable having been removed and a length of new cable inserted. Gentlemen, interruption of telegraphic communication causes great inconvenience and trouble to our customers and serious loss to ourselves. I am confident, however, that to any fair-minded man who has a full knowledge of the facts it must be abundantly clear that we have done and are doing in this matter everything which, in existing circumstances, it is possible to do, and that the interruptions are due to no default whatever either on our part or in the cable, but simply and solely to physical causes over which we have absolutely no control. The three sections of our system—the Dominica-Martinique, the Martinique-St. Lucia and the St. Lucia-St. Vincent sections—which were interrupted last year during the volcanic disturbances, still remain unrepaired. It will be still within your recollection that whilst our chartered repairing ship, the "Newington," was engaged in repairing the break of one of these sections, she had a very narrow escape indeed of being destroyed in a sudden eruption of the Soufrière of St. Vincent. The completion of the work had therefore to be postponed until more peaceful times. We are very desirous indeed to get the work completed, and I think we see our way in the course of a very few days to take it actively in hand. From St. Vincent there comes the welcome and encouraging intelligence that the inhabitants—even the most pessimistic of them—are beginning to feel that the volcanic disturbances are now over, and they are looking eagerly to the authorities to take active and energetic measures to restore the industries of the island. That, gentlemen, is very good news. It seems that a lake of clear water has recently been formed in the crater of the Soufrière, and this is believed to be, not, of course, an absolute proof, but at all events a hopeful indication, that at present no further eruptions are likely to occur. There is a curious and interesting precedent of nearly a century ago, which certainly seems to afford some warrant for such a belief. Just after the memorable eruption of the Soufrière, in 1812, a similar body of clear water formed at the bottom of the huge chasm opened by the eruption, and there it remained continuously until the disastrous outbreaks of last year. When I was in St. Vincent, in 1881, and visited the Soufrière under the escort of my good friend and kindly host, Sir George Denton, now governor of the Gambia, I remember we looked over the rim of the crater and watched for some time with much interest the great round lake of sea-green water which lay furiously swirling far down below us. We were told by people on the spot that so deep was the lake, and so fierce the eddying current, that although many strenuous attempts had been made to ascertain its depth, no plummet had ever touched the bottom. We cannot but hope very devoutly that events may fully ratify the present bright and favourable omen. I may remind you, gentlemen, that the Brussels Sugar Convention is now actually in operation, having come into effect in September last. Hopeful expectations appear to be entertained that beneficial results will eventually follow from it. At present, however, I am told the English market is overstocked with large accumulations of beet sugar, and, therefore, until these accumulations shall have been disposed of, the full benefit of the Convention will not be felt. You may, perhaps, have noticed in some of the newspapers that energetic efforts are being made in various parts of the West Indies to revive the cotton industry which at one time was carried on there, I believe, to a considerable extent. I have been lately in correspondence on the subject with the British Cotton Growing Association, which has its headquarters in Manchester, and, in writing to me the other day the secretary of the Association was good enough to furnish me with the following particulars. He writes thus: "The matter has been taken up very energetically, and the governors of the various islands, together with Sir Daniel Morris, the Imperial Director of Agriculture, are doing all they can to encourage this new industry. A large quantity of land has been put under cotton in Barbadoes, in several of the Leeward Islands and in Jamaica. The results so far have been very good, and point to a great success." If only for selfish reasons, and apart from very much larger and more important considerations, we are heartily glad to hear of such efforts as these being made. The successful establishment in the West Indies of this or any other important industry could hardly fail, as a matter of course, to bring some very welcome grist to our own mill. I now move the adoption of the report and accounts, and the payment of the arrears dividend therein set out.

Mr. HENRY HOLMES seconded the motion.

Mr. THORP asked whether the effect of the construction of the Panama Canal would be to greatly improve the position of the Company? He added that, according to the latest accounts, the revolution in Panama would probably bring about the making of the canal by the Americans. If the Company had a connection with that part of the world would it not tend to improve business?

The CHAIRMAN: I do not know. We all recollect a very old piece of advice—never to prophecy unless you know. The question seems to me one exceedingly remote.

The resolution was then carried unanimously.

A vote of thanks to the Chairman, Directors and staff terminated the proceedings.

CAPE ELECTRIC TRAMWAYS (LTD.).—At the meeting on Wednesday, the chairman, Col. Sir C. Euan-Smith, K.C.B., said it afforded gratifying proof that the company's tramway systems at Cape Town and Port Elizabeth both continued to exhibit steady progress as to traffic and revenue. The period under review exhibited a further increase of £15,837 in gross revenue, and of 1,245,000 passengers carried, compared with the preceding year. Their operating expenditure for the 12 months had proved very heavy, and the net profit was lower than that of the preceding year by some £15,000, due to causes that were quite unavoidable, and against which no foresight on their part could have guarded. The great strain on the rolling stock and permanent way from the sudden heavy development of the traffic during the war had rendered a complete overhauling of the permanent way, of the rolling stock and of the plant in Cape Town imperatively necessary; and all that, in conjunction with the erection of additional power plant and fresh rolling stock, had to be carried out at a time when rates for both skilled and unskilled labour and all prices, were, as they had since remained, abnormally high. That abnormal expenditure was, however, gradually diminishing, though much still remained to be done to the permanent way.

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Their plant in Cape Town was efficient and equal to the requirements of the traffic. In Port Elizabeth they had nearly completed the erection of an additional unit in the power house, and had added to the rolling stock, bringing it up to the level of traffic requirements. The expenditure on those works had been provided without recourse to any increase of capital. The excess of expenditure over original estimates for which funds had been provided had been met from reserve, which now stood at £137,000, and, notwithstanding the decrease in profits available for dividend, the net result to the shareholders was that they had received dividends of 12 per cent., tax free, on the year's working.

CHATHAM AND DISTRICT LIGHT RAILWAYS CO.—The directors' report for the June half-year states that the profits, after deducting interest on debentures, &c., amount to £1,275. 1s. 8d., which, together with £95. 9s. 8d. brought forward, it is proposed to carry forward. The accident which occurred on Oct. 30, 1902, caused a considerable diminution in the traffic receipts extending over the period covered by the attached accounts. The Westcourt-street route was closed to public traffic, and powers to construct an alternate route has been since obtained. This route is now practically completed and will be opened for public traffic shortly. In order to improve the service 10 additional cars were ordered and put in operation in June last, since which date the receipts have considerably increased, and it is anticipated that the accounts to Dec. 31 will show satisfactory progress. The parliamentary act for powers to extend the tramways to Rainham, Maidstone, and surrounding districts, received the Royal Assent in August. By agreement with Rochester Corporation the company withdrew its applications for extensions through Rochester, and the company has entered into an agreement with the Corporation for leasing for 42 years the lines authorised by the act just obtained by the Corporation.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

ARCHIBALD J. WRIGHT (LTD.)—Reg. Nov. 13, capital £3,000 in £1 shares, to acquire the business carried on by Mr. A. J. Wright at 318, Upper-street, Islington, N., and to carry on the business of electrical and mechanical engineers, merchants and manufacturers of and dealers in electric, magnetic, telegraphic, telephonic, photographic and other appliances and apparatus, &c. Mr. A. J. Wright is first chairman and managing director.

W. D. HOUGHTON & CO. (LTD.)—Reg. Nov. 9, capital £50,000 in £10 shares (2,500 preference), to acquire and carry on the business of a manufacturer of steel wire and steel wire rope hitherto carried on by W. D. Houghton, at Warrington. Reg. office, Sankey Wire Mills, Warrington.

WEST LONDON MOTOR CO. (LTD.)—Reg. Nov. 14, capital £2,000 in £1 shares (500 6 per cent. cumulative preference), to adopt an agreement with the Begbie Mfg. Co., and to carry on the business of mechanical engineers, electricians, gas, oil and electric engine and motor manufacturers and dealers. First directors D. Begbie and O. F. M. Mundy. Reg. office, 407, Oxford-street, London, W.

MORTGAGES AND CHARGES.

FLADBURY ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Oct. 31 of £150 debentures, part of series created same date, to secure £300, charged on company's undertaking and property, present and future, including uncalled capital. No trustees.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 27½d. per oz. (Nov. 19). Consols 88⅝—88⅞ for money, 88 1/16—88 3/16 for account; 2½ per cent. annuities 88½—89 (Nov. 19). Consols Pay Day Dec. 1; Stocks and Shares Continuation Days, Nov. 24 and Dec. 9; Ticket Days, Nov. 25 and Dec. 10; Pay Days, Nov. 26 and Dec. 11; Mining Share Carry-over Days, Nov. 23 and Dec. 8.

ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT UND UNION ELEKTRICITÄTS-GESELLSCHAFT.—The working of the combined undertaking for the past year has resulted in a disposable balance of 5,624,385m. (against 5,634,042m. in the previous year), after paying expenses, interest on loans and writing off certain amounts (2,812,644m. in all, against 1,362,923m.). As announced in our last issue, a dividend of 8 per cent. will be paid. The amalgamation of these companies did not come into force until Jan. 1 last, and it was chiefly in connection with this combination that some extraordinary writing off had been necessitated. Orders in connection with electric railway equipment, brought into the concern by the A.E.G., afforded (says the directors' report) indications of a prosperous future for that branch of the business.

CLEVELAND TRUST (LTD.)—At the meeting last week the chairman (Mr. G. Arthur Head) said the Trust still held the Saltburn electric lighting undertaking and their income from that source was slightly in excess of last year. A dividend of 6 per cent. was declared.

DORMAN, LONG & CO. (LTD.)—The profit for the year ended Sept. 30 was £57,476. 7s. After payment of interest, &c., a final dividend of 1½ per cent. is recommended, in addition to 2½ per cent. paid in June, caving £1,812. 8s. 8d. to be carried forward.

R. HORNSBY & SONS (LTD.)—A dividend of 8s. per share on the ordinary shares, making 5 per cent. for the year ended Sept. 30, tax free, is recommended. £5,000 has been placed to reserve and £1,443 carried forward.

MONTREAL WATER AND POWER CO.—The list closes to-day (Friday) of an issue of £70,000 4 per cent. prior lien gold bonds of £100 each of this company.

SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER CO. (LTD.)—At the general meeting of the debenture-holdders on Friday last the resolutions passed on the 4th inst. modifying the terms of the debenture issue were confirmed.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have ordered a further issue of £44,435 3½ per cent. pref. stock of the *Eastern Telegraph Co. (Ltd.)* and £250,000 4½ per cent. 1st mortgage debentures of the *Midland Electric Corporation for Power Distribution* to be quoted. The committee have been asked to appoint a settling day in and grant a quotation to 78,000 deferred ordinary Class B £10 fully-paid shares of the *Great Northern and City Railway Co.*, and also to allow a further issue of 1,500 5 per cent. cumulative perpetual preference £10 fully-paid shares of the *British Columbia Electric Railway Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Nov. 14	1,074	+ 239	24	80,633	+ 5,029
Ayr Corporation	,, 14	181	- 2	25	9,064	+ 40
Barnsley	,, 6	173	...	44½	8,048	...
Bexley District Council	...	...	...	...	...	...
Birkenhead	,, 15	1,604	+ 56	...	...	...
*Birmingham Tramways	,, 14	5,221	+ 119	19	98,904	+ 2,662
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 12	307	+ 2	§92	85,934	- 209
Blackpool and Fleetwood	,, 14	222	+ 14	20	19,087	- 111
Blackp'l, St. Anne's & Lytham	,, 12	161	+ 77	‡2	292	+ 122
Bolton Corporation	,, 15	1,656	+ 67	30	61,657	+ 7,525
Bournemouth Corporation	,, 11	516	...	33	35,427	...
*Bradford Corporation	,, 15	3,645	+ 353	32	126,864	+ 17,944
Brighton Corporation	,, 15	824	+ 63	51	45,236	+ 6,311
Brisbane Tramways	Sept. 30	2,291	+ 99	13	30,608	+ 475
*Bristol Trams & Carriage	Nov. 13	4,720	+ 419	25	133,010	+ 13,311
*Buenos Ayres & Belgrano	Oct. 18	3,077	+ 207	‡26	50,548	+ 3,759
Burnley Corporation	Nov. 14	791	+ 103	33	34,766	+ 6,098
Burton Corporation	,, 15	331	...	...	...	...
Calcutta Tramways Co.	,, 14	R35,100	+ R5,766	20	R656,971	+ R125,688
Camborne-Redruth	,, 16	116	...	2	6,433	- 63
Cardiff Corporation	,, 14	1,965	+ 352	33	65,856	+ 18,480
Carlisle Tramways Co.	,, 16	189	+ 42	¶45	8,885	+ 686
Central London Railway	,, 14	6,986	- 863	20	124,921	- 6,624
Chatham and Dist. Lt. Rys.	,, 12	508	+ 157	45	24,521	...
City & South London Rly.	,, 15	2,894	- 535	20	51,661	- 8,197
Cork Electric Trams Co.	,, 12	437	+ 17	35	23,269	- 3,421
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 6	540	+ 113	44½	20,482	+ 1,100
Dover Corporation	,, 14	165	- 16	‡33	7,992	+ 76
Dublin & Lucan Railway	,, 15	101	+ 10	20	2,679	+ 165
Dublin Southern District	,, 13	776	+ 69	¶19	21,739	+ 7,723
Dublin United	,, 13	3,716	+ 131	¶19	78,995	
Dudley—Stourbridge	,, 6	769	- 6	44½	57,310	+ 8,595
Dundee Corporation	,, 11	789	+ 23	...	...	...
East Ham Council	,, 14	613	+ 160	‡31	22,685	+ 7,094
Gateshead & Dist. Trams	,, 6	949	+ 94	44½	39,002	+ 5,180
Glasgow Corporation	,, 14	18,724	+ 1,050	24	329,766	+ 35,004
Gravesend—Northfleet	,, 6	285	+ 44	44½	10,842	+ 1,088
Greenock & Port Glasgow	,, 6	506	+ 11	44½	24,493	+ 1,970
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 6	262	+ 20	44½	12,139	+ 727
Huddersfield	,, 14	1,173	+ 173	32	41,663	+ 6,484
Hull Corporation	,, 14	1,895	+ 183	‡38	62,007	+ 8,363
Ilkeston Corporation	,, 11	106	...	‡26	4,966	...
Isle of Thanet Co.	,, 14	283	- 46	20	20,880	- 1,071
Kidderminster & District	,, 6	104	- 3	44½	5,787	+ 172
Kirkcaldy Corporation	,, 11	148	...	37	6,513	...
Lanarkshire Trams Co.	,, 12	269	...	§13	10,614	...
*Leeds Corporation	,, 14	5,105	+ 250	33	185,193	+ 11,079
Liverpool Corporation	,, 7	9,100	- 2	45	454,247	+ 14,525
*Liverpool Overhead Rly.	,, 15	1,636	+ 84	20	33,594	+ 2,209
London County Council	,, 7	10,010	+ 2,896	‡32	320,821	+ 58,057
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 14	11,815	+ 6,165	22	262,674	+ 141,578
Mersey Railway	,, 14	1,281	+ 321	20	26,612	+ 5,308
Merthyr	,, 6	201	+ 28	44½	8,876	- 117
Middleton	,, 6	269	+ 28	44½	14,359	+ 1,767
Newcastle-on-Tyne Corp.	,, 14	3,570	+ 488	20	70,144	- 3,745
*Newport (Mon.)	,, 14	448	...	7	3,208	...
Oldham, Ashton & Hyde	,, 6	537	- 7	44½	25,463	+ 1,504
Perth (W. A.) Elec. Trams.	,, 13	1,302	+ 237	§15	52,536	+ 5,775
Peterborough	,, 6	119	...	41	6,626	...
Poole and District	,, 6	162	+ 16	44½	13,722	+ 1,597
Portsmouth Corporation	...	...	...	...	...	...
*Potteries	,, 6	1,692	+ 40	44½	70,358	+ 3,707
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 6	48	+ 5	44½	6,784	+ 1,607
Salford Corporation	,, 17	3,813	+ 940	33	126,944	+ 38,109
*Sheerness	,, 4	63	...	30	2,706	...
Sheffield Corporation	,, 15	4,451	+ 348	20	98,236	+ 7,128
*Southampton Corporat'n	,, 12	906	- 22	...	...	...
Southend Corporation	,, 11	222	+ 27	32	11,641	+ 1,850
Southport Tramways	,, 6	250	+ 3	44½	14,173	+ 2,538
S. Staffordshire Trams.	,, 6	1,035	+ 308	44½	40,557	+ 6,568
*Sunderland Corporation	,, 15	1,135	- 27	33	41,726	+ 2,007
*Swansea Trams	,, 6	491	+ 53	44½	23,214	+ 1,133
Taunton Trams	,, 6	56	+ 2	44½	2,747	+ 190
Tynemouth and District	,, 6	233	- 8	44½	14,241	+ 795
Tyneside Trams Co.	,, 11	293	+ 52	45	14,746	...
Wallasey District Council	,, 14	596	+ 63	‡33	23,941	- 3,015
Weston-super-Mare	,, 4	58	- 7	44	5,541	- 505
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 6	357	+ 17	44½	17,451	+ 7,51
Wrexham	,, 6	113	...	31	4,463	...
Yorkshire Woollen District	,, 6	567	...	37½	14,323	...

(a) These comparisons are with the corresponding period last year.
* Partly electrical. ‡ Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed. Nov. 18	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Nov. 18 High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4½—4¾	5 5 3	April, Oct	4⅛	4 1/16
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
10	10/0	Barcelona Tramways Ord.	7⅞—8¼	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —102	4 9 6	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10¾	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 1	Feb, Aug	..	..
St.	6	†British Columbia Elec. Rlwy. Def. Ord.	81 —84	3 11 5	..	81	..
St.	5%	Do. Pref. Ord. Stock	93 —96	5 6 5	..	..	..
10	4/2½	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
4!	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	..	..
10	10/0	British Electric Traction Ord.	11½—12	6 13 4	..	11⅜	11⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 4 3	Feb, Aug	11⅜	11 1/16
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	122½	122
5	..	Buenos Ayres and Belgrano Ord.	2⅜—2⅝	..	..	2¼	2 1/16
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5 —5¼	5 9 1	..	..	..
5	3/0	Do. "B"	4¾—5¼	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	106 —109	4 12 10	..	109½	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	99 —102	4 18 9	..	..	..
5	2 6	Calcutta Tramways	6¾—7¼	3 2 1	..	7	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 11	..	..	..
1	1/2⅜	Cape Electric Tramways Shares	1⅜—2	7 10 0	..	2	1⅞
St.	4%	Central London Ordinary Stock	93 — 96	4 4 3	June, Dec	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	99 —102	3 18 10	..	..	..
St.	4%	Do. Deferred Stock	99 —102	4 0 0	..	..	..
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 11	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 —5¼	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 5	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	50 —52	6 2 7	Feb, Aug	51½	51
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	127 —130	3 17 3	Feb, Aug	..	..
St.	5%	Do. (1896)	125 —128	3 18 10	..	..	..
St.	5%	Do. (1901)	122 —127	3 19 7	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	110 —113	3 10 11	May, Nov	110	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 0	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 —13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3¾—4¼	6 13 4	..	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 —98	5 2 0	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7⅞—8¼	3 10 7	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 3 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾—4¼	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 3	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4½—4¾	2 12 8	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼—10⅝	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 6	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11½—12	4 3 4	..	11⅜	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 8	..	..	..
St.	..	Mersey Con. Ord. Stock	8 —11	..	..	8½	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	..	..	12½	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅝—¾	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	1⅛—1⅜	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 4 1	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 —102	4 18 0	..	101⅜	..
10	10/0	Potteries Electric Traction Ord.	8½ - 9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	8½—9¼	5 5 3	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 —94	3 9 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	49 —52	6 1 6	F,My,Ag,N	50¼	49
St.	30/0	Do. Preferred	92 —94	6 8 3	F,My,Ag,N	94½	93
St.	1/0	Do. Deferred	7⅞—8¼	0 12 6	F,My Ag,N	8⅛	8 1/16
100	8%	Commercial Cable Capital Stock	145 —155	5 9 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	Jn Ap,Jy,O	92½	91
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	7⅛	7⅛
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	7
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	7⅛	..
50	4½%	Do. 4½ per Cent. Deb.	97⅞—101⅞	4 10 10	Jan, July	..	..
20	3/0	Direct United States Cable	10¼—10¾	6 0 11	Ja,Ap,Jy,O	10⅜	10 1/16
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 —102	4 8 10	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	122 —127	5 10 8	Ja,Ap,Jy,O	123⅜	122
St.	17/6	Do. 3½ per Cent. Pref. Stock	85 —89	3 18 8	Ja Ap,Jy,O	86½	..
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	106⅜	..
10	2,6	Eastern Extension	11 —11½	6 1 9	Ja,Ap,Jy,O	11⅛	11 1/16
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 14 9	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 18 10	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝—102⅞	3 18 11	May, Nov	101½	100
10	5/0	Great Northern of Copenhagen	22½—23½	5 6 5	Jan, July	23	22⅝
10	4½%	Halifax & Bermuda4½%1stMt.Db. (rd.)	99 —102	4 8 4	June, Dec	..	..
25	12 6	Indo-European	36 —39	6 8 2	May, Nov	..	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..
2½	..	West Coast of America	1/16—⅛	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	95	..
10	..	West India and Panama	7/16—½	..	May, Nov	½	..
10	8/0	Do. 6 per Cent 1st Pref.	6½—7	8 11 6	May, Nov	6⅞	6⅝
10	..	Do. 6 per Cent. 2nd Pref.	4 —5	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 17 7	Jan, July	..	..
10	5/0	Western Telegraph xd & bonus	11⅜—12½	5 14 3	Mr,Jn,O,D	12⅛	11⅞
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 8	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	8½—9	4 8 11	Ja Ap Jy O	8⅝	8½
10	8/0	Do. 6 per Cent. Pref.	12⅞—13	4 12 4	Ja Ap,Jy,O	12⅝	12½
8	4/0	Reuter's	6¾—7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	116 —121	4 19 7	April, Oct	118½	118
		TELEPHONES.					
5	6 0	Chili Telephone (fully paid)	4¾—5¼	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	101 —103	5 18 9	..	..	101¾ 100½
St.	5%	Do. Def. Stock	74 —76	6 5 0	..	..	75½ 74½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	13¾	13 1/16
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5¼	4 15 3	Feb, Aug	5 1/16	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	94 —96	3 14 0	June, Dec	95	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 —104	3 17 5	..	..	102½ ..
1	0/7½	Oriental	1/16—⅛	7 2 0	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1¼	..	..	..	..
5	4/0	United River Plate	5½—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 - 107	4 18 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅜—½	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	116 —119	3 15 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 —11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 3	..	105½	..
St.	4½%	Bromley (Kent) El.Lt.&Power 1stDebs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—10¾	4 3 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10 —10½	3 6 8	Mar, Sept	..	..
5	3 0	†Calcutta Electric Supply Ord.	6½—7¼	4 6 8	..	7	6⅞
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	107 —110	3 13 2	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	9 —9½	5 5 3	Feb, Aug	9⅜	9⅛
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	3 18 3	Feb, Aug	5⅛	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 16 2	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5½—6	4 3 4	March ..	..	..
St	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10 —10½	4 15 3	Feb, Aug	10⅜	10¼
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13½	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 —127	3 18 11	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 9 5	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7½ - 8½	4 14 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¼	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 2 11	..	..	..
St.	27,6⅔	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	100½	100⅛
5	2 0	Folkestone Electricity Supply Co. Ord.	5½—6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10½—11½	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg.Co.&NottingHill Co.(Joint Station) 4% Deb. Stck.(red.)	101 —104	3 16 11	..	..	..
5	..	London Electric Supply Ord.	1¾—2¼	..	..	..	..
5	2/0	Do. 6 per Cent Pref.	4¾—5¼	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	4 0 6	Mr,Jn,S,D	100½	99½
10	8 0	Metropolitan Electric Sup. Ord.	17 —18	4 6 1	April, Oct	17⅜	17⅛
5	..	Do. 4½ per Cent. Cum. Pref.	4⅛—4¾	..	..	..	4 1/16
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 8	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —99	3 11 7	..	..	..
10	6 0	Notting Hill Electric Ord.	12½—13½	4 8 11	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..
5	2 6	Oxford Electric Ord.	5½—5¾	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —100	4 0 0	..	..	..
1	..	Rand Electric	1/16—1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	99 —102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14 —15	4 16 8	Feb, Aug	14⅜	14 1/16
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 2	..	100	99½
5	2/6	Smithfield Markets Electric Sup. Ord.	3 —3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
1	1/9	South London Electric Supply Ord.	3½ - 4	4 7 6	..	..	..
5	2 6	Urban Electric Supply Ord.	4¾ 5¼	4 17 7	..	5	4¾
5	2 6	Do. 5% Cum. Pref.	4⅜ - 5¼	4 17 7	..	5	..
5	6/6	Westminster Electric Supply Ord.	12 — 13	5 0 0	Mar, Sept	12⅜	12
5	2/6	Do. 5 per Cent. Cum. Pref.	6 — 6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½ - ¾	6 13 4	..	..	..
1	7½d.	Aron Electric Meter 6% Cum. Pref.	1/16—⅛	..	Mar, Sept	..	..
5	4 0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 5 8	..	..	..
St.	4½%	British Thoms'n-Houst'n4½%1stMt.Db.	103 —105	4 5 8	..	.03	..
5	3/0	British Westinghouse 6% Pref.	5½—5¾	5 4 3	..	5⅛	5⅝
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	100 —102	3 18 5	..	101½	101⅛
1	..	Brush Electrical Engineering	¾—1¼	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1⅛—1⅜	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	85 — 90	5 0 5	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	11 —12	6 5 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	106 —110	4 1 10	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅞—1	6 17 2	..	1 1/16	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91 —96	4 15 3	..	91½	..
1	0.7½	Chadburn's Ship Telegraph Ord.	¾—1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2½	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	100⅝—104⅞	4 16 10	Jan, July	..	..
5	..	Edison & Swan United("A"Sh.)(£8 pd.)	⅞	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock(rd.)	72 —77	5 5 3	June, Dec	73	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6½—6¾	5 3 8	H'lf-yearly	6⅞	6½
5	8/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	..	6 1/16	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 4	..	106½	..
2	1/2⅜	Electric Construction Co.	1½—1⅝	6 17 2	Jan, July	1⅝	..
2	2 9⅜	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 3	Jan, July	99⅛	..
1	..	Electrolytic Alkali Ord.	⅜—½	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	½—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¾—10¼	4 17 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	90 —92	4 0 10	..	..	..
5	6/0	Henley's Telegraph Works Ord.	14 —15	6 13 4	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	5⅛	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	18⅛	18⅛
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	100⅛	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 8	Mar, July	34½	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	..	..
5	8/0	Willans and Robinson Ord.	5 —6	5 8 4	Apr, Oct	5⅜	..
5	8/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 10	May, Nov	101½	..

* In calculating the yield, allowance has been made for accrued interest; but not for redemption. † Ex Dividend, ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

Mr. Lee de Forest's article in another column of this issue contains an interesting review of some of the practical points that should be observed in the erection of wireless telegraph apparatus. The author is competent to write on this subject, as the method which he is developing is becoming one of the most successful of the competing systems in the United States. Mr. de Forest is in this country at present, and has been conducting experiments between Holyhead and Howth (Ireland), with the co-operation of the British Post Office. As the Post Office has made experiments with other systems between the same two points, it is doubtless collecting some valuable comparative information which we trust will eventually be made public. The most interesting feature of the de Forest system, it will be remembered, is the employment of an "anti-coherer" in place of the usual coherer—that is to say, a device whose resistance is increased when impinged upon by Hertzian waves. With the aid of this piece of apparatus Mr. de Forest claims to have attained working speeds far in excess of those customary with an ordinary Marconi coherer, in fact 30 and 35 words per minute have been mentioned in connection with the Holyhead-Howth trials.

Once more the Automobile Club announces trials for electrical vehicles, but previous announcements to the same effect have met with such poor responses from manufacturers, that in the event of less than 10 entries being received from this country, no trials will be held. It is to be hoped that the entries will exceed this number, and that some reliable data may be forthcoming from the resulting trials. There must be some valid reason for the unusual modesty of builders of electrical vehicles in thus hiding their light under a bushel. It may be that the conditions and regulations imposed by the Automobile Club are not such as can be easily complied with, in which case they should certainly be modified to meet the circumstances; on the other hand, however, the advocates of electricity as a motive power may be fearful of putting their claims to the test. The fulfillment of the prophecy that electricity will soon supersede petrol entirely seems yet afar off, and the trend of events during the last two or three years is not calculated to instil optimistic ideas into the mind of the observer. If there are sufficient entries, the trials are to be held in May, and makers desiring to take part in them should communicate with the secretary of the Automobile Club at an early date.

The single-phase motor patent published in this issue has many points of interest. It relates to the motor employed by the Union Elektricitäts-Gesellschaft on a line recently described in our columns, and in our previous article we were able to give curves showing the actual performance of one of the motors. The most interesting point in connection with the motor itself lies in the fact that it is capable of returning energy to the line when running above normal speed. In this respect it is, of course, similar to an ordinary induction motor, but, unlike the latter, it possesses more than one working speed. The induction motor has only one normal speed—viz., that of synchronism—while the speed of the single-phase motor under discussion may be definitely altered by the adjustment of the impressed voltages on the rotor and stator. Commercial developments of the motor will doubtless take place shortly, and announcements to this effect will be awaited with interest.

After the reading of a Paper at the Society of Arts on the forthcoming St. Louis Exhibition last Wednesday evening, an interesting statement concerning British exhibits was made by Col. Watson, secretary to the Royal Commission appointed to watch the interests of the United Kingdom at the exhibi-

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tion. Although, in his opinion, our educational exhibits would probably excel those of any other country, he stated that our electrical and machinery exhibits would not be so good owing to the fact that British manufacturers are too busy to send their products to St. Louis. If this were the only reason for such an apparent lack of enterprise, Englishmen would indeed have cause to rejoice, but, as a matter of fact, the true reason is a far more subtle one. Naturally, exhibitors will send the best they have to this great exhibition, and all and sundry will have the opportunity of examining details of construction and design. The obvious result would be that American manufacturers would have an excellent opportunity of profiting by the best points of English design, and as there is a high customs tariff on British machinery in America, the result would be that Americans might subsequently be able to buy American-made plant after British models. It might even happen that America would send these machines back to our Free-Trade country, and thus compete with us in our home markets even more than at present. Col. WATSON'S statement was, doubtless, perfectly sincere, but the root of the matter lies deeper than he imagines.

IT is becoming a far too common practice for municipal authorities to let tenders for extensions to electricity works, and even to spend money on them, before the Local Government Board has given sanction for the loan which is to pay their cost. Mr. R. H. BICKNELL, one of the Local Government Board inspectors, spoke in very strong terms of this custom at an inquiry held at Chesterfield last week. He said that the Local Government Board was getting more and more particular with regard to this, as it had found that authorities in all towns had got into the habit of doing work and then applying for loans. This simply meant reducing such inquiries to a farce, and the Board strongly objected to its inspectors holding inquiries which were farces. It should be possible, he continued, to foresee when a considerable augmentation of plant would be necessary, and in such circumstances, if the Board were informed of the situation, it would send down an inspector as soon as possible. In one respect Mr. BICKNELL is right, for it is certainly not quite in order for a municipal council to spend money before it has obtained it. On the other hand, we must confess that we have some sympathy with local authorities in this matter, for the Local Government Board often delays many months in complying with the request for an inquiry with regard to a loan for works which are urgently needed. Possibly the attention drawn to this matter will now encourage the Board to be more prompt in its inquiries, and if necessary, to increase the number of its inspectors.

WE report this week the conclusion of an interesting case, which, we believe, will constitute a precedent in the law of employer's liability. A man at work in an elevated position on a building in progress of construction was struck by lightning and killed. The widow applied in the County Court for damages from the employers, on the ground that the man's death was a result of the occupation in which he was engaged during the proper execution of his duties. It was successfully argued that the exposed position of the man, necessitated by the work he was carrying out, was the cause of his death, and, in consequence, damages were given against the company employing him. As a stay of execution has been granted in view of an appeal, we may hope that we shall shortly have an authoritative decision on this interesting point.

THE discussion on Mr. SCHOFIELD'S Paper on "Destructor and Electricity Stations in Small Towns," an abstract of which we print in another column, was not productive of much fresh information. Mr. W. EMMOTT expressed the opinion that refuse is more effectively destroyed in a combined station, owing to the fact that a constant steam pressure must be maintained; as a matter of fact, however, it is by no means unusual to help matters along slightly by the addition of coal when a heavy demand for steam is made, and although this undoubtedly tends towards the better destruction of the refuse, it can hardly be considered economical. Mr. MELDRUM'S calculation relating to the value of clinker is certainly an ingenious one, but it is by no means certain that his contention would be borne out by practice. Certain undertakings in the past have not only been unable to find purchasers for their clinker, but have been at an entire loss as to means for its disposal. In any case 2s. 6d. per ton appears to be rather a high figure. The desirability of employing a separate generator at the destructor feeding on to the central station 'bus bars or network also appears doubtful.

Royal Society.—Among the Papers down for reading yesterday was one by Mr. T. C. Porter, communicated by Lord Rayleigh, F.R.S., on "Some Experiments in Magnetism."

Electric Sleeping Cars.—According to the *Scientific American*, a sleeping car service has been inaugurated on the electric lines between Columbus, Ohio and Indianapolis, Ind. The cars are complete sleepers, and are equipped with 600 H.P. motors.

Erratum.—On p. 173 of last week's *Electrician*, in the paragraph describing wireless telegraph patent No. 17,111 of 1902, "L. H. Walten" should read "L. H. Walter."

Reprieved by Telephone.—According to the *Electrical World* of New York, a man convicted of murder was reprieved by long-distance telephone to avoid the possibility of a fatal delay in the mails. To make assurance doubly sure, a telegram was also sent.

Manchester University.—A notice appeared in the *Gazette* for November 20th to the effect that application to Parliament is to be made for an act providing for the merging of Owens College into the Victoria University of Manchester, with the retention of its old title.

Institute of Marine Engineers.—Last week, on the occasion of the reading of the presidential address before the Institute of Marine Engineers, Sir John Gunn presented the Denny medal to Mr. C. W. Barnes, of the Northampton Institute, for an essay on "Ship Electric Lighting."

The District Railway.—Last week-end a portion of the embankment along the electrically-operated Ealing–Harrow branch of the District Railway subsided, as a consequence, it is stated, of the recent rains. The up line from South Harrow to Mill Hill Park was closed for traffic, and the company were obliged to revert to single-line working.

Opening of Frinton-on-Sea Lighting System.—Last Friday the electric light station in St. Mary's-road, Frinton-on-Sea, was inaugurated, the high sheriff, Col. R. P. Davis, J.P., performing the ceremony of starting the plant. A Provisional Order was obtained only last year by the Frinton and District Electric Light and Power Co., who have lost no time in the erection of the works, the contractors being Christie Bros. and Middleton.

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Steam Turbines in France.—According to *L'Electricien*, an electric power generating station, driven by steam turbines, is to be built in Saint-Ouen (Seine). When completed, a number of Brown-Boveri-Parsons steam turbines will develop on the aggregate a power of about 60,000 H.P. The contracts for four 7,500 H.P. steam turbines, including the corresponding electrical equipment, have so far been placed.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Accra—Lagos	Nov. 14, 1903 ..	Nov. 22, 1903
Lagos—Brass	Nov. 14, 1903 ..	—
Tenedos—Chio	Nov. 25, 1903 ..	—

The Engineers' Club.—An association with the title of the Engineers' Club has been formed for the promotion of social intercourse between members of the engineering and allied professions. The club has been founded under the auspices of the Junior Institution of Engineers, but membership is open to the profession generally upon proper introduction. It is hoped, in the future, to be able to engage permanent rooms so that members may enjoy the usual advantages of a club house. Intending members should communicate with Mr. Fred. S. Pilling, 20, Victoria-street, Westminster, S.W., one of the joint hon. secretaries. An attractive list of social gatherings is being prepared.

International Tramways and Light Railways Union.—The official circular of the Tramways and Light Railways Association gives some particulars of the 1904 Congress of the Union Internationale Permanente de Tramways, which will be held in Vienna from September 11th to 15th. The following subjects have been put forward for discussion :—(*a*) Depreciation funds. (*b*) Inspection of Transfer Tickets. (*c*) Possible Economies in Current Consumption per Car. (*d*) Brakes for Electric Tramways. (*e*) Protection against the Fall of Telephone and other Wires. (*f*) Use of Trailers in the Working of Electric Tramways in Cities. (*g*) Advantages and Disadvantages of Electric Traction for Light Railways. (*h*) Fall in Potential of Current for Light Railways. (*i*) Permanent Way for Light Railways Worked by Steam Traction.

Anglo-Spanish Telegraphy.—The Spanish Telegraph Administration have set apart a special direct wire between Bilbao and Madrid for the Direct Spanish Telegraph Co.'s traffic, and have further agreed to devote a direct wire between the capital and Valencia to messages exchanged with the latter place during the busy hours of the day. It has also been arranged that the Vigo station of the Eastern Telegraph Co. should work direct with Madrid, using the Hughes instrument. The effect of these connections is to give direct communication between Bilbao and Madrid and Valencia on the one hand, and to quicken communication between Vigo and Madrid on the other. The transmission of messages exchanged between Great Britain and many of the principal towns of Spain—especially those interested in the important fruit trade with this country—will thus be greatly accelerated.

Opening of the Ilfracombe Electricity Works.—On Saturday last the new electricity works at Ilfracombe were officially opened by Mr. H. A. Palmer, J.P., chairman of the Ilfracombe District Council. In 1898 a Provisional Order was secured by the Council, but in consequence of costly municipal water and drainage works being carried out at the time, the Order was transferred to an Edmundson's company — the Ilfracombe Electric Light and Power Co. Two water-tube boilers, producing together 6,500lb. of steam per hour, supply two 150 H.P. Belliss engines directly coupled to 90kw. continuous-current Crompton dynamos. The storage battery consists of 260 D.P. cells, having a capacity of 350 ampere-hours. Current is distributed by the three-wire system, the voltage between the outers being 240 volts. The mains (Callender's) are laid directly in the ground.

"Glasgow Telephones."—This is the title of a pamphlet, relating to the Glasgow municipal telephone system, which has been sent to us by the *Manchester Courier*. It contains an abstract statement of the revenue and expenditure for the year ending May 31, 1903. Taking the amount borrowed from the Corporation of Glasgow Loans Fund to be £250,300 and the sinking fund for 1903 as £5,806. 13s. 4d., it is calculated that the currency of the loan on the basis of this annual payment would be about 43 years ; but the licence expires in 10 years, when the Corporation is bound to sell to the Post Office. A sum of over £527 for canvassing, wages, &c., has apparently been provided out of capital, and the auditors suggest that the time has come when such expenses should be paid out of revenue. The original estimate for rents, taxes, &c., was £750, but this has been exceeded by £2,220. Bad debts are also said to be reckoned as revenue, and already there is a credit to capital expenditure of £170 for "scrap material sold."

Failure of Supply at West Ham.—At Tuesday's meeting of the Corporation, the electrical engineer reported a partial failure of the electricity supply due to an armature coil failing on each of the 1,200kw. generators, between 4:30 and 5 p.m. on October 31st. Four 200kw. engines were then started, and run with 50 per cent. overload. A portion of the load was switched off until 8:45 p.m., by which time one of the large engine armatures had been repaired, and all lights were switched on. The cause of the failure of the second alternator was due to a piece of sulphur used to fix the bolts to the flywheel becoming detached and damaging the armature coils. The cause of the first coil breaking down cannot be definitely traced, as the armatures had been cleaned and examined the same day. The cause is probably due to deterioration of the insulation between the coils. In order to minimise the risk of a recurrence of the same trouble, it has been arranged that all the coils shall be re-wound and re-insulated, and that the bolt-holes shall be corrugated to prevent the sulphur coming out.

Personal.—Mr. Alfred Rosling Bennett, who acted as general manager and engineer of the Glasgow Corporation telephone department since its establishment, has intimated to the Telephone committee that, owing to the many claims upon his time entailed by his outside duties, he desires to retire from the general managership. The committee recommend that Mr. Bennett continue in his present position until the close of the Corporation's financial year in March, and thereafter he be retained as consulting engineer; that Mr. John Macfee, who has been throughout assistant manager of the undertaking, be appointed general manager ; and that Mr. John MacCallum, who has hitherto held the office of cashier, be appointed as assistant manager and cashier.

Amongst the Italian ladies who had the honour to be presented to H.M. the Queen of Italy at the Italian Embassy on November 12th was the wife of Mr. W. B. Esson Mrs. Esson was born in Rome, and comes of the illustrious Giustiniani family, her father, who fought with Garibaldi, being a Roman and her mother a Venetian.

Miss Edith Ayrton, the daughter of Prof. W. E. Ayrton, F.R.S., was married yesterday to Mr. Israel Zangwill, the distinguished writer. Many leading members of the electrical profession were present at the subsequent reception at Mrs. Ayrton's house in Norfolk Square.

Record Cabling.—The cricket matches in Australia have been the means of giving much publicity to the question of speed of transmission on the submarine cables between Australia and England. The two systems are owned respectively by the Eastern and Eastern Extension Telegraph Companies and the Pacific Cable Board, and the following schedule of times occupied by the two routes in transmitting the accounts of the match with New South Wales last week-end is interesting :—On Friday last the Eastern route occupied 19 minutes, as against 17 minutes on the Pacific cable; on Saturday the Pacific took 50 minutes to get through, as against 12 by the Eastern, and on Monday the Eastern got the result of the match over in 15 minutes, whereas the Pacific cable only took 11 minutes. In order to get these messages through the line the whole route has to be cleared, and, in consideration of "urgency" the rate is increased

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from 3s. per word to 9s. per word. We need hardly remind our technical readers that "speed" in this case is a question of organisation, and has no connection with the electrical properties of the cables.

Notes on Radium.—Prof. Arthur Schuster, writing to *Nature*, describes the following interesting experiments made by him and relating to the heating effects of the radium emanation :—

Air charged with radium emanation was led through a tube in which I placed a thermal junction formed by iron and nickel wires. The junction was left charged to a high negative potential during about 10 minutes, then taken out and placed side by side with an unexposed junction in a metal vessel kept at constant temperature by a water jacket. The two junctions at first seemed to be at the same temperature, but the exposed one began to become warmer almost immediately, and after 20 minutes was about one-tenth of a degree higher than the other junction. The experiment was repeated with the same result. Test experiments were made in various ways to show that accidental temperature disturbances could not affect the experiment. Thus, after the wire had been treated exactly in the same way in a current charged with thorium emanation, the junction showed absolutely no change of temperature detectable by the galvanometer used.

We may draw an important conclusion from these experiments. Prof. Rutherford has given strong evidence to show that the excited activity really contains three successive stages of radio-active matter, the first changing into the second, and the second into the third. The fact that the maximum heating effect was only obtained 30 minutes after the wire was first exposed to the emanation seems to show that it is the last transformation in which the third excited activity finally disappears or becomes inactive which sets the energy free. Experiments are now in progress to test the matter further.

The experiment mentioned above with the thorium emanation was not altogether satisfactory, and I should not at present like to draw the conclusion that the excited activity due to thorium does not give a heating effect. I only mention it here to show that the treatment of the wire in the experiment independently of the presence of radium does not give rise to such variations of temperature as have been observed. Had any appreciable amount of the heating effect been due to the contact with the emanation, I should have expected the junction to show some rise in temperature when first introduced to the calorimeter. All these results should be considered as provisional only until a more detailed investigation has been made.

Electric Welding of Tramway Rail Joints.—A system of welding tramway or other rails by electricity is now being tried at Glasgow. It has been employed in certain towns in America, and has been introduced into this country by the Lorain Steel Co. A rolled steel bar of rectangular section is welded to each side of the web of the rails and the joint is made in three distinct welds, one at the centre and two at the ends. The centre weld is made first, and then, before the steel bar has had time to cool, the end ones are made. On cooling, the bar contracts and so pulls the ends of the rails together that the joint is a very close one, there being no space left unfilled with metal. Previous to the welding process, the ends of the rails and the steel bar, which really acts as a fishplate, are thoroughly cleaned with a sand-blast, and after the operation any irregularities are ground down by a surface grinder. The welder itself consists of an alternating-current transformer, having for its secondary winding a single loop of copper of large cross-section, the terminals of which engage the bars on either side of the rail. The terminals are operated by hydraulic pressure. A rotary converter takes the current from the trolley and changes it to an alternating current. Flexible cables connect with the welder transformer. At 500 volts about 250 amperes are taken. This is again transformed to the welding current of about 5 volts and 25,000 amperes. The current is on about two minutes at each weld, and it takes from 12 to 15 minutes to complete a joint. After the metal is brought to a welding heat the current is cut off, and the weld, while cooling, is confined under a pressure of about 37 tons. This, we are informed, prevents any deterioration of the metal, and results in a remarkably tough weld. The process is said to be equally applicable to old and new rails, as well as to bonding.

Opening of Ipswich Electric Tramways.—On November 21st the Ipswich electric tramways were formally opened by the Mayoress of Ipswich. All the buildings were designed by Mr. C. S. Peach, and comprise boiler house, engine room, battery room, workshop, economiser house, general offices and car shed. In the latter, provision is made for 40 cars on eight sets of rails, but only 26 cars have been purchased up to the present. A Meldrum refuse destructor has also been installed, and the chimney is 178ft. high. Coal will be used in four Danks dry-back marine boilers, having a total evaporative capacity of 46,000lb. of water per hour. In the engine room there are six Reavell three-crank compound engines directly coupled to A.E.G. continuous-current generators, two of which have a capacity of 240kw., two of 120kw. and two of 50kw. each. The two largest machines can be employed either compound wound for the traction load or as shunt machines for lighting. Round the entire engine room there runs a gallery, from three sides of which it is possible to obtain access to the pipe work, while the fourth side has been reserved for the switchboard, which was supplied by the Allgemeine Elektricitäts-Gesellschaft, through their agents, the Electrical Co. A Tudor battery of 248 cells, with a capacity of 400 ampere-hours, works between the outers of the three-wire system. In the engine room there is a 15-ton crane, having a span of 51ft., manufactured by Messrs. Ransomes and Rapier, and the workshop is equipped with a 5-ton crane by Messrs. Morris and Bastert. The contract for the exhaust, feed and drain piping was secured by the Sir Hiram Maxim Electrical and Engineering Co., who also supplied the surface condenser and pumps. Nernst lamps are used for lighting the engine room. The paper-insulated lead-covered cables for both the lighting and tramways were supplied and laid solid in wooden troughs by Messrs. Johnson and Phillips. Over 10 miles of 3ft. 6in. track were converted by Messrs. Dick, Kerr & Co., 6in. girder rails, 90lb. to the yard, being employed. In addition to the rails, there is one conductor laid for the return. The minimum radius of curvature is 40ft., and this occurs at more than one point. No less than 22½ miles of trolley wire, supported by side-pole bracket arms, has been erected, and each section box is provided with telephonic communication to the power house. The British Electrical Equipment Co. were contractors for the overhead equipment. Car bodies and trucks were built at the Brush Electrical Engineering Co.'s works, but the electrical equipment and subsequent erection was carried out by the British Westinghouse Co. Each single-truck, double-deck car is capable of seating 26 outside and 24 inside passengers. Wheel and slipper brakes are fitted with the Brush pattern of concentric spindle gear. Messrs. Kennedy and Jenkin acted as consulting engineers.

Institution of Electrical Engineers.—On Friday afternoon last a special deputation from the Institution of Electrical Engineers paid a visit to Windsor Castle with the object of presenting an address to His Majesty King Victor Emmanuel III. of Italy. The deputation, which consisted of Mr. Kaye Gray, president, Lieut.-Col. R. E. Crompton, C.B., Sir H. Mance, Dr. J. W. Swan, F.R.S., Prof. Silvanus P. Thompson, F.R.S., and Mr. W. G. McMillan, proceeded to Windsor by special train leaving Paddington at 4 p.m., and was received in the Vandyck room of the Castle, being introduced by Lord Kenyon, Lord-in-Waiting. The King of Italy, who wore Italian uniform, having shaken hands with the members, received the address graciously, and then entered into general conversation. After about 10 minutes His Majesty again shook hands with each member of the party, which returned to London at six o'clock. The address read as follows :—

May it please Your Majesty.

The Institution of Electrical Engineers of Great Britain, having in the spring of the present year rendered homage at the tomb of the illustrious physicist, Alessandro Volta, and having visited the electrical railways, power stations and works, which form so noble a monument to Italian enterprise of to-day, humbly beg permission to avail themselves of the present opportunity, and to lay before Your Majesty an expression of their recognition of the courteous and generous hospitality accorded to the members of this Institution, not only by their sister society, the Associazione Elettrotecnica Italiana, and by electrical engineers generally but also by the various municipalities and corporations of the districts visited by them. The members of the Institution who were fortunate enough to visit Your Majesty's dominions will never forget the genial kindness of their reception by the distinguished engineers and others whom it was their privilege to meet. During Your Majesty's presence in England, the President, Council and Members of this Institution respectfully tender an assurance of their devotion to the Sovereign of a nation for whom they entertain feelings of the highest respect, admiration and affection. We ever pray that the friendship and good-feeling between the two countries, of which the warmth of our reception in Italy gave convincing proof, may continually grow in intensity, and that Your Majesty may long be spared to guide the destinies of a nation to whom the people of this country are united by the bonds of an inalienable sympathy.

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In reply to a telegram sent to the Associazione Elettrotecnica Italiana, the following message has been received from Prof. M. Ascoli, one of the vice-presidents :—

Most sensible to the feelings that inspired your kind telegram. I thank the Institution of Electrical Engineers for the new proof of sympathy, and return most hearty greetings in the name of the Associazione Elettrotecnica Italiana.

A similar telegram to the Milan section of the Associazione Elettrotecnica Italiana, elicited the following reply from Signor Bertini :—

Homage added by Institution of Electrical Engineers to enthusiastic reception to our king by all England was learned with grateful feelings by Milan Section Associazione Elettrotecnica Italiana as a new token of friendship binding scientific bodies of the two countries.

St. Louis International Electrical Congress.—In connection with the International Electrical Congress to be held at the 1904 St. Louis Exhibition, it is announced that the following selections have been made by Prof. Elihu Thomson, president of the committee of organisation of the Congress for the officers of the various sections :—

Section and Subject.	Chairman.	Secretary.
A General theory, mathematical, experimental	Prof. E. L. Nichols, Cornell Univ.	Prof. H. T. Barnes, McGill Univ.
Applications:—		
General applications	Dr. C. P. Steinmetz, Schenectady, N.Y.	Prof. Sam'l Sheldon, Poly. Inst. Brooklyn
C Electrochemistry	Prof. H. S. Carhart, Univ. of Mich.	Mr. Carl Hering, Philadelphia.
D Electric power transmission	Mr. Chas. F. Scott, Pittsburg	Dr. Louis Bell, Boston
E Electric light and distribution	Mr. J. W. Lieb, jun., New York	Mr. Gano S. Dunn, Ampere, N.J.
F Electric transportation ..	Dr. Louis Duncan, Mass. Inst. Tech.	Mr. A. H. Armstrong, Schenectady.
G Electric communication ..	Mr. F. W. Jones, New York	Mr. B. Gherardi, jun., New York.
H Electrotherapeutics	Dr. W. J. Morton, New York	Mr. W. J. Jenks, New York.

The section officers will have charge of the proceedings of the Congress at St. Louis in their respective sections. The Papers that are to be read at the Congress will be communicated by invitation from well-known authors in America and other countries. They are to be read and discussed at St. Louis during the Congress week September 12-17, 1904. They are then to be printed and published in book form. Invitations to join the Congress are being issued to persons and parties interested in electricity. Over 6,000 circular letters of invitation will be sent out in the United States, and a similar number to foreign countries. Most of the circulars are being directed to members of electrical industries, societies and scientific institutions. Joining the Congress entitles the member to attend the various functions at St. Louis and also to receive a copy of the subsequent *Transactions*. It is expected that many will join the Congress who cannot expect to attend the sessions in St. Louis, merely to receive the printed *Transactions*. Already about 350 Americans have joined the Congress in response to circulars, and only part of the circular catalogue has been covered. Communications concerning the Congress should be addressed to the general secretary, Dr. A. E. Kennelly, Cambridge, Massachusetts, U.S.A.

Motor Car Registration.—Under the Motor Car Act which comes into force on January 1, 1904, the Local Government Board is empowered to make certain regulations to be applied by the County Councils and Borough Councils in the administration of the act. Therefore a list of such regulations has just been issued having reference to the registration of the cars and the granting of licences to drivers. Under the former heading, it is laid down that all County Councils and Borough Councils shall keep a register of motor cars, which may, at the discretion of the Council, be kept in two parts, one relating to cars and the other to motor cycles. To each Council have been assigned distinguishing index letters, which, together with a number, must be displayed upon the vehicle. A specimen form of application is appended to the regulations, and this must be used by all persons desiring to register a car. The fee for registration, as laid down by the act, is 20s. for a motor car and 5s. for a motor cycle. When a car changes hands, notice must be given to cancel the registration, or if it is wished to continue the registration in the name of a new owner, a fee of 5s. for a car or 1s. for a cycle must be paid. The badge to be carried by a registered car will consist of two plates, one bearing the letter or letters assigned to the particular County Council under these regulations, and the other bearing the number assigned to the car by the County Council. The letters and figures must be white upon a black ground, and of certain prescribed sizes. This plate must be kept illuminated at night time. The identification numbers can also, if the owner desires, be painted upon the car. In any case, however, such marks of identification must be carried both in the front and at the rear of the car. In the case of a motor cycle, duplicate face plates are allowed. When another car is attached to a motor car, the identification plate must be placed at the back of the trailer. The registering Councils will supply the plates if required, at a charge. Applications for licences as drivers must also be made upon a special form, and for these licences a fee of 5s. is charged. They are for a period of twelve months, and persons not residing in the United Kingdom are also entitled to them. Licences must be renewed at the end of one year, and 5s. is payable on every renewal. These licences, also, must be produced when required by a police constable. Motor car drivers' licences are granted to persons over 17 years of age, and for a cycle to a person over 14 years of age. The Motor Car Act, 1903, remains operative until December 31, 1906.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

To-day (FRIDAY), November 27th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "An Electrical Thermostat," by H. Darwin; (2) "On the Occurrence of Cavitation in Lubrication," by S. Skinner; (3) "A Lecture Experiment in Electrical Resonance," by Dr. W. Watson.

SATURDAY, November 28th.

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

10:30 a.m. Visit to the City-road Works of the County of London and Brush Provincial Electric Lighting Co.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street, Glasgow. Paper to be read: "Some Remarks on the Willans Engine," by J. H. Pocock.

MONDAY, November 30th.

SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Royal United Service Institution, Whitehall, S.W. Paper to be read: "Mechanical Stokers for Electricity Generating Stations," by A. Gay.

WEDNESDAY, December 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, Westminster. Paper to be read: "The Operation of Electric Lifts," by H. Church.

SOCIETY OF ARTS.

8 p.m. Ordinary meeting. Paper to be read: "The Fiscal Problem," by Sir Charles M. Kennedy.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. Meeting at the Royal Institution, Liverpool. Paper to be read: Recent Telephone Developments in Liverpool," by E. J. Hidden.

THURSDAY, December 3rd.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

8 p.m. Meeting in the University Buildings, when Mr. J. C. Vaudrey will deliver his inaugural address.

FRIDAY, December 4th.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Paper to be read: "Recent Developments in the Construction and Working of Gas Engines," by Prof. D. S. Capper.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, Westminster. Paper to be read: "Artificial Draught, as applied by Fans to Steam Boilers," by W. H. A. Robertson.

SATURDAY, December 5th.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street. Paper to be read: "Superheat," by W. H. Booth.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Induced Thorium Activity.—F. von Lerch has made a series of experiments to determine the chemical behaviour of the induced radio activity shown by metals exposed for some hours to Rutherford's thorium emanation. He works on Rutherford's hypothesis, assuming that thorium gives rise to thorium X, the latter to thorium emanation, and this again to induced thorium activity, by a series of sub-atomic transformations. The author finds that all metals activated by thorium emanation show the same index of decline. Palladium appears to absorb the emanation. When metals after exposure to the emanation are dissolved in acids, the radio-activity acquired remains attached to them, and re-appears on precipitating them from solution. It may, however, be detached from the metals by electrolysis, and made to precipitate on the cathode. The author believes that the induced activity is a new element or series of elements, the main constituent having a position between copper and lead in the voltaic series.

[E. VON LERCH, *Ann. der Physik.*, No. 12, 1903.]

Absorption of Cathode Rays.—P. Lenard gives a very interesting tabulation of the absorption of cathode rays possessing various velocities, ranging from that of light to $\frac{1}{2\,7\,0}$th of light. The experiments were carried out in hydrogen, argon and carbonic acid. In all these bodies, the absorption increased on reducing the velocity, and more rapidly than the reduction of the velocity. On reducing the velocity from that of light to $\frac{1}{1\,0\,0}$th that of light, the absorption is increased a millionfold. But this rapid increase of the absorption is not indefinitely maintained. At low velocities there is a turning point, after which the absorption tends towards a limiting value. The lower the velocity, the more does the individual character of the gas come into play. At the high velocities the mass alone seems to determine the absorption, whereas at low velocities it is more the number of molecules per unit volume which determines it. An exact correspondence between absorption and velocity cannot be established anywhere between half the velocity of light and zero velocity. The author proceeds to formulate a new theory of the constitution of matter based upon these observations. The ultimate constituent of the atom he calls the *dynamid*, on account of its electric field, which deflects and arrests the electron in its passage. The dynamid may be regarded as an electric doublet, whose moment may vary from one atom to the other. The atoms of the different elements are made up of different numbers of dynamids in exact proportion to their atomic weights. Every dynamid throughout the universe has the same mass, but the actual volume of the dynamids constituting a cubic metre of solid platinum is barely a cubic millimetre.

[P. LENARD, *Ann. der Physik*, No. 12, 1903.]

Spinthariscopic Phenomena.—T. Tommasina confirms Becquerel's contention that the sparkling observed in Crookes' spinthariscope is due to the cleavage of the zinc sulphide crystals provoked by the impact of α-rays. He finds that when the sparkling screens are stood in a dark drawer for several days, and then placed under the microscope in the immediate vicinity of a charged rod of glass or resin, the sparkling is restored, apparently by the renewal of the process of cleavage. The effect is better shown by a bare sulphide screen than by a screen kept under a glass cover. The author supposes that the slight agitation of the sulphide crystals produced by the presence of the electrified body exposes fresh surfaces for cleavage. Microscopic examination shows that the sparks are best focussed in the plane containing the most exposed edges of the sulphide crystals. Barium platinocyanide also shows the sparkling, but less distinctly than zinc sulphide.

[T. TOMMASINA, *Comptes Rendus*, November 9, 1903.]

Storage of N-rays.—R. Blondlot has made another remarkable discovery in connection with N-rays. He found that on concentrating N-rays with a quartz lens for some time upon a calcium screen and then taking away the Auer burner, the increased luminosity of the screen persisted as long as the quartz lens remained. The lens, in fact, possessed a kind of invisible N-ray phosphorescence. The same effect is shown by quartz plates, as well as Iceland spar, fluorspar and glass. The reflective power of metals is, as we know, enhanced by exposure to N-rays. This enhanced reflective power also persists for some 10 or 20 minutes. Lead becomes active in this manner on both faces if one of them is exposed to N-rays for several hours at a time. Aluminium, wood, paper, and paraffin do not store up N-rays, and the least trace of moisture completely eliminates the effect. Dry pebbles gathered in bright sunlight give out N-rays. The effect will be shown not to be quite analogous to phosphorescence in a further Paper.

[R. BLONDLOT, *Comptes Rendus*, November 9, 1903.]

The Magnetic Storm of October 31st.—T. Moureaux reports on the magnetic storm as observed at the Val-Joyeux station. It began suddenly at 6:12 a.m. by a simultaneous rise of the declination and the horizontal component and by the lowering of the vertical component. Great oscillations of the D and H magnets commenced about 7 a.m. and continued without interruption till 10 p.m. H began to fall again as early as 10 a.m. or 11 a.m., but the phase of maximum intensity was not reached till midday. At that time the vertical component Z, hitherto little affected, increased rapidly, and the other two elements showed sudden variations of great amplitude. Large oscillations were also noticed at 4 p.m., 5:30 p.m. and 7 p.m. The magnets were in a disturbed state all through the night. Indeed, it was not till 2 a.m. on November 1st that the vertical component passed through its minimum. The maximum variation of the horizontal component amounted to $\frac{1}{2\,0}$th of its normal value. The declination varied by a maximum of 2deg. 4min. An important group of sun spots, followed up since October 26th at the Parc St. Maur Observatory, crossed the central meridian on the day of the storm. Without being so large as the group observed on October 5th to 17th, which could be seen with the naked eye, it measured in its greatest length about $\frac{1}{1\,1}$th of the sun's diameter. No trace of an aurora was seen that night, but the sky was overcast from 7 p.m. The magnetic storm was also observed at the observatories of Lyon, Nice, Perpignan and Pic du Mudi.

[T. MOUREAUX, *Comptes Rendus*, November 2, 1903.]

RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 163.)

METHODS OF MEASUREMENT.

The means of investigating the rays from radio-active substances are similar to those employed for the X-rays, and may be divided into three classes: the electrical, photographic and fluorescence methods respectively. The first only, the electrical method, is suitable for accurate quantitative investigations of radio-activity, but the photographic and fluorescence methods have frequently been employed for rough comparisons and for experiments in which accurate measurements of the intensity of the rays are not required. Thus much of the work on the magnetic and electric deviation of the Becquerel rays has been done by causing the latter to trace their paths on a photographic plate. It must be pointed out that the different types of rays give often very different results with the three methods. Thus the electrical method depends on the absorption of the rays by the air, the energy of the rays going to produce ionisation, and with this method the easily absorbed or α-rays give by far the greater effect. These same rays, on the other hand, give relatively very little effect on the photographic plate. Thus the α-rays of uranium do not perceptibly affect a photographic plate, although they contribute over 99 per cent. of the total electrical effect when examined under ordinary circumstances (Soddy, *Jour.* Chem. Soc., 1902, 81, p. 860). This is probably due to the fact that the rays

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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are unable to penetrate the gelatin film sufficiently to affect appreciably the sensitive silver salt.

Many fluorescent substances behave differently under the action of the α and β-rays. Thus, zinc sulphide (Sidot's hexagonal blende) is extremely sensitive to the action of the α-rays and much less to the action of the β-rays, while with barium platinocyanide and willemite (zinc silicate) the contrary holds true.

The electrical methods alone demand a more detailed consideration. It has been shown in previous articles that, to obtain definite results, the conditions must be such that the "saturation current" is measured, as this current is an expression of the number of ions produced per second, and the latter is proportional to the intensity of the radiations absorbed by the air. Rutherford, in the research in which he showed that the ionisation from uranium was of the same character as that produced by X-rays (*Phil. Mag.*, 1899, V., 47, p. 109), showed also that the ionisation was proportional to the pressure of the gas, while the absorption of the rays was also proportional to the pressure. For different gases, although for thin layers the ionisation increases as the density of the gas, for thicker layers the total ionisation when all the rays are absorbed reaches a maximum, and then is approximately the same for all gases. A very careful series of measurements by Strutt (*Phil. Trans.*, A. 196, p. 507, 1901) has led to the conclusion that, with the exception of hydrogen, all gases are ionised by the various rays from

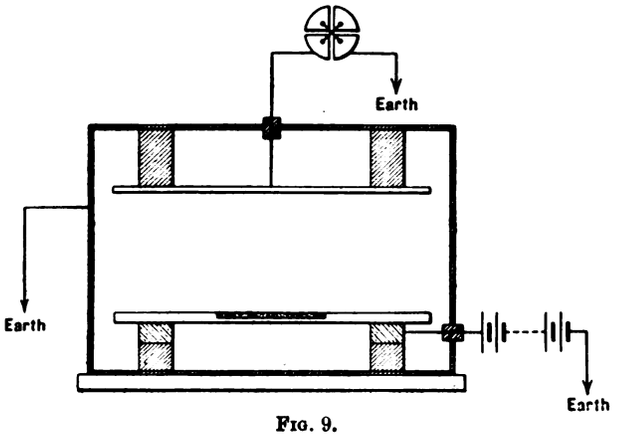

FIG. 9.

radio-active substances to an extent sensibly proportional to the density and independent of the nature of the gas. With hydrogen the ionisation is greater than it should be if proportional to the density, and this divergence is greater for the α than for the β-rays. We may conclude, as a first approximation, that the energy required to produce an ion is the same for the ions of all gases except hydrogen.

Fig. 9 represents an apparatus constantly employed by Rutherford for the electrical measurement of radio-activity. The two plates are each of about 36 sq. cm. area, and a known weight of the radio-active substance in fine powder is sifted uniformly over the lower plate, which is insulated and connected with one pole of a battery of 300 volts, the other pole being earthed. The upper plate is about 5cm. from the lower and is connected with one pair of quadrants of a Kelvin electrometer of the White pattern, the other pair being connected to earth. This upper plate is most carefully insulated, and the whole apparatus is placed in a metal box, provided with a door at the side through which the lower plate can be inserted or removed. To use the apparatus, both pairs of quadrants are at first connected to earth, the earth connection of the pair connected to the upper plate is then broken, and the *rate* of deflection of the electrometer needle from zero is measured by means of a stop-watch by noting the time taken for it to pass over a given number of divisions of the scale. The deflection of the electrometer needle is a measure of the difference of potential between the two pairs of quadrants, and since the capacity of the system is constant, of the charge communicated to the one pair, when the other is kept connected to earth. The rate at which this charge is communicated is a measure of the current through the gas. 0·5 gramme of uranium or thorium oxide in this apparatus produces a current of approximately 10^{-11} amperes. The measurements are usually comparative, the radio-activity of some standard, such as a known weight of uranium oxide spread over a given area, being compared with the activity of the substance to be measured. In this way the sensitiveness of the electrometer, which varies from day to day according to the extent to which the needle is charged, is eliminated. M. and Mme. Curie use a similar apparatus, which is represented in Fig. 10 in which the charge communicated to the one pair of quadrants by the current through the air under the action of the radiations being measured, is balanced by the communication of a similar charge of opposite sign, so that the electrometer needle shows no deflection. This is effected by means of a quartz electric balance which consists of a quartz lamina, which can be subjected to a known tension by means of weights, the two sides of the lamina receiving opposite charges of electricity, the amount of which is known for any known weight. The application of the weight is so regulated that at each instant the charges of opposite sign communicated to the electrometer are equal, and the time from the commencement to the completion of the application of the tension furnishes a measure in absolute units of the intensity of the current flowing through the air under the action of the radio-active substance. In this way the operation is performed by a null method, and is independent of the sensitiveness of the electrometer.

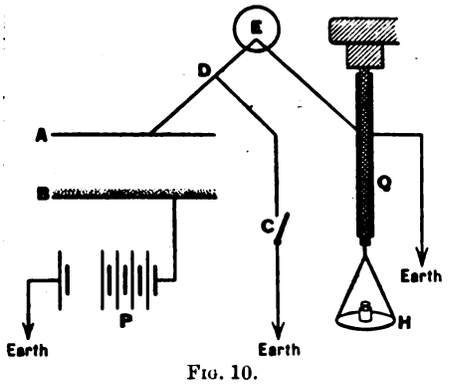

FIG. 10.

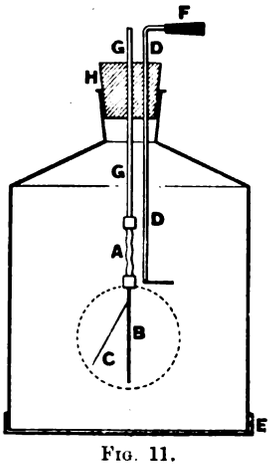

FIG. 11.

The simplest means of measuring radio-activity electrically is by means of a gold-leaf electroscope, and this instrument is very useful in certain cases, although its application is somewhat limited. It can, however, be arranged to detect far feebler ionisation than even the most sensitive electrometer, and has proved invaluable in many important researches. Fig. 11 represents an electroscope suitable for the testing of radio-active substances. It is modelled after one first employed by C. T. R. Wilson. It consists of a tin can with a removable lid, E, at the bottom for the insertion of the substance to be tested. A paraffined rubber cork, H, is pierced in the centre by the metal wire G, which carries at its end a rod of fused quartz, A. A thin brass strip, B, to which a single gold-leaf, C, is attached, is fastened to the lower end of the quartz rod. The charge is communicated through the rod D, which can be turned by the ebonite handle F so as to make contact with B. When the electroscope is charged this connection is broken, and the rods C and G and the outside of the metal vessel are connected to earth. The electroscope then represents a perfectly isolated charged system completely surrounded by metal and free from all external disturbances. The rate of collapse of the gold-leaf is observed by means of a reading microscope provided with a micrometer scale, through windows in the case of the instrument. For the measurement of radio-activity the substances to be compared can either be placed inside the electroscope by spreading known weights over suitable metal discs of similar area, or in the case of more active preparations can be placed at a fixed distance outside the electroscope so that the rays have to penetrate the metal walls. If the deflections are only taken between certain limits, it is found that they are very approximately proportional to the

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potential of the leaves. If the dimensions of the instrument are not too large and the radio-activity is not too great, the saturation current through the gas is attained and the rate of collapse is uniform between these limits.

The α rays are so easily absorbed that the radiation does not much increase beyond a certain thickness of the layer of the active substance. To make the measurements of different substances as comparative as possible, the smallest possible weight spread over a large area should be employed. But even then the activities of different compounds of different densities and states of division can only be approximately compared. On the other hand, the *change* of the activity of any given preparation with time can be very accurately studied by leaving it undisturbed on its original plate throughout the course of the measurements.

For the measurement of more active preparations than uranium and thorium the sensitiveness of the measuring instruments must be decreased by connecting them in parallel with suitable capacities. But it must be remembered that the voltage required to produce the saturation current increases as the current increases. For work with preparations of uranium a greater voltage than 300 is seldom required, and this can be obtained by means of a battery of Planté cells charged in parallel and discharged in series. But for work with radium much higher voltages are necessary to produce the saturation current, unless the intensity of the rays is cut down by absorption in suitable screens.

(To be continued.)

CONCERNING WIRELESS TELEGRAPH TRANSMITTERS.

BY LEE DE FOREST, PH.D.

Throughout the various attempts which have been made to approximate in wireless telegraphy, even remotely, something of the accuracy in resonance effects so well known in acoustics, sufficient attention has not been shown to the necessity for generating at the transmitter a long train of but slightly-damped oscillations. All refinements and closeness of tuning at the receiving station are futile if the transmitter radiates but three or four impulses at each condenser discharge. Failure here has been largely due to imperfect arrangement and construction of condensers, spark-gap, faulty insulation, &c., in the transmitter, a condition inevitable at the start of a new art, when apparatus at hand is entirely such as the physics laboratory can supply, and when a host of minor details and refinements are neglected—conditions which alone distinguish between the experimental laboratory work and actual engineering achievement.

The rapid damping of the transmitter oscillations are due chiefly to two causes: First, that from losses due to radiation from the antenna (which are considered useful and necessary), and, second, to losses resulting from leakage, heat and dielectric hysteresis, which are certainly detrimental to an extent little appreciated. Of leakage from the antenna, there will always be a certain amount. Thorough insulation, especially at top of the mast, and from all guy ropes, cannot be too strongly emphasised. If the antenna is connected to the resonator, or feeding circuit, inductively, whether by transformer or auto-transformer linking, the static potentials excited therein are slight compared to what result from the old method of attaching antenna and earth wires directly to opposite sides of the spark-gap. By the newer method, therefore, the problem of adequate insulation at the base of the antenna, where this enters the station house, is greatly simplified, for one may place his hand directly upon the bare antenna wire without shock or injury. At the top of the antenna, however, we have by the inductive connection with the resonator circuit, greatly amplified potentials, due to the fact that by such arrangement the oscillating character of the disturbance set up in the antenna causes a marked potential loop at the upper or open end of this oscillating wire; and by successive reflections of the current there, without change of sign, potentials several times those found anywhere in the closed oscillating circuit exist. As a result, the insulation at top must be especially thorough. A petticoat insulator, giving large and dry surface insulation, ought to intervene between antenna and its support. The layman is astonished at the facility with which these high-frequency, high-potential currents leak away, over surfaces carrying the slightest dust or moisture, or through the veins even of dry wood. Stone, even in dry weather, behaves like so much metal. Ebonite or glazed porcelain, or glass, are the best insulants here, and surface insulation is the controlling factor.

Mechanical reasons render it advisable to use steel guys for the mast, but if these be completely insulated from the antenna the leakage to them through damp air, and, indirectly, by currents induced in them, render it necessary to cut these guys into several short lengths, connected together by strain insulators (ropes with dead eyes or porcelains), and to most carefully insulate from earth at the bottom. In damp weather rope, especially if untarred, is but little better than wire.

If the air is moist or a heavy fog prevails, the invisible brush leakage from the antenna into this semi-conducting medium gives the effect of a large fictitious capacity between antenna and earth, greatly increasing its natural period of oscillation, and requiring readjustment of the constants of the closed resonator circuit, if it is intended to keep this and the antenna circuits in syntony. But worse than this is the fact that this apparent additional capacity is largely fictitious, and, as a leakage, represents a large hysteresis loss, not recoverable, but producing additional damping to the oscillation. The same phenomenon exists, often to a greater degree, in the condensers themselves. In any Leyden jars or glass plate condensers in air, vivid brushes are observed extending for an inch or more at the edges of the tinfoil. At these portions of the glass, especially if this latter contain any lead, a surprising amount of heat is generated, showing clearly that considerable losses of energy there exist, and unless the glass is the best of flint, a further loss in dielectric hysteresis exists.

The glass condenser in air is generally preferred by experimenters for the very reason that these brush leakages, while they also cause an additional capacity over what ordinary static measurements will show, act as buffers for the impulsive high-potential charging of the condenser, and save the dielectric from puncture. It is well known that a Leyden jar filled with oil is far more liable to break down, and especially so if the outer coating also be covered with oil or paraffin. When the condenser is placed in an oscillating discharge circuit, containing inductance, the potentials developed at the edges of the tinfoil are often several times that of the charging current (due to heating up and reflection of the charges there from resonance effects), and this effect becomes greatly exaggerated with the oil condenser. But it is just this resonance which is a *sine qua non* in syntonic working, and it is wrong to allow brush leakage, with the great damping resulting, to save the dielectric. The correct practice calls for a suppression of all brush losses at every cost, and to employ oil, or condensers otherwise sealed, and sufficiently bulky, to give requisite safety with capacity.

Another bad element is the chain usually employed in the Leyden jar. After a little usage this becomes badly eaten up, frequent small sparks are observed between its links and where it contacts with the tinfoil; I have sometimes known the chain to be actually burned in two. So aggravated do these faults of the Leyden jar become with much usage, that it is impossible to measure the period of oscillation of a circuit employing as condenser a battery of old jars. The foil frequently starts away from the glass, allowing all the losses and trouble from a gas dielectric. All in all, the time-honoured Leyden jar, one of our dearest heirlooms from early physicists, is the element employed in wireless telegraphy which is least suited to its task. Yet it is well-nigh universally advocated on account of its strength, convenience and cheapness when applied to small installations.

The amount of inductance existing in a battery of Leyden jars, when these are connected up as closely as possible, is surprising and little recognised. In fact, I may say that a condenser discharging aperiodically from lack of inductance in its discharge circuit does not exist. For high frequencies, the inductance in the sheets of foil themselves is sufficient, and the spark-gap and leads thereto supply the rest. In a battery of, say, 10 Leyden jars connected in parallel, I have found that

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the exact method of connection is of the utmost importance. For example, if the 10 be connected in one row the spark is not so violent, large or of so cracking a sound as when the jars are bunched. The best arrangement is in a circle, with leads from all of the jars of exactly the same length Otherwise, we get a tendency for a series of discharges from the several jars in turn, and not from the battery as a unit. Under certain conditions this little detail of grouping and connecting the jars has made all the difference in transmission of or failure to transmit signals. It is these little details of exact disposition of connections, &c., which are so apt to be overlooked by those familiar only with ordinary electric currents, that have so grave an influence in wireless telegraphy, especially where syntony is attempted. The high-potential leads to the transformer or induction coil may sometimes have an influence on the oscillating circuit to which they are attached. To minimise the effect, choking coils, preferably of a spiral form, should be inserted in such leads close to the points of connection.

The heating of the spark-gap terminals, especially where alternating-currents are employed for charging the condenser, is a simple proof of the losses existent in the spark. The wider the gap the greater the loss is through heating the column of air. A simple method of reducing this gap, while maintaining the requisite high potentials, is to employ a series of small gaps between balls or discs of small curvature. When large power is employed (exceeding 3kw.) it is well to provide special means for radiating the heat, and constantly renewing the supply of cool unionised dielectric. There is nothing in a liquid dielectric, but considerable is to be said in favour of the spark in air under pressure, as reducing sparking distances and allowing an especially sudden, disruptive breakdown—a spark of high conductivity and slight damping.

With a 1kw. transmitter it is easily possible to obtain a reading in a hot-wire ammeter, inserted in the antenna, of over 2 amperes, and five to 10 times as much in the closed oscillating circuit itself. This, with 20,000 volts applied at the condenser jars, gives roughly a calculation of about 70kw. This anomaly is, of course, explained by Hertz's calculations of the amount of energy radiated from his small dumb-bell oscillator. During a brief hundredth-thousandth of a second the energy put into the circuit at a 1kw. rate is radiated at a rate enormously greater. The exact quantitative relations here are difficult of measurement; they involve the exact potentials of resonance, the damping and duration of the wave-train, the power-factor, time-coefficient of expansion of the hot-wire, &c. But the test is a clear and convincing demonstration of the enormous quantities of energy which a small transmitter is radiating, and of the amount which the generator would be called on to supply could the much-desired undamped wave-train be obtained. It is evident that a direct-current source of high potential and relatively large output, with high-frequency oscillating circuit supplied as in the case of the Duddell singing arc, offers a solution.

In view of the above considerations it is not difficult to point out the fallacy in certain calculations which are often given to show the sensitiveness of a coherer or other wave detector, which is influenced at 100 miles by ½ H.P., or less, at the transmitter. Their sensitiveness is indeed remarkable, but if what such misleading figures seem at first sight to indicate, would be little less than infinite.

THE EDISON ACCUMULATOR FOR AUTOMOBILES.*

BY W. HIBBERT.

The problem of making an accumulator with an alkaline electrolyte has been before the world for many years, and has been attacked by a fairly numerous body of workers. It is known that Mr. Edison is one of this number, and various public statements have appeared as to the results of his labour. Most of these can be neglected as void of authority, but the account published by Dr. Kennelly before the America Institute of Electrical Engineers† was evidently based on carefully executed work. From this Paper we learned the general nature of the cell, together with certain useful numerical data. Fourteen watt-hours were obtained from 1lb. weight of the cell, the average E.M.F. being about 1·25 volts. It is not necessary to repeat here the other data from Dr. Kennelly's Paper, as they will be brought up to date by the facts to be quoted from my own tests. It is sufficient to say that very little was done during the next year. The matter seemed to fall into the background, and public opinion settled down to a vague belief that the cell had not yet reached the commercial stage. Indeed, I have heard doubts expressed as to the very existence of the cell. To some extent, I shared this scepticism, not because I doubted the existence of the accumulator, but because of its constitution. I doubted (and expressed my doubts in print) whether the plates would be altogether free from local action, and

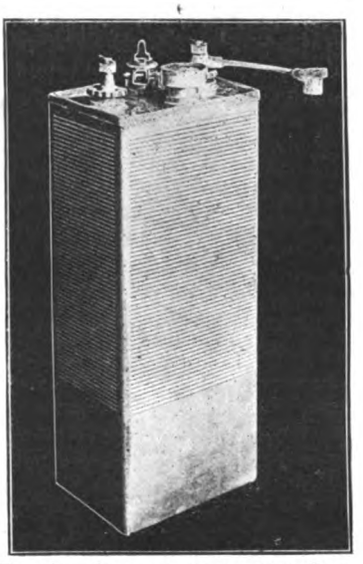

FIG. A.—STANDARD AUTOMOBILE CELL.

whether a very small amount of this weakness would not be sufficient to destroy the plate. These fears were based on the data afforded by Dr. Kennelly's Paper, more especially the thinness of the plates, and also the probable results of mixing graphite with the active material. Such anticipations were, I suppose, quite legitimate as anticipations, but they have not been justified by the results of actual trial. It is one of the striking features of the cell, that it recommends itself by work more than can be done by any verbal account.

In the early part of this year, I obtained three of Mr. Edison's cells of small size, and in early June was provided with a Standard automobile cell. Finally, during part of my summer vacation I was

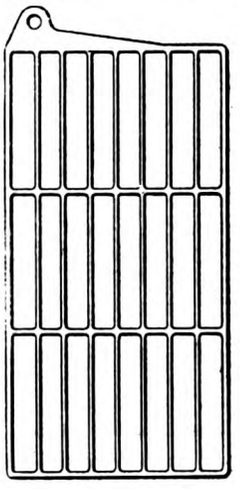

FIG. B.
PLATE WITHOUT POUCHES.

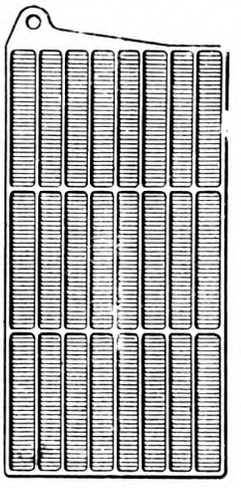

FIG. C.
PLATE WITH POUCHES.

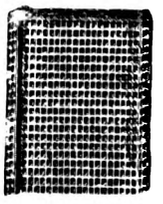

FIG. D.

Portion of Pouch, which, after being filled with active material, is covered by a similar tray, the two thus forming a closed box. The whole is then inserted into a slot and compressed and corrugated so that its edges extend slightly over the surface of the plate, being held in position by this means.

able to run about 500 miles on an automobile driven by 38 Edison cells. The general results of the work done on all these will be described in this Paper. I shall confine myself to a somewhat simple statement of the facts verified by myself, feeling sure that these will be most acceptable to the members of the Institution. But it may be worth while mentioning that well-known men at Milan, Paris, &c., have obtained laboratory results which agree in all the main particulars with my own. They have not as yet had the opportunity of testing on the road. A brief description of the cell will be advantageous.

* Paper read before the Institution of Electrical Engineers last night.
† *The Electrician*, Vol. XLVII., p. 266.

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Standard Automobile Cell.—This (Fig. A) contains 14 positive and 14 negative plates. Each plate is made of sheet-steel, nickel plated, punched with 24 holes of rectangular shape (Fig. B). In each of these holes is inserted a flat pouch or pocket containing the compressed active material (Fig. C). The walls of these pockets are perforated by exceedingly fine slots or holes, through which the liquid can penetrate (Fig. D). Thus the current can easily pass to and from the active material contained in the pockets.

Active Materials.—Both positive and negative plates are alike, except in respect of the active material. The pockets on the positive plate contain nickel peroxide; those on the negative plate contain finely divided iron. Each of these active materials is, I understand, mixed with flake graphite.

Electrolyte.—The liquid is a 20 per cent. solution of potash.

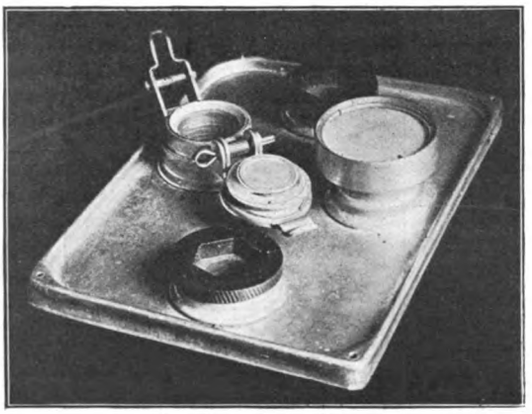

Fig. E.—Top of Case.

Arrangement.—The plates are fixed very near each other. Yet there does not seem to be any danger of short-circuits. The plates are thin, it is true, but being made of steel, they are thick enough to give rigidity. As a further precaution, vulcanised rubber separators are put between the plates, making the whole a compact mass, whose stability is calculated to resist all the ordinary mechanical shocks it is likely to undergo.

External Arrangements —The cell is sealed in its steel case, the top being fixed on by a special solder not acted on by the potash. Two stout connecting pins (from the positive and negative plates respectively) come through liquid-tight bushes of vulcanised rubber. These pins are made slightly conical, as are also the connectors which fit on them, and the mechanical finish and easy grip of this terminal add to the value of the battery. The connector is further

Fig. F.—Top of Case, showing Gravity Valve removed.

secured by a screw-nut and fastening pin. The connector has a much higher conductivity than those of the ordinary type of accumulators. On the top of the case (Fig. E) there are also: (*a*) A spring stopper with rubber flange, covering the hole by which the electrolyte is introduced, or distilled water added from time to time. (*b*) A vent hole guarded by a gravity valve. This provides for the escape of the gas evolved during charge. The hole and valve (Fig. F). are covered by a gauze nipple, which prevents escape of spray while allowing gas to pass. It also prevents any flame finding access to the interior of the cell through the stream of evolved gas. The complete cell stands 13in. high (overall) and measures 5·1in. by 3·5in. horizontally. It weighs 17·8lb. A large part of the external steel case is corrugated to increase its rigidity. An immediate consequence of examining these features of the cell is to impress the observer with their admirable fitness—perfection is hardly too strong a word. That which is so lacking in ordinary accumulators—mechanical strength or design—is here in obvious and large measure. The general mechanical structure of the cell is well calculated to remove or to diminish any antecedent adverse opinion.

Electrical Data.—The E.M.F. is 1·33, though, as there is a very persistent gaseous polarisation effect, the figure cannot be regarded as quite rigid. For a long time after charging it is much higher. The internal resistance is 0·0013 ohm. The output at 60 amperes is 210 watt-hours = 11·8 watt-hours per pound. The following diagram, Fig. 1, shows the arrangements used for charging and discharging.

E is the cell under test. *ttt*, pieces of trolley wire used for connections. $M_1M_2M_3$, mercury cups standing in a large tank full of oil. R, a standard resistance = 0·01009 ohm, verified by the Board of Trade. V and A, voltmeter and ammeter, both recalibrated for these experiments. Large lead accumulators were used for charging E. For the purpose of charging, constantan resistances of varying value and diameter were used to bridge M_1M_2. For discharging it was necessary to bridge M_2M_3 as well. The control of either strong or weak currents was quite easy and rapid by putting constantan

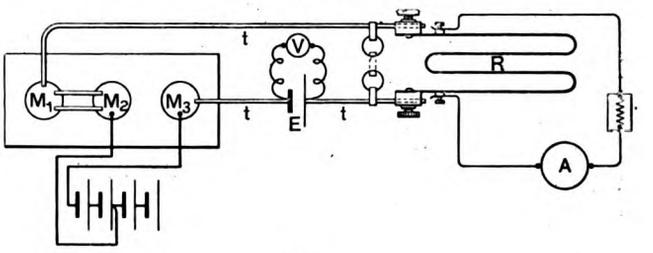

Fig. 1.

wires in parallel across the mercury cups. In very few of the experiments did the current vary as much as 1 per cent. The average variation was probably about 0·3 or 0·4 per cent. The curves in Fig. 2 tell their own story. A striking feature of the curves is the relatively high value of the capacity at the higher discharge rates. The difference in ampere-hours at 30 and 60 amperes is almost negligible. Even at 120 amperes the capacity is 93 per cent. of the maximum, and at 200 amperes is still as high as 82 per cent. These results at once indicate a valuable feature of the cell for many of the emergencies of engineering. That the quantity obtainable at the high rates should be such a large proportion of that possible at low rates is both surprising and agreeable.

Output.—In relation to the weight of the cell the work done is higher than usual. Taking the output at 210 watt-hours,* and the weight at 17·8lb., the specific output amounts to 11·8 watt-hours per pound of cell. This must be regarded as a high figure. It is true that nearly equal figures have been obtained with other cells, but confessedly at considerable risk. The weight of lead cells is reduced by making the supports very thin, but this shortens life. Output can be increased by using stronger acid, but this leads to rapid loss

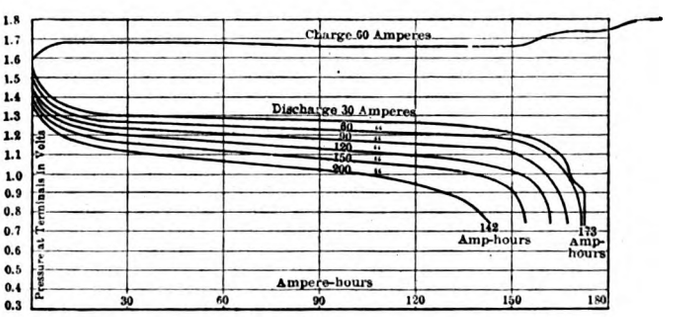

Fig. 2.

of charge if the cell stands idle. These serious risks do not accompany the method of getting high specific output in the case of the Edison cell. It is, as we shall see, able to retain a large proportion of its charge for a long time, and its relation to "life," although not yet fully verified by my work, is one of very considerable security as far as can be judged by the results already obtained. In relation to volume, the specific output is 1,564 watt-hours per cubic foot.

Influence of Temperature on Output.—In the case of lead cells, this is very marked. With the Edison cell, no definite series of experiments has been made, but accidental circumstances afford evidence of some interest. Some discharges were taken on two of the few very hot days of last summer. The high temperature of the

* This is at 60 amperes; at 30 amperes the output is somewhat higher.

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air, added to the heating effect of the currents, caused the temperature of the cell to rise very high. With a current of 150 amperes, it reached 54°C. The output rose to 163 ampere-hours, some 9 ampere-hours more than were obtained at a temperature of 33deg. This is an increase of 5·5 per cent. in capacity for a rise of 21deg., or an increase of 0·26 per cent. per 1deg. rise. Other experiments, not specially designed to test thepoint, indicated a detectable but small increase. The effect is, however, very much less than with the lead cell. With them it may be 2 or 3 per cent. per degree centi grade. With the Edison cell, a few degrees difference in temperature would produce hardly any change in the quantity output. This difference in the effect of temperature doubtless arises from the difference in the nature of the actions going on in the respective electrolytes. The continued working of the lead cell demands a continued supply of the acid at the internal working faces of the

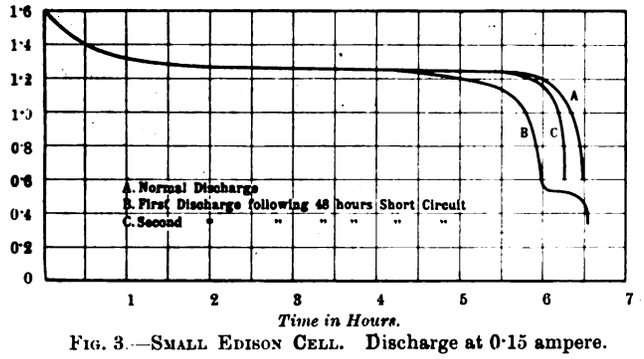

Fig. 3.—Small Edison Cell. Discharge at 0·15 ampere.

porous materials on the plates, and a rise of temperature helps to provide this by increasing the rate of diffusion of acid from the outside. In the Edison cell there appears to be practically no need for diffusion or circulation of the liquid. It is not an active material in the ordinary sense; it acts only as a conductor. Hence a higher temperature cannot change the action except by diminishing the internal resistance of the cell. Even here the action must be differential. For the liquid will diminish in resistance as the temperature goes up, while that of the plates themselves will increase. The first of these, however, being the greater, will determine the resultant change, with a consequent increase in chemical action before the pressure falls to a limiting value. For example, in the experiment described, which led to a final temperature of 54°C., the resistance of the electrolyte would be about 30 or 40 per cent. less than in the corresponding experiment at 33deg. It is also of interest to note that these experiments at higher temperatures were the earliest. The other experiments described in this Paper were all done subsequently, and therefore show that no injury had resulted from the heating due to higher external temperature and also to the excessive currents passing through the cell.

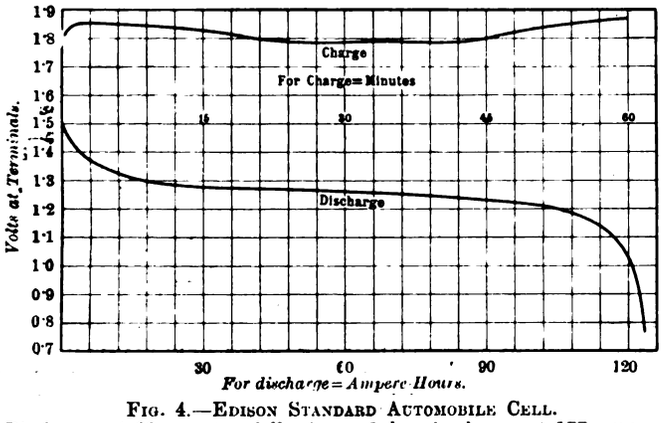

Fig. 4.—Edison Standard Automobile Cell.
Discharge at 60 amperes, following a 1 hour's charge at 177 amperes.

Internal Resistance.

It is not easy to determine this except at times when the pressure curve is tolerably flat. Attempts were made, however, to get an approximaation by opening the circuit for a moment or two and noting the rise in volts at the terminals. The value $(E - V)/C$ comes out as a tolerably constant figure from the various curves in Fig. 2. It rises from 0·0013 ohm with the lower currents, to 0·0016 with the higher. The value does not vary appreciably over the greater part of the discharge. But towards the end, where the pressure begins to fall quickly, the resistance rises at a fairly rapid rate. At the end it may approach 0·004 or 0·005 ohm.

Short Circuit.

With the object of testing the power of recovery, one of the small cells was partially discharged, and then short-circuited for 48 hours. After a subsequent long charge it gave the discharge curve B, Fig. 3. Compared with the normal discharge curve A, B indicates a deficiency. It is evident that the cell has not yet recovered. On charging again, however, and taking a second discharge (curve C), the deficit hardly appears; the cell has practically recovered from the harsh treatment to which it had been subjected.

High Rate of Charging.

The foregoing experiments prove conclusively that the Edison cell can maintain a high rate of discharge. The interest of this question hangs on its maximum charging rate, and this I have not been able to reach. The following curves (Fig. 4) show the course of an experiment made to test this point. The cell was first carefully discharged at 30 amperes down to 0 75 volt. It was then charged for one hour, 177 ampere-hours being put in. The current was not quite steady, varying from 180 to 176 amperes over most of the time. Near the close of the hour it fell to 166 amperes. The subsequent discharge shows that 124 ampere-hours were delivered, which equals 70 per cent. of the charge. Further experiments on this point appear in the later section dealing with the motor-car work, proving that the cell can be charged at over 200 amperes.

Flexibility of the Cell.

The new cell will probably be called upon to stand very rapid and large fluctuations in the value of the current. The following curve (Fig. 5) shows that it behaves like an elastic structure, its pressure

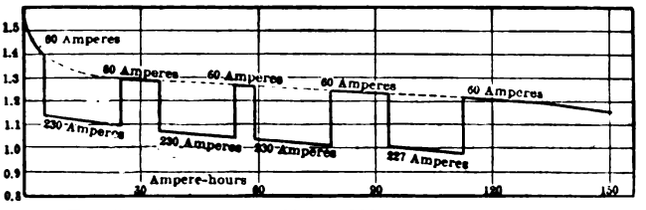

Fig. 5.—Discharge at 60 and 230 amperes alternately.

rising and falling with varying demand, but responding at such a rapid rate that the lines of changing pressure appear vertical on the diagram. The change to and from 230 amperes will appear more trying if the weight of the cell be kept in view.

Continued Discharge at Lower Voltage.

In most of the experiments so far described, the discharge was stopped when the terminal voltage fell to 0·75. At this point, as all the curves show, the pressure is falling rapidly, and would lead to the assumption that it must speedily reach zero. But this is not the case. At a still lower pressure the rate of fall suddenly alters, and the curve becomes flat again. Presumably this is due to a secondary chemical action arising when the active materials have been more or less changed by the ordinary discharge. The curves given below (Fig. 6) indicate the extent and variation of this prolonged discharge. They

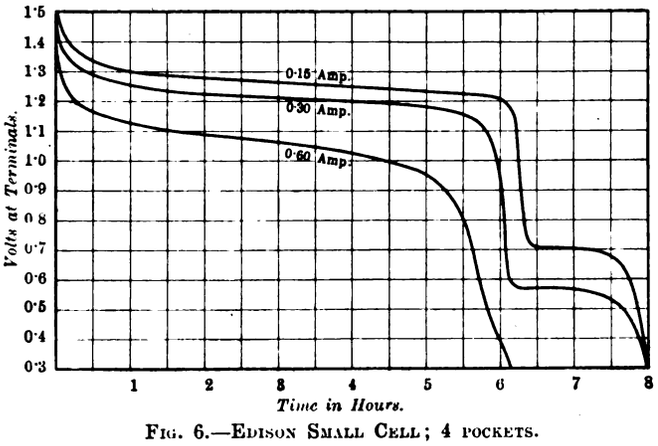

Fig. 6.—Edison Small Cell; 4 pockets.

were given by one of the small cells containing four pockets, two positive and two negative. The currents are small, but the indications are typical of the behaviour of larger cells.

Effect of Rest.

There are many experiments in my notebook which show that the cell does not suffer when allowed to stand discharged for fair lengths of time. A very good illustration will be given when dealing with the motor-car trials. A parallel question arises as to how far the cell can retain its charge when allowed to stand idle. Various trials have been made, two of which may be mentioned. A cell was charged fully and allowed to stand 48 hours before discharge began. It then yielded 155 ampere-hours=91 per cent. of the full discharge. Part of this deficiency is undoubtedly due to the

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fact that a discharge commencing immediately is enriched by the gases contained in the pockets along with the active material. The experiment just alluded to was therefore regarded as giving an idea of the immediate value of this gas effect, along with the 48 hours' action due to a short rest, such as the experiment was intended to detect. To get a better estimate of the effect of rest on the active materials, the cell was now charged up again and allowed to rest for 26 days. The discharge which followed gave 124 ampere-hours. Compared with the full discharge, 170 ampere-hours, this is equal to 73 per cent. But compared with the discharge taken after two days' rest, we have an efficiency of 80 per cent. after 24 days' rest. That is to say, the active material lost only 20 per cent. of its charge in 24 days. The reference here made to the effect of rest on a charged cell makes this a convenient place to say how persistent is the effect of the electrolytic gases on the E.M.F. When charging is complete the E.M.F. is about 1·6 volts, and if the cell be left on open circuit the value falls very slowly to about 1·85. It may be interesting to give a curve showing the time change in the E.M.F. when the charged cell is allowed to stand.

Efficiency.

Efficiency is not very much considered in the present methods of working traction cells. A laboratory experiment is of much less use on this point than on many others. The strength of acid employed enjoins on the user the advisability of charging up when the car comes in, and of giving the cells a "buck-up" charge if much time elapses before the car is used again. This reduces efficiency. Tested on the bench, the Edison automobile cell has an efficiency varying from 66 to 50 per cent. Charged and discharged at 60 amperes, I found it to be just about 60 per cent. Charged at 100 amperes and discharged at 60, the efficiency was 56 per cent. Charged for one hour at 177 ampere rate and discharged at 60 amperes, the efficiency was 50 per cent. The highest figure (about 66 per cent.) was obtained at 30 amperes. These figures are lower than would be found with good lead traction cells under the same condition of discharge following immediately after charge. But the experiment described under "Effect of Rest," in which a cell was kept charged

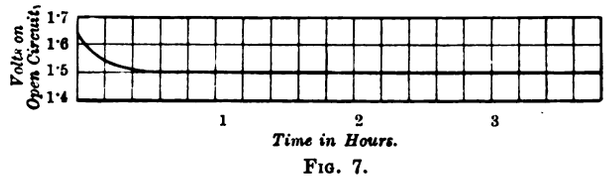

Fig. 7.

for nearly four weeks, proves that under garage conditions the Edison cell would have a much higher efficiency than the cells now used. The point is of secondary importance only, as the total cost of keeping a car in running order is so high in relation to the cost of energy that variations in the latter are of small moment.

Observations on the Road.

In considering the conclusions which could legitimately be drawn from the foregoing laboratory experiments, it was obvious that the results might be objected to on the ground that an accumulator intended for automobiles ought to do its work on the road, subject to all the irregular vibration which travelling entails. The force of this objection is obvious, and I was anxious to get some chance of watching the battery under running conditions. Fortunately, some 40 cells arrived from America in July last, and Mr. Dick had 38 of these placed on a runabout, and gave me the chance of observing their behaviour. To this opportunity I could devote only a part of my summer holiday, and therefore the observations do not cover such a long run as is desirable. But they were long enough and varied enough to show that the laboratory results are still obtained when the work is done on the road. A brief description of the car will suffice. It was a runabout made by the Stadebaker Company of Indiana, weighing, when fully loaded and carrying two persons, about 1,950lb. Of this 700lb. was due to the 38 cells and their wooden frames. Unfortunately, the battery and motor were unhappily mated, the latter being a Westinghouse 40-volt 24-ampere machine, while the cells gave an average pressure of about 48 volts. The motor was, therefore, overloaded all the time, and if it had been a point of importance to investigate the motor and car as well as the battery, some changes would have been necessary. But as the battery could, by careful observation be tested independently, and as time was not too plentiful the car was accepted as it stood. It is not necessary here to describe any of the mechanical details. The controller had four stops with four speeds, but the first and second were hardly ever used except momentarily. It remains now to state the results of the tests. The form in which this is done is of some importance, because it ought to deal with the battery side of the investigation: traction questions proper are subsidiary. A brief statement will clear them out of the way.

Tractive Effort.—On good level road the speed was close to 14 miles per hour, and the power about 1,920 watts, which is practically equal to 2,200 watts per ton. These figures indicate about 79lb. per ton for the tractive effort. Allowing for the motor efficiency, and putting it at 85 per cent. (probably not so good because of overloading), the tractive effort is 67lb. per ton. The work appears to be about 135 watt-hours per ton-mile, a higher figure than is usually taken in America. This is not astonishing, considering the want of balance between battery and motor.

Cost of Power.—Fourteen miles meant nearly 2 B.O.T. units. If we take the efficiency of the cells as low as 50 per cent. (it is always low in electric traction as usually carried out), the charging would be 4 units. At 2d. per unit the cost would be 8d., or 0·57d. per mile. Turning to the battery. The programme I drew up was intended to yield answers to the following questions:—1. Is the capacity of the cell the same when running on the road as when discharging in the laboratory? 2. Will the battery stand excessive discharge rates on the road? 3. Will it take a rapid charge and utilise it on the road? 4. Will it recover after lying discharged for some time? 5. Does the capacity change in any detectable degree by reason of the mechanical agitation? 6. What attention is required? When the car was handed over to me it had already been driven by the battery a distance of about 400 miles. This work was done in Paris, the charging being arranged by M. Gadot. This part of the work, however, I do not describe, the purpose being to exclude all but my own work. The following is a diary of our runs:—

Aug. 29.—Standing discharge, 159 ampere-hours.

Aug. 30.—Paris to Versailles and back, through the Park of St. Cloud. Good climb. Run about Paris. (39 miles.)

Aug. 31.—18 miles towards Rouen and back. About Paris. (48 miles.)

Sept. 1 and 4.—Journey to London. Car ran across Paris, then train to Havre; train also from Southampton to Waterloo. Motor overhauled at Niagara Garage, and then finished the discharge by running round London. At Southampton the battery had to be partially discharged through wire. (29½ miles.)

Sept. 5.—London to Northampton, stopping at Dunstable for a partial charge. Part of the discharge was taken next day round about Northampton. (77½ miles.)

Sept. 7.—Northampton to Leicester. One stiff climb at Hopping Hill. (32 miles.)

Sept. 8.—Partial charge at 100 A. for 90 minutes = 150 A.H. Leicester out towards Nottingham, 16 miles and back; through Loughborough. (38 miles.)

Sept. 9.—Charge 225 A.H. Repeated yesterday's run with extension. Discharge 150 A.H.

Sept, 9.—Charged 1 hour 55 min., 219 A.H. Repeated the Loughborough run. (77 miles.)

Last 6 miles run out next morning.

Sept. 10.—One hour's charge, 150 A.H. Same run. Discharge, 107 A.H. (32 miles.)

Sept. 10.—Charged 1 hour 20 min. = 242 A.H., and started off for Northampton. Storm all the way. Wind dead ahead. Most excessive discharge. (65 miles.)

Sept. 11.—Northampton to London, with partial charge at Dunstable. Run about in London. (71 miles.)

Allowed to stand discharged for 10 days.

Sept. 20.—Charged for 1 hour, 186 A.H. Run round London. (31 miles.)

Sept. 29.—Standing discharge, 158 ampere-hours.

The total distance run is 508 miles while under my control. Adding the 400 miles run before that time gives 908 miles. It will be observed that several runs were made from Leicester. This was due to the fact that Mr. Hales, the engineer to Mr. Wathes, was kind enough to arrange that he would be ready to assist in charging just as I liked, and at any hour. Mr. Hales also chose for me the route followed, my request being that it should be a fairly typical English road. The conditions of each run were decided not by the desire to make so many miles, but to solve one of the six questions already mentioned.

1. Is the capacity on the road equal to that found in the laboratory? In order to answer this and some other questions, I determined to eliminate the influence of car and motor, and to record observations of voltmeter and ammeter while discharging, just as is done in the laboratory. It seemed to me that the trouble involved (travelling with watch and notebook in hand) was worth facing, and it certainly taught me a great deal which could not have been definitely known in any other way. As will be seen in the sec. 5, a preliminary experiment proved that the battery had a capacity of 159 ampere-hours at 60 amperes.* The question was, would the same quantity be available on the road? From the many observations, I choose the record of September 9th as one of those most closely watched. The run was from Leicester to some miles beyond Loughborough and back, with a final run round Bradgate Park-road. Distance = 40 miles. Eighty observations of current during the 3½ hours make the ampere-hours 150. As the discharge was not then quite complete—the volts being above 0·75 per cell—it is evident that the quantity delivered in one complete discharge was practically the same as that found in the laboratory.

2. Will the battery stand excessive disharge rates on the road? The original intention was to allow this to be determined by choosing

* This is somewhat lower than I found in the laboratory. Detailed examination of the 38 cells proved that two cells were of decidedly low capacity—probably from the beginning. This would account for the deficit.

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stiff gradients for the car to negotiate. Accidentally, however, and most unpleasantly, we had a better test than that. The return journey from Leicester to Northampton was commenced in the afternoon of September 10th, the day of the great cyclonic disturbance which spread over England and the West of Europe. That 32-mile run will not easily be forgotten. My ordinary observations were impossible; recording was a failure. But I mentally noted that the current on the level rose to 55 or 60 amperes instead of 40, the wind being dead ahead and roads greasy. On the slopes the current was frequently 90 and 100, and on one hill the index passed out of my sight, and must, therefore, have been momentarily more than 150 amperes. The journey took 4 hours, as compared with 2·5 hours on our outward course. The last 6 or 7 miles were covered at a slow pace, and an interesting point crops up in that connection. Although I could not make a written note of the instrumental readings, I kept a pretty constant eye on the ammeter. While these data were fresh in my mind I calculated the discharge from the cells, and made it close to 190 ampere-hours. I regard this as a figure which errs on the side of deficiency rather than excess. If it be asked how this excessive quantity could be obtained, the answer must be found in that extra delivery at lower voltage, which is shown in Fig. 6. For many purposes this low-pressure discharge is useless, but for an emergency like that of this stormy afternoon it is a great consolation: it helps to carry the car home, although not counted in the normal capacity of the cell. It is noteworthy that the cells deliver the normal current with this lower voltage for quite an appreciable time.

3. Will the battery take a rapid charge (say one hour) and utilise it in discharge? Several experiments of this sort have been recorded. A one-hour's charge was tried at Leicester. Unfortunately the supply station belonging to Mr. Wathes was in a state of transition, but his chief engineer, Mr. Hales, took considerable trouble in giving us special facility; 150 amperes was the maximum current we could get at the time, owing to the unfinished state of the new building

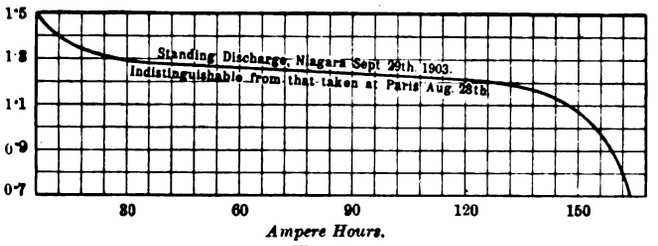

FIG. 8.

and machinery. The cells received 150 ampere-hours in the hour, and in the subsequent run delivered 107 ampere-hours = 71 per cent. of the charge. This is exactly the figure found in the laboratory test, and also in the standing discharge test described in (4) and (5). From these three experiments it is clear that with currents of 200, 175 and 150 amperes continued for one hour each the cell absorbs about 70 per cent. of the charge. I have not had facility for trying a still higher current, but it seems probable that the same proportion would hold good even with a higher current. In Leicester, as in London, the run obtained from a one-hour's charge was quite satisfactory.

4. Will the battery recover after standing discharged? The car was run about until its speed, and also the voltmeter, indicated that we were on the final slope of the discharge curves. The car was then allowed to stand 10 days in the discharged condition. At the end of that time it was charged as follows:—For 44 minutes at about 200 amperes = 156 ampere-hours; for 16 minutes at about 120 amperes = 30 ampere-hours; total = one hour's charge = 186 ampere-hours. The car was then run round London and covered 31 miles, yielding 134 ampere-hours. This figure for the discharge was found by numerous observations taken during greater part of the run, combined with less numerous readings for the rest of the time. The efficiency is 134/186 = 72 per cent. From these data, it is obvious that the behaviour of the 38 cells after 10 days' idleness in a discharged condition is very similar to that observed in the laboratory when quite new, and also very similar to that observed at Leicester under high charging rate. It was thought that the combination of harsh treatment due to standing discharged followed by excessive charging current would prove specially trying, but the cells behaved very well even under these circumstances. The test now recorded was followed by the final test on capacity as recorded under (5), the two tests taken together giving a decidedly affirmative answer to the question now under discussion. As the question respecting the wisdom of leaving a discharged cell idle is one of great importance, I will make one other remark. No injury appears to arise: the cell works as well after as before. But it is advisable to charge for a longer time after such an idle time. The chemical actions—the absorption changes—are a little slower than usual. Or perhaps it is more accurate to say that a greater proportion of active material is in need of restoration by the charge.

5. Does the capacity change in any detectable degree by reason of the mechanical agitations due to running? Accumulators used for automobiles always deteriorate in capacity after a longer or shorter time. Roughly speaking, even a good battery of the lead type shows a diminished capacity after about 600 miles run, even by the crude test of miles per charge. Such a test must always be crude, because of the influence of the road, wind and gradient on the distance covered, even while the battery is still fresh. As other duties prevented me taking charge of the car for more than 16 days, with no possibility of running anything like 1,000 miles, it was necessary to arrange for an accurate test of capacity, at the beginning and end of the trials. A standing discharge was, therefore, taken at Paris on August 29th, and gave 159 ampere-hours. This is slightly less than that found for a single cell in the polytechnic laboratory, but on examining each cell two were found to be decidedly low, and these two brought down the pressure to the final limit rather prematurely. However, as this figure was to act merely as a standard of comparison for a similar final test, it was accepted, with all the disadvantage of two somewhat inferior cells. On September 29th, after running 508 miles, the final standing discharge was taken, and gave 158 ampere-hours. In these experiments the errors of observation may exceed 1 but do not rise to 2 per cent. The result may be regarded as showing that the capacity remained intact during the 500-mile run. Remembering that there were two cells in the 38 which were obviously low, probably from the beginning, it is doing no violence to accept the capacity as normal at the end of my trials, and, therefore, at the end of something like 900 miles run since they were put on the car. Fig. 8 gives the discharge curve. The observations at Paris and at London are indistinguishable on the scale to which this curve is drawn.

Attention Required.

To practical men this is a most important point. They have not generally done justice to accumulators, because they have been unwilling to give them that unceasing examination which is devoted to the other parts of their mechanism. If the Edison cells needed more attention than that now given to lead cells, the need would be an objectionable feature to the men who have most to do with them. It was for this reason that I was so anxious to add to my laboratory work a series of trials from the garage point of view. For example, the laboratory could never decide one most simple question. The terminals and connections of the new cell cannot be "burned" in any way comparable with the method adopted for lead cells. Would the mere surface contact and screw-nut adopted by Mr. Edison make a lasting connection? Laboratory trials were useless for answering this question, even though it was obvious that the design of the terminal was exceedingly good from the mechanical standpoint. However, my 500 miles on the road were sufficient to test them; not one of them failed or became weak. Not one of the terminals proper had to be touched from the beginning to the end of the run. We had rough roads and rough weather, so that the motor was seriously overloaded and the car was so strained that it had to go into serious repair as soon as our run was finished, but the battery and its terminals endured it all. I was especially pleased to see that in the last charge but one, with a charging current of 200 amperes, the contacts were still so good that not one of them became unduly warm. Considering what they had gone through, this was a very good testimonial. Another point about which I had some misgiving, and one that had been mentioned in the American papers, was the question of frothing. It was said that, in charging, the evolved gases caused so much frothing that the liquid would soon be run out at the vent hole. During my laboratory experiments, extending over two months' continuous work, frothing occurred on two separate occasions. But on each occasion it lasted for about one minute only. In both cases it occurred at the end of a long charge. On the road frothing occurred with one or two cells on two occasions. Even these did not persist, and their evidence was rather in favour of the result being accidental. It is true that on the Continent I came across a cell which was said to froth rather persistently. But this probably arose from a very simple fact. A workman is very apt to treat the one kind of accumulator as he would the other. I found one of them even using oily waste to polish the cap which covers the vent-hole. It is obvious, however, that many kinds of grease will be objectionable, seeing that with the alkali they readily form soap solution, with a consequent tendency to froth. Soap, grease and all other colloids ought, of course, to be excluded, and are excluded rigorously from the cell. As the 38 cells on the car were practically free from any degree of frothing worth mentioning, although they were put together by men who had never seen the cell before, and as this agrees with my own experience in the laboratory, I think that the objection made on this ground cannot be substantiated. The point which requires attention, and which cannot be neglected with impunity, is the necessity for adding distilled water from time to time. As far as my own experience went, this was needed after about five or six chargings. This meant after each 160 to 170 miles run with our car. The frequency of the water addition cannot, however, have

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any settled relation to miles run. It depends on the number of times the cells are charged, and especially if overcharged. As different cars equipped with variable relative weight of battery run different distances on one charge, it is desirable to get this matter put into the right form at once. The men working at garage charging stations are apt to interpret everything in miles.

LIFE.

Respecting life, there is the general favourable tendency of the evidence already adduced. The cells used in the car had not changed by a detectable percentage of their original capacity at the end of my contact with them. That is the most direct testimony I can offer at present. Chemical examination is proceeding, but has not as yet reached a stage at which I can add to the present knowledge. The chemical changes may be summed up in the following equation—

After charge.				After discharge.		
NiO_2	KHO	Fe	becomes	NiO	KHO	FeO

But it is better to write the equation in a manner which, though less simple, will be more in accordance with the practical requirements. Thus:—

After charge.

$$n \,.\, NiO_2 \,|\, \begin{matrix} KHO \\ 12H_2O \end{matrix} \,|\, m \,.\, Fe$$

After discharge.

$$(n-p)\ NiO_2 \,|\, KHO \,|\, (m-p)\ Fe$$
$$p \,.\, NO \,|\, 12 \,.\, KHO \,|\, p \,.\, FeO$$

If I am asked my opinion as to the probability of life, the reply is definite enough. Having had these cells under close observation now for some months, I believe they will live in working order for much longer time than is usual. How much longer I cannot say, but I look forward with some confidence to such a duration as will make the Edison cell a permanent and valuable addition to the resources of electrical engineers.

THE TESTING OF ELECTRIC GENERATORS BY AIR CALORIMETRY.*

BY RICHARD THRELFALL, M.A., F.R.S.

In his interesting Paper on "Recent Electrical Design," Mr. W. B. Esson mentioned the uncertainties attending the testing of alternators (*Trans.* Elec. Eng., Vol. XXXII., p. 351). This uncertainty has been felt by many people as well as Mr. Esson, and may be said to constitute a serious difficulty to those who make or use large alternators. It has been the good fortune of the writer to succeed in working out a simple and practical way out of the difficulty by means of air calorimetry.

Two years ago an occasion arose where the testing of some large alternators for efficiency was a matter of necessity, and it was practically impossible to measure the brake horse-power developed by the engine under running conditions, owing to the field-magnets being built upon the flywheel, and to other structural peculiarities. The only alternative at first appeared to be running two of the machines as generator and motor respectively, but their relative fixed positions in the engine house prevented anything of this kind being attempted.

It appeared to the writer that only one course was open to him—viz., to enclose the alternators in a non-conducting casing, and to pump air through the system at a measured rate. Assuming that means could be found for the rapid and accurate measurement of a large current of air it would be only necessary to ascertain the temperature of the air on entering and leaving the system, in order to have all the data necessary for a computation as to the rate of dissipation of energy in the alternator. There would, of course, be corrections for heat entering or leaving the system otherwise than by means of the air current, but simple means were found for reducing this correction practically to zero. Assuming that M kilogrammes of air of specific heat σ pass through the system per second, being raised in temperature from t°C. to θ°C. in the process, and that no heat is gained or lost except from the alternator, it is clear that heat to the extent $M\sigma(\theta - t) = H'$ represents the rate at which power is being wasted in kilogramme-calories.

Let P represent the rate of external working of the engine in kilowatts, and P′ the power delivered by the generator as measured electrically also in kilowatts. Then the efficiency of the generator is $E = P'/P$.

Let H be the rate at which energy is carried out of the system by the air current, stated also in kilowatts.

Then $P' + H = P$, and $E = P'/(P' + H)$. This assumes that the generator does not "radiate" like a wireless telegraph transmitter. P′ can, of course, be exactly measured, and it will be shown that H also can be measured with quite sufficient accuracy.

* Paper read at the Institution of Electrical Engineers last night.

It is important to notice that the subject of measurement H is the actual loss in the generator from all causes, and the method has the advantage of the directness of the well-known Hopkinson test. Also, it is to be observed that if the efficiency is anything like 90 per cent. H is only one-ninth part of P′, and an error in the estimate of H becomes of less and less importance as the efficiency rises. For instance, if H were 10 per cent. in error, the efficiency would only be wrong by a little over 1 per cent. in the case where the actual efficiency was really 90 per cent. In practice the errors in estimating H are of the order of 2 or 3 per cent.

Now it is shown by J. S. Ames ("Rapports présentés au Congrés International de Physique," Paris, 1900, Vol. I., p. 204), that the most probable value for the gramme calorie in ergs is $4{\cdot}181 \times 10^7$ at 20°C. on the nitrogen scale, and though it is not pretended that in what follows it matters whether we use this number or the familiar 4·2—still it would be ungrateful to the physicists to ignore their labours by adopting the latter value. The specific heat of dry air at constant pressure is now known not to be absolutely constant and independent of pressure and temperature, but we may for the present purpose take Regnault's value of 0·2375 as amply accurate enough at ordinary temperatures and pressures. The effect of moisture in the air will be considered later. The energy gained by a kilogramme of dry air in rising by 1°C. at constant pressure under standard conditions is therefore very nearly $9{\cdot}93 \times 10^9$ ergs, or 993 watts if the gain of temperature is a degree per second. The round relation of 1kw. heating 1kg. of air 1deg. per second is obviously convenient. It is also convenient to set down that 1kg. of dry air measures nearly 773 litres, or 0·773 cubic metre, under standard conditions; and 1 cubic metre weighs nearly 1·293kg. Consequently, 1 cubic metre of air heated 1°C. per second requires 1·277kw.

The main difficulty in regard to the experiment consists in the measurement of the air current, and, therefore, this matter was first investigated. The investigations made originally with the object of carrying out the tests described in this Paper showed that the measurement of large currents of air can easily be made so as to give results within 2 per cent. of the true value. The measurement of air velocity is made by means of what is known as the Pitot tube, which is merely a tube bent in such a manner as to receive the full force of the stream of air on its open end. In consequence of some of the impinging air losing momentum by the impact, a certain degree of pressure is set up within the Pitot tube if the latter be closed except where it faces the stream, and this pressure will be referred to as the velocity pressure. The writer has been able to show that almost exactly half the momentum of the impinging air is destroyed by the quiescent air in the Pitot tube, and, in consequence, a velocity pressure appears almost exactly equal to $\rho V^2/2$ dynes per square centimetre, where ρ is the density of the air in grammes per cubic centimetre and V its velocity in centimetres per second. In general the mean pressure of the air stream is above or below the pressure of the external air, and, consequently, it is necessary to insert another tube in the air current which shall be subject merely to the static pressure of the stream. This is not very easy to do, but Heenan and Gilbert (*Proc.* C.E., Vol. CXXIII., p. 272) have shown that if we use a tube provided with a wide flange at the mouth, the tube being so placed that the air slides past the flange, we do, in fact, obtain the pressure sought. The diagram (Fig. 1) will make the arrangement clear. The same result is practically attained if a small hole be bored through the side of the pipe carrying the air current and an external connection be made to the manometer. In practice a hole is drilled and tapped in the side of the pipe, and into this hole a small pipe is screwed—care being taken that it does not project inwards beyond the inner surface of the main pipe. It is tempting but fatal to accuracy to use a side gauge consisting merely of a bit of pipe across the end of which the air stream blows. This gives rise to a suction which may rise to nearly the Pitot tube velocity pressure (with sign reversed), but unfortunately no two pipes will give the same suction. The thinner the walls of the pipe the greater the effect. Many attempts have been made from time to time to utilise the suction as well as the pressure, and it is believed that the discredit which has been thrown on the Pitot method of measuring the velocity of fluids is almost or entirely due to the uncertainties in the suction effect of a wrongly designed side gauge, which do not appear to have been sufficiently considered. The Pitot tube itself is deserving of the rank of an instrument of precision, simple though it is in construction.

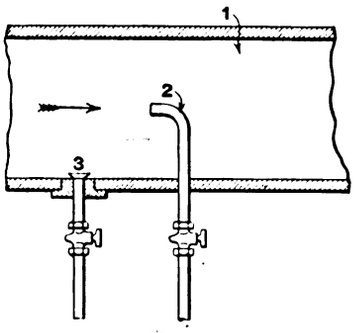

FIG. 1.

It is necessary to have a reliable manometer in order to obtain the value of the pressure difference with accuracy. A form of instrument which has been employed by the writer is figured (Fig. 2); it

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can be relied upon absolutely to within 0·01mm. of water pressure. It will be seen that it consists essentially of two bottles containing coloured water—the bottles are connected by a syphon, and the air space of each bottle is put in communication with its appropriate tube. The readings are taken by setting a pair of needle points just to touch the liquid surface, and then measuring how they differ in level by micrometer screws, or by callipering suitable jaws. Each needle point is carried by a shaft working on geometrical principles, and the result is that the insidious errors which always accompany attempts to read off small distances through walls of unworked glass tubes are got rid of. A convenient supplementary apparatus is a small multiplying pressure gauge, in which the motion of a float or bell is used to operate a finger moving round a dial. The dial is divided in such a manner that the square roots of the pressure differences can be at once read off, Such instruments, if carefully made, work remarkably well, and are very useful during a trial from the ease with which they are read. It is important to have as steady a stream of air as possible, for if the fluctations are rapid as compared with the "time constant" of the manometer, the latter will average up the pressure differences, giving the arithmetical mean pressure. It is clear, however, that what is required is the mean of the square roots of the pressure differences, as was pointed out by M. A. Rateau (*Ann. des Mines*, S9, Vol. XIII., p. 331, 1898).

It has already been stated that if exactly half the momentum of the air impinging on the air at rest in the Pitot tube is destroyed, we should get a pressure of $p=\rho V^2/2$, or $V=\sqrt{2p/\rho}$, or $V=1{\cdot}414\sqrt{p/\rho}$. The result of a very large number of measurements undertaken for the purpose of fixing on a suitable constant has been to show that in practice the relation is more nearly $V=1{\cdot}377\sqrt{p/\rho}$, p being in dynes per square centimetre, ρ in grammes per cubic centimetre, and V in centimetres per second. The reason of this difference is discussed elsewhere. If we take g at 982, p as being measured in millimetres of water, and ρ the density of dry air at 0°C., we can convert the above into a more easily applied formula.

$$V=1{\cdot}377\sqrt{\frac{98{\cdot}2}{0{\cdot}001293}}\times\sqrt{p}=379{\cdot}4\sqrt{p}\text{ centimetre per sec.}=747.0\sqrt{p}\text{ feet per min.;}\ =12{\cdot}45\sqrt{p}\text{ feet per sec.}$$

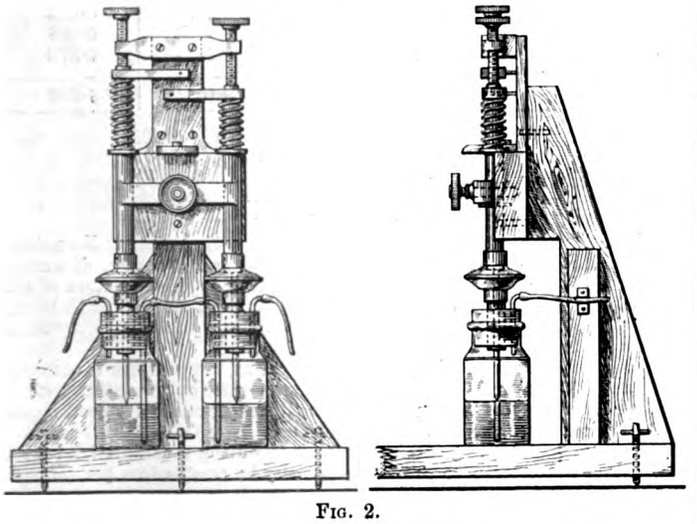

Fig. 2.

The ascertainment of the velocity of air at a certain point in the cross-section of a pipe is, however, only the first step towards discovering the delivery in cubic feet per second, say. In order to find the delivery we must know the velocity at every point of the cross-section. Now, in *Memoires* de l'Académie des Sciences, Vol. XV., 1858, Darcy showed that in the case of water in long pipes in which the fluid velocity is symmetrically distributed with regard to the centre of the pipe, there is a certain circle, the locus points at which the velocity of the water has a mean value—such that the delivery of the pipe can be obtained by multiplying the area of cross-section by the fluid velocity at the circumference of this circle. The radius of the circle is found by Darcy to be given by the expression in terms of the radius of the pipe R: $r=(4/7)^{\frac{3}{2}}R=0{\cdot}689R$.

This is obviously nearly 2/3 R, and is no doubt the origin of the common opinion that if a Pitot tube be inserted to a distance of one-third the tube radius from one side, the mean velocity will be measured. In no case within the writer's experience is this actually the case when we come to deal with air. If a fan be used, then in general the flow is for a distance of many diameters of the pipe—usually far from symmetrical. This is true even when the fan blows first into a box (from which the pipe takes its supply), which is very large compared with the diameter of the pipe. By using baffles of various shapes between the fan and the measuring point in the pipe it is usually possible to make the distribution symmetrical, but at the expense of a greatly increased resistance to the flow of air. Amongst other things tried, the writer has used very open muslin—mosquito netting, in fact—and this gives a very uniform, though arbitrary velocity distribution. M. Marey has made use of the same artifice. On the whole, the only safe way is to have a measuring

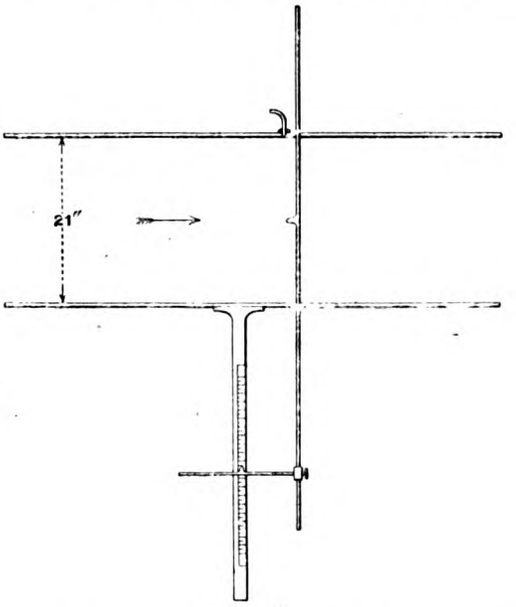

Fig. 3.

pipe made up of some light material—such as tin or millboard—at least 10 to 20 diameters long, though it may be made in several pieces if convenient, each piece being a trifle coned to fit into the next. Armed with such a pipe, the first thing to do is to start the fan at a convenient speed, and to measure the velocity distribution at several points across a diameter by the Pitot tube. Fig. 3 shows the arrangement adopted for this purpose. The chief difficulty is in keeping the fan going at a sufficiently regular velocity,

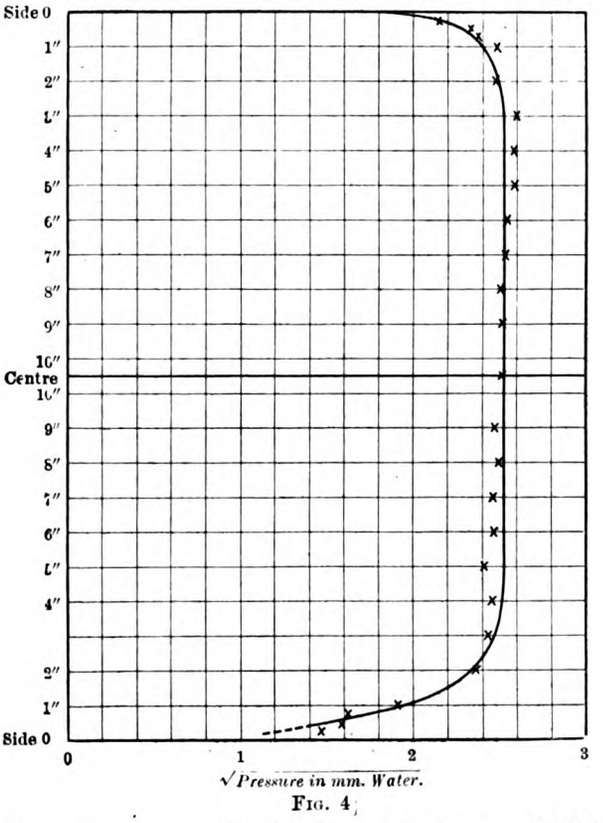

Fig. 4.

and a convenient way of testing this for the purpose of the experiment is to set up a second Pitot tube at some point in the measuring pipe, so that its tip is at the centre of the pipe. This subsidiary gauge, consisting of the Pitot tube and side gauge, is connected to a multiplying pressure gauge, as already described, and the system forms precisely a pneumatic ammeter, and shows if the current of air fluctuates at all. We have generally used the phrase "stream gauge" to indicate such an arrangement. If the velocity of the

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stream is kept constant by following the indications of the stream gauge, the calibration of the stream across a diameter of the pipe is easily carried out. In general, it is not necessary to investigate more than one diameter, but the condition is that the velocity distribution must not be too unsymmetrical. Fig. 4 shows a distribution curve actually obtained on one diameter, and it is not desirable to have the distribution more unsymmetrical than this. In selecting points for observation, it must be remembered that as we move outwards from the centre the observations become of greater and greater importance, so that the points of observation are taken closer together at the outer parts of the stream.

The observations being made, they are plotted as square roots of the pressure difference—conveniently in millimetres of water, as abscissæ—the Pitot gauge positions being taken as ordinates. From the resultant curve pairs of points are selected at opposite sides of the centre, and the area is imagined broken up into annular spaces, of which the points occupy the centre of section. The area of each annulus is easily calculated and multiplied by the mean of the two corresponding square roots of pressures. These quantities are all obviously proportional to the delivery of air across the annulus they represent, and the sum only requires to be multiplied by the constant—*e.g.*, 12·53 for cubic feet per second of air at 0°C.—in order to obtain the delivery. It is convenient to ascertain the mean velocity from this result by dividing the delivery by the area of the cross-section of the pipe. The position of mean velocity may then be obtained from the curve, and also the ratio of the mean to the central velocity evaluated. The latter is generally about 0·9, but it may be anything from 0·75 to 0·95, according to the length of pipe, mode of blowing, &c. If the fan be used to suck air through the apparatus, and the measurement of flow be made on the inlet pipe, the velocity distribution is generally more simple, but very often this course is otherwise inconvenient.

The first question which will occur to anyone thinking of the matter is the following:—How does the velocity distribution vary if the velocity of the air stream changes as a whole? The writer has carried out experiments for nearly two years on this subject—which is, of course, vital—and the conclusion is that, practically speaking, there is no variation at all. That is to say, if the apparatus be once put together, the fan can be driven fast or slow without making any appreciable change in the velocity distribution. The following table (Table I.) which gives the results of some careful experiments on a 6in. and a 12in. pipe, will show what sort of variation does actually occur; it is otherwise without significance for the present purpose.

Table I.—*Distribution of Velocity at Various Velocities.*

Series.	Maximum velocity in feet per minute.	Mean velocity / Max. velocity	Position of circle of mean velocity in terms of radius of pipe section measured from centre.	Diam. of pipe.	Remarks.
1	666·72	0·8845	0·768	6	Air current maintained by fan.
2	1,666·9	0·8623	0·766	6	
3	2,675·0	0·8742	0·773	6	
4	3,642·0	0·8750	0·765	6	
5	1,714·2	0·8872	0·773	12	Air current maintained by fan.
6	2,594·4	0·8990	0·801	12	
7	2,771·5	0 8861	0·773	12	
8	1,319·4	0 8066	0 737	6	Air current maintained by fall of gas-holder.
9	2,472·6	0·7900	0·721	6	
10	2,406·3	0·8148	0·725	6	
11	325·08	0·9168	0·863	6	Air current maintained by fan through pipe with baffle.
12	1,692·2	0·9132	0·798	6	
13	2,428·8	0·9076	0·796	6	
14	2,664·0	0·9054	0·793	6	

In experiments 8, 9, and 10, the delivery of air was separately estimated by timing the fall of the holder. The delivery for 6ft. of this fall is as follows, and may be compared with delivery measured by the Pitot tube and manometer, and deduced from the formula:—

Delivery by observation of gas-holder.	Delivery deduced from gauge readings and calibration of pipe by formula.	Error of gauge measurements, if timing of holder be taken as correct.	Mean error, assuming that the holder measurement is correct.
1,881·3	1,889·0	0·94% too high.	1% too low.
1,880·0	1,835·5	2·9% too low.	
1,880·0	1,866·0	1·28% too high.	

If the apparatus be altered by altering the relative position of the measuring pipe and fan, then a new calibration must be made. Described at length, as in what precedes, the work of preparation appears formidable. It is not so in reality, for when a little practice has been obtained the observations are quickly and easily taken. During a test of dynamo efficiency, of course it is only necessary to observe the stream gauge and keep the stream as steady as possible according to its indications, the absolute manometer being used from time to time as a check. The density of the air can easily be calculated from available tables—*e.g.*, Glaisher's Hygrometrical tables.

In order to illustrate the practice of measuring the flow of air in a pipe, a complete set of observations and calculations will now be submitted. These observations formed part of an actual test on the efficiency of a certain 300kw. alternator.

Table II.—*Distribution of Velocity in Pipe 21in. Internal Diameter.*

Distance of Pitot gauge from centre of pipe. (Inches.)	$\sqrt{\text{Manometer pressure difference in mm. of water.}}$ Left of centre.	Right of centre.
0·0 (centre)	2·516	2·512
1·5	2·518	2·488
2·5	2·536	2·506
3·5	2·5515	2·474
4·5	2·559	2·470
5·5	2·577	2·480
6·5	2·596	2·458
7·5	2·596	2·427
8·5	2·573	2·349
9·5	2·456	1·939
9·75	2·362	1·703
10·0	2·263	1·600
10·25	2·126	1·476

Delivery of Air by 21in. Pipe from Observations of Manometer Pressure Difference, the Square Roots of which were Plotted as shown in Curve 1.

Specification of shells measured in inches from side of pipe.	Pressure difference from curve. Right of centre.	Left of centre.	Mean of pressure differences.	Area of shells in square feet.	Area of shells × (pressure difference)$^{\frac{1}{2}}$.
10·5—5·0	2·528	2·528	2·528	0 6597	1·667
5—4	2·520	2·528	2·524	0 2615	0·660
4—3	2·500	2 526	2·513	0·3053	0·767
3—2	2·420	2·515	2·467	0·3487	0·860
2—1	2·200	2·460	2·330	0·3929	0·915
1—0·5	1·730	2·350	2·040	0 2135	0·435
0·5—side.	1·220	2·160	1·690	0 2237	0·378
				2·4054	5·684

$$\sqrt{\text{Maximum pressure difference}} \times \text{Total area} = 2{\cdot}528 \times 2{\cdot}4054, \quad = 6{\cdot}0812.$$

$$\frac{\text{Mean velocity}}{\text{Maximum velocity}} = \frac{5{\cdot}684}{6{\cdot}0812} = 0{\cdot}935.$$

Calculation of air delivered per minute by pipe 21in. internal diameter, the maximum pressure difference being in this case 6·29mm. of water. Barometer, 748·5mm at 59°F.—correction neglected. Temperature of air at intake: Dry bulb, 58·83°F. = 14·9°C.; wet bulb, 55·70°F. = 13·16°C. Humidity, 80 per cent. from tables: corresponding pressure of aqueous vapour, 10·1mm.

Density of mixture of air and water vapour at temperature of gauges 34°C. and 748·5mm. pressure, 0 001127 grammes per cubic centimetre.

If the humidity has been neglected, the density would have been more by 0·4 per cent., which is without significance.

Maximum and central pressure difference during a certain trial was 6·29mm of water. Hence maximum velocity in centimetres per second was—

$$= 1{\cdot}377\sqrt{\frac{6{\cdot}29 \times 98{\cdot}12}{0{\cdot}001127}},$$

$$= 1{,}019\text{cm. per sec.},$$

$$= 33{\cdot}43\text{ft. per sec.},$$

and average velocity—

$$= 33{\cdot}43 \times 0{\cdot}935,$$

$$= 31{\cdot}26\text{ft. per sec.}$$

Delivery = $31{\cdot}26 \times 2{\cdot}4054 = 75{\cdot}19$ cubic ft. per sec.
$= 2{\cdot}129$ cubic metres per sec.

In order to dispose of arithmetical details, we may as well complete the calculation in the above case, so as to find what the thermal capacity of such an air stream is.

Reducing to standard conditions, the delivery becomes—

1·864 cubic metres per sec. at 0°C. and 760mm.

1 cubic metre of the mixture of air and water vapour measured under standard conditions would contain—

13·5 litres of water vapour,
986·5 litres of dry air.

The weight of these constituents would be 11·61 grammes for the water vapour and 1,276 grammes for the air.

Thermal capacity of the water vapour with a specific heat of 0·48 is 5·6. Similarly, with specific heat of air of 0·2375, its capacity is 303·0, making a total of 308·6. The water equivalent of 1 cubic metre of this air when measured under standard conditions is thus 308·6 grammes. If we suppose that 1 cubic metre of the air is heated through 1°C., then

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the electrical energy required is 0·0215 Board of Trade units. The energy dissipated by the air stream is thus per degree of temperature rise and per cubic metre of delivery measured under standard conditions per second, 1,290 watts.

The actual stream was 1·864 cubic metres reduced to standard conditions, corresponding to 2,405 watts per degree rise in temperature. A convenient rise in temperature would be about 20°C.—corresponding to a dissipation of 48·1kw.

Arrangements at Dynamo.—Fig. 5 gives a general and sufficient idea of the arrangements adopted, for it is obvious that everything depends on the conditions obtaining in each particular case. The 300kw. alternating-current generator investigated by the writer ran for about one-third of its diameter in a wheel pit of concrete, and the structure had to be arranged accordingly.

Assuming that the air flow can be properly measured, the chief source of error lies in the possible leakage of heat into or out of the apparatus. So far as the upper part of the structure goes, it is quite easy to regulate the fan so that the mean temperature of the enclosure is only about the same as that of the engine house, and this disposes at once of all danger of errors arising from direct leakage through the walls. The case is not so simple for the wheel pit, for though concrete is not a good conductor of heat, there was a good deal of it, and consequently elaborate precautions were taken. The pit was boarded round and felt ¾in. thick fastened on over the boards. If the trial is prolonged till the tempeature becomes steady throughout the system, then the concrete may in this case be assumed to have very approximately the temperature of the engine room, for the foundations were not filled in, but the concrete structures

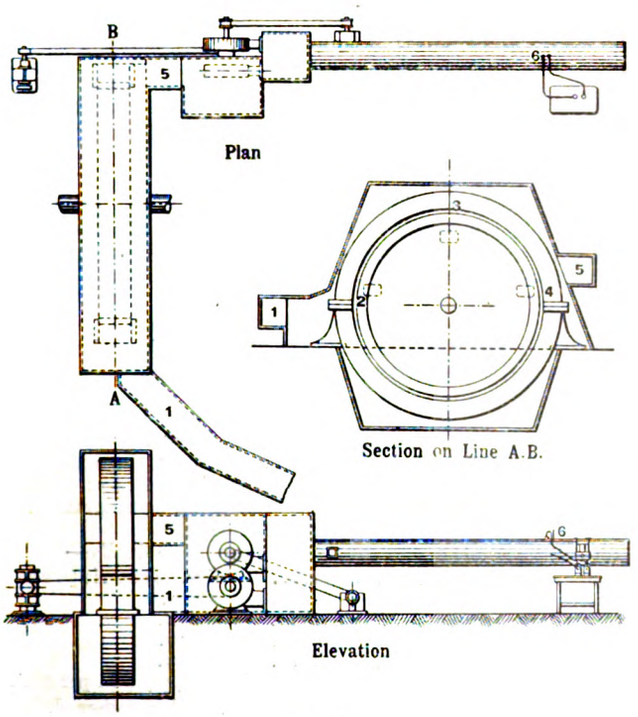

Fig. 5.

carrying the engine were freely exposed to the air. The boarding throughout was ½in. T. and G. boards fastened to 4in. studding. The casing was fitted as well as possible, and was then papered over with paper faced with bright—so-called—tinfoil, probably pewter foil. This not only acted as a preventive of air leakage, but gave a considerable degree of thermal insulation as well. Incidentally, the paper was cheap and gave the apparatus a smooth and clean appearance. The entry air duct leading outside the building had an area of 4 sq. ft., and was protected from warming (rather unnecessarily) partly by felt and partly by the tinfoil paper. A window was provided at the junction of the air duct with the generator casing, and a standard thermometer was hung in a convenient position for observation through the window. There was a lamp which could be turned on when required, so that the observer might have every opportunity of observing as well as possible. The thermometer position is indicated by the figure 1 in the Plan, Fig. 5.

The air propeller was at the other side of the generator casing, and was placed in a large box; the air so drawn from the casing was propelled down the measuring pipe. The opening into the fan box from the casing was of considerable size, though not really large enough, and the temperature was observed at several points in the opening by means of a standard thermometer—for instance, as indicated by the figure 5.

The arrangement described was decided upon before anything was erected, and was chosen on the assumption that there was sure to be a certain amount of air leakage into the casing from the engine room. If this had taken place, the volume of air passed would still have been properly measured; the only error remaining over would have been in the false supposition that air entering from the engine room had the same temperature as air entering from outside the building. In the event it turned out that it was quite easy to stop all appreciable leaks, so that for the future it will not be necessary to place the fan between the generator casing and measuring pipe unless it is more convenient to do so.

The object of bringing in air from outside the building was, of course, to start with air colder than that surrounding the generator casing. By regulating the speed of the fan it was quite easy to adjust the air supply so that the average temperature inside the casing was the same as that of the engine room; the air at entry was colder, and at egress warmer, but, owing to the stirring action of the generator, the walls of the casing were practically at the engine room temperature. By this simple device so often used in calorimetry all errors due to unconsidered streams of heat were avoided.

Thermometry.—The thermometers employed were centigrade mercury in glass thermometers, each degree being 9mm. long and subdivided into tenths. These thermometers were Kew standards, They were compared together during the tests, and their positions were interchanged during the trials. No doubt special platinum thermometers recording the temperature difference of entry and exit would have been preferable if only in the saving in labour, but the writer's apparatus for this purpose happened to be absorbed in other experiments at the particular time of the trials. For a rise of 20°C. the temperature difference should be ascertained to about 0·2deg., and closer in proportion as it is less, so as to be accurate to about 1 per cent.

Fans.—Two fans by Heenan and Froude were employed to draw the air through the system. They were driven by motors, and took about 5kw. between them. In many of the experiments one fan only was employed, and it would not have been necessary to use more than one in any case if more care had been taken to have all the openings as large as the air duct coming from outside the building—*i.e.*, 4 sq. ft. cross-sectional area.

Electrical Measurements.—The subject of power measurement in alternating-current circuits is one not altogether unfamiliar to those who were members of the Institution of Electrical Engineers in the early 90's. It might be supposed that nothing remains to be said on the subject, yet it is certainly not two years ago since the writer came across a statement by a competent authority to the effect that it was impossible to say how much energy was employed in producing a pound of carbide of calcium, for the reason that the manufacturers themselves did not know to within 20 per cent. what was being used. If this is really the case, it does not speak well for the scientific attainments of those engaged in the industry; but, even regarding it as a gross exaggeration, there is undoubtedly some foundation for the charge. The trials with which we have to deal were made by taking up the power in a large tank filled with water. In the greater number of the trials the current was led through iron strip measuring ¾in. wide by $\frac{1}{25}$in. thick, this strip being stretched round large nails driven into heavy boards nailed to the sides of the tank. Care was taken to wind the strip in zigzags about 2in. apart, and the ends of the strips were brought up to near the surface of the water with which the tank was filled, so as to give some freedom of adjustment of resistance. Connection was made to the heavy copper ribbon or bar which projected from the mains to the depth of about 2ft. under water. It was supposed that there might possibly be some doubt in the minds of the parties concerned as to the electrical measurement of the power, and consequently the tank was provided with about 250ft. of thin 2in. leaden piping, arranged so as to expose its full surface to the stream of hot water set up by the current in the strips, the latter being, of course, nearly at the bottom of the tank. Arrangements were made for sending a stream of water through this lead pipe and passing the stream over weighing buckets, an arrangement which had been previously used by the writer with complete success. It is obvious, in fact, that with proper thermometry such a power absorber is a huge calorimeter, and would enable estimates of power to be obtained independent of any electrical instruments whatever. In the result, the electrical measurements were found to be so satisfactory that recourse to calorimetry was not necessary.

The scheme adopted was the following:—A suitable kilowatt balance by White of Glasgow was tested on a continuous-current circuit against multi-cellular voltmeters standardised by cells, and the currents directly measured by a potentiometer and manganin resistance tested by the standardising department of the Board of Trade. The constants supplied with the balance were thus verified to within a fraction of 1 per cent.—in fact, to within the range of possible experimental errors. The tests were carried out with about 80kw., and care was taken to use about the same electromagnetic forces with the balance as were subsequently used during the trials. The balance was henceforward taken as correct. The resistances supplied for use in the pressure coils of the balance were tested

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against standards, and were found to require no correction for the present purpose. By varying the resistances in the pressure arm of the balance and altering the weight of the balance sliders it is possible to measure the same power under a variety of circumstances as regards the resistance of the pressure coil. From a number of experiments made some years ago on alternating currents of the frequency employed in these trials it had been found that changing the resistance of the pressure coil made no difference in the power measured, suitable weights being employed; it was clear, therefore, that the balance time constant was too small to affect its readings at the frequency used, and this agreed perfectly with the results of calculation, and with the makers' statement and certificate of test. The balance itself, therefore, may be regarded as trustworthy. As a check two independent methods were employed. An oscillograph was procured from the Cambridge Scientific Instrument Co., made according to Mr. Duddell's patents, and this was set up in a special observing house erected outside the engine house. The curves showed that both pressure and current curves passed through zero at the same instant to within 2 or 3 per cent.—*i.e.*, as nearly as could be seen. Photographs were taken of these curves on films placed over the tracing screen, and the records were examined at leisure. Both current and pressure curves were fairly smooth and of the same form, and still no relative displacement of the curves could be detected. A new instrument in the shape of a very sensitive hot-wire voltmeter was devised by the writer a year before the trials took place. With this instrument it was possible to make measurements of the voltage accurate to about 1 per cent. with less than half a volt as the total voltage in question. The instrument was calibrated by passing large unidirectional currents through the standard resistance of 0·0002 ohm and simultaneously observing the P.D. by the new instrument, and by a comparison with cadmium cells. The alternating current it was desired to measure was then sent through the same resistance, made of very thin strips of manganin in parallel, and exhibiting no measurable skin effect at the frequency employed. By making simultaneous observations on the Kelvin balance, a standardised multicellular voltmeter, and the writer's new instrument with its manganin resistance in the main balance circuit, it is clear that the question as to the accuracy of the balance can be referred to the fundamental units almost directly. The result was, as before, to show that the balance had no error which was capable of detection by these appliances—*i.e.*, it was less than 1 per cent.

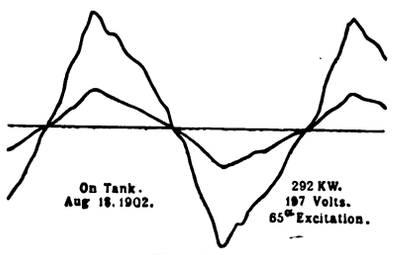

FIG. 6.

Heat Evolved by Generator.—After some preliminary trials, the makers of the generator suggested that it would be more satisfactory to them if some means were found for introducing a known quantity of heat. This could, of course, be measured in the manner adopted, and would give a means of testing the reliability of the method. It will be convenient to consider this test first, though it was not the first test made.

Ten lengths of thin iron strip, similar to the strip employed in taking up the load in the tank, were stretched in groups of five each above and below the shaft in the enclosure containing the generator; these strips were stretched in a zigzag, and when placed in parallel series of five strips each had a resistance of about 1 ohm. The total length of the strip was about 130ft., the width ⅜in., the thickness $\frac{1}{16}$in., and the total area of heating surface was, therefore, about 16 sq. ft. It was necessary, in order to reproduce the conditions of the test, to make sure that the strips were not too hot, and did not cover too circumscribed a space. If these precautions had been neglected, the air current could not have prevented the formation of hot areas on the casing, which would, of course, have led to an unusual loss of heat by radiation and air conduction. The engine was kept turning round at its usual speed throughout the trial.

Current was turned into the strip and the power was kept constant by external adjustment, the balance being used to measure the power employed—viz., 38kw., as it happened. The most convenient current to employ was an alternating current similar as to frequency, &c. (and generated by a similar machine), to the current generated during the tests. The details of this test are given in Table III. below. The heat supply of 38kw. was chosen as it was the amount which the generator appeared to liberate at full load.

Air Measurements.—Density of air at 748mm. and 38·5°C. with humidity 52 per cent. at 68°F., 0·00111 gramme per cubic centimetre.

Velocity at centre of pipe—

$$V = 1{\cdot}377\sqrt{\frac{5{\cdot}66 \times 98{\cdot}12}{0{\cdot}00111}}; \quad = 974\text{cm. per sec.}; \quad = 31{\cdot}95\text{ft. per sec.};$$

= 1,917ft. per min.

Delivery of air = maximum velocity × area of pipe × 0·935; = 1,917 × 2·405 × 0·935; = 4,310·5 cubic ft. per min.; = 122·1 cubic metres per min.; = 105·3 cubic metres per min. at 0 and 760deg.

Heat Carried out by Air Stream.—Mass of air delivered per minute, 105·3 × 1·293 = 136·55kg.

Heat carried out, 136·55 × 0·2375 × 18·231; = 589·56 kilo calories per min.; = 9·826 kilo calories per sec.; = 40·865kw.

Heat supplied, 37·8kw.

Difference – excess, 3·065kw., uncorrected.

CORRECTIONS.

On August 20th a trial entirely similar to the above, but without any external source of heat being applied, and continued for about 15 hours so as to allow of a steady state being attained, had given 2·066kw. as the heating due to windage and conduction along the shaft. In this case, the temperature rise being only 1·554°C., air was drawn into the casing from the engine room, the temperature of the casing being therefore about 0·8°C. above that of the room, as compared with about 2°C. in the trial under consideration. In both cases the loss by cooling may be neglected.

Adding the windage and shaft heating, we have finally—

Heat supplied	37·8kw. as electric power.
Heat due to windage and conduction.	2·066kw.
Total heat supply	39·866kw.
Heat as measured	40·865kw.
Difference.....	0·999kw.

Difference (error) as percentage of true heat supply 2·51 per cent.

On August 26th another test was made under rather different conditions. The chief data are

Anemometer pressure difference, 4·82mm. water.
Inlet temperature, 17·99°C. Outlet, 36·8°C.
Temperature difference, 18·77°C.
Kilowatts supplied, 37·8.
Air supplied, 98·01 cubic metres per sec. at 0 and 760deg.
Heat measured, 39·16kw.—gross.
Heat measured, less windage, &c., 2·066. 37·094kw.
Difference, – 0·706kw., *i.e.*, there is a loss of that amount.

Difference as percentage of true heat supply, – 1·77 per cent.

Taking the two tests together, the average error is

$$\frac{2{\cdot}51 - 1{\cdot}77}{2} = +0{\cdot}37 \text{ per cent.}$$

Before leaving these tests, a word may be added as to windage and heating by conduction along the shaft. The shaft may be taken roughly at 14in. diameter, and 3ft. may be taken as the distance between the bearing and the hub of the flywheel. If we take the temperature of the bearing as 80°C., and that of the flywheel hub as 30°C., and regard them as a perfect source and perfect sink of heat respectively, it is easy to calculate an upper limit to the amount of heat carried in by conduction. For this purpose we may take the conductivity of the shaft at 0·2, the highest published value, and assume that the shaft loses no heat from its cylindrical surface. The result of the calculation is a maximum heat supply of 0·36kw., while probably one-fifth of this amount would be nearer the mark, seeing that the shaft is revolving 150 times per minute and is exposed to the air. 0·07kw. will be taken as a possible value. The windage

Table III.—*Engine Running Unloaded at 120 revs. per min. Fields Unexcited.*

August 28, 1902.

Time. Start. A.M.	Inlet temperature. F.	Outlet temperature. C.	Power in kilowatts.	Temperature. Armature core. C.	Temperature of room in C. Front of structure.	Temperature. Back of structure.	Anemometer reading. Millimetres.	Hygrometer. Dry bulb. F.	Hygrometer. Wet bulb. F.
11:45 P.M.	70·0°	36·0°	38·0	37·0°	29·0°	31·0°	27·56	..	..
2:0	69·6	38 0	38·0	..	31·0	34·0	27·56	68·0°	58·0°
2:1	69·8	38·35	38·0	39·5	30·4	32·0	27·62	..	..
2:3	70·5	38·40	38·0	39·7	30·0	31·2	27·72	..	..
2:4	68·8	38·40	38·0	39·8	..	32·7	27·50	..	..
3:0	68·9	38·30	38·0	39·8	..	32·0	27·64	..	..
3:15	68·0	38·20	38·0	39·5	..	32·7	27·51	..	..
3:30	68·4	38·30	38·0	39·7	30·3	32·1	27·54	..	..
3:45	67·7	38·40	38·0	39·7	30·2	32·9	27·48	..	..
4:0	68·6	38·45	38·0	39·7	30·0	32·2	27·56	68·5	59·0
4:15	69·6	38·8	38·0	39·7	30·0	31·2	27·70	..	..

Barometer 748mm. uncorrected. Average of inlet and outlet, 29·4°C.
Average inlet temperature, 20·28°C. } Difference, 18·23°C.
Average outlet temperature, 38·51°C. }
Average anemometer reading, 27·58. Anemometer zero, 21·92.
Average anemometer pressure difference, 5·66mm. water.
Average temperature of armature—left-hand side in case, 39·7°C.
Average temperature of air in engine room, 31·15°C.
Average temperature of tinfoil covering { Front—eight places, 36°C. / Back—two places, 36·5°C.
Power as measured, 38·0kw.
Less loss in external leads, 0·2kw.
Actual power expended inside casing, 37·8kw.

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and conduction between them accounts for 2·066kw., so we may say that the windage alone is 2kw., and arbitrarily charge half of this to the engine and half to the generator.

Tests of Generator Efficiency.

In all the following tests the method employed was the same as that fully described in the last section, and consequently the details of each test need not be given. The generator was run in all cases till the temperature became steady throughout the system. The fans were carefully kept at as nearly a constant speed as possible by keeping the voltage on the motors constant. Observations were made of the temperature of the air at two or three places on each side of the casing. The temperature of the casing itself was measured by holding a thermometer against it, the bulb of the thermometer being held against the casing by means of a large cork with a V-shaped depression cut across one face. This method was found to give accurate results by the following test: A certain furnace casing made of iron having been observed to be nearly cold at one side while it was hot at a point some 3ft. away, a piece of pure prismatic sulphur was employed as a pencil to draw a line from the hot to the cold area. The point of fusion of the sulphur was seen with exceeding sharpness. The thermometer was then held against the furnace casing by a cork cut as described, and was found to give (within a very small fraction of 1°C.) the correct melting point of prismatic sulphur.

During the observations for engine efficiency three observers read the temperatures—Kelvin balance and anemometer—a complete set of readings taking about 10 minutes. As soon as one set was finished another was begun, and at the end of about an hour all the data were brought on to a single sheet and averaged. The generator output was kept as nearly as possible constant by varying slightly the resistance in the shunt field of the exciter and adjusting the gas valve of the engine. A summary of results appears in Table IV., including the tests already described.

Table IV.

Date. 1902.	Kw.	Magnetising current.	T. C.° Inlet.	T. C.° Outlet.	Inlet. + outlet / 2	Mean temp. of casing back and front.	Heat supply measured. Kw.
Aug. 13	301·42	65 9	16·186	32·19	24·2	24·25	38·01
,, 19	0	51·83	19·44	30·35	24·9	28·2	25·04
,, 20	0	66·2	15·415	26·83	21·12	24·75	27·20
,, 20	0	0	24·42	25·97	25·20	24·4	2·066
,, 21	249·2	57·5	20·17	33·54	26·87	30·8	34·16
,, 26	37·8	..	17·99	36·80	27·4	29·4	39·27
,, 28	37·8	..	20·28	38·51	29·39	31·15	40 865
,, 29	262·4	61·2	20·95	36·35	28·65	33·10	34·07

From the above table are omitted several other tests at full load, all of which gave very nearly the same result, but were not actually considered, owing to some of the parties being unrepresented, or for some similar reason. Taking the test on August 13th, which was at the highest load, we can now deduce the efficiency of the dynamo. Allowing 1kw. loss for windage chargeable to the engine, the generator may be said to waste 37·01kw., together with whatever *loss* of power there may be in the exciter, this machine, though mounted on the end of the main shaft, not being included in the casing. The *output* of the exciter, however, appears as loss in the heating of the magnets, and is duly included. Neglecting the loss of power or heat generated in the exciter itself for a moment, we may say that the generator efficiency is

$$E=\frac{301{\cdot}42}{301{\cdot}42+37{\cdot}01}=89{\cdot}05 \text{ per cent.}$$

The exciter current was 65·9 and the external voltage 33·7, say. Assuming that the exciter efficiency is 83 per cent.—it was lightly loaded and of a well-tested type—we may say that its loss is

$$\frac{17\times 2{\cdot}221}{83}=0{\cdot}455\text{kw.}$$

Making this correction, the overall efficiency of generator and exciter taken as a single unit is $E'=88{\cdot}93$.

There is in this case no addition to be made for belting, as the exciter was mounted on the end of the main shaft. The friction in the outer and inner bearing is perhaps unjustly charged to the engine, on the ground that the flywheel carrying the magnets could not work without two bearings, as stated above. On the other hand, the engine is handicapped by having the extra weight of the magnets to contend with, *i.e.*, the mass per unit moment of inertia of the flywheel is greater than it would have been had the wheel been designed for a given moment of inertia without the limitations imposed by the alternator ring.

The question arises as to how the losses observed are made up. This is rather a question for the dynamo makers, and it will be fairer to allow those concerned to make whatever contribution they please in regard to the matter. Attention may, however, be directed to one or two points. In the first place, the copper magnetising loss is small, being 2·221kw. in the test considered. In the second test in the table—viz., that on August 19th—the alternator being run on open circuit, the magnetising current was adjusted so as to give the same internal alternating voltage as had been used during the full-load trial; the magnetising current was 51·83 amperes, corresponding to a loss of about

$$\frac{2{\cdot}221\times(51{\cdot}83)^2}{(65{\cdot}9)^2}=1{\cdot}37\text{kw.}$$

At the same time the total loss in the casing was 25·04kw., so that, subtracting windage loss—viz., 2·066kw.—as well as the Joulean waste in the magnet windings, we have $25{\cdot}04-(2{\cdot}066+1{\cdot}37)=21{\cdot}60$ as the iron losses pure and simple, the iron being brought up to the same induction as during the full-load trial. Now, if we treat the loss at full load in the same way, we find the iron loss plus the copper loss in main conductors $=38{\cdot}01-(2{\cdot}066+2{\cdot}221)=33{\cdot}723$.

An estimate can easily be made of the copper loss from the measured resistance of the alternator, making some allowance for "skin effect," which, however, is not important, the conductors being of rectangular section and four times as wide as they are thick. Frequency about 40 ~. The copper loss at full load is, therefore, about 3·07kw. Subtracting this, we have as the iron losses at full load $33{\cdot}723-3{\cdot}07=30{\cdot}653$, and at no load 21·60.

It occurred to the writer that this difference might perhaps be accounted for by the iron losses in the cores of the *magnets* at full load. The machine had been purposely designed for a constant kilowatt output with varying external resistance and large overload capacity—necessitating a high armature reaction—and it was evident that this must mean considerable fluctuation in the inductance of the cores and a corresponding fluctuation of the magnetising current. Test 3 will bring out the consequence of this reactiveness, for it shows that, with the same magnetising current as that used at full load, the no-load losses rise to 27·2kw., as against 25·04kw. in test 2, where the machine was excited merely so as to give the full-load voltage.

Engine Efficiency.

As soon as the dynamo efficiency is known it becomes the best possible "brake," and we may proceed to examine the behaviour of the engine. It would be outside the scope of this Paper to consider the result of such tests in detail, but it may be mentioned that the engine in question was most carefully indicated over the period of the tests already mentioned, and that the following figures were obtained, the engine being a two-cylinder tandem gas engine:—

Gross total, I.H.P.	517·05
Absorbed in pumping and friction at no load	70·00 (indicated)
Mechanical efficiency resulting	86·5 per cent.
Mean power	301·42kw.
Dynamo efficiency overall	88·93
Resulting kilowatts delivered by engine	338·9
Indicated kilowatts	385·75
Resulting mechanical efficiency	87·86

This is probably the most reliable result hitherto obtained for a gas engine of this size.

It is the writer's hope that other engineers will, as opportunity or necessity arises, adopt the thermal method of testing such generators as cannot be tested except by the very indirect method of making a brake test of the engine. If this be done it seems likely to lead to increased care being taken by makers of electric generators both in the design of their machines and in the "guarantees" as to the efficiency usually based hitherto on purely a priori calculation.

In initiating a system of testing it is right and proper to consider as far as possible every source of error, and this necessarily leads to the discussion of much detail; but it must not be inferred that the test is difficult to make. In the first place, it shares with the well-known Hopkinson test the advantage that the power lost is the direct subject of measurement, and a considerable error may be made in this estimation without proportionately affecting the result, so long as machines of high efficiency are in question. For instance, suppose that a 100kw. machine under full load is being investigated: let the measured loss attributable to the machines be 10kw.—the resulting efficiency is $100/110=90{\cdot}91$ per cent. Suppose that an error in the loss amounting to 10 per cent. of the apparent loss has been made, and that instead of 10kw. it is really only 9: the efficiency of the generator would then be really $100/109=91{\cdot}74$, and the error of the estimate would be $91{\cdot}74-90{\cdot}91=0{\cdot}83$—*i.e.*, less than 1 per cent. in the percentage efficiency figure.

The writer's thanks are due to his assistant, Mr. R. H. Bradbury, who undertook most of the anemometry and reduction of observations; and to the makers' representative, Mr. A. C. Coubrough, who began with a wholesome distrust of the whole system of testing, and after criticising it at every turn most carefully, and carrying it through himself on many occasions for the sake of the information it afforded on points of interest to designers of alternators, ended by attaining confidence in the results obtained.

The total works cost for labour and material for setting up the testing apparatus was £19. 9s., of which the greater part was for the wood used to make the casing, and which was afterwards used up for the most part, but the test is not credited with its second-hand value.

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ELECTRIC RAILWAYS.

There appeared in last Tuesday's *Times* an admirable article on "Railway Electrification," in which the subject was thoroughly discussed from every important standpoint. Commencing from the financial point of view, the writer called attention to the mild panic which has recently seized railway shareholders, and attributed it to the continued increase in the percentage of working expenses to receipts, to the constant addition to capital expenditure, and to loss of traffic due to competition. With the first two causes we do not propose to deal except in the very briefest possible manner. It is commonly known that repairs, maintenance and depreciation are paid out of revenue, and that it is not customary for railways to provide a sinking fund; hence, it is assumed that the property and rolling stock is working at maximum efficiency. This was all very well when there was little fear of competition and when there was no thought of having to make sweeping hanges in the system of working. But a new problem has presented itself in the form of "electrification," and the question arises as to where the money should come from to effect the change. True, it is not likely that a main steam line would "scrap" all its steam plant at the same moment, and work electrically thenceforward, but it is just as fallacious to suppose that the work of conversion can be done so gradually as to render unnecessary the raising of much additional capital. As a matter of fact, the difficulty is not with the main lines, but with the suburban and local traffic, and any attempt to put off the evil day in this connection would be absolutely suicidal. Tramway competition is really serious, and, as pointed out in *The Times*, it will become multiplied many times over when such undertakings possess their own right of way, as is now becoming the practice. It therefore behoves the railway companies to bestir themselves immediately, ere an amount of traffic is taken from them which they can never hope to regain. Moreover, Parliamentary Committees do not attach so much weight to opposition on the ground of competition as heretofore, and this should act as an additional goad. The loss of traffic is accelerated in a large number of cases by the railways being absolutely incapable of dealing with it efficiently. Briefly, they have more than they can manage, and past dividends have been paid by passengers who had no choice but to submit to unsatisfactory services. It therefore appears rather unreasonable of the railways to grumble at a loss which they themselves have been largely instrumental in bringing about.

Regarding the supply of electricity to railways, we fear that we cannot agree with *The Times* correspondent; he avers that, "There is not at the present time in London a supply of electricity available for public use at a price which is applicable to electric traction on a large scale." It is not exaggerating to say that there are several undertakings which would be perfectly willing to supply electrical energy at a suitable price. The City of London Electric Lighting Co. would, we are sure, be only too pleased to supply current for working the section of the London, Chatham and Dover line between the City

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and Herne Hill, and doubtless the South London Electric Supply Corporation at Loughborough Junction would be glad to assist. And again, it is hardly to be expected that the Charing Cross and Strand Co. would refuse to enter into a similar contract with the Great Eastern Railway and its connections, or that the North Metropolitan Electrical Power Distribution Co. would be loth to add sufficient plant, in the works they are acquiring at Willesden, to deal with the suburban traffic of the London and North-Western Railway. In fact, there would be little difficulty so far as power supply is concerned in the immediate future. Nevertheless, it is hardly accurate to make a general statement that "All recent experience of electrical production goes to show that a generating station worked by a railway company would not be able to produce current at as low a rate as one supplying both the railway and other companies." The writer evidently had the North-Eastern Railway in his mind when he wrote these words, but with certain exceptions, among which may be classed the comparatively small section of the North-Eastern Railway that is to be worked electrically to commence with, it is by no means clear that a railway company could buy power cheaper than it could produce it. Take, for instance, the case of a London suburban system serving an area of many square miles, and having a large and heavily-worked network of lines. The supply for the railway at the hours of maximum load would be quite sufficient to tax the powers of the largest generating station yet built; in fact, the power house which is being built for the Metropolitan Railway at Lots-road, Chelsea, will be, we believe, the largest works of this nature erected in any country. Moreover, the advantages which a railway company possesses with regard to its coal supply, and the wide territory at its disposal when choosing the site for its generating stations, cannot be over-estimated. On the other hand, given the power supply to the railway as its main load, there is no doubt that a general electric light and power supply to a small industrial district would help to level the load curve, as the times of maximum railway traffic naturally occur before factories and offices open and after they are closed for the day.

Turning now to the traffic problem as affecting London in particular, there is still more urgent need for immediate reform. Conveyance in the metropolis is both costly and tedious, while the abominably crowded condition of suburban trains demands that such trains shall either accommodate more passengers or perform their journeys in less time. "Acceleration" is the key to the situation, and can only be attained by the adoption of electricity. The construction of huge unwieldy steam locomotives is but a vain attempt to stem the tide. There is the same amount of time lost at the termini in shunting, coaling, watering, &c., all of which would be eliminated by electric traction. Certain improvements in methods of conveyance in London have already been made; but the fact of such undertakings as the new London County Council electric tramways being already taxed beyond their capacity is startling evidence that much more will have to be done without delay.

A number of additional tube railways are now under construction, and it is to be hoped that more will be authorised in the coming Parliamentary session. The campaign against them on account of vibration troubles and other real and imaginary nuisances should be strongly discountenanced by those in authority. Further transport facilities are, as we have already said, urgently needed, and even the increased capacity consequent on the electrical equipment of all the existing suburban lines will not be sufficient to meet the whole demand. The public would find additional surface or "elevated" railways a cause of far more annoyance than the modest electric railway burrowing beneath the surface. Even electric tramways, which undoubtedly serve the public better than horse tramways from every point of view, come in for their share of criticism. It is said, for instance, that owing to the noise caused by the cars and other vehicles running over the hollow conduits in South London, many persons are leaving the streets through which the lines run. Undoubtedly the tube system should be encouraged as much as possible in the metropolis, and London should profit to the full extent by its advantage of being built upon a clay sub-soil which is pre-eminently suitable to the construction of railways of this class.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"**The Dynamo**: its Theory, Design and Manufacture." 3rd Edition By C. C. Hawkins, M.A., and F. Wallis, B.A. (London: Whittaker & Co. 1903). 15s.

Since the appearance of the second edition of this book in 1896 electrical science and industry has greatly progressed, and we are pleased to find that the publication under review has been brought thoroughly up to date. In fact, in comparing it with the older edition, but little has remained, whilst much new matter has been introduced. As may be inferred from its title, the book appeals especially to dynamo designers, manufacturers and students, and to whom it may be thoroughly recommended on account of its completeness and clearness.

After a short introductory chapter, the properties of magnetic fields, their action upon each other and upon circuits in relative motion to them are very fully gone into, the phenomena being rendered more clear to the mind by hydraulic analogies and by a multitude of well-chosen illustrations. In a subsequent chapter the dynamos are classified after the customary manner except for the introduction of the term "homopolar dynamo." The magnetic properties of iron and steel are then discussed, numerous saturation and hysteresis curves being given. By far the greater part of the book is taken up, however, by the following chapters which deal in detail with the electrical and mechanical parts of continuous-current and alternating-current machinery, and we were very favourably impressed with the thorough manner in which the questions of commutation, sparking, armature reaction, heating, &c., are dealt with. The drawings given in these chapters are to the point and represent modern practice. On a previous occasion we have taken Mr. Hawkins to task for employing the term "inductor" for armature winding, and we regret to find that this mistake is persisted in in the book before us. Although this may appear to be only a small point, it is an important one, for writers of text books cannot be too careful in matters of terminology. The book concludes with a detailed description of typical dynamos of British, Continental and American manufacture.

Das Elektrische Kabel. By Dr. Phil. C. Baur. (Berlin: Julius Springer.) 1903. 8m.

Dr. Baur's book deals with the design, manufacture, testing and laying of cables (exclusive of submarine cable), and does not include the design of networks, the latter subject having already been treated with redundancy of algebra and graphics by other German writers. "Scientific Principles" occupy over one-third of the present volume and are entered into with characteristic thoroughness. The next section of the book, on cable manufacture, contains much good advice evidently derived from actual experience, and includes also several useful specifications issued by Government departments and other authorities. No receipts, either for rubber mixtures or for the compounds employed for impregnating paper and other fibrous insulating materials, are given, however, and this is to be regretted.

Another disappointment is that hardly anything is said with regard to the practical process of covering of electric light and

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power cables with paper insulation. On p. 133 we read, "So far as concerns the insulation of cables with paper only, we have too little experience in the manufacture to enable us to say anything of consequence." It is not clear whether "we" is to be taken to mean the author or "we in Germany": probably the author, for he goes on to recommend that the paper strip should be laid on without any overlap, whereas we believe we are right in saying that "half lap" is the common practice for cables of a fairly large size. Vulcanised bitumen, a material little employed in Germany, we believe, is not mentioned. Descriptions of the actual cable-making machines are not included in the section on manufacture, but in a chapter by themselves at the end of the book. They are rather incomplete.

In spite of the omissions to which we have called attention, the book contains much useful information, and we recommend its perusal to those who are interested in cable manufacture in this country. The volume is well printed and is in a serviceable binding, but the printers have hoisted a danger signal by printing one of the diagrams upside-down. Such a hint as this naturally makes one fear that the revision of the proofs for the elimination of less obvious mistakes may not have been carried out with sufficient thoroughness.

Directory and Map of Automobile Charging Stations. (London: The *Electrical Times*.) Paper, 2s.; leather, 3s. 6d.

This is a handy little directory and map of England and Wales, giving the names of over 700 places where batteries of electric motor cars may be charged. It also gives the times and price at which supply is available, and whether repairs can be carried out and garage given.

THE WIRELESS TELEGRAPH CONFERENCE.

(*Concluded from p. 160.*)

Comparing the original proposals with the "Protocol" finally adopted, it will be seen that Article III. of the former has been omitted. This article is practically covered by the previous Article I., except in one important particular. Any State agreeing to enforce Article I. would naturally only have power to do so in its own territory, not at sea nor in countries not signing the Convention. The proposed Article II. made it incumbent upon a Contracting State, when entering into an agreement with any company for working wireless telegraph stations, to make it a condition that the company would agree to conform to Article I. and accept signals on any system in *all* of its stations, whether within or without the jurisdiction of that particular State. The object was, of course, to prevent the boycotting of non-Marconi equipments by Marconi coast stations and vessels. This came up for consideration during the fourth sitting of the Conference, and the French delegates proposed a modification making the wording of the article more concise and also more precise, but also extending its provisions so as to make it necessary that a company should only be licensed on undertaking to carry out the provisions and regulations of the whole Convention in all parts of the globe. Neither Great Britain, Italy nor the United States were in a position to agree to this; and, as is seen by Articles II., III. and VII. of the Protocol, the conclusion arrived at with regard to this question has no very definite significance pending the next Convention, of which the present one was only the preliminary stage.

Between the fourth and fifth sitting, Capt. Bonomo (Italy) put in a long communication on the difficulties with regard to working wireless telegraph stations, especially if these were all equipped on the same system; even in this most favourable case there would, he contended, be many "*inconvénients*" in carrying out an international radio-telegraphic service. His arguments were much weakened, however, by a postscript to the effect that they must not be taken to apply to "commercial stations," of which he had had no actual experience. The communication included some particulars as to the organisation of the wireless telegraphic service of the Italian Navy. One system—the non-syntonised Marconi system of 1901—is employed exclusively as a standard. If a station, A, wishes to send a message to another B, she adjusts her receiver to its highest sensitiveness in order to make certain that no other signals are being sent. Having ascertained this, she transmits "understand" (- - - — -) four or five times, followed by the call signal four or five times. If, after five minutes, say, A does not receive a reply, she repeats the call; and so on until she receives a reply. The called station B would reply, for instance, by transmitting "understand" (- - - — -) three times, followed by her own call; that is to say, her own code name followed by that of A. Having received the reply, A will make her communication, following the international telegraph rules, commencing it with "understand" three or four times. The message having been completed, the respective calls are repeated. In the case of lengthy transmissions Capt. Bonomo suggests that conventional signals might be adopted to acknowledge receipt after a certain number of words, and he also suggests that a conventional signal should be sent by either station whose reception is impeded by atmospheric disturbances. Ships in distress, he proposes, should send the signal SSS DDD at intervals of a few minutes, and every station receiving these should suspend their other communications and reply to the ship, commencing by repeating the signal SSS DDD.

Article IV. of the Protocol, proposed by the French delegates, was accepted practically without discussion. On Article VII. of the Protocol there was considerable debate. It was generally agreed that the several terms of the Convention should not apply to naval, military and Government stations not open to the general public, but the latter part of the article making these stations subject to Article V. (*i.e.*, that their working should not interfere with that of other stations) was objected to by some of the delegates. As has been seen, the British delegates insist on this objection in their "declaration" appended to the Protocol.

SOME STATISTICS RELATING TO ELECTRICAL ENGINEERING.

BY WILLIAM POLLARD DIGBY, F.S.S.

(*Concluded from page 133.*)

The Import Trade.

In Table IV. the relation of the exports from the United Kingdom to the total capital invested in electrical manufacturing concerns is shown. The records show that while the investments have increased by leaps and bounds so that the aggregate subscribed capital has increased by 450 per cent. in six years, the exports of electrical apparatus of British manufacture have only increased by about 50 per cent. Or, regarding the exports in percentages of the aggregate subscribed capital, this percentage has fallen from 5·25 per cent. in 1897 to 2·07 in 1901. In this table are also shown the percentage which the imports bear to the aggregate subscribed capital; if it be regarded that these are a tax on the British manufacturer, we have here its relation to his capital. Could figures only be prepared of its relation to his annual turnover, a truer index of the state of affairs might be obtained. But even this would be open to the objection which can be raised to the writer's table, that the value of imports is only that value at its port of entry. How far its value may be swollen by transport charges, costs of erection (if machinery), profits of intermediaries (not expended in the United Kindgom), it is impossible to say.

Of the period which lapses between landing and completion of sale we cannot also speak. The main conclusions of this table are illustrated in Fig. 5. The suggestion may be hazarded that the firms comprising the return of the capital invested in the United Kingdom have found the home demands so great that all their energies have been absorbed in meeting the demands of the home markets. Unfortunately, while we have but few measures as to the scope of this market, it has long been anomalous that the statistics of foreign trade of the United Kingdom give us exact details of our over-sea trade, while our vastly greater internal commerce is almost immeasurable. Yet certain comparisons can be made, and while we have to ignore the domestic expenditure on fittings for household lighting, or for telephone apparatus; while we cannot compute

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Table IV.—*The Imports and Exports of Electrical Manufactures and Electric Lighting Apparatus considered in Relation to the Capital Invested in Electrical Manufacturing Concerns.*

At end of year.	Aggregate subscribed capital of electrical manufacturing firms.*	No. of firms contributing to aggregate capital.*	Total imports of electrical manufactures.	Percentage value of imports to aggregate subscribed capital.	Total exports of electrical lighting apparatus.	Percentage value of exports to aggregate subscribed capital.	Percentage over preceding year of		
							Increase of aggregate subscribed capital.	Increase (+) Decrease (−)	
								Exports.	Imports.
1902	£29,852,575	160	£687,514	2·29	£674,411†	2·07‡	14·8	+11·7	− 19·3
1901	25,990,606	154	849,257	3·26	589,517†	2·12‡	19·7	+ 1·4	− 33·0
1900	21,708,180	135	1,265,946	5·82	583,217†	2·51‡	29·1	+ 6·7	+106·3
1899	16,799,152	92	613,593	3·65	510,758	3·04	59·5	− 0·8	+ 66·9
1898	10,535,937	62	367,572	3·49	514,632	4·88	23·6	+14·7	+ 51·7
1897	8,519,430	44	242,185	2·96	448,732	5·25	29·2	+17·3	..
1896	6,596,244	24	..	..	382,438	..	..	..	..

* Vide Mr. Garcke's "Manual of Electrical Undertakings," 1903. † Includes re-exports of foreign electrical manufactures in 1900, 1901 and 1902 only. ‡ Percentages in this table reckoned on British produce only. See Table I.

the expenditure on dynamos and motors in factories, or in country houses; while we cannot even estimate the expenditure on electrical apparatus on those "shuttles of an empire's loom" which serve to bring the produce of foreign countries to what one school of political economists call the "dumping ground of the world," we are able to institute striking comparisons of the ratio which the imports of foreign apparatus bear to the expenditure on certain vast undertakings.

Electricity supply works may be considered. Mr. Garcke gives the aggregate capital invested both by companies (in the shape of ordinary and preference shares and debentures) and

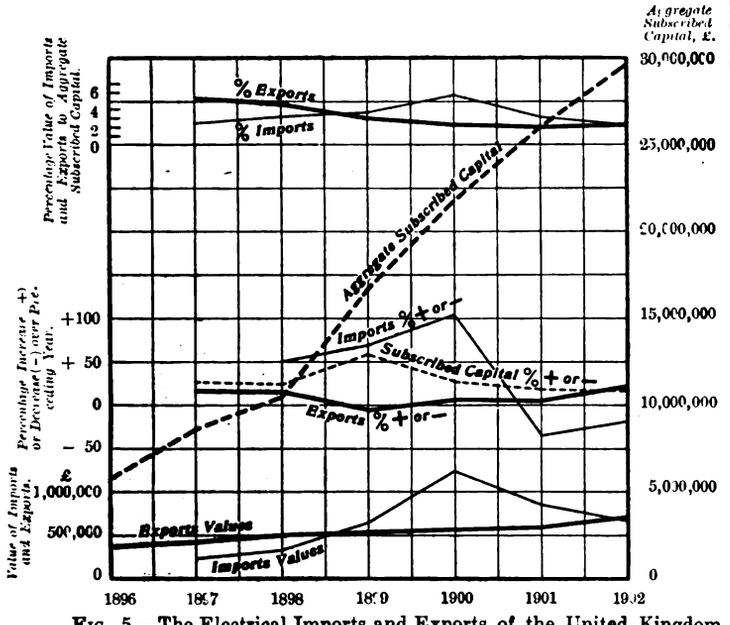

FIG. 5.—The Electrical Imports and Exports of the United Kingdom in Relation to the Aggregate Subscribed Capital invested in Electrical Manufactures.

by municipalities in the shape of loans. The yearly sum of these items is given in the first column of Table V., column 2 gives the annual increase. Referring to the "Manual of Electrical Undertakings," a glance at p. 111 gives the annual percentage of capital outlay under its different headings. The constancy of the yearly proportions is surprising, while it is obvious that the capital subscribed or authorised in any one year was not necessarily expended within that year, and that the expenditure tables merely give the percentage expenditure to the end of each year; the writer has, therefore, averaged the percentage disbursements for the six years under consideration under the heading of "Plant and Machinery," "Meters" and "Instruments," taking the mean total at 42 per cent. For the entire electrical equipment the mean total was taken at 76 per cent. The yearly ratio of the entire electrical imports to these values is given in column 6. Assuming for the instant merely that the entire imports from abroad were emptied into the central stations of the country during the six years, the total percentage amounts to 27·5 per cent. on the cost of the electrical equipment minus the cost of mains, or to 15·2 per cent on the entire cost. Such a comparison is, of course, somewhat

Table V.—*Electricity Supply Works.—Ratio of Imports of Electrical Goods to Capital Invested in.*

Year	Aggregate subscribed total capital invested.*	Actual increase in capital invested during year.	Est. exp'nditure on plant, machinery, meters, & instruments.†	Ratio value of imp'rted elec. goods to each £100 invested in machinery, meters and instruments during year.	Est. exp'nditure during year on entire electrical equipment.‡	Ratio value o imported electrical goods to each £100 invested in entire elec. equipment during year.
	£	£	£	£	£	£
1902	44,993,609	7,274,724	3,055,314	22·42	5,508,790	12·43
1901	37,718,885	11,507,686	4,833,228	17·57	8,745,841	9·71
1900	26,211,199	8,414,239	3,533,980	35·82	6,392,821	19·95
1899	17,796,960	3,654,394	1,534,803	39·97	2,777,163	22·09
1898	14,142,666	3,985,457	1,653,850	22·22	3,008,871	12·21
1897	10,157,309	2,359,036	990,879	24·44	1,792,899	13·50
1896	7,798,073	..	..	..	..	..

* From "Manual of Electrical Undertakings," 1903.
† Reckoned at 42 per cent. of year's increased investment.
‡ Reckoned at 76 per cent. of year's increased investment.

	In six years.	
Total increase in aggregate subscribed capital.....	£34,863,300	(*a*)
Estimated expenditure on "Plant and Machinery," "Meters" and "Instruments".....	14,631,246	(*b*)
Estimated expenditure on entire electrical equipment ..	26,475,588	(*c*)
Total imports of electrical apparatus	4,023,827	
Ratio of total imports to (*b*) 27·50 per cent.		
" " " (*c*) 15·20 "		

farcical, as probably not one-tenth of the foreign imports of electrical goods have found their way into central stations.

As to the exact extent in which foreign generators have entered our central stations it is not easy to spea . Several large machines have come from the Continent, while a still larger number are designated in *The Electrician* tables as the manufacture of large firms having factories both in the United States and Great Britain. Of electricity supply works in operation, it can be stated that in 95 per cent. dynamos or alternators of Continental manufacture are unknown, and that in the bulk of the remaining 5 per cent. the foreign-made machines only account for a portion of the generating equipment. We are on more certain ground when considering the position in the 37 electric lighting undertakings described in *The Electrician* tables as in progress. Here, out of an aggregate capacity of 12,365kw., 3,736kw. (roughly 30 per cent.) is accounted for by generators of German or Swiss origin. This disquieting figure is accounted for solely by the installations respectively at Dublin and Ipswich. A glance over the tables of the details of power-house equipment of electric traction undertakings owning their own power houses is less unpleasing to the British manufacturer. Among 90 undertakings described, apparently only two have dynamos of Continental origin, the aggregate capacity of which is probably under 1,000kw.

A PLEA FOR FURTHER INFORMATION.

Bearing in mind the voluminous character of the present "Trade and Navigation Returns," and the varied contents of a "Statistical Abstract," one naturally hesitates to suggest the inclusion therein of extra tables. The hesitancy is increased by the fact that on certain representations made to the Board of Trade the present monthly trade returns were increased in scope only last January. Unfortunately in this expansion, sufficiently detailed returns of the imports and exports of most

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interest to the electrical industries were omitted. The lack of differentiation is most unfortunate—polyphase motors and generators, telephone fittings, accumulators, Ruhmkorff coils, tramway motors, lamps, electric bells, cables and fittings for domestic use, all apparently hitherto entered under the one heading "Electrical Goods." The new returns provide for imports "Electrical Goods and Apparatus," "Electrical Machinery" and "Telegraph Cables and Apparatus." The exports are presumably all embraced under the last two classes only. The writer would suggest that some such classification as the following might be urged upon the Board of Trade by either the Institution of Electrical Engineers or by the London Chamber of Commerce in regard to both imports and exports of the United Kingdom :—

(*a*) Motors, generators, transformers, accumulators, or cables for central station purposes (lighting and traction).
(*b*) Equipments for electric traction—*i.e.*, car trucks, motors, controllers, or parts thereof.
(*c*) Motors, generators, transformers, accumulators or cables for factory or domestic use.
(*d*) Sundry electrical fittings, including house fittings for electric lighting, primary batteries, &c.
(*e*) Telephone cables and apparatus or parts of same.
(*f*) Telegraph cables and apparatus or parts of same.

Perhaps, also, the classification of steam engines might be provided with a sub-class—engines for electricity supply or electric traction.

The writer would respectfully suggest that under the ægis of the Council of the Institution of Electrical Engineers, possibly through a sub-committee appointed by them, a species of stocktaking should be conducted. Now stocktakings on an imperial scale were first urged in a northern city nearly three years ago, and such a compilation, or Domesday Book, of the electric supply and generating stations in the country as the writer now suggests, completed, say, at the end of the current year, together with additional classification in future blue books, would settle once and for all many vexed questions. The statesman who urged the imperial stocktaking did so in order that matters of grave import might be looked at in their right relations, and decisive policies determined. The writer would like to see the stocktaking so compiled as to include undertakings supplying electric light and power and electric traction. The labours of the committee would certainly be arduous, but the rebuffs encountered by a committee having the prestige of the Council at their back, infrequent. Moreover, in those instances where returns were entirely refused, a careful consideration of the individual case by the committee would enable the expenditure abroad to be estimated with very fair accuracy. If possible the expenditure of other industries along certain broad lines might be enumerated. The Council might also approach the Board of Trade and the Foreign and Colonial Offices and Agents-General with a view to the removal of various anomalies in the trade returns of the colonies, and with a view to obtaining from each consul a report on the electrical manufactures of the country, the destination of its exports and the source of its imports. The writer would also urge that the Council of the Institution should take steps, through either the Local Government Board or the Board of Trade, to obtain from each municipal authority constructing tramways or lighting undertakings a publication of all tenders received, and to obtain an affidavit from each contractor as to the extent in which his firm is tendering goods of other than British manufacture, such information to be published only in regard to the successful tenderer.

The writer makes this suggestion in view of representations made to him by a leading British manufacturer, citing an instance in which two orders amounting to a quarter of a million sterling were awarded to a Continental firm. This firm was informed that it was the lowest English tender but the margin was not stated.

The writer in compiling this Paper has endeavoured, he trusts successfully, to place his facts impartially, without bias in regard to either school of political economists. As to the conclusions which may be drawn, these he has endeavoured to avoid, while respectfully urging that the Institution of Electrical Engineers as a body should interest itself to obtain such figures as are requisite for a more complete presenting and consideration of the case.

A SINGLE-PHASE MOTOR.

In *The Electrician*, Vol. LI., p. 1,039, there appeared a description of a new system of single-phase traction introduced by the Union Electricitäts Gesellschaft, and the following relates to the motor employed. Messrs. Winter and Eichberg of Austria applied for a patent for "Improvements in and Relating to Alternating-current Dynamo-electric Apparatus," on October 24, 1902, and the complete specification was accepted exactly 12 months later. The number of the patent is 23,288 of 1902, and the following is the complete specification :—

When the primary and secondary windings (hereinafter referred to as P and S) of an alternating-current transformer are impressed respectively by the full voltage, that is to say, by voltages of the same phase and corresponding to the ratio of transformation, current flowing in each of the said windings will produce one-half of the magnetic field so as to create in both windings counter E.M.F.s corresponding to the said ratio and opposing the before-mentioned voltages—*i.e.*, each winding takes up half the magnetising current. But when the windings P and S are impressed by voltages which do not correspond to the ratio of transformation, one of the windings, for example P, will take up a sufficiently larger current than in the first case, and the other (S) will return a considerably greater current to the generator. The difference between the energies represented by these two currents is the total energy loss of the transformer, which includes the ohmic capacity, and iron losses; and the internally generated potentials are in this case as regards P smaller than that of the current supplied thereto, and as regards S greater than that of the potential applied thereto. Now let the primary and secondary winding system be arranged in the manner illustrated in Fig. 1 of the diagrammatic drawings filed with our provisional specification—*i.e.*, as separate bipolar ring windings disposed in such a way that S can move independently of P, whilst the current feed points and, therefore, the magnetic poles of S, are maintained on the line xx, which can be easily attained by providing the winding S with a segmental commutator, and causing the current to be supplied through brushes situate on the line xx. If now there be added to the windings P and S a further winding M, current in which produces a magnetic field, the axis yy of which is at right angles to the axis of the field of the windings P and S, and whose current as regards phase is the same, or approximately the same, as the currents in P and S, then a torque is produced which is proportional to the field of M, to the ampere-turns of the rotor S, and to the cosine of the displacement of phase between both these last magnitudes. The counter E.M.F. occurring at the commutator upon the turning of the rotor has its greatest effective value on the line xx, is in phase with the magnetic field having the axis yy, and opposes the E.M.F. of the current supplied to the rotor. If the angle of phase between the E.M.F. impressed upon S (this E.M.F. is hereinafter referred to as E^2) and the magnetic field of M is very small, and the influence of the magnetic leakage is disregarded, then the counter E.M.F. consequent upon the rotation may be regarded as nearly in the opposite direction to that of the E.M.F. impressed upon the rotor winding. With an increasing speed of revolution the total E.M.F. of the winding system S decreases. Any desired speed within practicable limits can be provided for by making variations in the difference between the potential (hereinafter called E_1) of the current supplied to the stator winding P and the potential E_2 of the current supplied to the rotor winding S. If the fall or loss in potential in the windings were not taken into account, then it could be said that the speed which the rotor acquires is proportional to the difference $E_1 - E_2$ when the magnetic field, having its axis on the line yy, has the same total strength as the field having its axis on the line xx and produced by current in the winding P, and having the potential E_1. When $E_1 - E_2 = 0$, *i.e.*, $E_2 = E_1$, the rotor stands still, and when $E_1 - E_2 = E_1$, *i.e.*, when $E_2 = 0$, the rotor runs synchronously; the E.M.F. due to the induction caused by the movement of the conductor in the field of M is then equal and opposed to the E.M.F. due to the static induction from P to S. There may be provided a starting and controlling system whereby, for example, the stator is subjected to a nearly constant voltage, whilst the rotor is supplied with current less in voltage than would correspond to the voltage of the stator with the ratio of transformation employed. The difference, or, rather, the quotient of the stator and the rotor voltages, then agrees with this ratio and the speed required. The speed is also dependent upon the strength and phase of the magnetic field of the winding M, and consequently, by variation of these factors, a regulation can also be produced. With the same object in view, the rotor potential can be maintained constant and the stator potential varied. If the rotor is turning and is subjected to a potential corresponding to a higher number of revolutions, then it advances to the higher speed; but if, on the other hand, it is subjected to a potential which corresponds to a lower number of revolutions, then it acts as a brake, and, as a dynamo, gives energy back to its circuit. When a means of driving is provided such machines may be caused to act permanently as dynamos and they can then be connected in parallel as easily as ordinary continuous-current dynamos. In the example shown in Fig. 1 the winding M is located on the stationary part, the excitation taking place from the exterior. The winding P is subjected to the full potential E_1, and the winding S to current of the suitably reduced potential E_2, supplied through brushes B^1, B^2. The regulation of the speed is effected chiefly by altering the E.M.F. of the current supplied to the winding S, but such regulation may also be effected by varying the current in the winding M. In the example shown in Fig. 2 the winding M is located upon the rotor, and is provided with a segmental commutator such that the axis of the field may remain on the line yy notwithstanding

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movement of the rotor. In this, as in the first example, the winding P is supplied with current at constant potential E_1 and the winding S with the current of variable potential E_2, and they convey the working current properly so-called, whilst current in the winding M supplies substantially the excitation only. The magnetic field which is produced by current flowing in the winding M approximately in phase with the working currents, is shown in Figs. 1 and 2 as being separately excited. As the points of contact for the currents in the windings P and S lie on one axis, *xx*, at right angles to the axis *yy* of the points of contact of the winding M, it will be seen that the former being equi-potential to the latter points of contact, the winding M can be dispensed with and its functions usurped by one of the two windings P or S, and in this way the simplified arrangements shown in Figs. 3 and 4 are obtained. In that shown in Fig. 3 M is combined with or usurped by P, and in that shown in Fig. 4 M is combined with or usurped by S. Instead of connecting the rotor with the secondary winding of a transformer divided into potential graduations, as is shown in Figs. 1 to 4, it may be connected with or to an impedance which utilises resistance, inductance or capacity, the torque being determined by the adjustment of the impedance. If the impedance is made very small—*i.e.*, should the terminals be short-circuited—then $E_2 = 0$, P is subjected to E_1 as before, and current flowing through M again provides the excitation either by the stator or the rotor. On the other hand, however, P can be used in conjunction with an impedance or can be short-circuited, as shown in Fig. 5, in which latter case $E_1 = 0$, S, on the contrary, being subjected to E_2. In the instances hitherto considered, the field produced by the current supplied to the windings P and S forms, together with the magnetic field of the winding M, a rotary field which is more or less uniform according to the strength and displacement of phase of the magnetic field of the winding M, and this rotary field reacts with the field of the rotor winding, which, if it alone were present, would form an oscillating single-phase field. It is not necessary that the two components of the rotary field be produced by currents of different phase; it is also possible to excite the winding M by

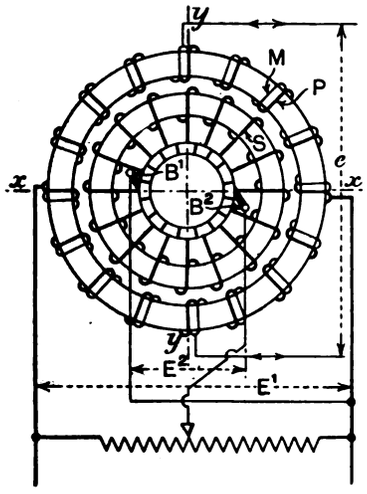

Fig. 1.

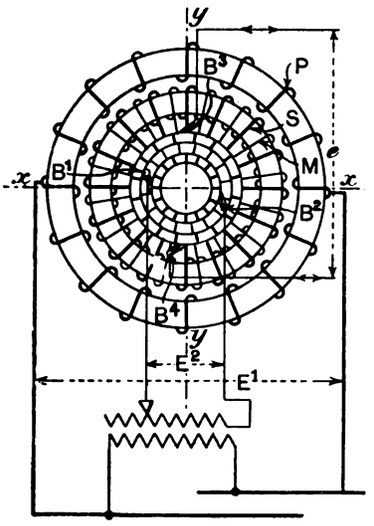

Fig. 2.

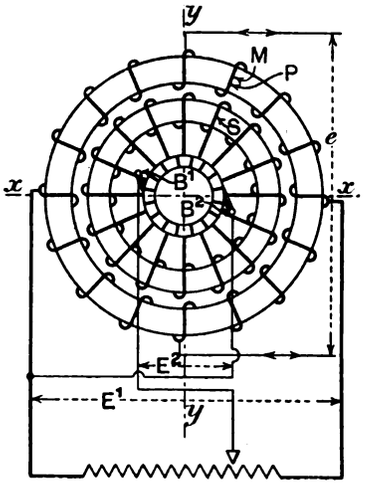

Fig. 3.

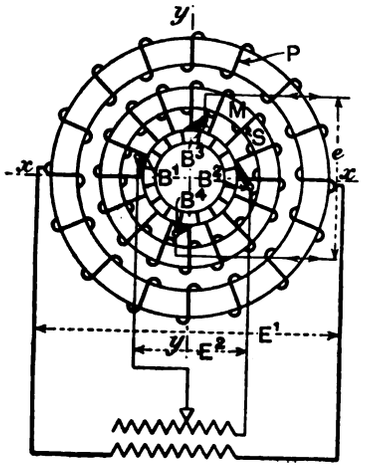

Fig. 4.

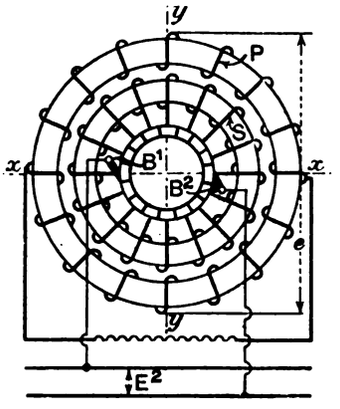

Fig. 5.

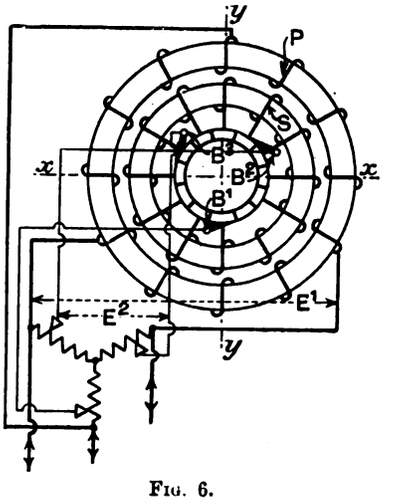

Fig. 6.

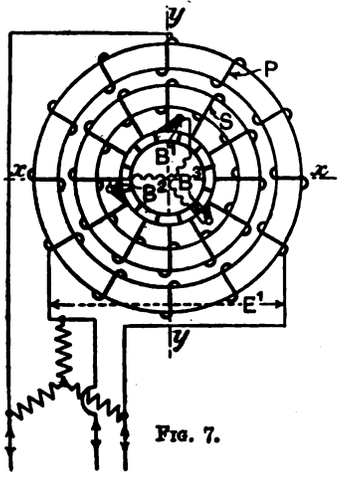

Fig. 7.

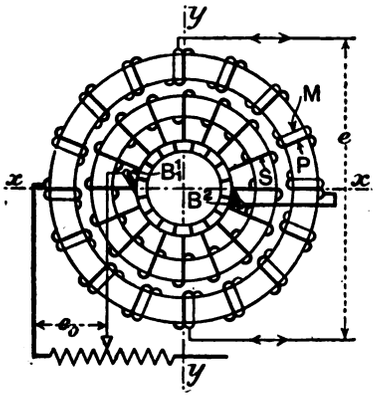

Fig. 8.

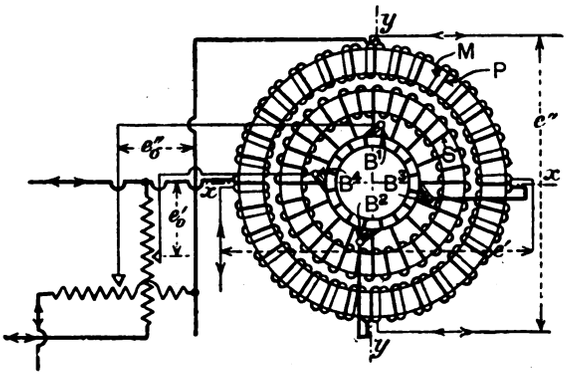

Fig. 9.

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the current coming from the brushes—*i.e.*, it is possible to substitute for the field winding, which generally has a large number of turns, a series winding with a small number of turns. The stator has hereinbefore been assumed to have been provided with a winding or windings in which the two currents may be different in phase and in which current of one phase supplied to M furnishes chiefly the excitation, whilst current of the other phase (the axis of whose field is identical with the commutation line on the rotor) conveys working current. This arrangement can be rendered more universally applicable by providing the stator with a conductor system adapted for use with currents of as many phases as may be desired, of which one is the working current proper whilst the others produce chiefly the necessary magnetisation. The rotary field of the stator acts upon the oscillating working field of the rotor. If polyphase alternating currents are conveyed to the rotor, then the rotary field of the stator acts upon all the single-phase systems of the rotor. In this case currents of all phases in the stator produce work. In a similar manner to that obtained in a before-described example, variation of speed can be obtained by producing an increase or decrease of the difference between the potentials of the currents supplied to the stator and to the rotor, and, in order that this may be effected, it is by no means necessary that the transformation ratio be P:S=1; on the contrary, it can be as desired. Provision is made for exerting a torque whilst the rotor remains at rest (for use, for example, when a vehicle fitted with a motor according to the invention is stationary upon a gradient) by impressiug an approximately equal voltage per turn of wire upon both the primary and secondary windings, and the speed is controlled by varying the voltage per turn of wire impressed upon the secondary winding. It is, however, not necessary that P and S be polyphase conductor systems for equal numbers of phases; on the contrary, one system, P, can have a number of phases different from that of the second system S. As in the single-phase arrangement, impedances can also be used in this case with the windings P and S, the minimum of resistance being obtained when P and S are short-circuited. Fig. 6 illustrates an example in which P and S are each triphase-current conductor systems. This example may be worked so that the phases II. and III. supply the magnetic field for phase I., phases I. and II. the excitation for phase III., and phases I. and III. that for phase II. Fig. 7 shows a modified arrangemeat in which S is closed only by impedances. Finally, an arrangement is also possible wherein P and S, as shown in Fig. 8, are connected in such a way that currents sent through them in series produce an equal sum of ampere-turns in each. Whereas in the arrangements shown in Figs. 1 to 7, when the rotor was at rest current at the full potential was supplied to P and S, and in such a way that the difference at the start was a minimum, the potential (e_0) which at the start is supplied to the series P, S, is in this case at a minimum, and increases with the speed. The working currents again co-operate with the magnetic field of M, and by varying the potential e_0 and the strength and phase of this magnetic field the speed of the rotor can be varied. Furthermore it is possibe to produce the magnetic field of M by current derived through brushes instead of obtaining it from a separate source of current. The series connections, hereinbefore described, specially for the case in which the rotating armature has brushes on one axis, as shown in Fig. 8, can also be employed in a simple manner for a polyphase system by using, instead of a single-phase primary system and a single-phase secondary system, a primary system and a secondary system each adapted for use with a number of phases, in these two systems the different phase windings being connected in series—*i.e.*, all conductors of the stator are in series, or in parallel series, all conductors of the rotor are connected in like manner, and the two systems are connected in series. In this case the magnetic rotary field must be produced by a separate polyphase conductor system M, the number of phases of this system, however, being quite independent of the number of phases of the other or working windings (see Fig. 9). An important condition to be observed is that the magnetic field, which is produced by the exciting currents, should be at right angles to the rotary field which would be produced by the currents flowing through the primary and secondary windings if they existed separately. Let e'_0 be the potential belonging to phase I., and e''_0 that belonging to phase II.; the potentials e'_0 and e''_0 take the place of the potential e_0. By adjusting the potentials e'_0 and e''_0 applied to the working windings connected in series, the intensity of the magnetic field being determined by the potentials e' and e'', the desired number of revolutions can be provided with various loads. The arrangement of apparatus illustrated in Fig. 1 and the other apparatus hereinbefore described can be used as generators as well as motors, because upon excitation through a determined magnetic field an E.M.F. must in all cases arise at the rotor terminals, and this E.M.F., quite independently of the number of revolutions of the rotor, is equal in phase and period to the magnetic field. All the figures relate to bipolar arrangements, and, therefore, only represent examples of construction, For an apparatus having a greater number of poles, the magnetic field axes *x.x* and *yy* are generally inclined to one another at an angle of 90deg. divided by half the number of poles. By "phase winding" is meant the winding system for each phase: thus, for example, the three parts of the stator winding of a polyphase induction motor constitutes the three-phase windings. The windings on the rotor are also shown as ring or gramme windings, but all suitable closed windings, such as are used for continuous current and with segmental commutators can be used.

Following are the claims:—

1. An alternating-current machine comprising a stator having a bi-phase or polyphase winding and a rotor having a normal continuous-current commutator winding and brushes located in one axis, wherein the rotor and the stator phase windings, which have the same, or approximately the same, field axis as the rotor, are subjected to any desired potentials of equal periodicity, either direct or through resistances inserted in series, whilst the magnetic field component which effects the torque is produced by the second or other stator phase windings by means of alternating currents of equal periodicity introduced externally in such a way that, by altering the difference of the potentials applied to the windings having the same axis, and independently thereof by altering the magnetic field, in the case of a motor the speed may be varied with any load, and in the case of a generator any desired voltage of the same phase of periodicity as the magnetic field may be obtained with any speed independently of the load, substantially as set forth.

2. In an alternating-current machine according to the preceding claim a polyphase or multi-axial construction of the rotor and a single-phase or mono-axial construction of the stator whereby these two parts exchange their roles, and the exciting currents are supplied through the commutator, substantially as set forth.

3. A constructional form of the alternating-current machine according to claim 1 with a polyphase stator and a rotor comprising a continuous-current commutator winding, corresponding in general to *n*-phases, and provided with brushes, wherein the stator windings by means of fixed points of supply, and the rotor windings, by means of the brushes, are connected directly, or by means of resistances inserted in series to outer circuits of equal periodicity, the effect stated in claim 1 being obtained by altering the potentials applied to the stator and the rotor, substantially as set forth.

4. In alternating-current machines, according to claim 1 or claim 2, the modification that the stator-phase winding, which has the same, or almost the same, axis as the rotor, is connected in series with the rotor by altering the position of the brushes in such a way that the currents passing through this series produce ampere-windings of approximately equal strength but opposite in direction, so that the effect referred to in claim 1 is obtained by varying the potential applied to this series and independently thereof by altering the magnetic field, substantially as set forth.

5. A constructional form of alternating-current machine according to claim 1 and claim 3, wherein the number of the stator and rotor-phase windings is equal, the windings corresponding to like phases being connected in series in such a way that the currents passing through these series produce ampere-windings of approximately equal strength, but opposite in direction, and by means of a separate polyphase winding system on the stator or the rotor a magnetic field is produced which at any moment is at right angles, or approximately at right angles, to the axis of the opposed ampere-windings, so that, by changing the potentials applied to this series, and independently thereof by altering the magnetic field, the effect stated in claim 1 is obtained substantially as set forth.

6. In an alternating-current machine, according to claim 1 or claim 2, the short-circuiting of one of the two windings having the same axis through resistances of any kind and amount, so that by changing the potential applied to the other winding, and independently thereof by altering the magnetic field, the effect stated in claim 1 is obtained substantially as set forth.

7. In an alternating-current machine, according to claim 3, the short-circuiting of one of the two winding systems through resistances of any kind and amount, so that by changing the potentials applied to the other winding the effect stated in claim 1 is obtained, substantially as set forth.

8. In alternating-current machines of the kind referred to, the separate or the combined arrangement of the exciting windings with the windings conveying the working currents located on the stator or rotor, substantially as set forth.

9. In alternating-current machines of the kind referred to, a winding or windings connected in series with the armature for the purpose of exciting the magnetic field M, substantially as set forth.

DESTRUCTOR AND ELECTRICITY STATIONS IN SMALL TOWNS.

The following is an abstract of the discussion which took place at the Leeds Local Section of the Institution of Electrical Engineers on November 19th in connection with Mr. S. D. Schofield's Paper, "Destructor and Electricity Stations in Small Towns." The Paper was published in our last issue:—

Mr. W. EMMOTT said the author would evidently do without a destructor if he could. Regarding the dust from the destructor, the only way to get over it was to place the electricity station and the destructor back to back. In a combined station better destruction of refuse was obtained because steam was bound to be kept within measurable limits of the standard pressure, in order to keep the engines going, especially with a variable load. If, however, the destructor was simply generating steam for pumping purposes the pressure might be varied 30 or even 40 per cent., but by doing so there was a risk of the refuse not being so effectually destroyed as would be the case under a combined electricity and destructor station. In connection with the height of chimneys used with destructor stations, he maintained that 90ft. to 120ft. was quite enough, but there seemed to be a tendency to carry the chimneys to 150ft. or more.

Mr. W. B. WOODHOUSE said that he entirely agreed with the author as to the destruction of refuse being purely a sanitary matter. For hygienic reasons, the destructor should be away from the densely

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populated portions of the town, but this was not the best position for a power station. He noticed that Shipley had a very good load-factor, and presumed that the 66·8 included charging the battery, &c., and was not the load-factor on the running power. He would like to know how many pounds of water were required per unit generated and whether the conditions in the various tests were the same; with a fair price for coal, 7·1lb. per unit with a load-factor of 66 per cent. was quite absurd.

Mr. PICKERSGILL said that on a low load-factor he could generate all the energy necessary, with one Meldrum furnace, for driving 9 miles of tramway. He had arranged the steam pipes at Cleckheaton with automatic valves, which were really back pressure valves in between the main valve and the steam valve, so that when the steam was highest in the destructor boilers it shut down the check valve on the coal fire boiler even when the fires had just been blown. The refuse obtained at Cleckheaton averaged over 70 units per ton destroyed. The figures given by Mr. Schofield were actually taken from watt meter readings, and included current for tramway purposes, the load being so arranged between the battery and the generators that the steam was kept practically constant all the time. Had the tramway load been higher, more units per ton could have been obtained, as for a considerable time steam was blowing off at the boiler, and the batteries could not take a larger rate of charge.

Mr. A. B. MOUNTAIN said the load-factor at Shipley had probably been taken on the hours that the plant was running, and not on the total for the year. There was a very great discrepancy in published figures as to the actual cost of destroying refuse, and definite figures on capital outlay, interest, special fund charges and repairs were badly wanted.

Mr. MELDRUM said the author had not put too favourable a construction on the destructor, and, as an instance, he called attention to the fact that no superheating was done, and that alone would make a very marked difference, particularly as a Parson's turbine was used, which would stand any amount of superheat with distinct advantage. The author had said that the value of refuse was in inverse proportion to the price of coal, but he did not quite agree with him. The balance-sheet in favour of the corporation gave £270 clear gain, but did not give the value of the clinker, although he believed that the whole of it was used, and he questioned, if it were to be bought, whether it could be got for less than 2s. 6d. per ton. If this item were added (say 2,000 tons), there was a further sum of £250 in favour of the destructor, making a total of something like £520 clear gain. To get over the difficulty of putting a destructor in the centre of a town, adjacent to the electricity works, some corporations were now putting the destructor at the most convenient point for its purpose, and the electricity works at the most economical point. With the destructor was installed a generator large enough to utilise the whole of the heat, and current was then conducted from this by a feeder, either to the switchboard of the electricity station or else on to the network at the nearest point. It was rather astonishing to find that in spite of all that was said against destructors, four out of every five ordered from Meldrums had been in connection with electricity works. With regard to the question of the height of chimneys, very much depended upon the locality, but about 80ft. would be found a fair average height, and this met the requirements of any bye laws.

Mr. MELVIN said that since the introduction of forced draught, destructors had been constructed in which the chimney gases were entirely odourless. He thought that 80ft. or 90ft. chimneys were quite sufficient.

Mr. H. N. LEACH (communicated) gave particulars of a test which Mr. Hammond had carried out on plant erected by Messrs. Heenan and Froude at Gloucester. The furnaces consisted of two grates, the boiler being a cross type of Babcock and Wilcox, mounted over the furnaces, with a separate combustion chamber intervening. The grate area was about 66 sq. ft., and the rate of burning throughout the test was about 50lb. per square foot per hour, making a total of about 1½ tons of refuse consumed per hour. The actual evaporation was 1·76lb., the feed being at a temperature of 55°F., and for the first six hours of the test the load was an artificial one, giving an average of 140kw. On two occasions the load fell to 100kw., half an hour being the period of the fall and rise. Steam blew nine times for continued periods during the first six hours of the test, the forced draught being cut off during such periods, whilst, during a subsequent period of six hours, the destructor supplied about 50kw. on the tank, the street lighting of the city (amounting to about 40kw.), and the feed, circulating and air pumps. No economiser intervened.

Mr. SCHOFIELD, in reply, said the capital cost had been overlooked in the Paper, as he was only anxious to find out the fuel value of the refuse. With regard to the load-factor, one set was running on tramway load the whole day and another set on lighting. The load-factor was taken on a basis of 20 hours a day, which was approximately the number of hours current was required for the cars. With regard to capital outlay, if a destructor plant was put down for destroying refuse alone it would not be so great as in the case of a combined station, because no very expensive boiler or economiser would be necessary. What was meant by the statement that the value of the refuse varied according to the price of fuel was that the price of household coal, as a rule, determined the fuel value of refuse. If household coal was obtained at 10s. to 15s. a ton it was not so carefully burnt as the more expensive coal, and, consequently, the fuel value of ashpit refuse was higher in the first case than in the last. With regard to the value of clinker, this did not concern the electricity department, nor was it an essential factor in the consideration of the two stations, as it was purely a sanitary matter. As a matter of fact, the clinker at Shipley was used for bacteria beds, and before the destructor was started thousands of tons were carted at a cost of 10d. per ton. It had been said that the cost of coal—namely, 0·266d.—was very low; but it would be noticed that he had not taken the units sold, but generated, the figures taken from that and other sources giving the cost of coal.

CORRESPONDENCE.

STEAM TURBINES v. RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to correct some of the statements appearing in your journal on the above. From Messrs. Belliss and Morcom's letter in yours of November 6th, I take the following passage:—"The 4in. difference in vacuum at 4 per cent. per inch as given in the Paper means 16 per cent. to the turbine" (referring to a reciprocating engine working at 24in. vacuum and a turbine at 28in. vacuum). What Mr. Wilkinson did say was "every 1in. *above* 25in. or 26in. has been found to reduce the steam consumption by about 4 per cent."—a somewhat different statement. A study of the theoretical work in steam by the Rankine cycle will demonstrate how steam consumption improves in a largely increasing ratio as absolute vacuum is approached. The turbine follows this law approximately. At 27in. vacuum the 4 per cent. is nearly correct, but at 24in. it is experimentally under 2 per cent.

In the same letter reference is made to some trials conducted by Prof. Ewing on a 500kw. turbine set in the Cambridge Electric Supply Co.'s station at the time I was engineer there. In comparing these with the trials carried out by me at the makers' works (Messrs. Parsons & Co., Newcastle-on-Tyne) a year previously, Mr. Wilkinson has quoted a wrong figure for the vacuum, and to this Messrs. Belliss and Morcom attribute a deterioration of 13 per cent. with a year's service. The actual differences in the two sets of trials were, firstly—vacuum, Newcastle 24·5in.; vacuum, Cambridge 25·7in. Secondly, steam pressure, Newcastle 139lb., Cambridge 148lb. Thirdly, in Newcastle air and circulating pumps were driven separately; in Cambridge the turbine drove both pumps; and, lastly, an efficient system of separators was in use at Newcastle, whilst at Cambridge the steam was wet. The results of the trials were 24·1lb. per kilowatt in my tests and 25lb. in those by Prof. Ewing.

To correct these the vacuum 1·2in. at under 2 per cent. per inch may count 2 per cent. The steam pressure, 9lb, is theoretically with 1 per cent. The amount which my figures at Newcastle were debited for pump-driving was 5 per cent. We then have

$$24\cdot1 + \frac{24\cdot1 \times 5}{100} = 25\cdot3, \quad \text{net Newcastle figure.}$$

$$25 + \frac{25 \times 3}{100} = 25\cdot75, \quad \text{net Cambridge figure.}$$

$$0\cdot45 \text{ difference.}$$

The difference in favour of Newcastle is, therefore 0·45lb. per kilowatt, equal to $1\frac{3}{4}$ per cent., a not unfair amount to claim for wet steam apart from being within the limit of error of instruments.

In your issue for November 20th a new point is raised. The large clearances necessary for the use of superheated steam in turbines, the implication being that turbines designed for high superheat are not economical when using saturated steam. I can only say that, during my long connection with turbine builders, guaranteed steam consumptions have not been reduced for saturated steam performances when the same engine has to run with superheat as well; and such guarantees have in all cases been fulfilled. Perhaps your correspondents will substantiate their allegation by an example.

I regret absence from home prevents me sending my own selection of seven reciprocating stations for comparison with turbine stations for your forthcoming issue, but for a future number I hope to let you have them.—Yours, &c.,

Loughborough, Nov. 24. JOHN H. BARKER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The difficulties which Messrs. Belliss suggest with regard to working turbines with steam superheated within practical and economical limits are purely imaginary, and appear to indicate a very restricted knowledge indeed of the subject under discussion. Perhaps it will be useful to state, for their information, that the clearances in the turbine are

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arranged to allow for expansion due to superheat, and if on occasion saturated steam is used, the economy is not let down to any greater extent than in the case of reciprocating engines designed to run with superheated steam running on saturated steam, and probably not so much. Exactly what is meant by the "maximum possible superheat" I am unable to say, but it is an undoubted fact that turbines give no trouble when working with superheated steam, whereas the troubles with reciprocating plants on high superheats are many.

It is true that I prefer to compare results "under actual daily working conditions" and to have "the outcome of every-day practice," but the table inserted in their letter gives neither one nor the other; there are so many additional factors controlling the figures given therein as to render them valueless and irrelevant to the subject under discussion.

I will, however, submit a proposal to Messrs. Belliss which is quite relevant to the present controversy—viz., that Messrs. Belliss select any 300kw. alternating-current plant running on superheated steam and driving its own condensing plant, and of which they have manufactured the engine. The plant selected shall have been in daily work on a lighting or traction load for the past two years without any renewals or repairs to the pistons and valves. This plant to be tested on full, half and quarter loads by an independent engineer. I will arrange to place a steam turbo set of the same output, and which fulfils the same conditions, at the disposal of the same engineer for a like test, and the steam consumption per kilowatt output on both tests shall be published in the technical press. It shall be a condition of this contest that both Messrs. Belliss and myself shall have representatives present at the tests.

In conclusion, will Messrs. Belliss say what extra clearance they give piston valves for 600° F. superheat.—Yours, &c.,

Harrogate, Nov. 25. GEO. WILKINSON.

THE INVENTOR OF THE DYNAMO-ELECTRIC MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The contents of Messrs. Slater, Heelis, Williamson & Co.'s letter which appeared in your issue of November 20th are so fully dealt with in my first letter, that I feel I ought not to do more than say that I adhere *in toto* to what I stated therein. Mr. Justice Buckley in the first instance, and the Court of Appeal later, have held in most unmistakeable terms that I was fully justified in what I have done, and that the action started by Dr. Wilde was without foundation. I am well content to leave the matter there, without discussing side issues.—Yours, &c. SILVANUS P. THOMPSON.

London, Nov. 24.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It appears to me that Mr. Gray's remarks regarding the proper scope of the Institution of Electrical Engineers have been, to some extent, misunderstood by the electrical press. I would, at any rate, venture to express my own view on the subject, with every deference to those who differ with me. In my opinion, an Institution of Electrical Engineers should, in accordance with the terms of its charter, be all sufficiently concerned with the technical work of an electrical engineer, leaving the business side of all questions in the hands of those who are responsible for the administrative and commercial working of their respective electrical undertakings. I am quite ready to admit that more often than not the successful engineer is successful because he possesses a business mind or has had a commercial training. That, however, is no argument against a separate association for dealing with the business aspect of things electrical, and anyone who is serving in the double capacity of director (or manager), on the one hand, and engineer on the other, would naturally seek attachment with both headquarters. I venture to suggest that a great deal of the work that certain prominent members of the Institution are engaged over in connection with pressing claims for revising legislation and such like, is far more connected with their interests as business men than as engineers, and that, as there is abundance of such work ahead, it would be as well if a separate body were formed to attend to it. The very constitution of the Institution shows that its work is really strictly technical. Thus, those who are only associated with electrical work from a commercial point of view are classed as associates, yet obviously these, rather than those who have attained academic or technical distinction, are the most suited for urging legislative reforms.

Again, it has been suggested that the proposed tariff reforms should be discussed in their relation to electrical work; but here, again, surely those who would be best adapted to represent the Institution are the "men of affairs" rather than those who, as distinguished engineers or electrical *savants*, are prominent members of council or vice-presidents. Tariff reform on an Imperial basis is a subject I myself have been very deeply interested in for a number of years, but not as an electrical engineer any more than a mere consumer of bread, and I should certainly not look to an institution of electrical engineers for taking the matter up. On the other hand, *should* I expect an association concerned with the commercial aspect of electrical undertakings to inquire into the matter in connection with their interests—and with useful results. We might surely do worse than note the way such institutions as the Institution of Civil Engineers regard the difference between technical (or scientific) work on the one hand and business on the other.

Certainly, if a "temple of engineering" were ever to be realised, that—as a sort of enormous trades union (of the right type) to guard and agitate the interests of all the trades concerned in any form of civil engineering (mechanical, railway, electrical, &c.) would be the most suitable channel for dealing with reforms associated with the business, as opposed to the technical, side of electrical work. Meanwhile, there would appear to be ample scope for an association to take up the interests of "commercial electricity" as distinct from the interests of those who, as engineers, *render* electricity a subject of commerce. I am aware, however, that a new body such as I speak of would, at first, be open to the objection of carrying less weight in name; but it would be more in accordance with reason.—Yours, &c. CHARLES BRIGHT.

21, Old Queen street, Westminster, Nov. 24.

THE QUESTION OF THE HOUR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have again to point out that "H. C. D." in the lengthy letter published in your last issue does not quote me correctly. He omits the words "within *our* 3-mile limit." The point is not important except as illustrating the curious inability of "H. C. D." to understand an opponent's argument. Again, I have nowhere said or implied that "cable rates cannot be increased except at the expense of the British public" and my reference to cables being a property 25 years ago surely bears upon "H. C. D.'s" statement in your issue of 6th inst., that "*as soon as*" (my italics) "public confidence had been established, capital for cable enterprise was easily obtainable both in Great Britain, *Europe and America*" (my italics). As I said, I traverse this statement.

I am sure "H. C. D." would not willingly misrepresent my views, but he states that the system of two foreign countries in regard to Protection and State subsidies (for cables) arouses my admiration. I have not expressed admiration, and do not feel any, much preferring the British system, where, as in cables, no duties are imposed against us. I need not labour the point as to raising capital abroad for cables, since at the end of the paragraph "H. C. D." admits that the public there eventually find the money. If it were not so, it is not likely the financiers would find it in the first instance. I know that the British cable industry (which also has been largely subsidised by our Government in some cases) is more prosperous than the foreign cable industry, but he does not meet my statement that there are many reasons for that in addition to Free Trade. I may say I have been familiar for over quarter of a century with Free Trade literature, and reckon myself a more logical Free Trader than "H. C. D.," only I have studied the open book of facts without allowing preconceived opinions or theories to influence me. All my bias is toward Free Trade

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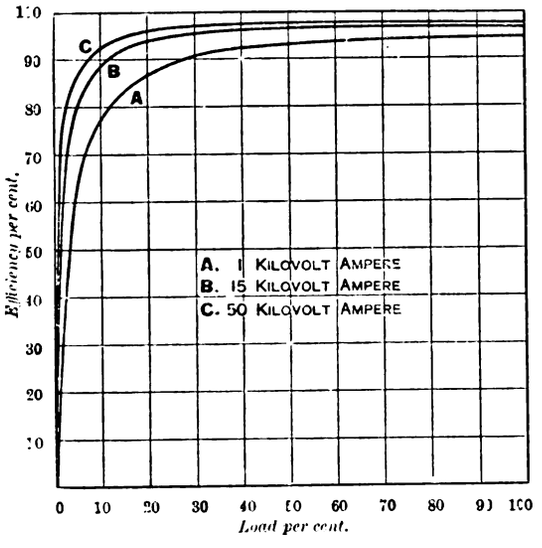
or the nearest approach to it we can now get. My acquaintance with submarine cable matters is also a long one.

The correspondence has, however, become too discursive, and, perhaps, too personal, to be suitable for your columns or interesting to your readers. I propose, therefore, to re-state the controversy a little more accurately than "H. C. D." does in his last paragraph, and there leave it. In an editorial article you, Sir, supported generally Mr. Balfour's views as to retaliation, with special reference to machinery. Mr. Bond wrote in opposition, and "H. C. D." intervened, using the submarine cable industry as an illustration in the discussion. I pointed out that there are no duties on cables sent abroad (Free Trade), while there are duties on machinery exported (Protection), and that we should endeavour to secure a measure of reciprocity on the latter by retaliation. "H. C. D." differs as to the policy proposed. *Voilà tout.*

I apologise for the length of this letter, which is, however, due to the imputation of statements which I never made, and views I have never held.—Yours, &c., G. R. N.

TRANSFORMER EFFICIENCIES.

The British Electric Transformer Co. have sent us the curves below to show that they can do even better with regard to transformer efficiencies than the German firm whose results were published in our issue of November 13th. They inform us that the curves



are in no way exceptional, being taken from their everyday practice. The sharp rise of the curves at light loads, and the high efficiency of the larger sizes, even at less than 10 per cent. of full load, are particularly noticeable, and serve to emphasise the remarks made by Mr. Mordey at the Institution of Electrical Engineers recently with regard to the exaggerated importance often attached to switching off transformers during the day time.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Localisation of Faults in Electric Light and Power Mains, with Chapters on Insulation Testing." By F. Charles Raphael. 2nd edition. (London: "The Electrician" Printing and Publishing Co., Ltd.) 7s. 6d.

"The Depreciation of Factories, Mines and Industrial Undertakings, and their Valuation." By Ewing Mathieson. 3rd edition. (London: E. and F. N. Spon, Ltd.) 7s. 6d. net.

"Calendar of the University College of North Wales," for session 1903-4. (Manchester: J. E. Cornish.)

"Subject List of Works on the Mineral Industries and Allied Sciences in the Library of the Patent Office." (London: The Patent Office.) 6d.

"Engineering Standards Committee: Report on the Influence of Gauge, Length and Section of Test Bar on the Percentage of Elongation." By Prof. W. C. Unwin. (London: Crosby Lockwood & Son.) 2s. 6d.

"Anwendung und Zukunft der Kondensatoren in der Wechelstromtechnik." By W. von Bisicz. (Berlin: Julius Springer.) 2.40m.

"The Practical Electrician's Pocket-book and Diary for 1904." Edited by H. T. Crewe. (S. Rentell & Co., Ltd.). 1s. net.

ROYAL COMMISSION ON LONDON TRAFFIC.

The Royal Commission on London Traffic devoted the whole day on Friday, November 20, to hearing police evidence.

Superintendent COLE, of the E Division of the Metropolitan Police, expressed the opinion that tramway termini should not be placed in narrow streets. In the average street tramways did not cause congestion. He suggested that sidings should be constructed at termini for the cars to change. Other matters which needed attention were the opening of streets by electric light and other companies, and the prohibition of traction engines hauling trucks in main thoroughfares.

Superintendent MANN, C Division, expressed similar views.

Superintendent POWELL, T Division, spoke as to the congestion due to the London United Tramways. Neither King-street, Hammersmith, nor High-street, Brentford, are wide enough for tramways, although he admitted that the advantages to the travelling public of the electric tramways were many. High-street, Brentford, was often blocked by as many as eight or ten cars behind one another, through not being able to pass a tradesman's vehicle. At Shepherd's Bush the terminus was dangerous, and he would prefer to see the loop system in use at King-street adopted there. Kew Bridge terminus was also dangerous on Bank Holidays.

Superintendent NOYISS, L Division, referred to the danger of the tramway termini at Blackfriars and Westminster Bridges, and also, owing to the numerous cars which crossed each other, at the Elephant and Castle.

Superintendent MULVANEY, H Division, also gave evidence.

Thursday, November 26.

Mr. J. H. BROWN, chairman of the Highways committee of the Battersea Borough Council, gave evidence on general matters as representing the London borough councils as a whole. He said there was a great predisposition in favour of the establishment of a special tribunal to deal with the question of London traffic. No detailed investigation had yet been made by his Council into the precise constitution of such a body, but, in the event of such a body being constituted, it should be by complete representation, *i.e.*, that the borough councils should be represented as well as the London County Council. There was also a feeling that if tramways were to be exempted from the jurisdiction of the tribunal, this would not only be unwise in itself, but would be opposed to the very *raison d'etre* of the tribunal. The borough councils considered that they should be endowed with further powers as to the breaking up of streets, and therefore strongly objected to the London County Council usurping their functions as the street authority so long as proof could not be given of any advantage that would accrue therefrom. The Battersea Council also desired the electrification of all the existing tramways in the borough area, and especially the establishment of the proposed line from the "Plough," Clapham, along the north side of Clapham Common to Wandsworth. Another necessary means of communication was the extension of the City and South London Railway from Clapham to the neighbourhood of Battersea Rise.

In answer to the chairman, Witness said that the number of street openings in Battersea had increased by 50 per cent. in one year, and last year totalled over 5,000. He was afraid that this large increase was likely to be a permanent one—at any rate, with regard to telephones.

Sir DAVID BARBOUR: You wish to be represented upon the special tribunal?—Yes.

What is your idea of the constitution of this tribunal?—My idea is that it should be a Government Commission upon the same lines as this one, and that it should act, say, for 10 years.

Would not there be objections to having a large number of members on such a board?—Yes, but the borough councils could be represented by one or two members who would look after the interests of all of them. I maintain that if the London County Council is represented, the borough councils also should be represented.

If the Borough Council wished, after the formation of the special tribunal to help to finance, say, a tube railway in its borough, would it not have to go to the County Council?—Yes, I suppose so.

Does not that go to prove that there should be a close connection between the tribunal and the County Council?—I am afraid I cannot answer that.

Continuing, Witness said that the Battersea Borough Council was perfectly willing to surrender its tramway veto, but not to the London County Council. However, he quite agreed that the County Council should be the tramway authority, as there should be continuity of lines as well as management. All the lines in Battersea were horse tramways in the hands of the London County Council. He put forward a suggestion that the Commission might, or might not, favour the subsidisation of the extension of the City and South London Railway which he had proposed.

Earl CAWDOR: Have you been into the question as to whether the special tribunal should be an executive body to actually carry out schemes, or would you propose that it should merely be a body to consider and report upon the scheme put before it?—We think it should be a body for carrying out schemes, and to act as a referee or superior Court of Appeal between the borough councils and the London County Council.

Have you considered the question of financing any schemes put forward by the tribunal or councils?—No.

Would you propose to have the schemes considered by Parliament afterwards?—No.

Do you think Parliament would be willing to part with its powers in this way?—No doubt Parliament could appoint a Commission which would be sufficiently powerful to carry out the functions of Parliamentary Committees.

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Sir GEORGE TROUT BARTLEY: Has the City and South London Railway Co. refused to carry out the extensions you propose?—We have not asked them to do it.

If it were profitable, do you not think the company would do it?—Yes.

Then why has nothing been done?—I cannot say.

Mr. GIBB: Would you give the tribunal absolute power?—Yes, and opponents should be allowed to appear before it.

Mr. H. G. HILLS, town clerk to the Wandsworth Borough Council, supported the views of the last witness as to the retention of the powers of the borough councils as to the highways. He thought all street openings could be made by the workmen of the local authority, in preference to the companies themselves. The local authorities always had the men and tools at hand, and knew the best time for making such excavations. The abolition of the local authority tramway veto was strongly objected to for reasons which had already been stated. With respect to the Borough of Wandsworth, the Borough Council suggested that the City and South London Railway should be continued from Clapham to Tooting; from Clapham to Clapham Junction, East Hill and Southfields, and from Kennington through Brixton to Streatham Common. It was also the opinion of the Council that direct communication was greatly needed between Clapham Junction and the north of London. The following electric tramways were also deemed necessary:—From Clapham to the Borough, via Battersea Rise; from Streatham to Wandsworth, via Tooting Bec Common; and from High-street, Putney, to Wandsworth High-street, via Putney Bridge-road. Finally, all local schemes of communication should be referred to a central authority, so as to maintain a continuity of the systems to the centre of London, and also to avoid overlapping. This tribunal should be appointed by the Government.

By the CHAIRMAN: The power of veto in respect of tramways had frequently been of great advantage to the borough and had not caused any injustice. It had saved the expenditure of large sums in Parliamentary proceedings. But for this power of veto, the borough council would be frequently engaged in opposing tramway bills in Parliament. He considered that both as to the routes and the period of construction of tramways, the local council knew its requirements best. He did not think his Council would agree to surrender its veto to a special tribunal. In fact, he did not consider the veto in its present condition was absolute, which he desired it to be. With regard to the suggested extensions of the City and South London Railway, he did not mean to say that the Borough Council should give financial support to these. Representations had been made to the company, and it really resolved itself into the company deciding whether it was worth its while to make the extensions. His suggestions were merely academic. Probably it would be here that the tribunal would have considerable influence by pointing out to the companies the directions in which extensions would be useful.

Mr. A. B. BRYCESON, town clerk of Woolwich, agreed with the previous evidence as to the desirability of the retention of the local veto in tramway matters. In Woolwich, as a matter of fact, this right had never been enforced, and he had never heard of any abuse of this privilege.

The Commission adjourned until to-day (Friday).

LEGAL INTELLIGENCE.

Re Electrical Publishing Co. (Ltd.).

A petition presented by Mr. T. W. Sheffield, electrical engineer, Trevelyan-buildings, Corporation-street, Manchester, for the compulsory winding-up of the Electrical Publishing Co. (Ltd.), was heard by Mr. Justice Buckley on Tuesday, on a contributory's petition.

Mr. ASTBURY, K.C., for the petitioner, stated that the circumstances, according to the petition, were that the company was formed in July, 1902, for the purpose of carrying on the business of publishing an electrical review. The capital was £14,500, of which £8,800 had been allotted. A portion was paid up and a portion allotted with 50 per cent. paid. The objects of the company included the carrying out of an agreement with Mr. Theodore Feilden, who was to be editor and publisher of the magazine. Mr. Feilden was appointed life director, manager and editor of the publication for a consideration of 5,500 ordinary and 1,000 preference shares and remuneration for his services at the rate of £6 per week from the date of the registration of the company up to the date of publication, with travelling expenses in London of 10s. 6d. a day, and in the provinces of £2. 2s. a day. Petitioner complained that Mr. Feilden had nothing to sell, and it had turned out that there was no publication and no preparation for any publication. Mr. Feilden had been going on ever since drawing moneys from the company, and now, after great pressure had been brought to bear, he suggested that he might publish this magazine early next year, but nothing had been done, and petitioner alleged that the company was simply a company for putting this monthly or weekly sum into Mr. Feilden's pocket. Para. 6 of the petition said the company went to allotment in June, 1902, and at the date of the balance-sheet, in June, 1903, 9,000 ordinary and 2,200 preference shares, including the vendor's, had been issued, and £2,249 paid up in respect of them. Mr. Feilden had continued to draw his salary and expenses, £1,350. 2s. 7d. having been expended on manager's salary, office expenses, furnishing, &c., leaving a balance in the bank of £1,012. 17s. 7d. The prospectus originally issued stated that the maturing of Mr. Feilden's project had been the result of much careful thought, but he (Mr. Astbury) would remark that they now knew there was no magazine. The prospectus went on to say there were technical details of the magazine which it would be impolitic to divulge, but that leading authorities had declared the publication to be virtually unique, and so on. Upon the faith of these statements petitioner had applied for and been allotted 100 shares, on which he had paid £50. The petitioner in 1902 urged Mr. Feilden to publish the magazine, and in April, 1902, paragraphs appeared commenting unfavourably upon the delay in the production of the magazine and complaining that Mr. Feilden was working for his own interests and not those of the shareholders. The petitioner called Mr. Feilden's attention to this, and Mr. Feilden said he would take proceedings for libel, but he had not done so. Up to the present time the magazine had not been published, and there was no prospect of it ever being published, although Mr. Feilden had produced a few copies of a dummy magazine. If the whole of the authorised capital were subscribed and called up it would be inadequate for producing the magazine and maintaining it for 12 months, and Mr. Feilden (counsel contended), with his experience as a printer and journalist, must have been aware of this at the time the company went to allotment. The only asset was the name of the "Electrical Magazine." There could not be a copyright in a name, and, moreover, there was another magazine on the register of the same name. In addition to the petitioning creditor, he was supported by other shareholders holding 541 shares.

In answer to the Judge, Mr. ASTBURY said the vendor had £6,500 in shares, and the total amount allotted was £11,354.

The petition was opposed on behalf of 58 shareholders besides Mr. Feilden, and Mr. BUCKMASTER, K.C., said the petitioner had circularised the shareholders, and had only secured the support of a few.

The JUDGE said: If we assume Mr. Feilden is to blame (I am not saying he is), he holds 6,500 shares, and supposing a meeting should be convened to consider the question whether there should be a voluntary winding up it would be useless. The petitioner represented a minority only of the shareholders.

Mr. ASTBURY said if he went into details he could say a good many things about this company which were unsatisfactory, but as his lordship took the view he had expressed he would not waste time.

The petition was then dismissed.

[We desire to say that the Electrical Publishing Co. (Ltd.), referred to in the above report, has no connection or association whatever with "The Electrician" Printing and Publishing Co. (Ltd.), sole proprietors of *The Electrician*.]

Post Office Telephone Poles.

At a special sitting at Kingston-on-Thames on Friday Judge Russell heard an application by the Postmaster-General to compel the Urban District Council of Wimbledon to consent to the erection of telephone poles and wires in certain parts of Wimbledon.

Sir ROBERT HUNTER, for the Postmaster-General, said the authority of the Court was sought for the construction of three small lines of telephone wires and posts. Application for consent was made to Wimbledon Council on Aug. 27 but this was refused unless the lines were laid underground in some parts and ornamental iron poles were erected in others. This the Postmaster-General was unable to agree to, on the ground of the great expense that would be entailed. The matter came before this Court for decision.

Mr. MARTIN ROBERTS, assistant engineer-in-chief to the Post Office, said that in connection with the Post Office telephone exchange at Wimbledon they had 213 subscribers and 32 others awaiting connection. The Postmaster-General had already spent about £1,250,000 in establishing a telephone system in London. If they were compelled to lay wires underground, it would be impossible to make the service pay. The introduction of a cheap telephone rate had stimulated the use of the telephone.

Mr. BUTTERWORTH, for the Council, said the character of some of the roads where these lines were to be erected was such that they should be carried underground, and as to the other roads iron poles would be much more acceptable to the inhabitants than unsightly wooden ones.

Judge RUSSELL said in regard to some of the roads referred to the proposal of the Postmaster-General to erect iron poles there instead of underground wires he considered a proper one. As to the other roads, he did not think that painted wooden poles would interfere with the æsthetic character of the neighbourhood, and he thought the proposals of the Post Office were fair. He declined to allow costs.

Workmen's Compensation.

At Oldham County Court last week Judge Bradbury resumed the consideration of the claim of Mrs. Mary Andrew for damages from the Failsworth Industrial Co-operative Society for the loss of her husband, who was struck by lightning whilst at work and killed on Aug. 14. The facts were reported in our issue of 30th ult., when the case was adjourned for scientific evidence.

JAMES APPLEYARD, fire beater at the Hope Spinning Co., said that just before the storm on Aug. 14, while at work, his attention was called to the clouds by the engineer. The clouds were coming from the north-west and south-east, and they met directly above the building where the fatalities occurred, and burst into a flash of lightning. The point of contact was just over the building. At the time the clouds met he was about 200yds. away from defendants' building.

Mr. ELLIOTT (for defendants): Who asked you to come and give evidence?—The claimant. As soon as she mentioned the matter I remembered all about these clouds coming from opposite directions. I had a conversation with the engineer about it at the time, and he specially drew my attention to the clouds.

Dr. GARRARD, head of the testing and experimental department of Ferranti Limited, said he had studied electricity for about 10 years. He had heard all the circumstances under which Andrew met his death. He understood that the man was working 25ft. from the ground,

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that he was working in an exposed position on the scaffold, and that some of the girders in the body of the building were exposed. He considered, taking all those facts into regard, the man was in an exposed position. There would be a good connection with the earth when wet. He was elevated a certain distance above the ground, and he would constitute a point to which a flash of lightning would be attracted on its way to the earth. A man working on an elevated scaffold runs an appreciably greater risk of being killed by lightning. There was a zone of immunity to a person in the street according to the slant of the roof. Andrew was working on a scaffold 23ft. high, and there was a chimney at the gable end of the row of cottages near where deceased was working. The chimney was 35ft. high.

Mr. ELLIOTT: The chimney being 12ft. higher than the scaffold, or, I would put it, only 7ft. higher than the men who were working on the scaffold, ought not that chimney to have afforded protection for a space of 7ft. all round? That being so, are you not surprised that the lightning did not strike the chimney top?—No; it would be just about the limit.

Mr. J. M. FAULKNER, Strangeways, erector of lightning conductors and an electrician, said that as soon as he heard of a lightning fatility he, whenever he could, visited the spot with a view to seeing the effects and to endeavour to discover a cause and remedy. He had seen the position of the man Andrews at the time of his death, and his opinion was that he would constitute the line of least resistance to earth for the lightning. He considered the dangerous factor was the moist condition of the brickwork.

Mr. ELLIOTT said that his Honour had adjourned the case on the previous hearing to enable Mr. Fripp (for the claimant) to bring expert evidence as to whether the girders in the building increased the risk.

Judge BRADBURY: No, I adjourned the case to see if I could get any assistance from experts as to whether this man was working in a more dangerous position by reason of his being where he was. It is obvious that under normal circumstances a man may be struck by lightning. That is a risk which everybody is open to. Beyond that normal risk there may be, under certain conditions, an abnormal risk, that is, an increased risk, owing to a person's position at the moment. It was alleged that this was one of those cases. I did not feel sufficiently gratified to decide the point without expert assistance.

Mr. ELLIOTT said that all the evidence came to was that Andrews was exposed at a certain height, and that anyone else who might be exposed to a similar height, not necessarily on a building or doing the same kind of work, would run similar risks. It was admitted that thisman was killed by a flash of lightning. Then the question for his Honour to decide is whether death was caused by accident. He understood his Honour had already decided that being struck by lightning was an accident. He, therefore, submitted that, first of all, this was an accident. An accident was some fortuitous or unforseen event without design. In a case like this there must be some design. It was the design of Providence, a design concealed from men. It was for plaintiff to prove that the accident arose out of the man's employment. There must be something materially connected with the employment of the man which must in some way cause the accident. But in this case it was the lightning and not the man's employment. The lightning might have killed the man even if he had been in the street. As a matter of fact it did strike a man on the ground floor. He asked the judge to say that Andrew's death did not arise out of his employment, but from something entirely outside it, which was never contemplated either by the employer or the employé.

Judge BRADBURY, in giving judgment, said the question was, did the accident arise out of this man's employment? It no doubt arose in the course of his employment. It seemed to him to be not a question of law but of fact, and in such a case the judge had to consider the facts, and say, as a question of fact, did it arise out of the man's employment. The words "arising out of his employment" might be looked at in two ways. It had been contended that it must arise out of the work which the man was actually doing; if there was no connection between the work and the accident then it did not arise out of the employment. He agreed with that view. Although it might not be connected with or have any relation to the work the man was doing, yet, in point of fact, the position in which the man was doing the work, the place which he must necessarily occupy whilst doing that work, if it was a position of danger, had to be taken into consideration, and then it might be fairly said that the accident arose out of his employment, not because of the work he was doing, but because of the dangerous position in which he was working. If he came to the conclusion that the position in which the man was working was a dangerous one, and in consequence of that this accident occurred, he could fairly hold that it arose out of his employment. Was it a dangerous position? Was the man exposed to something more than normal or ordinary risk, if there was such a thing as normal or ordinary risk—something more risky than what everybody, so to speak, incurred in any place or time during a thunderstorm? They knew that lightning was erratic, and that no circumstances could afford safety on occasions. It had been urged by counsel that a man was struck on the ground floor of the building, but if beyond that normal risk which everybody must run, if in the particular circumstances of a particular vocation there was something appreciably and substantially beyond that risk, which ordinary persons had to face, and which was necessarily concomitant with the occupation which the man was engaged in, he (the judge) thought he was entitled to say that the extra risk and danger to which a man was exposed was something arising out of his employment. As a result of the evidence, especially that of Dr. Garrard, he found that the accident arose out of the man's employment, and he therefore gave judgment for plaintiff for £300 and costs.

Mr. Elliott's application for a stay of execution was granted, £1 per week to be paid to the widow until the appeal was heard.

Knight v. Isle of Wight Electric Light and Power Co. (Ltd.)

This case came before Mr. Justice Joyce on Wednesday and Thursday, an action brought by plaintiff, who carries on at Ryde a school for ladies, to restrain defendants from interfering with the enjoyment of her property by reason of noise, smells and vibration from defendants' works, which adjoined her premises. The defence was a general denial of the alleged nuisances, and the defendants further said that the works they had carried out were works authorised by Provisional Order, and that such temporary annoyance as might have been caused by the erection and starting of the work was speedily abated.

The hearing had not concluded when we went to press.

Re B. Bridgwater & Co. (Ltd.).

A petition by Messrs. Pfeil & Co. for the compulsory winding-up of this company was ordered by Mr. Justice Buckley on Tuesday to stand over for a week.

ELECTRIC LIGHTING, POWER AND TRACTION NOTICES.

Electric Lighting Notices.

The following notices of intention to apply for provisional electric lighting orders have been given:—

CORPORATIONS.—Birkenhead (extension of area to Prenton and Upton), Chippenham, Devizes, Huddersfield (extension to Golcar), Lichfield (to amend 1901 order by extending time and also area of supply to Whittington, Shenstone, &c.), Saffron Walden, Widnes (to amend 1901 order by extending time and authorising transfer of powers).

URBAN DISTRICT COUNCILS.—Brentwood, Brynmawr, Gainsborough, Heysham, Kirkby-in-Ashfield, Malden and Coombe, Mansfield Woodhouse, Melksham, Southgate, Sutton-in-Ashfield, Thornbury and Watford (to extend area of supply).

RURAL DISTRICT COUNCIL.—Bath.

COMPANIES.—Ashford Electric Supply Co. (for Ashford), County of Durham Electrical Power Distribution Co. (for Southwick and the rural districts of Sunderland and Houghton-le-Spring), County of Surrey Electrical Power Distribution Co. (for Epson Rural District, Cheam, Cuddington and Ewell), Empire Electric Light and Power Co. (for Acton, Brentford, Brentwood, and Wanstead), Gloucester Electric Power Co. (for Stroud, Nailsworth and Dursley), Keynsham Electric Light and Power Co. (for Keynsham), Metropolitan Electric Supply Co. (for Acton), Milford-on-Sea Electric Supply Co. (for Milford-on-Sea), Ramsgate and District Electric Supply Co. (for Ramsgate and district), Shropshire and Worcestershire Electric Light and Power Co. (for Bromsgrove and Stourbridge, &c.), Shropshire and Worcestershire Electric Light and Power Co. (for Bridgnorth and Wenlock, Oakengates and Dawlep, &c.), Twickenham and Teddington Electric Supply Co. (for Hampton Wick and district), Twickenham and Teddington Electric Supply Co. (for Maldens, Coombe and Ham), Urban Electric Supply Co. (for Walton-on-Thames), Urban Electric Supply Co. (for Newton Abbot, extension), Western Electric Distributing Corporation (for Trowbridge and Bradford-on-Avon, urban and rural), Western Electric Distributing Corporation (for Clevedon, Portishead and Long Ashton), Messrs. M. H. Bennett and R. C. Quin (for Horley), and Messrs. H. Foote, L. Milne and E. J. Owen (Southern District Electricity Corporation, for Ely), and the same promoters (for Newquay).

In the following cases clauses for electric lighting powers are to be inserted in bills which will be promoted next session:—

Shipley Urban District Council, to extend area of supply to Baildon, to confer further powers in regard to Council's electricity undertaking, to borrow money for electricity or other undertakings, &c.

Leicestershire and Warwick Electric Power Co., to extend periods limited by 1902 act, to remove restrictions as to erection of generating stations, to acquire provisional orders and electricity undertakings, to pay interest or dividends on shares or stock during construction of works, &c.

Lancashire Electric Power Co., to authorise erection of generating stations on lands other than those specified in 1900 act, to extend time, to acquire provisional orders from other undertakers, to pay interest out of capital, &c.

Derbyshire and Nottinghamshire Electric Power Co., to acquire from undertakers provisional electric lighting orders and to apply for and carry into effect such orders, to authorise alteration of capital and increase of borrowing powers, to pay interest out of, and commissions on, issue of capital, to subscribe to capital issue of and to lend moneys to other companies, &c.

A bill is being promoted to incorporate a company for erecting electricity generating stations and supplying electricity in parts of the counties of London and Essex, and in the county borough of West Ham, &c.

Doncaster Corporation, to extend area of electricity supply to portions of rural district.

Electric Traction Notices.

Tramway provisional orders are to be applied for by the following:

CORPORATIONS.—Brighton (for extensions of electric tramways, &c.), Dewsbury, Folkestone, Liverpool (for extensions), Ossett, and Sunderland (for extension of electric tramways, &c.).

URBAN DISTRICT COUNCILS.—Altrincham (for construction of electric tramways, to enter into agreements for supply of electrical energy, &c.), Calverley, Wardle.

COMPANIES.—A company is applying for a provisional order to construct electric tramways between Cardiff, Penarth and Dinas Powis.

United Kingdom Tramway, Light Railway and Electrical Syndicate, Ltd. (for Bishop Auckland, Shildon and Spennymoor).

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In the following cases bills are being promoted :—

London County Council, for powers to construct new and reconstruct existing tramways in various metropolitan boroughs, to work the new and reconstructed tramways by electric traction, for incorporation of provisions of the London County Tramways (Electrical Power) Act, 1900 ; running powers over Bexley tramways, to acquire so much of the Bexley line as is situate in parish of Plumstead, &c.

Bournemouth Corporation, to construct tramways and tramroads, to extend time for construction of authorised tramways, to run omnibuses within and beyond borough, to enter into agreement with Christchurch Corporation for working tramways, &c.

Newcastle-upon-Tyne Corporation, to construct and work electric tramways within and beyond city boundary, to attach brackets, &c., to buildings, to enter into contracts for construction, working and maintenance of tramways, &c., to use electricity generating station for any purpose of the Corporation, &c.

East Ham District Council, to revive and amend powers to construct tramways authorised by Council's tramway orders 1898 and 1900.

Croydon Rural District Council, for construction of electric tramways in Coulsdon and Beddington.

Baker Street and Waterloo Railway Co., to acquire additional lands enlarge tunnels for station purposes, further capital powers, &c.

Bristol Tramways and Carriage Co., to construct additional electric tramways, to vary time of purchase by local authority, &c.

Charing Cross, Euston and Hampstead Railway Co., to alter authorised railways of the company, for additional capital, for powers to pay interest out of capital, &c.

Great Northern and City Railway Co., to extend time, &c.

Harrow Road and Paddington Tramways Co., to acquire lands, &c, to enter into agreements with local authorities and others, to transfer undertaking to Metropolitan Electric Tramways (Ltd.), &c.

Imperial Tramways Co., to construct new tramways in North Riding of Yorkshire, &c.

London United Tramways (1901), Ltd., to construct new electric tramways in Middlesex, Bucks. and Surrey, to extend time for completion of authorised tramways, to enter into agreements with local authorities and railway companies as to through booking, &c.

London United Tramways (1901), Ltd., also seek powers to construct railways to connect underground with the Hammersmith station of the Metropolitan District Railway Co., to enter into agreements for supply of electrical energy, to empower company and Metropolitan District Railway Co., or any other railway company having stations on or near to any of the company's tramways or railways, or any company or person owning or working tramways in London, Middlesex and Surrey, to enter into agreements for interchange of traffic, &c.

London, Camberwell and Dulwich Tramways Co., to adapt lines for electric traction, to enter into agreements for the supply of electric energy, to amend powers of purchase by local authorities and to enter into working and other agreements, &c.

Metropolitan Railway Co., to revive powers and extend time for compulsory purchase of lands and completion of works authorised by 1899 Act, &c. ; to convert and consolidate the different classes of shares and stock (including debenture stock) into stock, to re-arrange capital, to raise additional capital, &c.

Metropolitan District Railway Co., to extend time for purchase of lands and completion of authorised works, &c., to adopt uniform or zone rates, &c.

North Staffordshire Railway Co., to work railways and canal by electricity, to provide electric or other tugs for haulage on their canal from the Trent to the Mersey, &c.

Preston, Chorley and Horwich Tramways Co., to construct new electric tramways, to abandon portion of authorised tramways, &c.

Saddleworth and Springhead Tramways Co., to abandon undertaking and to dissolve company.

Southport and Lytham Tramroads Co., for extension of time and to extend Southport Corporation tramways, capital powers, &c.

A bill is being promoted to incorporate the Trafford Park Dock and Railway Co., to acquire undertaking of West Manchester Light Railway Co., to construct electric tramroads, &c., to acquire running powers over the tramways of Stretford District Council, Salford Corporation, &c.

Tyneside Tramways and Tramroads Co., for running powers over Newcastle Corporation tramways and to effect junctions therewith, to make provisions as to through booking, &c.

Watford and District Tramways Co., to extend time for constructing tramways authorised by the company's 1901 act, &c.

West Metropolitan Railway Co, to abandon undertaking authorised by West Metropolitan Railway Act, 1899.

It is proposed to promote a bill to incorporate a company to construct an underground electric railway between North and South Woolwich, to authorise agreements with regard to supply of electricity, &c.

Power is sought to incorporate a company to construct and work electric tramways from Preston to Blackburn, to enter into agreements with local authorities, &c., to erect electricity generating stations, &c.

Combined Lighting, Power and Traction Notices.

In the following cases powers for electricity supply, electric tramways, &c., are being sought :—

Barrow-in-Furness Corporation, to construct electric tramways and tramroads, to supply electricity for traction, &c.

Bristol Corporation, to extend borough boundaries and to extend to all the tramways of the Bristol Tramways and Carriage Co. authorised and constructed within area provisions of sec. 55 of Bristol Tramways Extension Act, 1898, with respect to purchase, to transfer to Corporation powers of Barton Regis Electric Lighting Order (1902), to extend the period for laying distributing mains, &c.

Bexhill Corporation, to extend powers of electric supply, to lay down electric works in, and break up streets not dedicated to, public use, to refuse supply to persons in debt to Council, to allow discounts, to provide, sell, let for hire and fix lamps, fittings, meters, motors, &c., to make provision for securing safety of consumers' premises, to alter and amend terms of Bexhill Electric Lighting Order, 1897, as regards right of consumers to demand supply of electricity, and to make further provision as to accounts of undertaking, &c.

Carlisle Corporation, to extend area of electricity supply, to supply electrical energy to local authorities and companies beyond city boundary, to fix conditions of demand for supply of electric energy when separate supply exists, to refuse supply in certain cases, to provide, sell, or let on hire and deal in, electric motors and apparatus, to exempt apparatus let on hire from distress or execution, to allow discounts, to alter date for filing accounts, &c.

Chesterfield Corporation, to construct and work electric tramways, to purchase, sell and let on hire electric motors, dynamos, fittings, &c., to exempt same from distress or execution, to authorise Corporation to do any works that may be required on premises of consumers of electric energy, to make special conditions as to supply where consumers have independent plants, to authorise refusal of supply in certain cases, to allow discounts, to make special provision as to the use for lighting of energy supplied for power, &c., to attach brackets, &c., for lighting or tramways to buildings, to extend area of electricity supply, to supply electric energy to local authorities of districts where tramways are authorised, or (with consent of authority) to private consumers, to extend powers to extended area of supply, to borrow money, &c.

Leeds Corporation, to repeal all or some of local acts or orders (confirmed by Acts of Parliament) now in force within or with respect to city of Leeds, including tramways orders of 1898, 1902 and 1903, the electric lighting orders 1898 and 1901, and the tramways order relating to Horsforth of 1903, to empower Corporation to appoint committees and to delegate their powers and duties, &c., to provide for continuance of existing tramway undertaking and to construct and complete tramways, to make provision for maintenance and improvement of electricity supply works, to acquire land for generating station, &c. In another bill promoted by Leeds Corporation in regard to their waterworks, power is sought to lay telephonic mains on roads and highways.

Manchester Corporation, to construct additional tramways, to relay and reconstruct existing lines, &c., to work or lease tramways within and beyond borough, to extend period for construction of certain authorised tramways, to exercise running powers over and to form junctions with any tramways or light railways which can be worked in connection with Manchester Corporation tramways and to convey and deliver passengers, animals, minerals, parcels, &c., to authorise agreements with regard to working of lines, supply of rolling stock, electrical energy, &c., and to confirm and carry into effect any agreement entered into before passing of act between Corporation and Ashton-under-Lyne Corporation and the Urban District Councils of Withington and Altrincham, to empower Corporation to supply electrical energy to local authorities and companies, to accept transfers of or acquire electricity undertakings in adjoining or neighbouring districts, and to supply electrical energy within such districts, to authorise agreements for supply of electrical energy for traction, power or lighting, to make special provision in regard to premises having separate supply and to make other provisions in regard to electricity undertaking, to empower the Corporation to borrow or raise money, &c. In another bill further powers in regard to electricity sub-station at All Saints, Oxford-street, and to authorise certain agreements, &c., are sought.

Rotherham Corporation, to construct new tramways, to authorise proceedings against persons robbing prepayment meter boxes, to authorise Corporation to supply electricity in bulk to neighbouring authorities, to fix conditions of demand where separate supply exists, to authorise Corporation to provide, sell and let on hire meters, fittings and apparatus for lighting and power and to undertake wiring of premises, to exempt from distress or execution electric fittings, &c., let on hire, to allow discounts, to alter date of making up annual accounts, to lay pipes in streets not dedicated to public use, &c.

Swindon Corporation, to extend area of electricity supply, to supply electricity in bulk to neighbouring authorities, to make special terms where consumer has independent supply, to enable Council to refuse supply in certain cases, to manufacture, sell and let for hire motors, fittings and apparatus for lighting and power, to exempt apparatus and fittings let on hire from distress or execution, to allow discounts and to alter date for filing annual accounts, &c., to extend time for completion of tramways authorised by Swindon Corporation Tramways Order, 1901, to run omnibuses and motor cars, to postpone payments of sinking fund for tramways and electricity supply, &c.

Tynemouth Corporation, to alter date of filing annual statement of accounts of electricity undertaking, &c.

Wolverhampton Corporation, to construct electric tramways in Heath Town and Wednesfield, to enter into agreements as to construction and maintenance of tramways, to run omnibuses within and beyond borough, to empower Corporation to supply electric energy in bulk to local authorities and others outside borough, to accept transfer of electric lighting undertaking in, and to supply electricity within adjoining districts, to make conditions as to supply of electric energy to premises having separate supply, to refuse supply in certain cases, &c.

Acton Urban District Council, to authorise Council to attach brackets to buildings for lighting, to supply electrical energy outside district, to sell, let on hire and fix lamps, meters, electric fittings, &c., for lighting and power, to provide that consumers of electrical energy give notice to Council before removing, to sanction refusal of supply in certain cases, to allow discounts, to alter date for filing accounts, &c.

Ilford Urban District Council, to enter into agreement for supply of electrical energy, to allow discounts, to refuse supply in certain cases, to supply electric fittings, &c., on hire, and to exempt same from distress, to

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alter date for filing accounts, to require consumers to give notice before removing, to make special provision where consumers have separate supply, &c.

Kettering Urban District Council, to supply electricity in bulk to local authorities or company authorised to supply or use electricity in any adjoining district, to supply electric motors, fittings, &c., on hire and to exempt same from distress, to make and enforce bye-laws for wiring, &c., to alter date for making up electric lighting accounts, to allow discounts, to exempt Council from compulsory supply in certain cases, to require consumers to give notice to Council before removing, to attach brackets to buildings, &c., to extend scope of sec. 176 of Public Health Act, 1875, so as to include purchase of land and buildings for electric lighting, &c.

Leyton Urban District Council, to construct and work electric tramways, &c., to acquire part of tramway of Lea Bridge, Leyton and Walthamstow Tramway Co., to run omnibuses, &c., to attach brackets and wires to buildings, for lighting and traction, to amend Electric Lighting Acts of 1882 and 1888, and the Electric Lighting Orders Confirmation (No. 2) Act, 1894, to restrict placing of electric lines or wires above ground or across streets, to supply electric energy to local authorities in adjacent district for traction, &c., to purchase, sell, let, deal in and fix and repair electric wires, fittings, lamps, motors, &c., to exempt fittings, &c., let on hire from distress or execution, to borrow money, &c., to make bye-laws with respect to wires and fittings in premises, to make provision as to supply of electricity where consumer has separate supply, to require consumers before leaving premises to give notice, and to impose penalties for default; to authorise Council to refuse supply to persons whose payments for electric energy are in arrear (whether such payments be due in respect of same or other premises), to allow discounts, to alter date for filing accounts, &c., to authorise Council and any local authority or person authorised to supply electric energy to enter into agreements, &c., to authorise Council (with consent of Wanstead Council) to supply electrical energy in Wanstead, to provide and work omnibuses and motor cars in connection with tramways, &c., to borrow money, &c., and to charge moneys so borrowed (and interest) upon security of whole or any part of revenues of Council arising from electricity or other undertakings for time being, and on any funds and rates established and leviable by the Council and by the issue of bills, and to empower Council to apply any of their funds to any of the purposes of the intended act, &c.

Llanelly Urban District Council are promoting a bill to confirm and sanction agreement of Dec. 4, 1899, with British Insulated Wire Co. (Ltd.) for transfer of Council's electric lighting powers to company (or to Llanelly and District Electric Lighting and Traction Co.), to amend Llanelly and District Light Railway Order, 1902, by extending the time for commencement and completion of lines, to acquire undertaking of Llanelly Tramways Co. (Ltd.), and to transfer same to British Insulated and Helsby Cables (Ltd.), to confer upon Council or company (or other transferee of the electric lighting powers) further powers with regard to their electrical undertaking, to supply electricity for traction beyond district; to provide, sell and let on hire and fix lamps, motors, electric fittings, &c.; to attach brackets, &c., to buildings; to provide that all consumers of electrical energy for lighting give notice to Council (or transferees of powers) before removing, to enable them to refuse supply in certain cases, to allow discounts, to alter date for filing annual accounts, &c.

Radcliffe Urban District Council, to revive powers of Council's 1900 tramway order, to confirm agreement with Bury Corporation, to construct new tramways, to supply electricity in and beyond the district for lighting, power, &c., to supply electric fittings and to make provision for free wiring of houses in district, to alter date of filing accounts of electricity undertaking, to allow discounts, to refuse supply in certain cases, to make special provision where consumer has separate supply, to authorise Council to consolidate and to fix equated periods for repayment of their loans and for the use of stock, &c.

Skipton Urban District Council, to supply electric fittings, to make and enforce regulations for securing safety in regard to wiring, &c., to alter date for filing accounts of electricity department, to allow discounts, to exempt Council from liability to supply in certain cases, &c.

Soothill Nether Urban District Council, to construct and work or lease electric tramways, to authorise Dewsbury Corporation to construct tramways, to erect and maintain electricity and refuse destructor works, to supply electricity within and beyond area of Soothill Nether Council, to purchase, sell, let on hire, or deal in and fix electric motors, fittings, &c., and to exclude same from distress or execution, to allow discounts, to make bye-laws with respect to electrical wirings, to exempt Council from liability to supply in certain cases, to confer further borrowing powers for electricity supply and traction purposes, &c.

Stratford Urban District Council, to construct and work additional electric tramways, to obtain running powers over tramways of Manchester Corporation and to enter into agreements with that body to run omnibuses, to supply electricity outside district, to grant special terms for supply of electricity in quantities, to wire consumers' premises, to grant wayleaves for wires, cables, &c., to acquire undertaking of West Manchester Light Railway Co., &c.

Wallasey Urban District Council, to construct and work tramways, to own and run omnibuses, to exempt electric fittings let on hire from distress, to supply electricity in bulk for railways or tramways outside the district, to make special provisions in regard to supply of electric energy to premises having separate supply, to attach brackets to buildings, to allow discounts, to refuse supply in certain cases, &c.

Empire Electric Light and Power Co. seek power to construct electric tramways in Romford and Hornchurch, to enter into agreements with Romford Council and other local authorities as to supply of electricity, &c.

Miscellaneous.

UNIVERSITIES.—A bill will be presented for incorporating Owens College, Manchester, with the Victoria University of Manchester, and for the transfer of property, rights and powers of Owens College to the Victoria University of Manchester, &c.

A bill is also being promoted to merge Yorkshire College, Leeds, in the Victoria University of Yorkshire, and to transfer the property, powers and liabilities of the college to the new university, &c.

COMPANIES.—In the bill of the Blyth and Cowpen Gas Co., power is sought to enable company to manufacture, sell, let on hire and deal in engines, dynamos, motors, meters, &c.

Aylesbury Gas Co., Hampton-in-Arden Gas Co., Corbridge Gas and Light Co. and Barnard Castle Gas Lighting Co., seek powers to enable them to make application for powers to supply electric energy, &c.

Power is sought to incorporate a company to supply gas in Withnell and also to enable it to apply for powers to produce and supply electricity, &c.

In the bill of the Crystal Palace District Gas Co. it is proposed to insert a clause to make further provision for protecting company's mains from injury resulting from electrolytic action, &c.

A simular clause is to be inserted in the Barnet District Gas and Water Co.'s Bill.

In the Milwr and District Mines Drainage Bill power is sought to enable company to construct tramways or railways in or through any of their tunnels or levels, to generate and supply electric energy, hydraulic power, &c.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Sheffield Corporation desire applications for the post of general manager to take the control and management of the working of their tramways. Applications to the town clerk (Mr. Henry Sayer) Town Hall, Sheffield, by noon Dec. 1. See also advertisement.

The Sanitary Commissioners of Gibraltar require an assistant electrical engineer. Salary £200, increasing by annual increments of £10 to £250 per annum. Applications by Dec. 16 to Mr. William Wallace Copland, secretary and engineer, Sanitary Commissioners' office, Gibraltar. See also advertisement.

An assistant for sub-station and outside work is required by Walsall electricity department. Applications to borough electrical engineer (Mr. Alex. Wyllie), Wolverhampton-street, Walsall. See advertisement.

A chief clerk is required for Ashton-under-Lyne Corporation tramways department. Applications by Dec. 7.

An under foreman is wanted to take charge of electric repair shop, comprising armature winding, bench and machine work. Applications to Messrs. Harland and Wolff, Belfast.

Sunderland Corporation received a large number of applications for the position of general manager of their municipal tramways and the following were selected for interview by the Tramways committee:—Messrs. Luntley (Wolverhampton), Whitehead (Coventry), Dayson (Sunderland), Brindley (Rochdale), Slattery (Blackpool) and Coutts (Ayr). Yesterday (Thursday) Mr. Dayson, who is assistant manager at Sunderland, was selected for the position.

Mr. T. Percival Pask has been appointed assistant electrical engineer of the Natal Government Railways, the appointment dating from Oct. 1.

Mr. H. A. Brimelow of Bolton has been appointed assistant electrical engineer at Oldham, Mr. S. H. Rhodes, who was recently selected for the appointment, having withdrawn.

Mr. W. H. Alabaster, of Salford electricity works, has been appointed assistant electrical engineer to the Corporation of Melbourne, Victoria.

Mr. W. J. Crawford, B.Sc., Glasgow, has been appointed lecturer in engineering at the Technical Institute, Rotherham.

Leek District Council have appointed Mr. Robert M. Carr of Maidstone resident electrical engineer.

Archangel (Russia).—There was, some time back, a proposal to establish an electric tramway service in this town, but, due to the recent failure of an omnibus service, and the competition of steamers which ply between the port and the town, this scheme has, for the present, been abandoned. A proposal to light the more populous part of the town by electricity was to have been put in hand this year, but this project has been postponed. A few electrically lighted street lamps have been set up by private persons.

Arc Lamp Litigation.—We have received the following from Arc Lamps Limited in reference to the report of the proceedings before Mr. Justice Kekewich which appeared in our last issue.

JANDUS ARC LAMP AND ELECTRIC CO. (LTD.) *v.* ARC LAMPS LIMITED.

The trial of the above action, which the Jandus Company have widely advertised as brought against us for infringement of their patents, has been postponed solely on their application. We were fully prepared, and expected that the case would have come on for trial last week; this would have been so but for the application made to Mr. Justice Kekewich on the 18th inst., when counsel on behalf of the Jandus Company stated

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hat, as his clients had come to the conclusion that neither of the patents sued on in the action could be supported in their present form, it would be necessary to apply to amend both specifications, and for that purpose the trial would require to be postponed. To this course the Judge (Mr. Justice Kekewich) consented on the following terms—viz.:—

1. No further advertisements or threats to be issued by the Jandus Company.
2. No claim to be made by them for damages for any infringement up to the date of the order.
3. The costs of the application and all costs occasioned by the Jandus Company, having sued on invalid specifications, to be paid by them to our company in any event.
4. All amendments to the specifications (which can only be by way of disclaimer) to be made within four months.

We shall prosecute with all possible speed our defence in this action, and endeavour to bring the matter to a satisfactory end as speedily as possible. In the meantime the indemnity which we have already given to our customers will be continued in respect of all lamps supplied, or to be supplied.

Ashcroft (B.C.)—The Ashcroft Water, Electric and Improvement Co., of which Mr. C. R. Patterson is manager, was formed recently for the purpose of lighting the town of Ashcroft and supplying consumers with electric power. Water supply is also undertaken by the company, and this is provided by means of a pump driven by an induction motor. The power house is situated 4 miles from the town. The same company similarly operate a large pump for the purpose of irrigating a ranche of about 300 acres. Water is pumped up to this ranche from the Bonaparte river, some 300ft., at the rate of 1,400 gallons per minute.

Barking.—The Barking-Beckton tramway was officially inspected last week.

Battersea.—On Wednesday the Borough Council sanctioned extensions of the electric lighting mains at an estimated cost of £554. 17s. 1d., the erection of pumping plant for artesian wells at the station at £554. 9s. 4d., and supplying and fixing new cross-pieces to steam range at the station at £75.

It was resolved to ask the London County Council to again promote legislation to enable local authorities to wire consumers' premises.

The London County Council have intimated their regret at being unable to see their way at present to promote the legislation desired by the Borough Council prohibiting the use of overhead wires for supplying electricity for lighting from one area to another.

Bedwellty.—The Council are negotiating with the Powell Duffryn Co. for a supply of electric current for public lighting.

Blackburn.—The report of the tramway department for the half-year to September shows a deficit (after meeting interest and sinking fund charges) of £600. The revenue is improving, and extensions are being carried out which are expected to convert the system into a financial success.

Brixham.—The District Council have appointed Mr. E. S. Sanders, at an inclusive fee of £50, consulting engineer to prepare and carry out an electric lighting scheme for the compulsory area.

Chesterfield.—On Friday an inquiry was held into the application of the Corporation to borrow £15,000 for extensions of the electricity works. The town clerk (Mr. John Middleton) and the borough electrical engineer (Mr. R. L. Ackland) gave evidence in support of the application.

Mr. Middleton said the loan was required in consequence of the increasing demand for electric current for lighting and power. The committee commenced to supply current in October, 1901, and at the end of December, 1902, £31,274 had been expended. At the end of 1902 there were 192 consumers, representing an equivalent of 15,204 8 c.p. lamps connected, and by October, 1903, there were 291 customers, with 22,855 8 c.p. lamps. The demand was still increasing.

The Inspector (Mr. R. H. Bicknell) commented on the fact that work had been commenced and money expended before the inquiry had taken place, and said the Local Government Board was getting more and more particular about that kind of thing. Such a course simply meant reducing inquiries to a farce. The Board's engineers, of course, knew the necessity of immediately carrying out works sometimes, but in the present instance, seeing the growth in the demand had gone on so rapidly, it might have been possible, perhaps, to foresee that a considerable augmentation of plant would be necessary.

There was no opposition.

Colne and Trawden Light Railway.—This new line, constructed by the Colne and Trawden Light Railway Co., was officially inspected on Tuesday. The line connects with Nelson Corporation tramways, and completes a large electric tramway system, joining several of the main centres of population in North-east Lancashire.

Clydebank.—The Council will transfer their electric lighting order to the Clyde Valley Electrical Power Co.

Derby.—An inquiry was held here on Wednesday into the application of the Corporation for permission to borrow £33,400 for extensions of electricity generating plant and mains.

The town clerk (Mr. G. T. Lee) and the borough electrical engineer Mr. T. P. Wilmshurst) gave evidence in support of the application. Mr. Wilmshurst, who supplied the technical details, said that in March the equivalent of 87,000 8 c.p. lamps was connected; at present the number was 100,000. The capacity of the present plant was equivalent to about 110,000 8 c.p., and there was also a spare set. Plant of 600 H.P. was required (Mr. Wilmshurst said) for the tramways. It was proposed to convert the system of distribution in the centre of the town from alternating to continuous for lighting, and the present system would have no connection with the tramways or the new lighting extensions. When they had the new plant the total power for lighting (with reserve) would be sufficient to supply 130,000 8 c.p. lamps. Application had already been made for sanction to change the system. About £2,000 of the loan had already been expended on boilers, &c.

Doncaster.—The new electric tramway extensions were officially inspected on Wednesday, and subsequently opened for traffic.

Dumfries.—The Council have decided to invite offers for the transfer of their electric lighting order.

Dundee.—The city electrical engineer (Mr. H. Richardson) reported to the Tramways committee on Monday on the progress made with the alteration of the electricity supply system. During the progress of the work temporary alterations had been made in the cables to certain parts of the town with a view to giving steadier and better light to consumers until the new cables were laid. The first batch of cables under the new contract had been tested, and would be delivered in a week or two, when the work of laying them would be begun by the contractors, the British Insulated and Helsby Cables (Ltd.).

Dunfermline.—The application of the National Electric Construction Co. for a provisional order is to be opposed by the Council.

Eastern Extension, Australasia and China Telegraph Co.—The Hon. George Peel, a director, and Mr. F. E. Hesse, the general manager, of the Eastern Extension Telegraph Co., left London on Wednesday to visit the company's stations.

Egremont.—The Council, who propose to lease their electric lighting order (obtained in 1900), have applied for an extension of time.

Electric Fire Protection.—Recent improvements in the construction of electrically-driven pumps have brought them to the front in connection with fire-extinguishing installations, the ease with which they may be started and the small amount of attention required being greatly in their favour. The Midland Railway Co. has recently ordered from Messrs. Merryweather & Sons two sets of electric "Hatfield" pumps, each of a capacity of 700 gallons per minute. These are to be fixed at their new depôt at Heysham Harbour, in connection with a complete system of fire mains and hydrants.

Exeter.—The City Council have decided to pay the city electrical engineer (Mr. H. D. Munro) £105 as an honorarium for special services in connection with the erection of the new power station, and at the same time Mr. Munro's salary has been increased from £275 to £350 per annum.

Exhibition.—The Inventions Exhibition at Brighton, promoted by the Corporation, was formally inaugurated on Wednesday. Among the exhibitors are the National Telephone Co., who exhibit telephones in great variety, including the megaphone instrument and a new fire alarm.

"Express" Tramcars.—It is reported that the London County Council are going to run an express service of morning and evening cars on the south side of the river for the benefit of persons engaged during the day in the City and West-end. In the run from Tooting to Blackfriars over a quarter of an hour will thus be saved. The express trams will not stop after leaving Kennington for the bridges. The maximum legal speed will be kept up during the journey, and the special cars to be used will be labelled "express." No mention is made of how the service will fit in with that now existing, nor as to what punishment will be meted out to obstinate draymen.

Frome.—An unopposed inquiry was held on Wednesday into the application of the Council to borrow £8,500 for electricity works, which are to be erected and maintained by a company for a period of years.

Gelligaer.—The Council have asked the Dowlais Company to supply electric current for lighting Bedlinog.

Glasgow.—At the Corporation meeting last Thursday it was decided to apply for powers to construct several tramway extensions into the country north and south of the city. This step has been taken to forestall a threatened application by the Clyde Valley Electrical Power Co.

Glasgow-Paisley Tramways.—The extension of the last section of the Paisley-road tramway (1½ miles in length) was opened yesterday.

Hackney (London).—In consequence of the Guardians' decision to instal 400 8 c.p. lamps in their new buildings in Gainsborough-road, and two firms at Hackney Wick making large demands, the Electric Lighting committee have decided to lay a feeder at an estimated cost of £4,500. A distributor is to be laid at an estimated cost of £460, and another at an estimated cost of £215. The com-

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mittee have sanctioned the expenditure of £538 for extras for cable connections in Messrs. Johnson and Phillips' contract.

Hamilton.—The charge for electric current for lighting has been reduced by Edmundson's Electricity Corporation to a flat rate of 4d. per unit, the maximum demand system being abolished. The charge for power is 2d. per unit for the first two hours and 1d. after. At present the equivalent of over 9,000 8 c.p. lamps is connected, and the demand for current for lighting and power is maintained.

Handsworth.—The Council have notified the City of Birmingham Tramways Co. to sell to them so much of their undertaking as lies within the Council's area.

Holyhead.—The Council have acquired a site for electricity works.

Hull.—The Electric Lighting committee is considering a request to extend the cables to the Newland Park estate at an estimated cost of £550.

Injunction.—It will be seen from an announcement made by the Simplex Steel Conduit Co. (Ltd.) in our advertisement pages that the company has obtained a perpetual injunction against certain infringers of their manufactures, and the company give notice that they will take legal proceedings against any person found passing off as "Simplex" fittings goods not manufactured by the Simplex Steel Conduit Co. (Ltd.). The company, who have been put to considerable trouble and expense, ask for the co-operation of the electrical trade in their endeavour to put a stop to these malpractices.

International Telephony.—Telephonic conversations between France and Belgium in 1902 numbered 217,160, or nearly twice the number of conversations exchanged between France and England, Switzerland, Germany, Italy and Luxembourg in the same period.

Inverness.—At a special meeting of the Town Council on Wednesday a draft agreement with Edmundson's Electricity Corporation for the erection and maintenance of electricity works at an estimated cost of £18,000 was approved. The corporation are to receive £2,100 for the transfer of their powers, being the amount already expended in connection with electric lighting.

Ipswich.—The following scale of charges for electricity supply has been fixed by the Council: Lighting 6d. per unit, with rebates making the minimum 4d.; power and domestic uses 2d. per unit.

Islington (London).—At the Council meeting on Friday the borough treasurer (Mr. Towers) said there had been no subsidy from the rates for the electricity undertaking. A transfer of a loan debt of £12,285. 5s. 10d. from the electricity undertaking to the general rate had taken place.

In the earlier days of the electricity undertaking the arc lamps and columns required for public lighting were considered to be part of, and were treated as assets of, the undertaking, and money borrowed for that purpose became likewise a liability of the undertaking. Subsequently, after £13,054 had been borrowed, the London County Council decided that lamps and lamp columns did not constitute part of the undertaking, but should be provided by the vestry, as the local authority under the Metropolis Management Acts, and not as undertakers for the supply of electricity. It then became necessary to transfer from the accounts of the electricity undertaking the balance of the loan outstanding (£12,285. 5s. 10d.) and the lamps and columns, which represented £14,979. 19s. Since the transfer the interest and sinking fund had been paid out of the general rate, but prior to that they were paid out of the revenues of the electricity undertaking. The general rate had repaid to the undertaking the amount of the sinking fund (£768. 17s. 6d.), but there was still owing to the undertaking £1,656, which represented interest paid on loans up to the transfer. If they had that £1,656 they could pay off the £1,496. 3s. 7d. deficit. The annual cost of the 10 arcs recently erected in Petherton-road would be £30. 6s. 8d. per lamp for those alight all night, and for those alight half the night the annual cost per lamp would be £16. 14s. 10d. The average would be £24. 17s. 11d. per lamp per annum.

Java.—A railway connecting Banjoewangi with the network covering the whole of Java was recently completed, and runs through a country which is very fertile, and the speedy development of which may be anticipated. The railway skirts the base of the mountains the whole way and crosses numerous streams with steep falls, and it is locally considered that these might have been utilised to work the railway electrically. A correspondent writes us that it is incredible that so cheap and readily available a means of power should have been lost. The area of the watershed in the district of Banjoewangi is about 1,000 square miles, the streams being, however, somewhat scattered. There are many waterwheels and turbines in use on the coffee and other estates in this district.

Banjoewangi has four telephone exchanges, with 43 subscribers, the subscription being from 16s. to £2 a month, according to distance.

Keighley.—Extensions of the electricity supply mains were authorised at the last meeting of the Council.

Kimberley.—The De Beers Consolidated Mines have just commenced supply at Kimberley from their new station, on the alternating-current system. The generating sets are Westinghouse three-phase revolving field generators, with Parsons turbines, and the cables are of B.I.W. make. Mr. Percy A. Robins has been consulting engineer for the works, and is now resident engineer-in-chief. The station started with a demand for 2,500kw. out of the total station capacity of 3,000kw. Current is generated at 5,000 volts, and transformed down to 220.

Kimberley Borough Council, whose lighting service commenced in October, 1900, have now a total connection of the equivalent of 32,000 8 c.p. lamps to 510 consumers.

Ladysmith (South Africa).—Ladysmith electricity station is now supplying electric current. The plant includes three 30 H.P. Robey boilers, two Willans 100 I.H.P. engines, and four E.C.C. generators, having a capacity of 25kw. each. The E.C.C. dynamos are of the 6-pole type, compound wound and capable of delivering 25kw. at 200 volts. Each dynamo had to run with an overload of 20 per cent. for two hours and to stand an overload of 30 per cent. without sparking. The tested temperature rise at the end of 12 hours run did not exceed 60deg. on any part of the machine. The two generators forming one set were mounted on a heavily ribbed cast-iron bed-plate arranged for bolting to horns on the engine bed-plate. The field magnet yokes are of steel, to which laminated pole-pieces are bolted. All the armatures are interchangeable and of the slotted drum-wound type, well ventilated. The Willans engines are the 2 G size, and designed to run at 460 revs. per min. The three-wire system of distribution, with overhead conductors, has been adopted. There are 175 32 c.p. incandescents and three arc lamps for street lighting. The charge for current to private consumers is 1s. per unit. The contractors for the scheme were Messrs. Hubert Davies and Spain.

Leeds.—Leeds tramways committee discussed on Monday a request from the Wakefield and District Tramways Co. for running powers over the Council's tramway from the company's terminus at Thwaitgate to the centre of the city, but consideration of the matter was deferred. A report by Mr. Hamilton, the tramways manager, providing for extra cars at the busiest periods of the day, was adopted. This involves the employment of men on the "split turn" system.

The Corporation have decided to expend about £100,000 during the winter in tramway extensions, and about 12 miles of additional lines are to be laid.

Light Railways.—Manchester Corporation have asked the Light Railway Commissioners to insert in the Stretford and West Manchester Light Railways (new lines, &c.) Orders clauses (for the protection of the Corporation) relating to compensation for damage by fusion or electrolytic action. The Commissioners decline to insert the clause, as it is considered that it might conflict with regulations to be made by the Board of Trade, but they suggest that the matter be made the subject of an agreement between the parties. Manchester Corporation has referred the matter to its Tramways committee with power to act.

The Board of Trade have granted Herts. County Council running powers over projected light railways or tramways in Watford, but the application of the Watford and District Tramways Co. for running powers over the projected light railway from Bushey to Watford has been refused.

London County Council.—At Tuesday's meeting loans for electric lighting purposes were made to Islington (£849) and St. Pancras (£6,040).

Tramways.—The report of the Highways committee recommending expenditure of £35,000 for the rebuilding of car sheds at Streatham was approved.

The same committee recommended the expenditure of £91,030 in respect of the erection of the New Cross car sheds in connection with the electric working of the Council's tramways, and of granite paving works, laying of rails and construction of conduits in connection with the car sheds. Also that the New Cross car sheds be erected without the intervention of a contractor. An amendment that the work be put out to tender was defeated, and the committee's recommendation adopted.

The Highways committee have notified Camberwell and other councils through whose districts the lines of the southern tramways pass that they can only recommend the County Council to purchase that undertaking on the understanding that the borough councils will consent to the adoption of the overhead trolley system and to the doubling of the tramlines where necessary.

The Establishment committee have appointed Mr. W. R. P. Hederstedt an assistant in the engineers' department at a commencing salary of £500 per annum; and Messrs. W. J. Aris Watkins and Schaffhausen A. Colam as assistants in the engineers' department at £7 per week each.

Maidstone.—Thirty-seven incandescent electric lamps are to be erected in courts and small streets abutting on thoroughfares where mains are at present laid. Sanction to a further loan of £1,770 for electricity extensions has been obtained.

Marylebone (London).—At the Borough Council meeting last night, Councillor E. White's proposal that a committee be appointed to confer with the Metropolitan Electric Supply Co. on the subject of the present deadlock between the Council and the company stood adjourned, as was also the motion by the same councillor concerning the engagement of Mr. Arthur Wright. On the report of the Electric Supply committee it was announced that Mr. Coun-

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cillor E. R. Debenham had been appointed chairman of the committee. On the subject of the Council's costs in the recent arbitration proceedings, the Electric Supply committee proposed that these should be taxed by a Master of the Supreme Court, and that the Council should engage such legal assistance as was required for this purpose. The report also referred to the points reserved in Mr. Justice Buckley's judgment in the action brought by the Metropolitan Electric Supply Co. against the Council for specific performance, and the report states that, as these matters have not yet been decided, it will be necessary to apply for an extension of time for the payment of the purchase money awarded in the arbitration before the courts rise in December. The committee received the authorisation of the Council to retain counsel for this purpose.

With regard to the promotion of a bill by the Council to amend the Electric Lighting Order Confirmation (No. 1) Act, 1901, a sub-committee has been appointed to consider all matters relating to this bill.

Following the report, a series of resolutions by Councillor E. White upon the question of the costs incurred in connection with the Council's electric lighting matters came up for discussion, but were adjourned by consent until after the completion of the costs in the recent arbitration.

Maryport.—An extension of two years for carrying out the provisions of the electric lighting order has been applied for.

Mexico.—The Mexican Gas and Electric Light Co, whose head offices are in London, have replaced three old plants at Mexico city by a new three-phase service, the consulting engineers for the work being Messrs. Strain and Robertson of Glasgow, with Mr. C. F. Beames as resident engineer-in-chief. The total connections reach already the equivalent of 40,000 8 c.p. lamps out of a total plant capacity of 120,000. The number of consumers is already 2,200. The new service commenced supply in June last.

Motor Fatality.—A serious motor carriage accident on Sunday last has deprived Messrs. Vickers, Sons and Maxim of the services of one of their directors (Mr. Siegmund Loewe). The regretted accident was occasioned by Mr. Loewe endeavouring to avoid a collision with a lady crossing the road, and in turning the car he ran into a tree. Mr. Loewe was also chairman of the Roburite Explosives Co. and of the Anglo-French Nickel Co.

Municipal Telephony.—We last week, p. 182, published a letter from Mr. W. E. L. Gaine, general manager of the National Telephone Co., to the Mayor of Brighton. Further correspondence has since ensued. The following is from the Mayor of Brighton to Mr. Gaine:—

Town Hall, Brighton, Nov. 17, 1903.

I am in receipt of your letter, and the question of laying the same before the Council at their next meeting is receiving consideration. I have also sent a copy to Mr. Carden, and am awaiting receipt of his observations thereon. You write under a misconception with reference to certain points, and these I wish to deal with.

Firstly, your assumption that Mr. Carden will be eventually indemnified by the Corporation for any expenditure referred to is entirely incorrect.

Mr. Carden acted in this matter without the knowledge of the Corporation, and I would wish to say clearly and emphatically that he has not received from the Corporation any money or any promise to pay money. There is not the slightest possibility of his being repaid a single farthing.

As to the question of no charge being made to subscribers to the telephone service until such subscribers are able to speak to 749 others, I would point out that Burgess Hill is not receiving preferential treatment in this respect, as these terms are identically those granted to subscribers throughout the Brighton area. This promise does not constitute a breach of the provisions contained in the Corporation licence against the giving of favour or preference.

Following is Mr. Gaine's reply:—

The company is unable to concur in the view you express that the action of the Corporation in granting to the earlier subscribers to its telephone system a period of time in respect of which no charge is made does not constitute a breach of the provisions contained in the Corporation licence against the giving of favour or preference. In the view of the company these subscribers do obtain an undue preference as against subsequent subscribers.

An extract from a circular letter recently issued by the National Telephone Co. to telephone subcribers in the Tunbridge Wells district is as under:—

Owing to faulty construction of the late Corporation lines, their insulation has proved to be so defective that, when connected to the company's more sensitive system they have developed faults which have seriously interfered, not only with their own working, but with that of the whole system. In many cases it will be necessary to at once replace parts of the lines, and, although this will be done with the least possible inconvenience to the subscribers, it is feared that some little disturbance of the service may still be caused.

Nelson's "Victory."—The cockpit of H.M.S. "Victory" is to be lighted electrically to enable visitors to view it with greater convenience.

New Zealand.—The City of Wellington Electric Light and Power Co. has now 77,500 equivalent 8 c.p. lamps connected. The whole city is lighted by electricity by 900 20 c.p. incandescents and 35 15-ampere arcs. The supply of current commenced as far back as 1892, and there are now about 1,400 consumers. The cables are carried overhead and are being extended to the suburbs as the demand for current increases.

The Wellington city authorities have under construction about 15 miles of electric tramway, which it is anticipated will commence running in 1904, the power house being also in course of construction. The overhead trolley system has been adopted.

Electric tramways are in course of construction in Christchurch and Dunedin, and will shortly be running in Christchurch. The Auckland lines, which have been running for nearly a year, have proved a great success.

The New Zealand Government has just passed a bill conserving to the State all water-power rights, and they have engaged Mr. Hancock, of California, to report upon water power in New Zealand and its adaptability for electric power transmission. The Huka Falls is the chief source of power at present in use, and is estimated at 37,000 H.P. The electric tramways at Dunedin are to be run by power generated at the Waipori River, about 14 miles distant from the city.

A report just to hand from a correspondent informs us that a reliable make of incandescent lamps would find a slow but steady market in Wellington and other large cities, and he points to the great future for electric working in New Zealand when the abundant water power available is utilised.

At Gore, Otago, the Borough Council propose to change the present direct-current system of supply to an alternating one, current being generated at Malaura, 7¼ miles distant, at 5,000 volts, to be transformed down to 250. It is anticipated that this change over will be made in about six months from the present date.

Norwich.—It is announced that the City Council will not support the application of the Norwich Mutual Telephone Co. for an extension of time for carrying out their agreement with the Corporation for providing and equipping an independent telephone exchange.

The company obtained in June, 1901, a licence from the Postmaster-General, and an agreement was entered into by the company with the Corporation, one of the conditions being that the work should be completed within two years. The period has now expired, but the company had asked for an extension of time, on the ground that they had entered into an agreement with a contractor for carrying out the work.

P.O. Telegraph Service.—On the subject of the technical qualifications required by candidates for promotion to the rank of superintendent or assistant-superintendent of Post Office telegraphs, notification is made that from June 1, 1904, the subjects of examination will be revised. Before promotion to either of the above ranks officers must pass a qualifying test as follows:—

1. Crossing and looping wires with facility and certainty.
2. Tracing and localising faults in instruments.
3. Tracing and localising permanent and intermittent earth, contact and disconnection faults on wires.
4. Methods of testing the E.M.F. and resistance of batteries and a general knowledge of the essential features of the various description of batteries.
5. System of morning testing, both as regards sending and receiving currents, with the necessary calculations in connection with the same.
6. Making up special circuits in cases of emergency.
7. Joining up and adjusting single-needle, single-current and double-current Morse, both simplex and duplex, and Wheatstone apparatus.
8. Fitting a Wheatstone transmitter to an ordinary key-worked circuit.
9. Measuring resistances by the Wheatstone bridge.
10. A general knowledge of telephone switchboards and of trunk line working.

Officers who have attained the rank of assistant superintendent or superintendent without passing this examination will be required to do so before promotion to higher superintendentships. It is, therefore, to the advantage of the staff to take timely steps to qualify in technical knowledge, as vacancies cannot be kept open merely to enable candidates to gain knowledge they should have already acquired. Officers who fail to pass will not be eligible to be re-examined, at their own request, until one year has elapsed. Officers whose technical certificates are more than two years old at the date of their promotion are liable to be required to undergo re-examination. Possession of the technical certificate only proves the holder to be qualified for promotion so far as technical knowledge is concerned, and does not commit the department to select him for promotion at any time.

Paisley.—The dispute between the Council and Mr. W. M. Murphy as to the setts to be used for tramway track construction has been settled amicably, and the work is being proceeded with.

Plymouth.—The official inquiry into the application of the Corporation to borrow £258,152 for various works (referred to in our last issue) was continued on Friday, Saturday, Monday and Tuesday, when the matter was again adjourned until to-day (Friday).

Presentation.—A case of cutlery was presented to Mr. T. J. Ballard, resident electrical engineer at Aston Manor, by the staff and employés of Sheffield Corporation electric supply department, on his leaving Sheffield.

Ramsgate.—The Council will support the application of the Ramsgate and District Electric Supply Co. for a provisional electric lighting order if the company makes a deposit of £2,000 with the Council. The Isle of Thanet Electric Tramways and Lighting Co. is also applying for an order.

Rosario (Argentina).—This city has a population of 80,000, and the Rosario Electric Co., whose alternating-current supply service

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commenced in 1890, has this year added a continuous-current system of supply. The equivalent of 24,000 8 c.p. lamps is connected, including 50 H.P. for motors, to 620 consumers.

Russian Submarine Telegraphs.—The *St. Petersburg Gazette* states that Felten and Guilleaume Carlswerk Actien-Gesellschaft have been asked to submit an estimate for the making and laying of a submarine telegraph cable, 80 versts (about 53 miles) long, across Lake Baikal. The depth of water in the lake is said to vary from 600 to 900 sagènes (700 to 1,050 fathoms).

Smoke Nuisance.—At Willesden on Tuesday the Metropolitan Electric Supply Co. was summoned by Willesden Council for causing a nuisance by the emission of smoke from the company's Acton-lane works. Mr. R. D. Muir, for the company, said £700 had been spent this year on means for lessening the nuisance, in addition to two engineers being appointed since July whose sole duty was to minimise this trouble. A fine of £5 and £20 costs was imposed. Notice of appeal was given.

Spanish Imports.—In connection with the official statistics published as showing Spain's imports and exports during the first nine months of the present year, it is noticeable that the importation of incandescent electric light bulbs has been considerably reduced, owing to increased manufacture of these goods in Spain. The imports of these bulbs during the nine months amounted to only 945,473, against 1,214,512 in the same period of 1902.

Staines.—The District Council received notice of an application by Edmundson's Electricity Corporation for a provisional electric lighting order.

Stoke-on-Trent.—An inquiry has been held into the application of the Corporation for powers to borrow £30,640 for electricity supply and refuse destructor works.

Mr. J. B. Ashwell (the town clerk) said 88 per cent. of the manufacturers in the borough were in favour of electricity supply, and there were indications of a large demand for current for both light and power.

Mr. P. J. S. Tuddeman (the borough electrical engineer) said it was proposed to instal two 3-grate destructor furnaces and two Lancashire boilers, and the steam thus raised was to be used chiefly for the generation of electrical energy. The continuous current three-wire system of distribution would be adopted and consumers would have current supplied at 240 volts. A demand of about 200kw. for lighting was expected at the outset. It was proposed to charge for lighting £1 per quarter per kilowatt demanded plus 3d. per unit used, the charge for power to be half those rates. The North Staffordshire Infirmary would be one of the principal customers.

There was no opposition.

"Telegraphic Champion."—It is claimed for Mr. W. M. Gibson of New York, who has won the "Carnegie Medal and World's Championship" at the tournament of the American Telegraphers' Association, that he is the best all-round telegrapher in the world. The test was the sending of 25 messages and 500 words of Press matter, and receiving 25 messages and 500 words of Press matter on the typewriter. Mr. Gibson's training was in the Montreal office of the Great North-Western Company.

Telegraphing or Telephoning from Moving Trains.—Mr. J. Edgar, of Nithsdale, Wrexham, sends some particulars of his system for the utilisation of railway metals for telegraphing or telephoning from moving vehicles. Several foreign patents have been applied for, and those for the United States and for France have been granted.

West Ham.—The Corporation have agreed to supply electricity, as a stand-by supply, for the London County Council pumping station at Abbey Mills on payment of £200 for laying the mains, transformer, &c. The County Council are also to provide and erect a transformer chamber and take current of a minimum value of £85 per annum.

Whickham.—The Council will transfer its electric lighting order to the County of Durham Electrical Power Distribution Co.

Willesden.—The Council have approved the draft agreement for the sale and transfer of the Council's generating station and plant at Taylor's-lane, subject to such alterations as their solicitor and their electrical engineer (Mr. E. T. Ruthven Murray) may consider necessary in the interests of the Council.

A draft agreement with a company for the supply of electrical energy in bulk to the Council is under consideration by the Electricity committee.

A special committee is to report as to the advisability of erecting dust destructor works.

Wimbledon.—The following tariff for electricity supply was adopted by the Council on Wednesday evening in lieu of the maximum demand system:—

For private lighting the charges for all quarters of the year are as follows:—1 to 200 units per quarter 5d. per unit, 200 to 400, 4½d., 400 to 800, 4d., 800 and upwards, 3½d. per unit. All electricity supplied for street lighting and lighting public offices is to be charged at 3d. per unit. The charge for power supply is to be 2d. per unit for all apparatus taking more than 1 ampere at 220 volts. Smaller apparatus is to be supplied at private lighting rates.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

The Urban District Council of *King's Norton and Northfield* invite tenders for about 2 miles of electric cable for their tramways, including laying. Specifications, &c., from the consulting engineer (Mr. C. H. Gadsby), 20, Victoria-street, Westminster, S.W., and tenders to the clerk (Mr. Edwin Docker), 10, Newhall-street, Birmingham, by Dec. 10. See also advertisement.

Preston Corporation invite tenders for the supply and erection at their tramway power station of a traction switchboard and accessories. Tenders to the consulting and resident electrical engineer (Mr. Walter H. Tittensor) by Dec. 12. See advertisement.

The directors of the *North-Eastern Railway Co.* are prepared to receive tenders for telegraph apparatus, wire, and line stores for six months ending June 30, 1904. Forms of tender from the company's telegraph superintendent (Mr. C. H. Ellison) and tenders to the secretary (Mr. C. N. Wilkinson), York, by noon Dec. 7.

The directors of the *Great Western Railway Co.* invite tenders for their proposed power station at Park Royal, near Acton, for water-tube boilers, engines, three-phase generators and auxiliary plant. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London, by Dec. 7.

Brighton Corporation invite tenders for six water-tube boilers, two separately-fed superheaters, economisers, induced-draught fans and motors, steel chimney stack, feed-pumps and exhaust heater, together with foundations and brickwork for same; a system of steam, exhaust, feed, blow-off and suction pipes, together with their valves; cast-iron storage tanks, hot-well tank and water purifier, and 30 cast-iron circulating water pipes. Tenders to Mr. F. J. Tillstone, Town Hall, Brighton, by 10 a.m. Dec. 7.

London County Council invite tenders for supply, delivery and erection in the Greenwich electricity generating station of four 3,000kw. three-phase generators with exciters. Tenders to the clerk (Mr. G. L. Gomme) by 10 a.m. Dec. 8.

London County Council invite tenders by Jan. 19 for six electrically-driven three-throw boiler feed pumps for their Greenwich electricity station; also Dec. 15 for 4,100 tons of steel slot rails and 1,490 tons of steel conductor tee rails. Tenders to clerk in each case.

London County Council also invite tenders for wiring and fitting for electric lighting of five sub-stations and three car sheds in connection with the Council's tramways. Tenders to Mr. G. L. Gomme, County Hall, Spring-gardens, S.W., by 10 a.m. Dec. 8.

West Ham Education committee invite tenders for wiring, &c., of Whalebone-lane higher elementary school, Stratford, and Shipman-road school, Custom House. Tenders to Education Department, 95, The Grove, Stratford, E., by 5 p.m. Dec. 14.

Crewe Corporation invite tenders for wiring the new municipal buildings. Tenders to the borough electrical engineer, Mr. H. H. Denton, Electricity Works, by Dec. 4.

Wimbledon Electricity committee invite tenders for water softening and storage plant. Tenders to chairman by noon Dec. 8.

Maidstone Corporation invite tenders, Dec. 7, for construction and equipment of light railways.

The *Birmingham*, Tame and Rea District Drainage Board invite tenders by Dec. 8 for three Lancashire boilers.

Bradford Corporation require tramway stores for 1904. Tenders by Dec. 19.

Cologne Municipal Council invite tenders for erection and equipment of an electricity station at Ehrenfeld.

TENDERS RECEIVED AND ACCEPTED.

Brighton Corporation have accepted the tender of the Genera Electric Co. for 31 street fire alarms and one switchboard for the police department at £368. The offer of the company to supply 31 street fire-alarm telephone posts at £8 each and a 30-line fire-alarm central-station switchboard at £120 was also accepted.

The British Westinghouse Company has secured a further order for 10 magnetic brake equipments for the Bath Electric Tramways (Ltd.). These sets will be duplicates of those already supplied by the company.

The Lorain Ste l Co. have secured an order for the extension of the municipal electric tramways on the surface-contact system at Wolverhampton, and the contract for the track work has been let to Mr. H. Holloway at £40,000.

Blackpool Town Council have accepted the tender of the British Westinghouse Company for a 450kw. traction set, with Browett engine.

Battersea Borough Council have placed an order with Messrs. Potter & Co. for pumping plant for the artesian wells at the electricity works, at £521.

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Dartford Council have accepted the tender of W. T. Henley's Company for supplying and laying cables at £462. 14s. 4d., and for house services at £85. 5s.

Portsmouth Council have accepted the tender of the British Westinghouse Co. for six transformers at £52, and that of Davis & Co. for an iron platform and ladders, at £65.

Wigan Town Council have placed an order with Johnson and Phillips' electric cable works for cables.

Leeds Corporation have placed an order with Edgar Allen & Co. for tramway points, crossings and special junction track work.

Aston Board of Guardians have accepted the tender of the National Telephone Co. for telephonic apparatus at £76.

BUSINESS NOTICES.

Mr. T. Featherstone Smith, who has been for some years past general manager of the Cape Asbestos Co. (Ltd.), has commenced business with his sons, as merchants and agents, under the name of Featherstone Smith & Sons, 67, Leadenhall-street, London, E.C.

The name of the B. and S. Folding Gate Co. is, owing to the expansion of business in various directions and in connection with the introduction of other classes of machinery, &c., to be changed to that of Arthur L. Gibson & Co.

The name of Isidor Frankenburg (Ltd.), has been altered to I. Frankenburg & Sons (Ltd.). This alteration has been made in order to identify Mr. Isidor Frankenburg's sons with the name of the company and involves no change in the directorate or management of the business.

The Electrical Co. (Ltd.), 122-124, Charing Cross-road, London, W.C., desire it to be known that their old telephone numbers, 5028, 5028A and 2433 Gerrard, have been altered respectively to numbers 4311, 4312 and 4313 Gerrard.

Messrs. Thos. Mayhew Bear and Joseph Blomfield (trading as the ritannia Co.), engineers, Colchester, have dissolved partnership.

Mr. E. Garside, for the past five years associated with the switch department of Ferranti Limited, has resigned his position of chief draughtsman with that firm in order to take up the management of the works and drawing office of Messrs. Lionel Robinson & Co. (Ltd.), Ferry Works, Thames Ditton, Surrey.

LIQUIDATIONS, BANKRUPTCIES, &c.

In our full report last week of the meeting of creditors in the matter of Ferranti Limited several errors occurred. Amongst the committee of 10 appointed to assist the directors in preparing a scheme of reconstruction or re-organisation for subsequent submission to the creditors the name of Mr. Brotherton occurs. This gentleman is not Mr. Brotherton of the New Brotherton Tube Co., but Mr. J. Brotherton, of the British Insulated and Helsby Cables (Ltd.). Mr. Bamworth represents the Carron Company on the committee, Mr. Lamb the London Electric Wire Co., Mr. Taylor Messrs. Taylor, Tunnicliffe & Co., Mr. Colls Messrs. Babcock and Wilcox, and Mr. Estler Messrs. Estler Bros. The chair at the meeting was taken by Mr. Scott Lings, a director. The company was represented at the meeting by Mr. Scott Lings, Mr. S. Z. de Ferranti and Mr. A. B. Anderson, directors. The receivers and managers (Messrs. A. W. Tait and Arthur Whittaker) were present to give information. The G.C. Railway are not represented on the committee.

In the bankruptcy of Geo. Neale, 2, Fulham Palace-road, London, S.W. (formerly trading with John Carnaby as the South-Western Electrical Contracting and Maintenance Co.), the first meeting of creditors will take place on Dec. 4 at Bankruptcy-buildings, London, W.C., and the public examination on Jan. 15.

A second and final dividend (10s.), making 20s. in all, in the bankruptcy of J. F. Worthington, electrical engineer, Foundry-street, Hanley, will be payable on Dec. 2, at 26, Corporation-street, Birmingham.

Claims against the Electric Tramways Trust (Ltd.) must be sent by Jan. 1 to either the liquidator, Mr. Leslie Morse, 32, Queen Victoria-street, London, E.C., or Mr. R. A. Goodman, Granville House, Arundel-street, London, W.C.

The discharge of Fredk. King, electrical engineer, Stone Bridge, was granted at Bristol Bankruptcy Court, subject to a suspension for two years.

A meeting of the Prism Globe Syndicate (Ltd.) will be held on Dec. 29 at 60, King-street, Manchester, to receive an account of the winding-up.

A meeting of the Railway Equipment and Construction Co. (Ltd.) will be held on Jan. 14 next at Hamilton House, Victoria Embankment, London, E.C., to receive an account of the winding-up.

Edward Chester & Co. (Ltd.) 120, Bishopsgate-street, London, E.C., is to be wound up voluntarily. Mr. D. F. Basden, 33, St. Swithin's-lane, London, E.C., has been appointed liquidator.

Sales by Auction.—Messrs. Weatherall and Green will sell by auction at Brunswick-buildings, Brunswick-place, City-road, London, on Nov. 30 and following day, at 12 for 1 o'clock, the whole of the valuable plant and stock of the Renewable Electric Lamp Co. (Ltd.) (in liquidation), comprising the complete equipment of an incandescent electric lamp factory. Further particulars are set out in an advertisement. Catalogues from the auctioneers, 22, Chancery-lane, London, W.C.

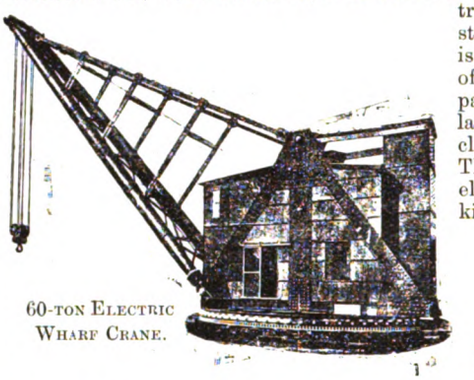
Plant for Sale.—Mr. George Adams, 144, High Holborn, London, W.C., has for sale a small combined electric lighting plant, particulars of which are given in an advertisement.

The Newcastle-upon-Tyne Electric Supply Co. (Ltd.), owing to removal of their new power station, have for sale several Ferranti modern high-tension switch gear panels complete with latest type oil-break switches and fuses, 'bus bars, synchronising gear, high-tension voltmeters and synchronisers. Further particulars are given in an advertisement. Communications to the manager, 50, New Bridge-street, Newcastle-on-Tyne.

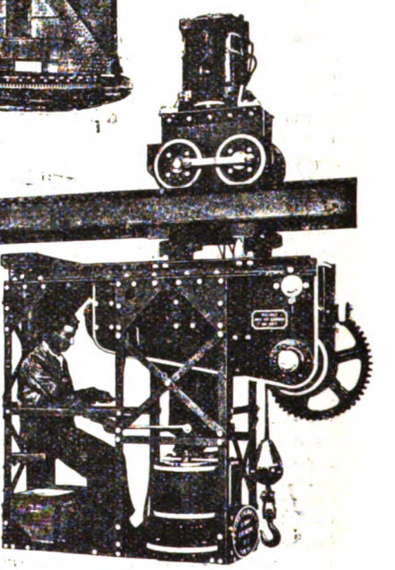
Messrs. Cannington, Shaw & Co. (Ltd.), Sherdley Glass Works, St. Helens, have for sale two Silvertown and one Mather and Platt dynamos. See advertisement.

Factory Premises for Sale.—A freehold manufacturing site, up to 50,000 sq. ft., without restrictions and within 2 miles from City and West-end, is advertised for sale in anothe rcolumn.

Catalogues, &c.—A pamphlet (No. 1A) issued by Messrs. Siemens Brothers & Co., York Mansions, York-street, S.W., deals with electrical crane and capstan equipments, and is a handsome work of nearly 70 quarto pages, illustrating a large variety of this class of machinery. The advantages of electric driving for all kinds of cranes, hoists



60-TON ELECTRIC WHARF CRANE.



30CWT. ELECTRIC TRAVELLER.

winches and capstans have attracted the attention of engineers for some time past, and it has come to be generally acknowledged that the electrical system excels in mechanical simplicity, accuracy of control, speed, working economy and easy adaptability to the varied requirements occurring in the practical use of this type of machinery. In the case of wharf cranes, of which a number of fine examples are shown in the book under notice, the advantages of the electrical system of driving is especially demonstrable. The illustrations, of which we have made reduced examples, show the electrical equipment supplied by Messrs Siemens to the mechanical details of a number of well-known engineering firms. Our illustrations show a 60-ton wharf crane supplied to the Japanese Government and a 30cwt. traveller supplied to the North-Eastern Railway Co. for their Forth Bank goods warehouse at Newcastle, the mechanical portion in each case being provided by Messrs. Cowans, Sheldon & Co., and the electrical equipment by Messrs. Siemens Brothers & Co.

A new list of labour-saving tools and appliances is issued by Messrs. Beanland, Perkins & Co., of Leeds.

A pamphlet describing the merits of "Westrumite," a new disinfectant road-making and dust-laying agent, is issued by the London and District Westrumite Co., Dacre House, Victoria-street, London, S.W., and will interest tramway engineers and owners of tramway undertakings, motor vehicle owners and builder,. and all to whom the condition of our main roads is a source of anxiety.

Messrs. Mosses and Mitchell are issuing a circular calling the attention of engineers to their "Tuffarine" grey valves, which, it is claimed, have greater value for stationary and marine engine work than the company's red valves, which have been for so many years in general use.

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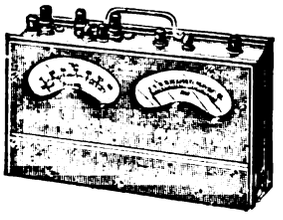
The Union Electric Co., 151, Queen Victoria-street, London, E.C., are placing upon the market a new combined portable precision (moving coil) type ampere and voltmeter. This instrument consists of two moving-coils instruments surrounded by a stout oak case, in the lower part of which is a 6-cell battery. This apparatus will work either erect or lying on its back. The voltmeter scale is divided into 75 equal divisions, and the instrument will read as a voltmeter from 0 to 3 volts for primary and secondary batteries from low voltages, from 0 to 150 volts for private plants and battery installations, or from 0 to 600 volts for supply station light and power mains. For ohmmeter readings, using the 6-cell battery, insulation up to 500,000 ohms may be measured, or by using the line voltages and the other terminals of the instrument, the insulation of live circuits may be determined by using a simple mathematical formula.



The amperemeter scale is divided into 60 equal divisions, and the instrument being of the shunt type may be used with a number of shunts (say one shunt from 0 to 30 amperes, and another shunt from 0 to 150 amperes); or, for millivolt readings, by putting the instrument into direct circuit of low voltage, voltages as low as $\frac{1}{1000}$th of a volt may be measured. The complete apparatus, which is shown in the illustrations, weighs 9lb., and can be supplied in a leather case.

Dining Table Lighting.—Messrs. D. H. Bonnella & Son, 58 and 60, Mortimer-street, Cavendish-square, London, W., are supplying a new device for dining table lighting and similar use.

The arrangement consists of an undercloth, which is placed beneath the ordinary white tablecloth. This undercloth is formed of baize, into which is sewn at regular intervals strips of metallic braiding, alternately connected at one end, the whole terminating in a length of flexible cord, which can be attached to a floor plug. Upon this undercloth is sewn an upper cloth (specially treated on the underside with a coating of india-rubber, which renders it waterproof) entirely enclosing the rows of metallic braiding. The colour of this uppercloth is fast, so that, should any liquid be upset, the dye will not stain the tablecloth. An ivory connector with two sharp metallic points is attached to the fitting to be illuminated, with flexible cord, and it is only necessary to press the points through the white tablecloth into the undercloth to make electric connection. A connector can also be attached to the underside of the fitting, permanently if desired, doing away entirely with the use of flexible cord. The advantage of this arrangement is that it allows an electric light to be taken from any point on the table without damage to the cloth.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Nov. 18 to 24, with the ports of destination:—

Africa—Cape Town, £1,064; Delagoa Bay, £1,475 (including £1,237 telegraph material); Durban, £917; Port Elizabeth, £170. *Argentina*—Buenos Ayres, £1,620 (including £1,541 telegraph cable); Rosario, £57. *Australasia*—Melbourne, £30; Perth, £24; Sydney, £2,430; Wellington, £5,050. *Belgium*—Antwerp, £584. *Brazil*—Rio Janeiro, £17. *China*—Shanghai, £255. *France*—Paris, £14. *Germany*—Hamburg, £50 (telegraph material). *Holland*—Amsterdam, £129; Rotterdam, £15. *India*—Bombay, £34; Calcutta, £826 (including £201 telegraph material); Madras, £315. *Malta*, £17. *Portugal*—Lisbon, £159. *Rodriguez*, £70 (telegraph material). *Straits Settlements*—Penang, £27; Singapore, £298 (including £89 telegraph material). *Sweden*—Stockholm, £70 (telegraph wire). *Zanzibar*, £578. Total, £16,295, against £32,785 in the corresponding date last year (Nov. 19 to 25).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

September 1, 1903.

18,818 A. L. WEEKES. Voltmeters and ammeters.
18,829 W. E. LANGDON, J. C. FULLER and G. FULLER. Insulators.
18,841 S. A. REED. Selective systems for electrical communication.*
18,853 J. T. ARMSTRONG and A. ORLING. Relays.
18,854 J. T. ARMSTRONG and A. ORLING. Telegraphic recording and perforating apparatus.
18,860 L. M. CASELLA. Switches.
18,867 O. IMRAY. Telegraph apparatus. (Société des Telegraphes Multiplex [Système E. Mercadier], France.)*

September 2, 1903.

18,907 W. FAIRWEATHER. Glasgow. Controllers. (Diehl Mfg. Co., U.S.)*
18,934 H. PRATT and F. VINCE. Storage batteries.
18,953 A. R. L. WILLIE. Indicator for controllers of electric vehicles.*
18,958 J. B. HANNAY. Electrolytic manufacture of caustic soda, &c.

September 3, 1903.

18,964 C. TURNBULL, jun. Liverpool. Regulation of dynamos.
18,980 J. W. TUNSTALL. Liverpool. Electric signalling.
18,998 W. S. FROST. Electric generating and motive power machine.
19,012 V. ZINGLER. Electric lampholders.
19,015 MARCONI'S WIRELESS TELEGRAPH CO. and E. RIDDLE. Contacts especially suitable for induction coils.

September 4, 1903.

19,029 J. H. A. MCGUIRE. Leeds. Switch trolley heads.
19,053 H. COOLEY. Leicester. Guiding trolley-heads along frogs and crossings.
19,054 W. P. W. WEATHERILL. Manchester. Overhead electric equipment.
19,063 J. T. ARMSTRONG and A. ORLING. Electro-capillary detectors, relays and recording apparatus.
19,065 C. E. FOSTER, E. R. GROTE and M. V. ELY. Electrical measuring instruments.
19,092 W. R. SYKES, jun. Electric locking apparatus for signals.

September 5, 1903.

19,130 J. W. LEA and J. H. PERRINS. Birmingham. Globe lamps.
19,142 A. T. METCALF. Keighley. Driving and speed regulating mechanism for dynamo-electric generators when carried on vehicles.
19,172 SIEMENS BROS. & Co. and F. LYDALL. Controlling electric cars.*

September 7, 1903.

19,185 G. WILKINSON. Halifax. Mercury vapour lamps.
19,196 T. PARKER. Wolverhampton. Production of sodium and potassium
19,220 H. LAMBEILLE. Middlesbrough. Automatic life-guard for electric cars*
19,225 O. RENNERT. Apparatus operable by thermostatic instruments.
19,249 C. E. SCHONFELDER. Electric controlling apparatus.
19,250 A. J. BRIGGS. Kingston-on-Thames. Telephone receiver holders. (Date applied for Sept, 6, 1902, date of application in U.S.)*
19,251 S. G. BROWN. Telegraphy.
19,256 D. BEAULIEU. Automatic fire alarm.*

September 8, 1903.

19,291 E. T. PARKER. Wolverhampton. Electric extraction of sodium potassium and the alkaline metals.
19,319 A. J. ABRAHAM. Glasgow. A cell recorder.
19,341 R. T. HAYES. Laying pipes for electric light.
19,363 H. R. GARRARD. Liverpool. Insulated cables.
19,366 C. D. ABEL. Reducing metallic compounds and fusing metals in the electric furnace. (Siemens and Halske A.E.G., Germany.)
19,367 E. L. PINCHING and W. H. WALTON. Insulation of conductors.
19,368 H. PARKES. Electro-deposition of copper.
19,383 F. J. LE MAITRE. Electric ignition for explosion motors.

September 9, 1903.

19,399 E. WHITE and J. WALDRON. Wolverhampton. Pipe sockets for facilitating inspection of electric wiring.*
19,419 L. B. MILLER. High frequency appliances.
19,427 J. P. TRUMBLE and T. M. TRUMBLE. Mechanical switch for tramways and light railways on a surface contact system.
19,437 W. A. BROWN. Raising and lowering arc lamps.
19,449 R. THURY. Apparatus for reducing or preventing sparking. (Date applied for, Oct. 16, 1902, date of application in Switzerland.)*
19,454 E. WEINTRAUB. Operating vapour lamps from an alternating-current source. (Date applied for, Oct. 18, 1902, date of application in U.S.)*

September 10, 1903.

19,491 C. E. FOSTER, E. R. GROTE and M. V. ELY. Arc lamps.
19,492 J. G. LEES. Controlling and operating points of electric rail and tramways.
19,513 A. KUCHINKA. Underground current conductors and surface-rail contacts for electric street railways.
19,514 P. REITZ. Drum switches for electric vehicles.
19,520 C. F. SCOTT. Alternating current apparatus. (Date applied for, Sept. 13, 1902, date of application in U.S.)*
19,521 C. F. SCOTT. Systems of alternating-current distribution for railways. (Date applied for, Sept. 13, 1902, date of application in U.S.*)
19,522 H. CHITTY. Rotary electric machines.
19,524 G. M. GEST. Manhole terminals for conduit sections.*
19,540 R. D. PETERS and H. J. ELLINGSON. Electrically operated and controlled railway signals.*
19,547 W. P. THOMPSON. Magnetic excitation of synchronous alternate and three-phase current machines. (Berliner-Maschinenbau A.G. vorm. L. Schwartzkopff, Germany.)*
19,553 H. CASEVITZ. Printing telegraph apparatus. (Date applied for, Sept. 11, 1902, date of application in France.)*

September 11, 1903.

19,583 R. DEUTGEN. Berlin. Flexible isolation tube.*
19,633 J. R. FOTHERGILL and H. FOTHERGILL. Detecting Hertzian waves.

September 12, 1903.

19,657 W. J. STEWART. Glasgow. Working of points and plough-guides on electric tram or railways.

September 14, 1903.

19,714 G. ROBERTS. Winchester. Terminal for sparking plugs.
19,715 S. H. HOLDEN. Electrolytic meters.
19,748 W. PETO. Protecting terminals and ensuring good electrical contact.*
19,780 G. BAMBERG. Electric lamps.

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September 15, 1903.

19,799 Sherard Cowper-Coles & Co. and S. Cowper-Coles. Electrotypes.
19,801 W. L. Bailey and W. A. Tritton. Electrochemically-deposited jacket for explosion engines.
19,815 J. Smith. Oldham. Carbon holder.
19,836 S. E. Page. Insulated joints for railroad rail sections. (Weber Railway Joint Mfg. Co., U.S.)*
19,848 H. Olthoff and M. Durnberg. Automatic receivers.*
19,858 R. J. Alpe and I. H. Davis. Birmingham. Sparking plugs.
19,877 Siemens Bros. & Co. Electromagnetic relay apparatus. (Siemens and Halske A.G., Germany.)*
19,882 G. B. Baby. Electric fuses.
19,886 B. G. Lamme. Electromotive force regulators. (Date applied for, Oct. 2, 1902, date of application in U.S.)*
19,887 B. G. Lamme. Controlling apparatus for electric motors. (Date applied for, Sept. 29, 1902, date of application in U.S.)*
19,894 W. C. Robinson. Incandescent lamps.
19,896 W. E. Evans. Driving dynamos by steam turbines. (Gesellschaft zur Einfuhrung von Erfindungen m.b.H., Germany.)*

September 16, 1903.

19,927 H. W. Clothier. Manchester. Construction of switch gears.
19,948 L. J. Hunt and Sandycroft Foundry Co. Liverpool. Alternating current induction motors.
19,961 Sir Hiram Maxim Electrical and Engineering Co. and J. Harrington. Tumbler switches.
19,965 W. C. Head, W. A. Snape and R. C. Volland. Electric lamps.
19,974 F. W. Massey and T. C. Perkins. Birmingham. Trolley mechanism.
19,956 A. Oesterreicher and L. Nemelka. Automatic block-signalling.*
20,000 G. Bamberg. Rectifying alternating currents.

September 17, 1903.

20,012 T. Ballard and W. Howard. Sheffield. Cable terminal.*
20,017 J. Maclean. Glasgow. Field magnet bobbins.
20,027 A. D. Smith. Keighley. Switches.
20,043 J. R. Crawford. Glow lamps.
20,047 J. R. Quain. Automatic lighting by supplementary currents in case of failure of main current.
20,061 J. Morin. Receivers for wireless communication.*
20,072 E. du Bois. Coin mechanism for electricity meters.

September 18, 1903.

20,101 J. Maclean. Glasgow. Armatures for dynamos and motors.
20,102 J. Gray. Bracket attachments for telegraph and like posts.*
20,109 J. W. Hamm. Manchester. Variable resistances.
20,128 B. G. Lamme. Electric lighting. (Date applied for, Sept. 29, 1902, date of application in U.S.)*
20,137 J. W. Ewart. Arc lamps.
20,155 P. Rieunier. Liverpool. Electricity meters. (Date applied for October, 1902, date of application in France.)*
20,163 A. G. Bloxam. Treatment of liquids with ozonised air or other gaseous oxide mixtures. (E. Dillan, Germany.)

September 19, 1903.

20,219 W. S. Boult and C. R. Boult. Electric traction.
20,230 E. P. Wetmore. Automatic circuit-breakers.*

September 21, 1903.

20,245 R. F. Hall. Birmingham. Rheostats, motor starting regulators, &c.
20,249 W. Macaulay. Ireland. Electric sparking device.
20,274 Sir Hiram Maxim Electrical and Engineering Co., A. W. Hill and J. Habrington. Casing or conduits.
20,285 W. Blackmore. Separation of ores by electromagnets.
20,291 C. F. Ritchel. Electric fittings (Date applied for, Oct. 13, 1902, date of application in U.S.)*
20,301, 20,302 and 20,303 Morgan Crucible Co. and C. W. Spairs. Commutator brushes.
20,310 J. Grouvelle and H. Arquembourg. Transmission to a distance of the variations in any source of energy.
20,313 G. A. Wedekind and H. P. R. L. Porsche. Production of a porous hard electrode mass insoluble in alkalies from metallic oxides or metallic powders.*

September 22, 1903.

20,337 G. G. Jackson. Gillingham. Magnetic minder for iron ships.
20,366 L. Frank. Birmingham. Coverings for insulating wires.
20,401 C. E. Hunter and W. H. Warren. Switches.*
20,405 F. Schrottke and Gesellschaft für Drahtlose Telegraphie m.b.H. Liverpool. Producing rapid electrical oscillations and devices therefor.*
20,423 H. M. Hobart. Ventilation of dynamo-electric machines.
20,424 F. Punga. Sparkless running of commutating dynamo-electric machines.
20,425 H. J. Haddan. Fastening insulator blocks to walls, ceilings, &c. (Schauzenbach & Co., Germany.)

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1902.

21,901 Schmidt and Fabre. Accumulators.
22,067 J. H. Sutton and L. Gregson. Conduits for cables.
22,140 Chiesa. Electric signalling apparatus.
22,352 Myers Apparatus for locating breaks and earths in circuits, or for comparing the resistance of one circuit with another.
22,705 Hellmann. Electric motor-car.
24,429 Hooper. Insulated conductors.
24,704 Carolan (G.E. Co., U.S.). Ice scrapers for electric railways.
25,151 B.T.-H. Co. and Clinker. Synchronism and phase indicators.
26,034 Carolan (G.E. Co., U.S.). Recording instruments.
25,038 Carolan (G.E. Co., U.S.). Electric track brakes.
26,041 Carolan (G.E. Co., U.S.). Arc lamps.
26,042 Carolan (G.E. Co., U.S.). Electric Motors.
26,043 Carolan (G.E. Co., U.S.). Electrical synchronising devices.
26,045 Carolan (G.E. Co., U.S.). Electric rock drills.
26,046 Carolan (G.E. Co., U.S.). Power transmitting ropes.
26,047 Carolan (G.E. Co., U.S.). Transformers.
26,104 King. Automatically-moving points of tramway and railway lines, applicable also to switches on trolley wires.
26,272 Ablett. Alternate-current motors.
26,375 Carolan (G.E. Co., U.S.). Electrical connectors.
26,376 Carolan (G.E. Co., U.S.). Insulation of switches.
26,380 Carolan (G.E. Co., U.S.). Automatic potential regulators.
26,382 Carolan (G.E. Co., U.S.). Rheostats.
26,420 Statter. Switchboard frames.
26,455 Meatchem. Electrically-operated point shifters.
26,468 Hood and Honey. Fuse boxes.
26,694 Down (Franzen). Electric control and lighting of gas burners.
26,876 Stelljes and Typewriting Telegraph Corporation. Electrical transmission of type-recorded messages.
27,089 Rosenberger. Electric power for sewing machines.
27,150 Ramoneda. Sparking plugs for explosion engines.
27,237 Byng and Casperd. Electrical connection for conduit boxes.
27,475 Hawkes, Mouflet and Taylor. Coin-operated apparatus for administering electric shocks.
27,838 Smith. Electric lampholders.
27,895 Laschet. Casing for supporting the effective iron rings of electrical machines.
27,897 Pognon. Electric ignition for internal combustion engines.

1903.

10,532 Goetze. Vacuum tube for the production of spectra.
11,552 Harris. Section insulating bridges for overhead conductors.
12,484 Braun. Transforming electric waves for wireless telegraphy.
13,221 Magneto-Electric Co. and Leonidus G. Woolley. Magneto-semaphore mechanism.
14,106 Hadden (Bergmann-Electricitäts-werke Aktien Gesellschaft). Electric ventilating fans.
14,523 Manson. Ship's telegraph alarum.
14,979 Aron. Electricity meters.
15,337 Roos. Magneto-electric ignition for internal combustion engines.
15,532 Electric and Ordnance Accessories Co. and Hall. Dynamo-suspension gear for electric lighting of railway carriages.
16,132 Evans (A.E.G.). Rectifying polyphase alternating currents by unipolar or aluminium cells.
16,450 Siemens Bros. & Co. (Siemens and Halske A.G.). Signalling apparatus worked by alternating currents.
17,072 Payne. Syntonising two circuits, and apparatus. (Secret document under sec. 44, Patents, &c. Act, 1883.)
17,666 Holzknecht. Determining action of Röntgen rays.
18,376 Thompson (O. and H. Keller). Connection block for conductors applicable also as an insertion contact and ceiling rosette.
18,586 Langdon Fuller and Fuller. Porcelain insulators.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

"BELSIZE" MOTOR CAR AND ENGINEERING CO. (LTD.)—Reg. Nov. 21, capital £30,000 in £1 shares, to acquire and carry on the business of motor motor and car builders and electrical and mechanical engineers carried on as Marshall & Co. First directors: J. Barber, C. Higginbotham, H. Summers, J. H. Smith and J. Whitehead. Reg. office, Belsize Works, Clayton, near Manchester.

BRITISH ACCUMULATOR CO. (LTD.)—Reg. Nov. 20, capital £5,000 in £1 shares, to acquire the business of electric accumulator sellers and merchants now carried on as the British Accumulator Co., and the right to sell in the United Kingdom and colonies electric accumulators either wholly or partly manufactured by the Allgemeine Accumulatorenwerke Actiengesellschaft of Vienna, and to carry on the business of manufacturers and vendors of electric accumulators, and all other articles used in connection with electric lighting and accessories thereto. First directors, A. Lederer, E. Lederer, J. Lederer, M. Pal and F. von Gerson, C.E.

ELECTRICAL TURNERY (LTD.)—Reg. Nov. 20, capital £2,000 in £1 shares, to adopt an agreement between Electrical Turnery (Ltd.), T. H. Cramp, A. G. Scott and H. Wyman, and to carry on the business of turners of wood, ivory, bone, metal and other materials, pattern makers, founders, cabinet makers, telegraph, telephone, electric and general engineers, manufacturers of and dealers in electrical and other bells, telephones, lamps and apparatus, &c. The principal subscribers are J. H. Maunder (110 shares), C. F. Quicke, consulting engineer (50 shares), J. Connolly, electrician (70 shares), A. G. Scott (60 shares), C. F. Freedman (60 shares), T. White, electrical engineer (150 shares), A. Jaray, electrical engineer (60 shares), and H. Wyman (260 shares). First directors, C. H. Freedman, A. Jaray, J. H. Maunder, C. F. Quicke, A. G. Scott and H. Wyman.

STATUTORY RETURNS.

MATHER AND PLATT (LTD.)—In return to Sept. 10 the capital is £1,000,000 in 50,000 preference and 50,000 ordinary shares of £10 each, of which 40,000 preference and 40,000 ordinary shares have been taken up. £10 per share has been called up on 21,705 preference and 2,500 ordinary shares and £7. 10s. per share on 7,495 preference. £298,262. 10s.

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has been received. £483,000 is considered as paid on 10,800 preference and 37,500 ordinary. No mortgages or charges.

MONTE VIDEO TELEPHONE CO. (LTD.)—The return to Nov. 12 gives the capital as £160,000 in 87,000 preference and 73,000 ordinary shares of £1 each, of which 86,492 preference and 72,688 ordinary shares have been taken up. £159,172 considered as paid. Motrgages and charges nil.

SIR HIRAM MAXIM ELECTRICAL AND ENGINEERING CO. (LTD.)—According to return to Sept. 28, the capital is £190,000 in £1 shares, all of which have been taken up. £1 per share has been called up on 42,500 shares and £37,292. 12s. 6d. has been received, leaving £5,207. 7s. 6d. in arrears. 147,500 shares are considered as fully-paid. Mortgages and charges, £20,000.

MORTGAGES AND CHARGES.

CITY OF WELLINGTON ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Nov. 5 of £75,000 5 per cent. first debentures, part of series created May 7, 1903, to secure £100,000. Property charged, company's undertaking and property, present and future. No trustees. No previous issue of same series.

F. A. GLOVER & CO. (LTD.)—Issue on Nov. 14 of debenture for £500, part of series created April 11, 1902, to secure £6,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £5,000.

KENT ELECTRIC POWER SYNDICATE (LTD.)—Memorandum of satisfaction in full of charge, dated May 21, 1903, securing £1,500, has been filed.

LANGDON-DAVIES MOTOR CO. (LTD.)—Issue on Oct. 26 of £200 and on Nov. 12 of £400 debentures, part of series created Oct. 15, 1902, to secure £6,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £4,800.

WOKING ELECTRIC SUPPLY CO. (LTD.)—Issue on Oct. 31 of debentures for £50, part of series created Nov. 2, 1899, to secure £25,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £22,550

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26⅞d. per oz. (Nov. 26). Consols 88⅞—88⅞ for money, 88⅞—88⅝ for account; 2½ per cent. annuities 88⅝—88⅞ (Nov. 26). Consols Pay Day, Dec. 1; Stocks and Shares Continuation Days, Dec. 9 and 28; Ticket Days, Dec. 10 and 29; Pay Day, Dec. 11; Mining Share Carry-over Day, Dec. 8.

ARON ELECTRICITY METER (LTD.)—The transfer books will be closed from Dec. 7 to 26 inclusive.

BRITISH ALUMINIUM CO. (LTD.) At an extraordinary meeting on Friday the resolution for reducing the capital from £400,000 to £310,000 was confirmed.

GENEVA TRAMWAYS CO. (LTD.)—The report for the period from the incorporation of the company to Sept. 30 states that the company was registered on Dec. 6, 1901, for acquiring shares of the Compagnie Genevoise des Tramways Electriques, owning and working a complete system of tramways, about 136km., in and about the city and canton of Geneva. In the belief that the suspension of profit earning by the Swiss company was occasioned by temporary causes only, the directors obtained from Messrs. L. Hirsch & Co. loans, amounting to £38,250, with which to meet the debenture interest falling due on July 1, 1902, and Jan. 1, 1903; but when it became apparent that a protracted period must elapse before the Swiss company could earn sufficient profit to provide the company's debenture interest, and that further funds would possibly be required for both companies, the directors were compelled to propose to the debenture holders a rearrangement of the finances of the company. At a meeting of the holders on June 25, 1903, it was resolved to postpone for three years from Jan. 1, 1903, the payment of interest on the 4½ per cent. debentures, and to authorise the company to create £20,000 of 5 per cent. short term prior lien debentures charged upon the shares held in the Swiss company, and to issue £39,692 5 per cent. third debentures in satisfaction of the previous advances of Messrs. L. Hirsch & Co. Neither class has yet been issued.

LANCASTER AND DISTRICT TRAMWAYS CO.—At the meeting on Saturday, the chairman (Councillor A. Bell) referred to the negotiations for the sale of the undertaking to the Corporation, whose valuer estimated the concern as worth £30,610, not including stables, horses, &c. The Corporation offered £27,000, but the directors asked for £30,000, or expressed their willingness to themselves appoint a valuer to act in conjunction with the valuer to the Corporation, and to accept whatever sum these two gentlemen decided upon. The Corporation declined those terms and withdrew their offer. He (Mr. Bell) believed that by electrifying and doubling the line the traffic between Lancaster and Morecambe could be increased sixfold.

MORECAMBE TRAMWAYS CO.—At the meeting on Thursday last the chairman (Mr. S. J. Harris) said that the directors had given a good deal of consideration to the question of electrifying the line, but he regretted not being in a position to report to the meeting that they had made arrangements with the local authorities. The adoption of electric haulage would be in the interests of the company and the town of Morecambe.

POWER GAS CORPORATION (LTD.)—The report for year ended Sept. 30 states that the extension and remodelling of the works at Stockton-on-Tees have been completed, and the cost is included in the amount of the advance to Messrs. Ashmore, Benson, Pease & Co. (£115,036). New contracts of considerable value have been secured for the installation of power gas plant, both in this country and abroad, and also for the extension of existing installations. An act was obtained in the past session conferring powers for the distribution of electricity and power gas throughout North Staffordshire and parts of the counties of Derby, Flint and Denbigh. The corporation has acquired the sole rights in this country for the manufacture and sale of the appliances patented by Mr. Benjamin Talbot for mechanically agitating the fuel in gas producers. The profit for the year was £13,082. £2,000 has been written off preliminary expenses, and a dividend at 5 per cent. per annum upon the ordinary shares is recommended, leaving £1,693 to be carried forward.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to allow 50,000 7 per cent. cumulative preference fully-paid £1 shares of the *Blackheath and Greenwich District Electric Light Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Nov. 21	1,040	+ 238	25	31,673	+ 5,268
Ayr Corporation	,, 21	171	+ 4	27	2,288	+ 52
Barnsley	,, 13	169	- 27	45½	8,217	- 27
Bexley District Council	,, 20	153	...	7	1,333	...
Birkenhead	...	...	...	...	...	...
*Birmingham Tramways	,, 21	4,877	+ 242	20	103,781	+ 2,904
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 19	300	+ 15	§33	86,235	- 203
Blackpool and Fleetwood	,, 21	186	+ 1	21	19,873	- 110
Blackp'l, St. Anne's & Lytham	,, 19	167	+ 87	13	459	+ 209
Bolton Corporation	,, 22	1,657	+ 175	33	63,294	+ 7,700
Bournemouth Corporation	,, 18	779	...	34	36,206	...
*Bradford Corporation	,, 22	3,353	+ 276	33	130 218	+ 18,241
Brighton Corporation	,, 22	751	+ 102	52	45,987	+ 6,414
Brisbane Tramways	Oct. 7	2,300	- 90	14	32,908	+ 385
*Bristol Trams & Carriage	Nov. 20	4,303	+ 566	26	137,313	+ 18,577
*Buenos Ayres & Belgrano	Oct. 25	3,006	+ 265	1	3,066	+ 105
Burnley Corporation	Nov. 21	751	+ 95	34	35,317	+ 6,193
Burton Corporation	,, 22	295	...	...	...	...
Calcutta Tramways Co.	,, 21	R35,525	+ R4,530	21	R692,496	+ R120,009
Camborne-Redruth	,, 23	122	...	3	868	...
Cardiff Corporation	,, 21	1,769	+ 433	34	67,666	+ 18,863
Carlisle Tramways Co.	,, 21	158	+ 34	¶ 46	8,994	+ 721
Central London Railway	,, 21	7,138	- 95	21	132,059	- 6,719
Chatham and Dist. Lt. Rys.	,, 19	503	+ 206	46	25,024	...
City & South London Rly.	,, 22	3,030	- 461	21	54,691	- 8,658
Cork Electric Trams Co.	,, 19	392	+ 33	36	24,261	- 3,383
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 13	527	+ 123	45½	21,009	+ 1,223
Dover Corporation	,, 21	157	+ 6	†34	8,150	+ 88
Dublin & Lucan Railway	,, 22	87	+ 6	21	2,766	+ 171
Dublin Southern District	,, 20	726	+ 87	¶20	22,465	+ 7,765
Dublin United	,, 20	3,459	+ 45	¶20	82,454	
Dudley—Stourbridge	,, 13	782	+ 33	45½	38,171	+ 3,628
Dundee Corporation	,, 18	792	+ 46	...	...	...
East Ham Council	,, 21	589	+ 191	†34	23,274	+ 6,885
Gateshead & Dist. Trams	,, 13	897	+ 49	45½	39,899	+ 5,229
Glasgow Corporation	,, 21	18,593	+ 1,293	25	343,159	+ 36,298
Gravesend—Northfleet	,, 13	228	+ 36	45½	11,070	+ 1,124
Greenock & Port Glasgow	,, 13	550	+ 64	45½	25,042	+ 2,035
Halifax Corporation	,, 11	1,180	+ 126	‡33	47,625	+ 5,386
	,, 18	1,172	+ 87			
Hartlepool Tramways	,, 13	243	+ 26	45½	12,888	+ 753
Huddersfield	,, 21	1,103	+ 132	33	42,766	+ 6,616
Hull Corporation	,, 21	1,834	+ 220	†34	63,842	+ 8,583
Ilkeston Corporation	,, 18	124	...	1	124	...
Isle of Thanet Co.	,, 21	268	+ 29	21	21,148	- 1,042
Kidderminster & District	,, 13	97	- 5	45½	5,884	+ 166
Kirkcaldy Corporation	,, 18	148	...	38	6,6 0	...
Lanarkshire Trams Co.	,, 19	564	...	§14	11,178	...
*Leeds Corporation	,, 21	4,992	+ 332	33	195,020	+ 11,729
Liverpool Corporation	,, 14	10,163	+ 455	‡47	339,691	+ 63,644
	,, 21	9,105	+ 2,868			
*Liverpool Overhead Rly.	,, 22	1,592	+ 104	21	35,186	+ 2,313
London County Council	,, 14	9,764	+ 2,720	†33	330,585	+ 60,776
Lowestoft	,, 21	142	...	...	...	...
Manchester Corporation	,, 21	10,798	+ 5,915	28	273,467	+ 147,293
Mersey Railway	,, 21	1,817	+ 110	21	27,929	+ 5,478
Merthyr	,, 13	202	+ 27	45½	9,077	- 90
Middleton	,, 13	255	+ 44	45½	14,614	+ 1,811
Newcastle-on-Tyne Corp.	,, 21	3,448	+ 567	21	73,592	- 3,178
*Newport (Mon.)	,, 21	414	+ 169	3	1,284	+ 675
Oldham, Ashton & Hyde	,, 13	582	+ 15	45½	25,995	+ 1,579
Perth (W. A.) Elec. Trams.	,, 20	1,295	+ 266	§46	53,851	+ 6,041
Peterborough	,, 13	150	...	42	6,776	...
Poole and District	,, 13	252	+ 23	45½	13,974	+ 2,025
Portsmouth Corporation	,, 21	1,819	+ 271	†34	68,495	+ 4,140
*Potteries	,, 13	1,658	- 94	45½	72,016	+ 3,693
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 13	39	- 1	45½	6,774	+ 1,606
Salford Corporation	,, 23	3,604	+ 617	34	130,518	+ 88,727
*Sheerness	,, 11	53	...	31	2,759	...
Sheffield Corporation	,, 22	4,236	+ 397	21	97,472	+ 7,525
*Southampton Corporat'n	,, 19	854	+ 12	...	...	...
Southend Corporation	,, 18	213	+ 42	33	11,854	+ 1,892
Southport Tramways	,, 13	259	+ 9	45½	14,482	+ 2,547
S. Staffordshire Trams.	,, 13	991	+ 314	45½	41,548	+ 6,882
*Sunderland Corporation	,, 22	1,655	+ 82	34	42,776	+ 2,083
*Swansea Trams	,, 18	507	+ 58	45½	23,721	+ 1,992
Taunton Trams	,, 13	44	- 7	45½	2,792	- 197
Tynemouth and District	,, 13	214	- 9	45½	14,455	+ 786
Tyneside Trams Co.	,, 18	288	+ 49	46	15,033	...
Wallasey District Council	,, 21	569	+ 87	†34	24,510	+ 3,102
Weston-super-Mare	,, 11	39	- 8	45	5,580	- 513
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 13	871	+ 42	45½	17,828	+ 7,556
Wrexham	,, 13	116	...	52	4,580	...
Yorkshire Woollen District	,, 13	388	...	28½	14,710	...

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed. Nov. 25	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to Nov. 25 Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4½—4¾	5 5 3	April, Oct	4⅝	4⅝
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	128½	126¾
10	10/0	Barcelona Tramways Ord.	7½—8¼	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	2	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —102	4 9 6	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼—10½	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 1	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	80 —83	3 12 3	..	..	..
St.	5%	Do. Pref. Ord. Stock	93 —96	5 6 5	..	94	..
10	4/2½	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	103½	..
10	10/0	British Electric Traction Ord.	11½—12	6 13 4	..	11⅞	11½
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —11½	5 4 3	Feb, Aug	11⅛	11⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	122½	..
5	..	Buenos Ayres and Belgrano Ord.	2⅜—2⅝	.. ..	..	2⅛	2⅜
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5 —5¼	5 9 1	..	5 1/16	..
5	3/0	Do. "B"	4¾—5⅛	5 14 3	..	5¼	5 1/16
St.	5%	Do. 5 per Cent. Debs.	106 —109	4 12 10	..	106	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	5 0 9	..	100	99½
5	2 6	Calcutta Tramways	6¾—7⅛	3 2 1	..	7 1/16	6 15/16
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 11	..	107½	105
1	1/2½	Cape Electric Tramways Shares	1¾—2	7 10 0	..	..	..
St.	4%	Central London Ordinary Stock	91 — 94	4 6 0	June, Dec	94½	91
St.	4%	Do. 4 per Cent. Pref. Stock	99 —102	3 18 10	..	..	..
St.	4%	Do. Deferred Stock	96 — 99	4 1 8	..	..	..
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 11	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 — 5¼	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 5	..	99½	..
St.	2½%	City and South London Rly. Con. Ord.	50 —52	6 2 7	Feb, Aug	50	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	127 —130	3 17 3	Feb, Aug	..	..
St.	5%	Do. (1896)	125 —128	3 18 10	..	126	125½
St.	5%	Do. (1901)	120 —125	4 1 1	..	120	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	6%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 0	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 —13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3¼—4¼	6 13 4	..	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 —98	5 2 0	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7½—8¼	3 10 7	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	.. ..	..	..	..
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 3 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾—4¼	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 8	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4¾— 5	2 10 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼—10⅝	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 6	Jan, July	..	..
10	5,0	London United Trams. 5% Cum. Pref..	11½—12	4 3 4	..	11⅝	11⅝
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 8	..	105½	..
St.	..	Mersey Con. Ord. Stock	8 —11	.. ..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	.. ..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	.. ..	.. ..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1⅛	.. ..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —104	4 16 2	..	102½	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 4 1	..	..	..
5	..	New General Traction Ord.	½	.. ..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2¼	.. ..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	100 —103	4 19 0	..	101¼	..
10	10/0	Potteries Electric Traction Ord.	8½ - 9¼	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	8¾ - 9½	5 5 3	Feb, Aug	9⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	.. ..	.. ..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	.. ..	.. ..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	.. ..	.. ..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 — 94	3 9 8	June, Dec	91½	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 0	Jan, July	..	..
10	..	Amazon Telegraph	2½— 3½	.. ..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	.. ..	.. ..	..	..	..
St.	15/0	Anglo-American	49 —52	6 1 6	F,My,Ag,N	49½	..
St.	30/0	Do. Preferred	92 — 94	6 8 3	F,My,Ag,N	93¾	93
St.	1/0	Do. Deferred	8 —8½	0 11 10	F,My Ag,N	8 1/16	8
100	$2	Commercial Cable Capital Stock	145 —155	5 9 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	Jn Ap,Jy,O	91½	90½
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	16	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	97⅝—101⅝	4 10 10	Jan, July	..	..
20	3/0	Direct United States Cable	10¼—10⅜	6 0 11	Ja,Ap,Jy,O	10⅜	10¼
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 —102	4 8 10	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	122 —127	5 10 8	Ja,Ap,Jy,O	124½	122
St.	17/6	Do. 3½ per Cent. Pref. Stock	84 —87	4 0 11	Ja Ap,Jy,O	84½	84
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	105½	..
10	2,6	Eastern Extension	11 —11½	6 1 9	Ja,Ap,Jy,O	11⅛	11
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 14 9	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 18 10	Feb, Aug	99⅛	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝—102⅝	3 18 11	May, Nov	..	..
10	5 0	Great Northern of Copenhagen	23 —24	5 4 2	Jan, July	..	..
100	4½%	Halifax & Bermuda4½%1stMt.Db.(red.)	99 —102	4 8 4	June, Dec	..	..
25	12/6	Indo-European	36 —39	6 8 2	May, Nov	38¾	38¾
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..
2½	..	West Coast of America	⅞—1	.. ..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅞—1	.. ..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6½—7	8 11 6	May, Nov	7	..
10	..	Do. 6 per Cent. 2nd Pref.	4 —5	.. ..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 17 7	Jan, July	..	..
10	5%	Western Telegraph	11¾—12¼	5 14 3	Mr,Jn,O,D	11¾	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 8	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	8¼—8½	4 11 5	Ja Ap Jy O	8⅜	8⅜
10	3/0	Do. 6 per Cent. Pref.	12½—13	4 12 4	Ja Ap,Jy,O	12 15/16	12½
8	4/0	Reuter's	6¾—7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	116 —121	4 19 7	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed. Nov. 25	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, Week to Nov. 25 Highest.	Lowest.
		TELEPHONES.					
5	6/0	Chili Telephone (fully paid)	4¾—5¼	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	101 —103	5 18 9	..	102⅜	100½
St.	5%	Do. Def. Stock	79 —81	6 0 6	..	80½	75½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	..	..
5	2,6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼—5⅜	4 13 0	Feb, Aug	5¼	5⅛
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 —97	3 14 4	June, Dec	96	94½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 —104	3 17 5	..	..	..
1	0/7½	Oriental	15/16—1	7 2 0	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	.. ..	..	..	..
5	4/0	United River Plate	5¼—6	5 16 8	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 - 107	4 13 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅞—1	.. ..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	116 —119	3 15 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 —11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 3	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10¼—10⅜	4 3 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10 —10½	3 6 8	Mar, Sept	..	..
5	3,0	Calcutta Electric Supply Ord.	6⅛—7½	4 6 8	..	7 1/16	7
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	107 —110	3 13 2	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	9 — 9½	5 5 3	Feb, Aug	9¼	..
5	2/3	Do. 4½ per Cent. Pref.	5¼—5⅝	3 18 3	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	4 1/16	4 1/16
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 16 2	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5½—6	4 3 4	March ..	5⅜	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10 —10½	4 15 3	Feb, Aug	10⅜	10¼
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13¼	13⅛
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 —127	3 18 11	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 9 5	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7¼—8¼	4 14 2	..	8⅛	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12¾	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	108 —111	4 2 8	..	110	..
St.	27/6⅔	Do. Second Deb. Stock Prov. Certs.	99 —102	.. ..	..	100⅛	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5¼—6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10¾—11¼	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
5	..	London Electric Supply Ord.	1⅞—2⅛	.. ..	..	..	..
5	3/0	Do. 6 per Cent Pref.	5 —5⅜	5 9 1	..	5⅜	5⅛
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	4 0 6	Mr,Jn,S,D	99	..
10	8 0	Metropolitan Electric Sup. Ord.	17¼—18½	4 3 9	April, Oct	17½	17½
5	..	Do. 4½ per Cent. Cum. Pref.	4⅛—4⅜	.. ..	..	4¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 8	Jn, Dec ..	111	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 — 99	3 11 7	..	..	..
10	6 0	Notting Hill Electric Ord.	12½—13½	4 8 11	March....	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..
5	2 6	Oxford Electric Ord.	5¼—5¾	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —100	4 0 0	..	..	..
1	..	Rand Electric	⅞—1⅛	.. ..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14 —15	4 16 8	Feb, Aug	14⅝	14½
5	3 6	Do. 7 per Cent. Pref.	7½—8¼	4 2 4	Feb, Aug	8⅛	8
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —101	3 10 4	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3 —3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
£	1/0	South London Electric Supply Ord.	3¼—3⅝	4 13 4	..	3⅜	..
5	2,6	Urban Electric Supply Ord.	4¾ 5¼	4 17 7	..	..	..
5	2,6	Do. 5% Cum. Pref.	4¾—5¼	4 17 7	..	5	..
St.	6/6	Westminster Electric Supply Ord.	11½—12½	5 8 4	Mar, Sept	12⅜	12
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6¼	3 16 11	..	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½—¾	6 13 4	..	..	..
1	7½d.	Aron Electric Meter 6% Cum. Pref.	½—¾	.. ..	Mar, Sept	..	..
5	4 0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	6⅝	..
5	3 0	Do. 6 per Cent. Pref.	5¼—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	103 —108	4 4 10	..	..	..
St.	4½%	British Thoms'n-Houst'n4½%1stMt.Db.	103 —105	4 5 8	..	104	..
5	3/0	British Westinghouse 6% Pref.	5⅜—5⅝	5 6 8	..	5 1/16	5⅛
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	100 —102	3 18 5	..	101½	101¼
½	..	Brush Electrical Engineering	¾—1½	.. ..	March ..	1	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1⅝	6 17 2	Mar, Sept	1½	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	98½	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	85 — 90	5 0 5	Jan, July	..	..
5	5,0	Callender's Cable Construction Ord.	11 —12	6 5 0	Jan, July	5⅜	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	106 —110	4 1 10	Nov, May	108½	108
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91 —96	4 15 3	..	94¾	94
1	0,7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	1 1/16	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2½	6 18 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	100⅝—104⅞	4 16 10	Jan, July	..	..
5	..	Edison & Swan United("A"Sh.) (£3 pd.)	¼	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	.. ..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock (rd.)	72 —77	5 5 3	June, Dec	72⅜	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6¼—6⅜	5 3 8	H'lf-yearly	6 1/16	6¼
5	8/0	Do. 6 per Cent. Cum. Pref.	6 —6¼	4 12 4	..	6¼	6 1/16
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 4	..	106½	..
2	1/2½	Electric Construction Co.	1¼—1⅝	6 17 2	Jan, July	..	..
2	2 9½	Do. 7 per Cent. Cum. Pref.	2¼— 3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 3	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅜—⅝	.. ..	..	..	..
1	7½	Do. 7 per Cent. Cum. Pref.	¾—1	.. ..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	91 1/16	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¾—10¼	4 17 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 —99	4 0 10	..	..	..
5	6/0	Henley's Telegraph Works Ord.	14 —15	6 13 4	Feb, Aug	14½	14
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	18 1/16	18⅜
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 8	Mar, July	35⅛	34½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	5 —6	5 8 4	Apr, Oct	5⅜	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	Apr, Oct	6	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —103	3 19 3	May, Nov	101½	..

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. ‡ The London Stock Exchange Committee have refused to note these.

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NOTES.

THE description which we publish this week of the works of the Yorkshire Power Co. are chiefly interesting by the fact that this generating station will probably be the first one in this country in which the new Curtis turbine will be employed, although the Lancashire Electric Power Co.'s works, which have also been designed by Mr. PARSHALL on similar lines, will probably be ready almost as soon. In view of the low steam consumptions which electrical engineers have been led to expect from this steam turbine, the working results will be most interesting. The guaranteed steam consumption of the turbines for the Yorkshire station is only 19lb. per kilowatt-hour with steam at 150lb. per square inch pressure and with 150°F. of superheat. Without going down to the lower steam consumptions spoken of in connection with this turbine, if a set occupying a fraction of the space of the most efficient reciprocating engine, and at as low a first cost, can be guaranteed to give the above result without an abnormal repair bill or any other contingent extra expenses, it will indeed be a keen competitor of our old and well-tried friend.

THE Paper on the Edison cell, read by Mr. W. HIBBERT before the Institution of Electrical Engineers last week, and reprinted in full in our last issue, has been the subject of much comment and speculation during the week. On the whole, however, it must be confessed that it was rather disappointing. The cell itself is undoubtedly an excellent one, and an improvement in several respects on the old lead type, but the meagre details available as to the composition of the active material and other details of its construction should be strongly supplemented by Mr. HIBBERT in his reply to the discussion, which has been adjourned until the middle of January. The performance of the cell on the road was admirable, and the author's statement to the effect that one cell had worked over 2,500 miles on a motor car running about the streets of London and still had its original capacity seemed almost incredible. It would be interesting if Mr. HIBBERT could exhibit this particular cell on the table at the Institution, and also if he could give some information concerning the price of the battery, which, according to rumour, is exceedingly high. Lead traction cells of equal capacity, weight for weight, as Edison cells, and occupying less space, are obtainable; and thus the whole matter almost resolves itself into the question: Is the increased durability worth the extra cost?

ON another page of this issue will be found a description of the de Forest system of wireless telegraphy which has recently been introduced into this country. Considerable success has attended the working of the system in America, and several of its main features are already familiar to English engineers. The establishment of every new system, however, tends to make increasingly difficult the "standardisation" of the work, and hence the longer legislation is delayed the more difficult does the problem become. It is rumoured that an attempt is being made to effect a combination of several or all of the existing systems in this country. Not for a moment is it to be imagined that all concerned would consent to such an arrangement; but it is by no means improbable that some of the leading workers might do so, and the result of such a movement might place those who stood outside in rather a difficult position. A "combine" of this sort would greatly strengthen the financially weak but honest concerns which are now having a hard struggle for existence; but, on the other hand, the formation of one large company with a practical monopoly in wireless telegraphy might not assist the progress of the new industry.

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In another column we give a short summary of Herr J. Stark's Paper on the "Ionic Theory of the Electric Arc." It is, we believe, the first attempt to apply the modern electron theory to the phenomena of the arc lamp, and on that account deserves more than a passing notice. The author carefully distinguishes between the glow discharge and the arc, and determines their respective spheres of influence. The normal current density of the glow discharge is nearly proportional to the gaseous pressure and inversely proportional to the absolute temperature. The current density of the arc, on the other hand, increases with the temperature, and is only slightly affected by the pressure. As a rule, the current density of the arc is from a hundred to a thousand times greater than that of the glow discharge. But then it requires a temperature which always keeps above 3,000deg., whereas the glow-light cathode cannot have so high a temperature, but may have any temperature below that. As a consequence, there is a somewhat different process of ionisation in the two cases. In the glow discharge, the negative electrons, in traversing the cathode drop of potential, acquire an amount of kinetic energy more than sufficient to ionise the gas by impact in the negative glow light. They would, indeed, only require a drop of 50 volts, whereas the normal cathode fall of potential in air is 340 volts. The corresponding cathode fall in the case of the arc is only some 15 volts, and this fall is incapable of driving the necessary number of electrons out of the substance of the cathode. Hence there must be some other influence at work, and this influence the author identifies with the high temperature, which has an even more pronounced effect than ultra-violet light.

The much-disputed question as to the "counter E.M.F." of the arc is answered by the author as follows :—"There exists a counter E.M.F. in the arc when the anode is very hot, and it represents the sum of the internal E.M.F.s of the anode and the cathode. But it is much smaller than the minimum tension. The latter is not due to the counter E.M.F., but to the fact that a minimum of work must be done at the cathode in order to produce the radiation of negative electrons in sufficient density." It cannot be said that the theory of the arc even in this modern form is by any means complete, but since it offers a new basis, theoretically sound and amenable to experimental verification along many independent lines, the electron theory of the arc deserves to be assiduously cultivated.

We commented in our issue of August 7th upon a circular addressed by the Board of Trade to tramway and light railway promoters, criticising a number of points in the construction and equipment of electric cars. The current official circular of the Tramways and Light Railways Association publishes a series of notes received from two companies commenting on those criticisms. These notes agree in traversing the Board of Trade objections to the reversed staircase, one pointing out that it is much safer for passengers ascending and descending than the old pattern. The other mentions a rather neat device—fitting a plate glass riser in the fourth step, thus giving the motorman a side view. We recently mentioned an equivalent device adopted by the Electric Railway and Tramway Carriage Works of perforating the riser of this step. The notes also agree with each other, and substantially with the Board of Trade, on the subject of adjustable trolley stops and means of securing trolley heads from falling, but differ as to the advisability of fitting folding steps, and also as to the pattern of life-guard in use and the use of a trolley rope. The moral seems to be that it is at present premature to stereotype devices, the suitability of which can only be proved by fairly long experience, and depends, to some extent, upon local conditions. In this connection we think it rather unfortunate that many tramway engineers prefer not to run the risk of fitting life-guards of other than the trigger type, although they believe them to be more suitable in given cases, simply for the reason that the Board of Trade officers have strongly approved of the trigger type. A more efficient, a more truly automatic and less troublesome guard is conceivable, but progress in this direction has been nearly stopped since the opinion of Board of Trade inspectors in favour of trigger actuation has been made so manifest. We by no means undervalue that type of life-guard, but it is certain that it lacks one of the most important qualities of the ideal, and it is prima facie absurd to suppose that it represents the limit of invention.

That foreign experience supports our view of the objections to official dictation is evident from a communication from the Tramway Union of France, also published in the official circular of the Association. M. Lepine, Prefect of Police for the Department of the Seine, has recently circularised the tramway company in this district calling upon them to submit designs of life-guards for his approval. He lays down two technical conditions only—that the guards shall not project beyond the platform, and shall be so fixed that they can be lowered on to the track, either by the drivers or even automatically; and he refers to the success which has been achieved by life-guards in use on the tramways at Marseilles and Munich. The French Tramway Union does not agree, and fears that the order may lead to the adoption of crude apparatus, which will have to be removed after a short trial. It cites the case of Berlin, where the police have "suppressed" the net life-guards used by the tramway company, and another in which the authorities of Nuremburg have prohibited the use there of the Munich pattern of life-guard, one of the examples suggested by M. Lepine. It is stated that during 1902 there were in Munich four deaths, six cases of serious and 55 of slight injuries, due to the crushing of sufferers under the front part of the car. In some cases the injuries were aggravated by the life-guard. These examples of the mistakes made elsewhere may not deter M. Lepine, but we believe that the Board of Trade officers recognise that selection by experience is the most satisfactory process, and that they will give a fair consideration to all apparatus put before them, although it may differ from something previously approved.

We have reported at considerable length the proceedings of the Royal Commission on London Traffic from the commencement, and the importance of the subject has warranted us devoting a good deal of space to this matter. Railway and tramway questions have so far predominated, and the problem

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which the Commission has to solve is not made less difficult by the difference of opinion existing between the London County Council and the London Borough Councils. On the one hand, the former has made up its mind that if a permanent traffic commission be appointed as the controlling tramway and railway authority for London, as suggested in the reference to the present Commission (*The Electrician*, Vol. L., p. 667), its functions should be limited to railways, and that absolute power should be vested in the London County Council with regard to tramways. Necessarily, this would involve the abolition of the veto now possessed by the Borough Councils, who, in their turn, are one and all against such a procedure. Indeed, so jealous are the Borough Councils of this right to exercise authority, that in one or two instances objection has been made to the constitution of any new Traffic Commission which would take from them their present right of veto. The majority of the Councils, however, have expressed their willingness to surrender all powers which they may have concerning tramways to such an authority, provided the London County Council also waives its objectionable right of veto.

As the law stands at present, a Borough Council can negotiate with a company for extensive road widenings as a price for its consent to a tramway, and the scheme can then be vetoed by the London County Council on general principles. Later on, the London County Council may itself promote a similar tramway, and exact from the Borough Council one-third of the cost of road-widenings, in accordance with its usual practice. One case of this kind has actually occurred in Hammersmith; and there would doubtless have been many more if companies were not naturally shy of promoting tramway schemes within the county of London, owing to the attitude of the London County Council in opposing schemes, not on their merits, but solely because the Council considers that it should be the only tramway authority in the metropolis. If any alteration in the existing state of affairs is made, it should certainly include the establishment of a permanent Traffic Commission for London, to regulate railways, tramways and all other traffic, and to which all vetoes should be surrendered. With absolute power as to schemes presented to it, for devising schemes itself, and for making suggestions as to extensions of existing means of communication, such a tribunal would be in a position to improve locomotion in London much more quickly and at much less expense than is possible under present conditions. It is of supreme importance, however, that the new authority should only be an administrative one, and have no power to build tramways or railways itself.

In the interests of electric traction, as well as in the interests of the public generally, it is to be regretted that the Central London Railway has not yet devised some means to prevent the possibility of the derailment of cars on cross-overs. Traffic was interrupted for several hours one evening this week from this cause. As explained in our columns last September when the first of these derailments occurred, the cause is apparently the push of the rear motor car as the train passes the unguarded portion of the rails, and we were then informed that this would in the future be obviated by switching off the rear car when the train was taking cross-overs. Perhaps this precaution is neglected by the drivers, or possibly the phenomenon is now found to be due to another cause, but in either case an effective remedy should be sought.

Personal.—Dr. J. A. Ewing, F.R.S., who, it will be remembered, resigned the Professorship of Magnetism and Applied Mechanics at Cambridge University to take up the position of Director of Naval Education, has been elected Honorary Fellow of King's College, Cambridge.

Wireless Telegraphy in French Africa.—The Paris newspapers state that Col. Marchand is shortly to undertake a mission to inspect the French possessions in Africa and to consider the possibility of establishing wireless telegraph communication between the Soudan, French West Africa and Algeria.

The Metric System.—It is reported that early next session a bill will be introduced into the House of Lords for the compulsory adoption of metric weights and measures throughout the United Kingdom. It is stated further that Lord Belhaven will move the first reading, which will be seconded by Lord Kelvin.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Lagos—Brass	Nov. 14, 1903 ..	Dec. 2, 1903
Tenedos—Chio	Nov. 25, 1903 ..	Nov. 29, 1903

Institution of Electrical Engineers.—At the meeting of the Institution of Electrical Engineers on Thursday next, an interesting ceremony will take place prior to the reading of the Papers. December 10th is the 300th anniversary of the death of William Gilbert, and to commemorate the event the Institution will present to the Borough of Colchester, in which town Gilbert was born in 1544 and died in 1603, a historical picture representing Dr. Gilbert in the act of showing his electrical experiments to Queen Elizabeth and her Court. The Mayor and other representatives of the borough of Colchester will officially attend the Institution meeting on Thursday next in order to receive the picture. M. E. Hospitalier will then read his Paper, and, if time permits, the discussion on it will be followed by Dr. Behn-Eschenburg's Paper, as announced on p. 239.

Proposed Yorkshire University.—A communication from the Privy Council, in which it is announced that their lordships agree to recommend the grant of a charter, has been received by the agents for the promotion of the proposed Yorkshire University. The grant is on the understanding, however, that the West Riding County Council makes a substantial subvention towards the university, and that the promoters undertake to raise a capital sum of £100,000 by the earliest possible date. The communication also states that exception is taken by the Privy Council to the title, "Victoria University of Yorkshire," and the suggestion is made that another title should be found which does not imply possessory interest in the whole of Yorkshire, since Leeds is to be the centre of the university. It is also suggested that the name "Victoria" may lead to confusion with the Victoria University of Manchester.

Motor Vans and Waggons.—The Automobile Club of Great Britain and Ireland has decided to form an association for motor van and waggon users as a section of the Motor Union. The objects of the association are set out as follows:—

(1) To represent the views of motor van and waggon users before the Local Government Boards; (2) To resist undue restrictions being placed upon the use of motor vans and waggons by local authorities; (3) to consider any claim for financial and legal assistance in respect of actions

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at law, either civil or criminal, in connection with the use of motor vans and waggons; (4) to inquire into the question of tare weight of motor vehicles and other questions connected with the use of mechanically-propelled vehicles for the carriage of goods, and to collect information respecting the use of motor vehicles likely to be of service to the members; (5) to originate and promote improvement in the law from time to time directly or indirectly affecting self-propelled vehicular and locomotive road traffic, and to support or oppose alterations in such law; (6) to popularise and assist the development of self-propelled vehicular and locomotive road traffic; (7) to give information and advice, and generally to protect and extend the rights and privileges of users of motor vans and waggons.

Dredgers in Natal Harbour.—The South African representative of Messrs. Greenwood and Batley informs us that the Natal Harbour Department has just given the firm an order for the lighting of the suction dredgers "Curlew," "Ibis" and "Water Rat," in order that these dredgers may work by night. The plant will consist of three complete sets of 7 B.H.P. 4·4kw. de Laval steam turbo-dynamos arranged to work either condensing or non-condensing at a steam pressure of 50lb. and 110lb. per square inch, two of them having been fitted for the latter pressure. The voltage of the dynamos will be 110. These sets are very compact, weighing, we are informed, only 8cwt. each and occupying a space of 5ft. by 2ft. by 2ft. 6in. high, and they require little in the way of foundation. The erection of the plant and the wiring of the dredgers will be done by the department, under the supervision of Mr. G. Stobie, the harbour electrical engineer, and it is expected that the plant will be completed and in operation early in the new year.

Opening of the Barking-Beckton Tramway.—The light railway for which the Barking Urban District Council obtained powers in 1899 running from Barking to Beckton has been inspected and approved by the officials of the Board of Trade. The line itself is only 1 mile of single track, but the Council have other tramway powers which will soon be put into force. The main feature of interest is that the line has to cross a lift-bridge. On the whole, the ground covered by the tramway is level, but gradients as steep as 1 in 25 occur. The gauge of the track is standard, and the rails are of the girder type, weighing 90lb. per yard. There are curves as sharp as 45ft. radius. Side poles are employed for supporting the trolley wires, and the feeders are laid on the solid system. Seven double-deck cars, seating 50 passengers each, have been provided. They are equipped with two 30 H.P. motors. Mr. A. H. Seabrook, the resident engineer, is also tramway manager, and Mr. W. C. C. Hawtayne was consulting engineer to the scheme.

Breakdown at Lincoln.—An unfortunate but unavoidable occurrence took place at Lincoln on Thursday last week, when the entire generating station had to be shut down for a short time just at the period of maximum load. A short-circuit occurred on a consumer's premises, and the fuse, in blowing, started an arc on to the lid of the fuse box, causing an earth. The excess current developed a fault in one of the network boxes, and apparently set up a short-circuit between the outers of the three-wire system. Triple concentric cables are used, and it was, therefore, impossible to attempt burning the fault out; everything was, therefore, shut down, and the network split up so as to isolate the faulty section. Certain sections of the city were got on again before 8 p.m., and all consumers, with the exception of those on the one faulty section, were being supplied later in the evening. By the following evening the normal supply was resumed. We are informed that the box in which the fault occurred has not yet been removed, and therefore no further details are available.

London Electrical Contractors' Association.—At a meeting held last Tuesday evening, with Mr. E. L. Berry, president, in the chair, Mr. F. B. Joseph read a Paper on the theme, "Are we Tradesmen?" Reasoning by way of elimination, the speaker arrived at the conclusion that, considering the scientific knowledge, the artistic skill and the business capacities which electrical contractors of to-day must necessarily possess, they were entitled to call themselves professional men. If this be conceded, then a code would have to be drawn up, and the speaker suggested one or two points, with regard chiefly to commercial etiquette, which might be embodied therein. In the discussion which followed, Mr. Joseph's views were not generally accepted, and the general tenor may be summed up in the idea that it was not so much what a man called himself as what he did which told of his worth. But this more or less academic controversy soon changed into more practical channels. Several speakers urged the desirability for framing rules to the effect that the wiring of buildings ought to be done by the same firm which supplies the fittings, because otherwise it was not only difficult to fix responsibilities in case of complaints, but much time and trouble was occasioned by the contractor for the fittings having to trace the wires laid by someone else. A useful suggestion was made by a speaker, who advocated that a plan of the wiring should be made and completed as the work went on.

New German Cable.—In 1900 the first cable connecting Germany and America by way of Emden, Azores (Horta) and New York was laid, and a second cable is being laid side by side with the older one. The first section of the new cable, extending from Borkum to Horta, as well as the connection between Emden and Borkum, was completed by the end of October, two months in advance of the contract time. The *Elektrotechnische Zeitscrift* states that in the first 800 nauts of cable, the copper employed weighs 500lb. per naut, and the gutta-percha 290lb. per naut. The conductor consists of a central wire 2·73mm. (0·107in.) in diameter, around which are stranded 12 wires 0·910mm. (0·036in.) in diameter. The spaces between the last-named wires are filled up with Chatterton compound. At a temperature of 24°C. the resistance per naut is given as 2·42 ohms. Gutta-percha and Chatterton compound are applied in alternate layers, three of each material being used. It is stated that the insulation resistance is not less than 400 megohms, and the capacity not more than 0·435mfd. per nautical mile. In the second length of cable, of about 1,150 nauts, the conductors weigh 400lb. and the gutta-percha 280lb. per nant. The middle wire has a diameter of 2·42mm. (0·095in.), and the surrounding conductors are each of 0·81mm. (0·032in.). At 24°C. the resistance per naut is said to be 3·025 ohms. The specified insulation resistance is the same as the larger cable, but the capacity is 0·405mfd. per naut. As a protection against teredos, the first length of the cable, which is laid in comparatively shallow waters, is wound with brass tape. The armouring of the shore end consists of 12 galvanised iron wires, 5·1mm. (0·201in.) in diameter, upon which again are wound 14 wires of 7·6mm. (0·30in.) diameter. An armouring of 18 galvanised steel wires 3·1mm. (0·122in.) in diameter forms the protection for the heavy deep-sea cable, while 17 galvanised steel wires, 2·1mm. (0·0825in.) in diameter, are employed for the lighter deep-sea cable. There are three different sizes of intermediate cable, the armourings being:—Eight galvanised iron wires 7·6mm. (0·30in.) in diameter; 10 galvanised iron wires 7·1mm. (0·295in.) in diameter, and lastly, 12 galvanised iron wires 5·1mm. (0·201in.) in diameter. A tensile strength of from 40kg. to 47kg. per square millimetre (57,400lb. to 67,400lb. per square inch) was specified for the iron wires, and for the steel wires a tensile strength of from 110kg. to 132kg. per square millimetre (157,000lb. to 190,000lb. per square inch).

Administration of the Motor-Car Act.—The Highways committee of the London County Council, which has been carefully considering the question of the administration of the Motor-Car Act of 1903 in London, has made a report to the Council upon the matter, and makes one or two recommendations, owing to the opinion which it holds that there are other matters to be dealt with than those considered in the regulations of the Local Government Board, which were summarised in our last issue. Under the act any manufacturer or dealer in motor cars may be assigned a general identification mark, which may be used for any car on trial. For this the registering authority may charge any fee up to £3, and the Highways committee of the London County Council recommend that the maximum should be charged. Other matters not dealt with by the Local Government Board are specified as follows:—(*a*) The prohibition of motor cars on special roads. (*b*) Speed limit. (*c*) Erection of notice boards. The committee, however, agree with the Local Government Board that the provisions of the act for the reduction of the speed limit in certain districts to 10 miles an hour and the prohibition of motors in certain

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streets should not be resorted to unless, after a time, this becomes absolutely necessary. It is, therefore, the intention of the Highways committee of the London County Council to submit a further report, after having watched the working of the act, dealing with other details. An advertisement will shortly be issued stating the date by which the Council will be prepared to register motor cars and motor cycles and to issue licences for drivers. The committee does not propose that the Council should provide plates for the use of owners.

An Extensive Pump Manufacturing Plant.—The firm of Henry R. Worthington is now erecting at Harrison, N.J., what is probably the largest pump manufactory in the world. These works will accommodate from 4,000 to 5,000 men, and will cost about £400,000. They consist of a main machine shop with side galleries over 1,006ft. long, an erecting shop 592ft. long and of the same section as the machine shop, and an erecting shop 210ft. in length and four galleries in height in the side bays connecting the two shops. The main foundry is 600ft. in length, and there is also a special foundry for small work, 410ft. in length, with a building 200ft. by 60ft. in size, for cleaning castings, connecting the two. The pattern shop is four storeys high and 550ft. long, and is divided by fire walls into four sections. The north section will be used for offices and drawing offices, the adjoining section for the pattern shop, and the balance of the structure for pattern storage. The power house is a building 172ft. by 102ft. Electric power distribution is to be employed throughout, and the grounds will be illuminated by arc lamps. There are many other buildings which will be used for packing, storing and shipping goods, &c. The buildings are so arranged that additions can be built when the work demands it. All will be connected by a complete system of railway tracks which will enter the buildings and place the works in direct communication with the Delaware, Lackawanna and Western, the Erie and the Pennsylvania Railroad systems. The new plant will be devoted entirely to the mannfacture of waterworks machinery, water meters, cooling towers, condensers, feed-water heaters, centrifugal pumps and steam pumps of all kinds.

Royal Society.—The anniversary meeting of the Royal Society was held on Monday, when the following Council was elected :—President, Sir William Huggins, K.C.B., O.M., D.C.L., LL.D. ; treasurer, Alfred Bray Kempe, M.A. ; secretaries, Prof. Joseph Larmor, D.Sc., D.C.L., LL.D., and Sir Archibald Geikie, D.C.L., Sc.D., LL.D. ; foreign secretary, Francis Darwin, M.A., M.B. ; other members of the Council, George Albert Boulenger, F.Z.S., Prof. John Rose Bradford, M.D., D.Sc., Prof. Hugh Longbourne Callendar, LL.D., Frank Watson Dyson, M.A., Prof. Harold Baily Dixon, M.A., Sir Michael Foster, K.C.B., D.C.L., Prof. Percy Faraday Frankland, Ph.D., Sir Robert Giffen, K.C.B., LL.D., Prof. William Dobinson Halliburton, M.D., F.R.C.P., Ernest William Hobson, Sc.D., Prof. John Wesley Judd, C.B., LL.D., Prof. George Downing Liveing, M.A., Prof. Augustus Edward Hough Love, M.A., Adam Sedgwick, M.A., William Napier Shaw, Sc.D., and Captain Thomas Henry Tizard, R.N., C.B. It will be seen that Sir Archibald Geikie was elected as successor to Sir Michael Foster, who retired from one of the secretaryships. The report of the retiring Council pointed out in what directions contributions to the Society had been distributed. To the International Catalogue of Scientific Literature foreign countries had contributed £6,829. Reference was also made in the report to the two new departments which have been organised in the National Physical Laboratory—viz., optics and photometry—and also to the fact that the equipment of the engineering laboratory had been greatly augmented. Sir William Huggins, the president, then delivered his address, at the commencement of which he paid great tribute to the memory of the 16 fellows and four foreign members who had died since the last anniversary meeting. Dealing with the general advance of science, he briefly referred to the formation of the new Faraday Society, which he pointed to as the result of the inevitable specialisation of natural knowledge into distinct branches. This was happening nowadays so rapidly that these specialised activities found themselves confined and trammelled by the necessary limitations of one society, such as the Royal Society. The pressure from within became gradually too great to be controlled, and could find relief in only one of two ways : by the division of the Royal Society itself into a number of sections or branches, which remained integral parts of the Society, or else by what actually happened—the successive formation and swarming off as need arose of special societies restricted to the study and promotion of a single branch of science. Without in any way regarding these institutions as rivals, Sir William Huggins desired that the Royal Society should be modelled on the lines of the Académie des Sciences in Paris, which was divided into 11 sections, each dealing with a separate branch of science; and the question still remained an open one to him as to whether the Royal Society, without entering into any formal relationship with the special societies, could not meet the pressing need of integration in respect of its own publications and those of the special societies. Would it not be possible, he asked, to extend to the more important of the special societies the privilege of duplicate publication in their own memoirs of all Papers read before the Royal Society dealing with their particular branch of science ? Sir William Huggins, at the close of his address, announced the names of the recipients of the Society's medals, which were given in our issue of November 13th.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

To-day (FRIDAY), December 4th.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Paper to be read : "Recent Developments in the Construction and Working of Gas Engines," by Prof. D. S. Capper.

INSTITUTION OF CIVIL ENGINEERS : STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, Westminster. Paper to be read : "Artificial Draught, as applied by Fans to Steam Boilers," by W. H. A. Robertson.

SATURDAY, December 5th.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street. Paper to be read : "Superheat," by W. H. Booth.

TUESDAY, December 8th.

FARADAY SOCIETY.

8 p.m. Meeting in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W. Papers to be read : (1) "Total and Free Energy of the Lead Accumulator," by Dr. R. A. Lehfeldt (Adjourned Discussion.) (2) "Bitumen in Insulating Compositions," Part I., by D. A. Sutherland. (3) "Notes on Aluminium Welding," by Sherard Cowper-Coles. (4) "Electrochemical Installation at the Borough Polytechnic Institute," by F. M. Perkin.

INSTITUTION OF ELECTRICAL ENGINEERS : GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street. Paper to be read : "The Training of an Electrical Engineer," by Prof. F. G. Baily.

THURSDAY, December 10th.

INSTITUTION OF ELECTRICAL ENGINEERS : STUDENTS SECTION.

2 p.m. Visit to the Incandescent Lamp Co.'s Works, Brook Green, Hammersmith.

KING'S COLLEGE ENGINEERING SOCIETY.

5 p.m. Meeting at King's College, Strand. Paper to be read : "Aluminium," by Prof. E. Wilson.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Presentation of Picture of Gilbert to the Mayor and Borough of Colchester. Papers to be read : (1) "The Slow Registration of Rapid Phenomena by Strobographic Methods : The 'Ondographe' and 'Puissancegraphe' (Wave Recorder and Power Recorder)," by E. Hospitalier ; and (time permitting) (2) "On the Magnetic Dispersion in Induction Motors and its influence on the design of these Machines," by Dr. Hans Behn-Eschenburg.

INSTITUTION OF ELECTRICAL ENGINEERS : DUBLIN LOCAL SECTION.

8 p.m. Meeting at University College. Paper to be read : "An Experimental Study of Stationary Electric Waves, with Special Reference to the Phenomena of Electric Resonance and Overtones," by the Very Rev. Monsignor Molloy.

FRIDAY, December 11th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda : (1) "A Method for Mechanically Reinforcing Sound," by the Rev. T. C. Porter ; (2) "The Simmance-Abady 'Flicker' Photometer," by Messrs. Simmance and Abady ; (3) "Exhibition of a Conductometer," by R. Appleyard ; (4) "A Model to Illustrate Various Properties of Wave Motion," by Prof. L. R. Wilberforce.

SATURDAY, December 12th.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street. Paper to be read : "Steam Turbine Machinery," by A. A. Wynne.

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THE DE FOREST WIRELESS TELEGRAPH SYSTEM.

Last week we were enabled to witness some highly successful and interesting experiments in the transmission and reception of telegraphic signals by Hertzian waves between Holyhead and Howth, a distance of 65 miles as the crow flies. Some three or four weeks ago Dr. Lee de Forest, the inventor of the system which is known by his name, came to England from the United States of America and installed two complete sets of apparatus at the Holyhead and Howth stations formerly used by the engineers of the General Post Office when experimenting with wireless telegraphy between the two countries. From the time that the suggestion was first made that Dr. de Forest should exhibit his system in this country considerable interest has been evinced by several of the Home Government departments, and, in addition to the fact that Post Office officials are in constant attendance at the stations, the following gentlemen were present at a demonstration last week:—For the General Post Office, Mr. J. Gavey (Engineer-in-Chief) and Mr. John Ardron (Assistant Secretary, Telegraphs); for the War Office, Major Bayly and Lieut. Evans; for the Admiralty, Lieuts. Loring, A. Yeats-Brown and Davies. The Director-General of Newfoundland, Mr. Burchell, was also present, while last Tuesday the working of the system was explained and demonstrated to representatives of the Dutch Government. We are informed that all present on these occasions expressed their entire satisfaction, and in these circumstances Dr. de Forest is to be congratulated on the favourable reception which has been accorded him.

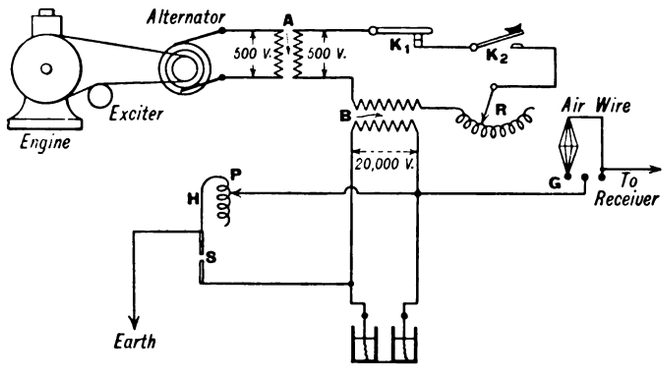

FIG. 1.—DIAGRAM OF CONNECTIONS OF TRANSMITTING APPARATUS.

A clear idea of the method of working may be obtained from the drawings which we reproduce herewith. In Fig. 1, on the extreme left, is a 3 H.P. petrol engine loaned for the occasion by the Fairbanks Morse Co. of America; to this is coupled by a belt a 1 kw. alternating-current generator, designed to work at 500 volts and a frequency of 50 ~ per sec. The alternator is excited by a small continuous-current machine shown in close proximity to the engine; this is driven by the mere contact between its pulley and the belt. Current is taken from the alternator to the primary of a one to-one transformer, denoted by A, whose object is to steady the load and prevent any induced high potentials due to static discharges or other causes finding their way to the generator. From the secondary of transformer A, current is then taken, by way of K_1, K_2 and R, to the primary of the step-up transformer B, which raises the potential from 500 to 20,000 volts. In the experiments which we witnessed, B was an oil-cooled transformer, but in the future it is proposed to build and use such appliances in the form of the body of an induction coil without a complete magnetic circuit; greater convenience and portability will be thereby secured.

K_2 is a sending key of extremely simple design, and in many respects similar to an ordinary Morse key. It is mounted on the top of a box, and by means of a bell-crank lever breaks the 500-volt circuit within the box. No oil or insulating medium other than atmospheric air is employed to minimise the spark at break, and the contacts consist of small pieces of ¼in. circular steel rod with surfaces brought flush together. The box is, however, designed for the reception of oil if it be required to work with more than 6 amperes. K_1 is a change-over switch, of which more will be said hereafter. R is what is termed a "reactance regulator," and its true function is to prevent the formation of an arc across the spark-gap should the rate of delivery of energy to the circuit become excessive. It is not automatic, but if a tendency to arc at the spark-gap should occur, then the handle of the reactance regulator may be so operated as to cut in more turns of wire and thus choke down the excess energy.

Coming now to the oscillating circuit itself, which is supplied with power by the secondary of the transformer B, two or three features of unusual interest and ingenuity will be observed. Herein is a practical illustration of the point relating to the disposition of Leyden jars, explained by Dr. de Forest in his article published in last week's *Electrician*. As a result of careful investigation he has discovered that the efficiency of a number of Leyden jars depends, to a large extent, on the relative positions which they occupy, and

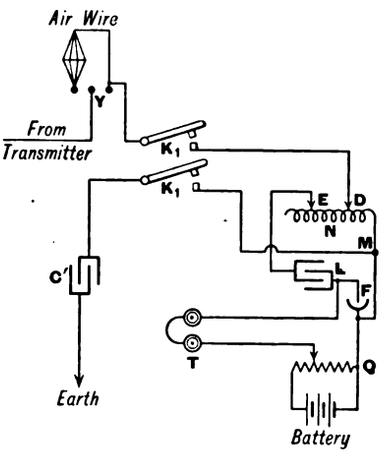

FIG. 2.—DIAGRAM OF CONNECTIONS OF RECEIVING APPARATUS.

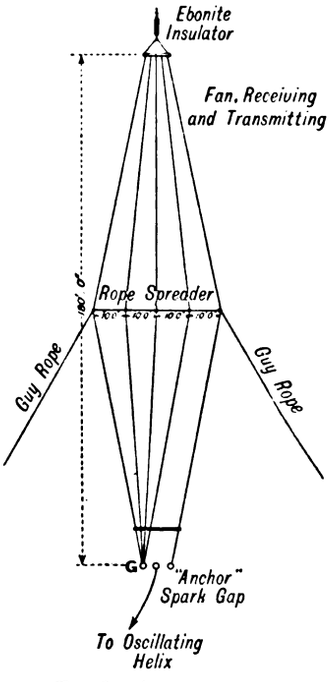

FIG. 3.—ANTENNA.

further research led him to conclude that by placing the jars in a circle the very best results would be obtained. But, obviously, such an arrangement would be far too inconvenient and cumbrous to adopt in actual practice, and, therefore, he arranges them in rows with the shortest possible length of conductor between; the number employed in the experiments under notice was 12, in four rows of three in a row, and these were connected up in two parallel sets, each set having six jars in series. The total capacity of the jars used, when grouped in this manner, is 0·006mfd. S is the spark-gap, the electrodes consisting of ¼in. brass rod, nickel-plated, with their sparking surfaces about ¼in. apart. This latter dimension may be varied, however, by vertical movement of the upper electrode through a binding post. A remarkably clean, snappy spark is obtained, with an entire absence of arcing, its normal frequency being about 60 ~ per sec., although the frequency of the oscillating circuit is, of course, considerably higher. The helix H plays a most important part in the operations, as, by it, an approximation to syntony is obtained. It consists of four turns of ¼in. nickel-plated copper tube, the helix itself having a diameter of about 18in. By means of the movable contact P, the amount of self-induction in the circuit may be varied at will, and owing to the extremely high oscillating frequency, very little movement makes a considerable difference to the nature of the waves emitted. At G there are two spark-gaps, each $\frac{1}{32}$in. in length, the middle electrode being attached to P and the Leyden jars, that on the left hand side to the four-wire antenna, and that on the right-hand side to the single remaining wire. Now, it is perfectly

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obvious that in transmitting signals these spark-gaps will be bridged with ease, but in receiving quite the reverse holds good, and they act, to all intents and purposes, as insulators. Hence, it will be seen from Figs. 1 and 2 that in transmitting all five antenna wires are in parallel, but in receiving only four are in parallel, and these four are at the same time in series with the remaining one. In the latter case the result is a vertical loop, having a single wire for one side and four wires for the other.

The receiving apparatus (Fig. 2) consists of an adjustable inductance N, a "responder" F, one adjustable capacity L, a potentiometer Q, a telephone T, and a fixed capacity C^1. Unfortunately, the patent rights relating to the responder are not yet secure, but Dr. de Forest informs us that it works upon an electrolytic principle, the resistance becoming decreased upon the reception of Hertzian waves. Moreover, it requires the time constant of the oscillating circuit, so that the maximum effect is obtained—that is to say, so that the circuit is as nearly in tune with the transmitted waves as possible. Another device for obtaining the best effect is found in the potentiometer Q, by varying which the loudest possible sound is obtained in the telephone receiver.

Fig. 3 shows the antenna. The extreme height is 180ft. above the top of the cliff, which is itself over 400ft. above sea level. This altitude might well be expected to provide ideal conditions for the transmission and reception of Hertzian waves; but, as a matter of fact, considerable difficulty in making a good earth connection is experienced. About halfway up the mast the receiving wires are kept 10ft. apart by means of a rope spreader, and the extreme outside wires are attached to guy wires fastened to the ground. At the top, all five wires are metallically connected, but at the bottom only four are connected, the remaining one being insulated from the rest. Bare tinned 7/22 copper wire is used, and is exceedingly light and suitable. It will be seen from Fig. 2 that, when receiving, the four wires of the antenna, with the earth, act as a condenser, and thus the impulses are received on a complete loop, since the other side of the condenser C^1 is also earthed.

One of the chief advantages of the system lies in the fact that, so long as the frequency of the transmitting spark is maintained practically constant, no adjustments whatever have to be made; this is of considerable advantage, and permits the employment of a less highly-skilled operator than in the case where elaborate and delicate adjustments have to be carried out. No pretensions to syntony are made; on the contrary, Dr. de Forest is very emphatic in pronouncing the opinion that absolute tuning is utterly impossible at present. He certainly does adjust his circuits so as to obtain maximum effects, and, in doing so, he doubtless tunes them, but he does not claim that his apparatus then becomes unaffected by all other waves, nor that other instruments than his own are unable to pick up signals intended for himself. However, it is by no means difficult to distinguish, in the telephone receiver, oscillations of different frequencies. For instance, by varying the frequency of an ordinary electric trembling bell and holding it in the proximity of the antenna, the variations could be followed with great accuracy. Thus, the actual frequency of the emitted oscillations are actually reproduced. During the course of the experiments the engine slowed down, and the frequency of the transmitting spark consequently diminished; this was immediately perceptible to the highly-trained telegraph operator at Howth, who almost immediately sent the following message:—"You have my sympathy. I can hear your engine slowing down." On one occasion a violent hailstorm came on, and the sounds heard in the telephone receiver

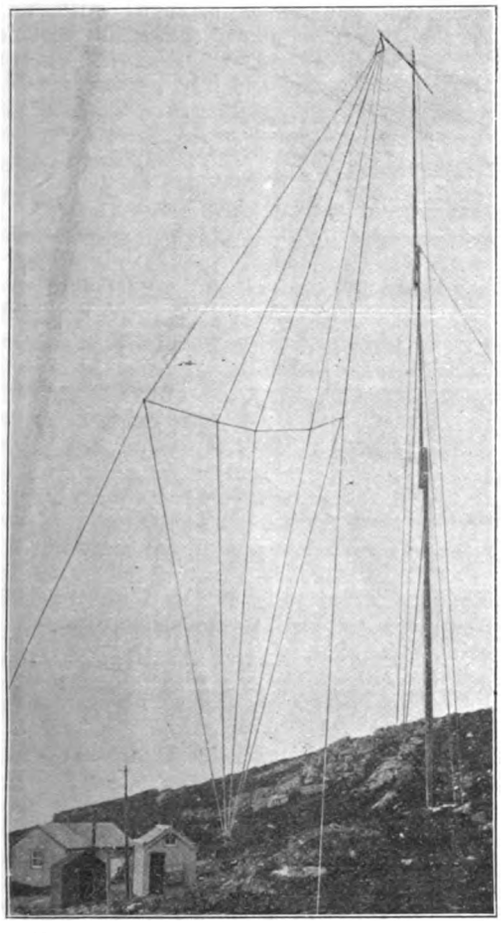

FIG. 4.—SHOWING ARRANGEMENT OF ANTENNA.

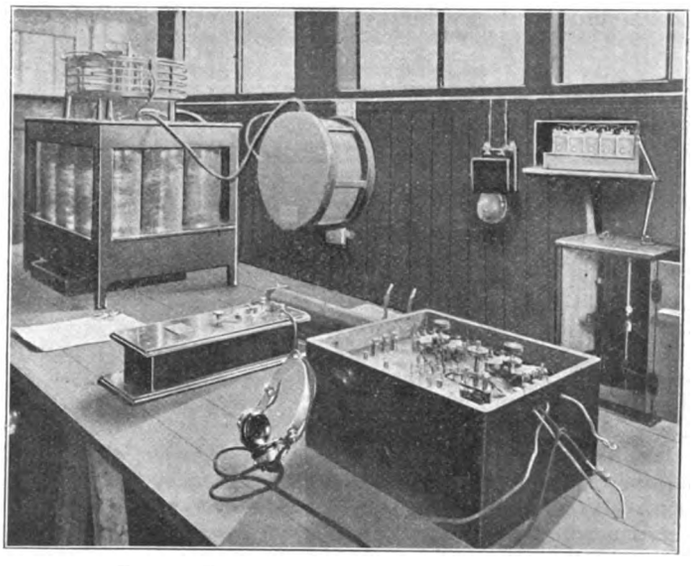

FIG. 5.—TRANSMITTING AND RECEIVING APPARATUS.

no "tapping back." It will be remembered that he formerly employed a device, the operation of which depended upon an entirely different principle (see p. 171, *The Electrician*, November 20, 1903), but he has now abandoned it, and has adopted the present one, which is apparently a great improvement.

Owing to the fact that a permanent connection is made at Y, a change-over switch, K_1, has to be provided, which completes the primary circuit of the step-up transformer B when it is desired to transmit signals and at the same time breaks both wires of the receiving circuit. On receiving, however, the switch has to be changed over, thus breaking the primary of the step-up transformer in the transmitting circuit and making the necessary connections from the antenna to the responder. On the reception of an impulse by the antenna, it is conducted by way of Y, D, E and L to the responder F, and thence by M and C^1 to earth. This has the effect of setting up violent oscillations in the circuit D, N, E, L, F, M, which immediately causes coherence in the responder, and a signal is received in the telephone receiver T. The adjustable inductance N and adjustable capacity L are employed for varying

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were such as to warrant the supposition that the hailstones were electrically charged. A continuous crackling noise was heard, but above all could be distinguished, without the slightest difficulty, the signals sent out 65 miles away. Stray signals and "atmospherics" were also received, but there was no hesitation in deciding that such impulses had never emanated from the Howth transmitter. It is perfectly safe to say that if only the spark could be made to produce articulate speech, the problem of wireless telephony would be solved. Dr. de Forest is working at the question at the present time, and he thinks that it will be accomplished by the employment of very high voltage continuous current with the adoption of the "speaking arc" phenomenon.

We measured speeds of from 20 to 30 words per minute, while on one occasion no fewer than 16 words were correctly received in 30 seconds. To make the tests beyond suspicion we were allowed to select our own messages, which were then sent to Howth and re-transmitted within a few minutes. All messages were not timed, but only a few selected indiscriminately; in no instance did the speed fall below 20 words per minute.

After the conclusion of the above tests a receiving device, invented by Mr. Nevil Maskelyne, was attached to the antenna, when signals were received with the same ease and rapidity as before. Mr. Maskelyne uses a sounder in connection with his instrument, but there is, apparently, no reason whatever why an inker should not be employed with equally good results. No alteration in the arrangement of the antenna and oscillating circuit was made, and there is obviously much to be said in favour of two systems which adapt themselves to one another with such ease. Unfortunately, we are unable to describe Mr. Maskelyne's coherer owing to the patent rights not yet being secure, but we may say that it appears to be both simpler and less expensive to manufacture than a filings coherer.

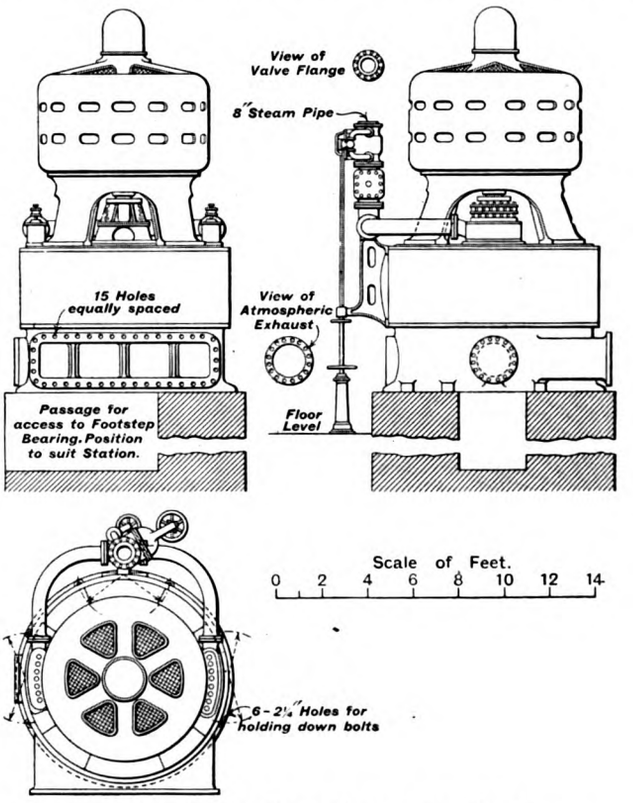
THE YORKSHIRE ELECTRIC POWER CO.'S GENERATING STATION.

The Yorkshire Electric Power Co. will shortly be in a position to supply power to consumers. The buildings for the first generating station are in the course of erection, and contracts have been entered into providing for 6,000kw. of plant and mains. We give a plan of the site location of power station buildings and arrangements of sidings and roadway. This station is one of the four generating stations which the Power Company propose to erect, and is situated on the banks of the Calder, in the district of Thornhill, on a plot of ground adjoining Ravensthorpe and Thornhill station of the London and North-Western Railway, where a junction is effected with the Lancashire and Yorkshire Railway.

A word as to the basis upon which the company are founding their undertaking may be of interest here as bearing upon the somewhat unusual type and arrangement of plant, and also upon the design of the buildings.

Mr. Parshall, who is the consulting engineer to the Power Company, reported that, investigation having been made regarding the cost at which the individual user can produce power for himself under the different conditions of amount of power and load-factor, it had been clearly recognised that the only advantage which the Power Company possessed over the user who has equal facilities in respect to coal and water, was in the magnitude of the undertaking. Against this has to be set the cost of transmission, transformation and distribution. It follows, therefore, that, as a beginning must necessarily be made on a small scale, the advantage which the supply company has over the user must be small, and it becomes necessary to reduce capital expenditure to the lowest possible limit. With these principles in view, the plant now about to be described has been designed, and it is interesting to note by what methods economy in capital expenditure has been attained.

A three-phase system at a frequency of 50 cycles per second has been selected as being most economical and convenient for generation and transmission, the power being generated at from 10,000 to 11,000 volts. The next consideration is that of the generating unit, and it was decided to adopt the steam turbine on account of economy in space and steam consumption. The type adopted is that known as the Curtis turbine, which is being built by the British Thomson-Houston Co. at Rugby. A detailed description and sectional drawing of this turbine was published in our issue of November 20th. Briefly, it may be described as an extension of the principle adopted in the De Laval turbine, where the thermodynamic energy of the steam is converted into kinetic energy, and utilised by impact upon blades set around the periphery of a wheel. In the De Laval turbine the energy is transmitted through one wheel only, whereas in the Curtis turbine of the size adopted by the Yorkshire Power Company the energy is transmitted through four wheels in series, thus reducing the speed to a practicable limit. The size of unit adopted is 1,500kw.; the form and dimensions of the combined turbine and generator is shown below. It will be seen that the set is arranged with a vertical shaft, with the generator above the steam turbine. The



ELEVATIONS AND PLAN OF CURTIS TURBINE AND GENERATOR.
1,500kw., 1,000 revs. per min., 11,000 volts, 50~.

generator has six poles, and is designed for a normal full load output of 1,500kw., with 100 per cent. power-factor at a speed of 1,000 revs. per min. The full-load current will be 86·5 amperes and the voltage between terminals 10,000. The field regulation between no load and full load, with constant field excitation, is 8 per cent. The maximum temperature rise after a run at full load for 24 hours is not to exceed 40°C. The steam consumption is guaranteed not to exceed 19lb. per kilowatt-hour with dry saturated steam, and will be considerably diminished under actual conditions, provision having been made for 150°F. of superheat and a vacuum of 28in. The approximate weight of turbine and generator is 58·5 tons.

The boilers selected are of the water-tube type, and are being made by Messrs. Babcock and Wilcox. Each boiler has a heating surface of 5,730 sq. ft., and a grate area of 100 sq. ft., and is fitted with a superheater and a chain grate stoker. Each boiler is rated to evaporate 20,000lb. of water per hour into steam at 150lb. per square inch from water at 60°F., and to superheat the steam by 150°F.

The condensing plant is provided by Messrs. Babcock and Wilcox, and is being made by Messrs. Mirrless, Watson &

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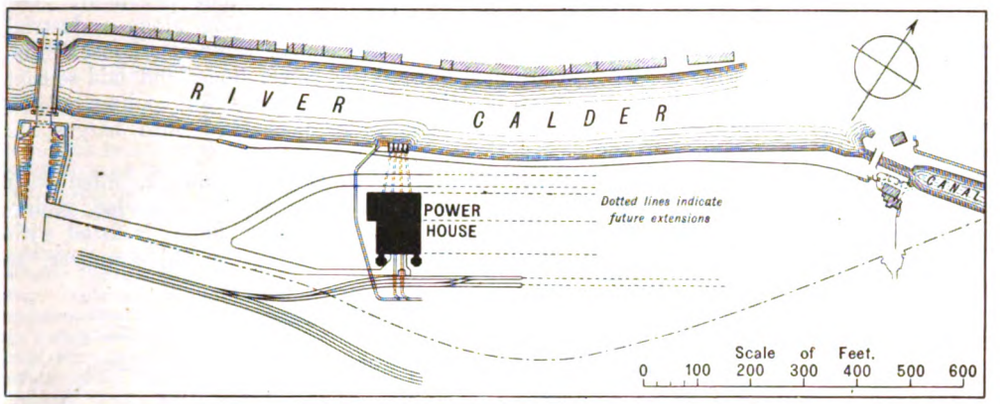
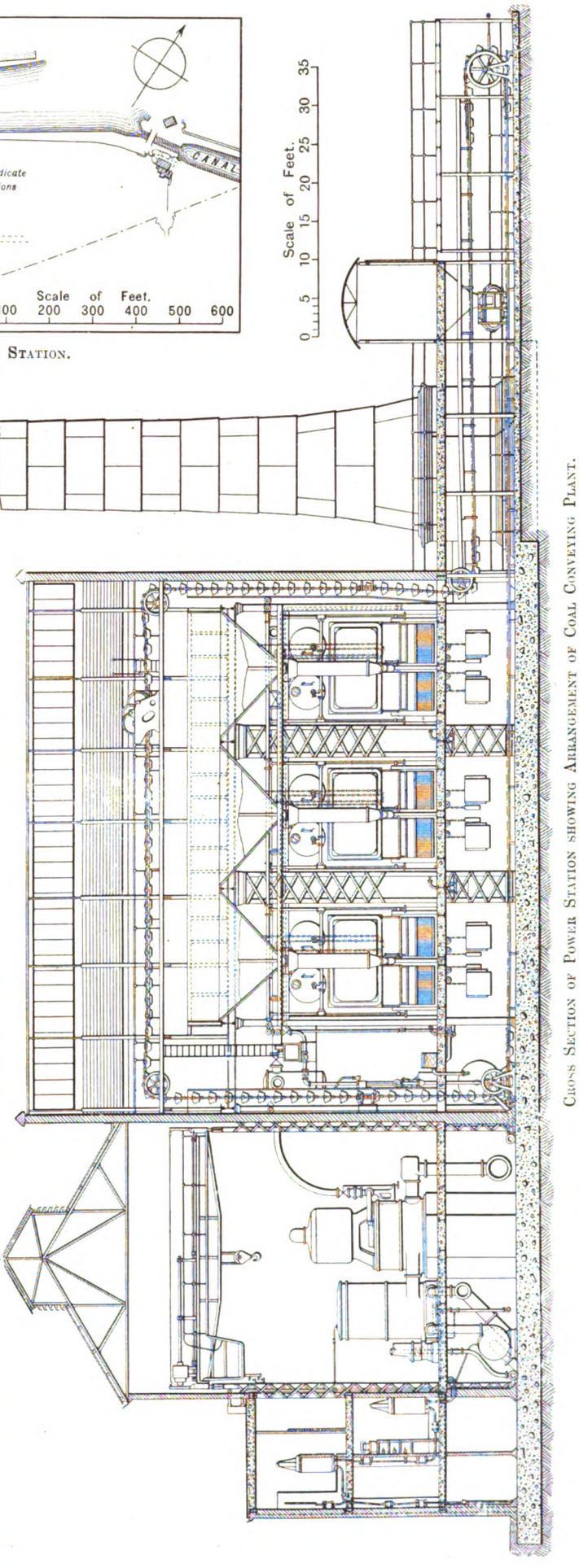


Block Plan of Site showing Position of Power Station.



Cross Section of Power Station showing Arrangement of Coal Conveying Plant.

Co., Glasgow. The condensers are of the vertical surface type, each condenser having a tube surface of 4,500 sq. ft., arranged for passing the water four times through the condenser, and having baffle plates to guide the steam through four times in the opposite direction. To each condenser is attached a three-throw air pump of the Edward's type, 15in. by 8in. at 165 revs. per min., coupled directly to an electric motor. Each condenser is provided with a centrifugal circulating pump, made by J. and H. Gwyne & Co. Each pump is rated to throw 160,000 gallons per hour against a head of 28ft. The pumps are directly driven by electric motors.

Three turbine sets, each of 150kw. capacity when running at 2,000 revs. per min., are provided for supplying power for excitation and auxiliary purposes. The turbines are of the Curtis type, arranged with a horizontal shaft. The voltage supply for excitation and power is 220 volts. These sets are provided with a surface condensing plant, 1,200 sq. ft. cooling surface, with a three-throw air pump of the Edwards type and a motor-driven centrifugal circulating pump.

The switching apparatus is arranged for four generators and eight feeders. The 'bus bars being in two sections which can be connected by a switch, each section is connected to two generators and four feeders. All the switches are of the oil-break type, operated by electric motors and made by the British Thomson-Houston Co. The switches are operated from a switchboard carrying the instruments and measuring devices.

The arrangement of the plant is shown in the plan and elevation, from which will be seen, on referring to the plan, that this plant is laid out in units, comprising one chimney, three boilers, and two generating sets, each generating set being provided with a separate condenser, air pump, circulating pump and suction pipe. As each generating unit will yield 1,500kw. the unit of plant is, therefore, 3,000kw. The present installation of plant comprise two such units, making a total capacity of 6,000kw. When additions come to be made to the plant a single unit of 3,000kw. will take the place of two 1,500kw. units. By the arrangement of plant adopted, each addition to the generating plant bears its own proportion of the capital expense, and initial capital expense on account of the future requirements is therefore avoided.

Referring to the arrangement of plant in the engine house it will be seen that the turbine generator and condensing plant are arranged in close proximity to each other, and each unit has its own condensing plant and an independent circulating system. A novel feature in connection with the circulating system is the use of a dry air pump for the purpose of preventing an accumulation of air in the pipes and condensers. To effect this, pipes are connected to all points at which air is likely to accumulate, such as the top of the condenser, bends in pipes, and carried up to an air cylinder placed about 40ft. above. A suction pipe connects the air cylinder to a dry air pump placed on the engine room floor. The air pumps discharge from the condensers into a ring main which discharge into hot wells placed underneath the feed pumps in the boiler room. The arrangement of steam piping comprises a main header with

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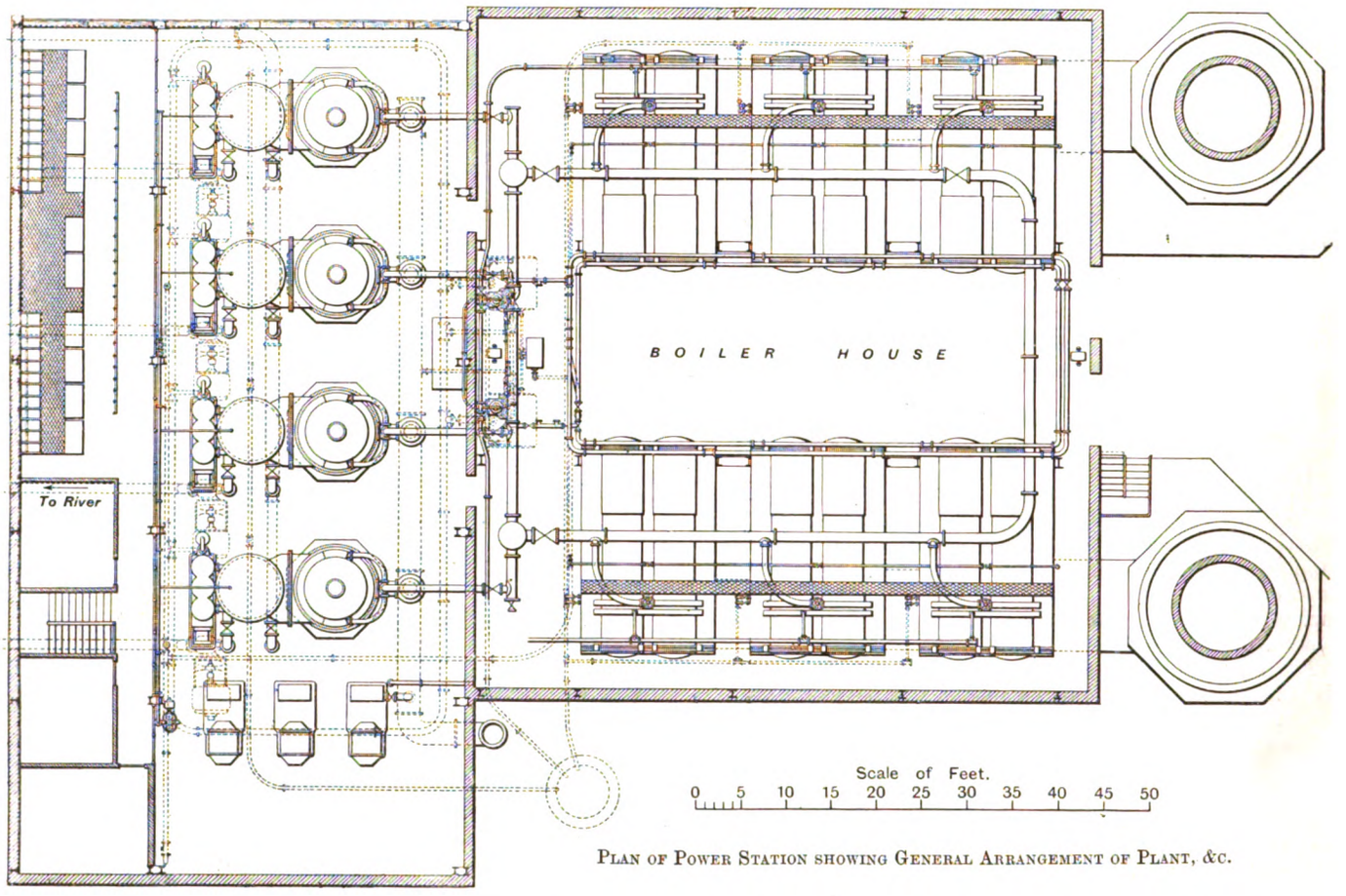
branch connection from each group of boilers, the connection being made through steam separators of large capacity.

Referring again to the block plan the lines of extensions for the buildings, the railway sidings and connections to the railway are seen. The rail level is 22ft. above the ground level, and the space between the rails and ground is to be utilised for coal storage. Two bunkers opposite each boiler house are fitted as coal hoppers for supplying a coal conveyor which transports the coal to overhead bunkers in the boiler room. As the buildings extend along the lines shown in the plan, the sidings will be extended, and opposite each boiler room coal hoppers will be placed for receiving coal and discharging same into the conveyor. A hopper is also provided for receiving coal brought by road and for discharging into the coal conveyors. The coal conveyor is of a light pattern of a new design made by Messrs. Babcock and Wilcox, of presssed steel plate, and has a capacity of 25 tons per hour. The ashes will be handled by trucks running along industrial railway tracks laid in the basement of the boiler house. The tracks are continued outside the power house and laid so that the ashes may be deposited and spread for cooling on the ground inside and afterwards discharged into barges for conveyance elsewhere.

The buildings consist of a steel framework, filled with brickwork, erected on a slab of concrete extended underneath the whole building. The boiler house is fitted with overhead bunkers, which are filled by a coal conveyor, as already described. The chimneys are each 150ft. high and 10ft. in diameter, and are built of steel, and brick lined.

According to present arrangements the plant described and illustrated in this article will be complete and ready for the supply of power to consumers towards the end of 1904.



PLAN OF POWER STATION SHOWING GENERAL ARRANGEMENT OF PLANT, &c.

PHOTOMETRIC TESTS OF STREET LAMPS.

The fifth quarterly report on tests of street illumination, with a statement of comparative costs, has been issued by Mr. J. W. Bradley, Westminster city engineer. The report deals with the quarter ending September 30, 1903. Items 3 and 5 are of greatest interest to electrical engineers, the comparative costs of candle-power per annum working out at 9·4d. for the arc lamp and 9·12d. for the Sugg high-pressure incandescent mantle lamps. Unfortunately, the information contained in the report is of the scantiest, and hence it is quite impossible to draw any but the most general conclusions from these figures. It is stated, for instance, that the tests on the gas lamp were taken at three different angles; but this information is obviously incomplete, unless the angles themselves are given. Again, there is nothing to denote how long the mantles have been in use, and, considering the variation in illumination of the incandescent mantle, especially when used in street lamps, it should have been made clear whether the candle-powers are averages of periodic tests or under what conditions they have been measured.

The photometer employed for the tests is shown in the accompanying illustration. It is a portable type, designed by Mr. William Sugg, and the intensity of the light to be tested is compared with that of a 2 c.p. pentane standard, situated in a well-ventilated chamber lined with dead-black velvet. The horizontal chamber is also lined with the same material, and the respective illuminations are thrown upon a Ritchie screen. At the top of the elevated structure on the right-hand side of the illustration is fixed a mirror with its reflecting surface downward. Obviously, by looking through the rectangular aperture, the observer is enabled to see reflected in the mirror both sides of the Ritchie disc, divided by the black partition. The end of the horizontal chamber opposite to the pentane standard is left open, so that the light from the lamp under

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TESTS OF STREET LAMPS (GAS AND ELECTRIC) WITH STATEMENT OF COMPARATIVE COSTS.

Description and position of lamps.	No. of lamps tested.	Ave. candle power.	C'pital cost of lamp.	Interest and sinking fund per lamp per annum.	Cost of illumin't per lamp per ann.	Cost of lighting and maintenance per lamp per ann.	Total cost per lamp per annum.	Hrs. of burning per ann.	Total cost per c.p. per hour.	**Test No. 5. Total cost per c.p. per annum.**	Ave. total cost per c.p. per an. inc. tests to date (5 series).	Total No. of t'sts up to date
			£				£ s. d.		d.	d.	d.	
Electric arcs, Trafalgar-sq. (Charing-cross & Strand Electric Light Co.)	6	554	40	On 30 years' period, say £2	£28		30 0 0	3,940	·0033	**13·0**	11·62	34
Electric arcs, Pall Mall (St. James' and Pall Mall Electric Light Co.)	6	585	45	On 14yrs'contract, say £4	£30		34 0 0	3,879	·0036	**13·95**	14·76	37
Electric arcs, Hyde Park-cor. (Westminster Electric Supply Corp.)	5	563	..		£22		22 0 0	3,940	·00238	**9·4**	8·7	29
Refuge lanterns, 4 incandescent mantles, Victoria-street	4	113	15	On 30 years' life, say 15s.	£8 15 6	£3 16 0	13 6 6	3,940	·0072*a*	**28·3**	31·14*g*	20*g*
Sugg's high-pressure lamps, Whitehall, incandescent mantles	6	481	15	Do. 15s.	13 6 2	4 3 10	18 5 0	3,940	·00232*b*	**9·12**	10·3	29
Ordinary single burner, inc. mantle, footway, Victoria-st. type, each 4·2 cubic ft. per hour	6	49	6	Do. 6s.	2 0 0	1 4 0	3 10 0	3,940	·00435*c*	**17·15**	18·15	34
Ordinary flat flame, footway in Whitehall, 2 burners, each 6·16 cubic ft. per hour	6	58	8	Do. 8s.	£5 0 2		5 18 2	3,940	·0062*d*	**24·4**	24·7	27
Ordinary single burner, inc. mantle, Carlton House-terrace type, each 3·25 cubic ft. per hour	6	41	6	Do. 6s.	1 10 11	1 1 0	2 17 11	3,940	·0043	**16·95**	18·95*g*	22
Ordinary flat-flame burners, footway, Chandos-street, Strand, 3 burners, each 5 cubic ft. per hour	6	49	8	Do. 8s.	£9 0 10		9 8 10	3,940	·0117	**46·3**	47·3*g*	24
Scott-Snell lamp, Victoria-st. & S.S.*e*	6	184	..	..	..	..	..	..	..	..	..	6
18in. Windsor lantern, 2 Kem burners S.S.	6	68	..	..	..	..	..	..	..	..	..	6
Refuge lamp, Victoria-st, 3 C burners	1	107	15	15s.	5 18 9	3 0 0	9 13 9	3,940	·00552*f*	**21·73**	21·73*h*	2
Footway lamp, Victoria-st, 2 C burners	1	77	6	6s.	3 19 2	1 13 0	5 18 2	3,940	·00467	**18·4**	18·4*h*	2

a A few defective mantles. *b* Burners re-arranged in "trident" form. Tests taken at 3 angles. *c* Condition of mantles improved. *d* Only burn 5 cubic ft. per hour after midnight. *e* Great variation in different lamps. *f* "Trident" form. It is found that the "trident" arrangement of incandescent burners is a decided improvement on the "group" arrangement. *g* Average of four series only. *h* One series only.

observation may fall upon one side of the disc. In order to obtain equal illumination on both sides of the disc, the whole

SUGG PORTABLE PHOTOMETER.

photometer is wheeled either nearer to or further away from the lamp until equilibrium is obtained.

Fiscal Policy and the Tramway Industry.—The Tramways and Light Railways Association have issued invitations for December 11th to hear an address by Mr. Atherley-Jones, K.C., M.P., the president of the Association, on "Fiscal Policy in Special Relation to the Tramway and Light Railway Industry." Sir C. Rivers Wilson, G.C.M.G., the past president, will take the chair at 8 o'clock at the Society of Arts, John-street, Adelphi, and a discussion and vote will follow in which several gentlemen of eminence in engineering and commercial circles are expected to take part.

SOME NOTES AND GRUMBLES FROM INDIA.

(FROM OUR CALCUTTA CORRESPONDENT.)

Those of us in India who receive electrical plant and instruments from home manufacturers are greatly beholden to the electrical and engineering press for the prominence given recently to our grumble about bad or careless packing, the use of straw and so forth. As if to emphasise the complaint, there has since been a new crop of similar cases reported all round and a number of further examples of the use of straw—the last, we hope.

I wish in the present instance, however, to draw attention rather to the local conditions to which those carrying out electrical enterprises are subject and the difficulties they will meet. A précis of the recently-enacted "Indian Electricity Act, 1903," appeared in your columns recently, and there are evident signs that this act is going to serve a useful purpose. Several of our great electrical firms have special representatives in the country, and they appear to be so far satisfied with their survey that rumours are afloat of many new cities being likely to receive the benefits of electric supply before long. And though electric light is not "the poor man's light" in India—he prefers a wick floating in castor oil or rancid fat—the electric fan is rapidly becoming the Sahib's necessity, so far as the plains are concerned. It therefore follows that many more firms should join in the scramble for the best concessions while they can instead of leaving all to our American cousins. The Americans are here, of course, and the largest job, so far—namely, the Cauvery transmission—has gone to them. Rangoon, which began talking of having electric light in the days of the Jablockoff candle, has now arrived at the stage of receiving tenders, and 25 worthy councillors—for the most part native—have been sagely discussing the relative merits of polyphase and continuous current. Let us leave them to it, and in 20 years they will probably decide that gas—undiluted by mantles—is best.

This is the way with local authorities, who are generally apprehensive lest either they come by a loss or other persons by a profit. But offer to finance and carry out a complete scheme and they will probably agree, and there is money in it

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in many cases. Think of the load-factor when nearly half your load is electric fans, running for the most part 12, 14 or even 24 hours a day for eight months in the year. Think of the native shop, where work goes on the whole night by the aid of the oil glimmer—the native shopkeeper has not been reached yet in Calcutta, where the demand is generally abreast with the supply, but some day his turn will come and a method of free-wiring his mud hut will be evolved. He will not pay 8d. a unit, nor even 4d., but he will make dividends for the supply company for all that. I have heard of one case where native shops are given a supply at 2 rupees per 16 c.p. lamp per month, or, say, 1d. a night, and even if 12 hours is the daily use there is money in it; at 8 hours' use this may be taken at 2d. a unit.

Local authorities sometimes have the saving grace of unconscious humour. The Calcutta Corporation, in its unregenerate days, made itself notorious and was made almost famous (in a sense) by the late G. W. Steevens' "In India." As the Capital of the peninsula it is rightly the first city to have everything electrical: public supply, a fine tram service and so forth. But in the streets we have ordinary gas, and darkness that can be felt, except in the immediate neighbourhood of Government House where Welsbach mantles (and stone pavements!) have recently been laid on. Last year the electric supply company is said to have offered to light one of the principal roads free gratis for three months to show what lighting means, but the offer was refused.

We have overhead wires in great profusion in Calcutta, both for lighting and traction, not to mention telegraphs and telephones. Now it is tolerably evident that whereas in open country comparatively light supports can be used, strengthened by stays and cross-stays, in a town strong poles are a necessity, since staying, even at terminals and angles, is often difficult. In early days there was considerable friction over this matter, seeing that the company were bound to stay where it was practicable, in consequence of the rules, while the local authority utterly objected. A worthy civilian was seen one day pulling with might and main at a 7/10 stranded steel terminal stay, which he considered objectionable; but, fortunately, it withstood the pull and continued to take up the strain of No. 0 copper. Rumours were even current of an intention to follow American precedent, and cut down all the offending stays, in which case it is possible that the posts would in some cases have soon followed. More peaceable counsels have now prevailed, though there is still trouble occasionally over tree cutting. In a tropical city the growth of good trees is a great desideratum except to the owners of overhead wires; when the violent nor'-wester storms begin the two disagree, and the wire sometimes comes down. Now, we all know from Mr. Trotter's I.E.E. Paper, that 500 volts continuous current is harmless in England—or, at any rate, in Westminster—but 225 volts has proved fatal in quite a number of cases in India, during storms, to natives with bare feet. A tree has been the prime cause generally, the unpleasant habit of hard-drawn copper rolling itself up into a coil again being an accessory. There is, however, a very simple remedy for all this—namely, to fit a short-circuiting device on each span, such that, if any wire breaks, its fall immediately brings it into contact with the other pole, or the earthed third wire, and blows the section fuse on that side. This idea was independently proposed by several engineers, and was patented last year by Messrs. Girling and Nicholl, of the local supply company. The device, the cost of which is exceedingly low, is being fitted all over Calcutta, and is bound to have a wide application elsewhere.

This reminds me of an article on "Electrical Installations in India" in one of your contemporaries for October 9th, which is evidently written without a correct knowledge of the facts. The writer begins by attributing to the Calcutta Tramway Co. "repeated deaths of natives by falling wires." In point of fact, there have been about half-a-dozen deaths from overhead wires, but not one from the circuits belonging to the tramway company. Even of car accidents there have been extraordinary few, and those generally due to carelessness on the part of the victim. Next this correspondent gives long extracts from rules which "came into force on September 15th," whereas the rules in question from which he gives incorrect abstracts, have not come into force even now in November. It is, in fact, well known that they are in the hands of the Advisory Board of the Government of India. Again, he states that "A condition precedent to the consideration of an application for a licence is the consent of every local authority concerned." In England we know that provision pretty well, but in India it does not exist. A reference to section 4 (1) (*a*) of the act shows nothing more than that, "Before granting a licence, the Local Government *shall consult* every local authority concerned," though the objections may be rejected summarily if insufficient.

We are somewhat behind the age in one or two matters. Recently the Calcutta Corporation issued some draft tramway rules so idiotic that a wit was moved to write as follows in the columns of the chief paper, the *Englishman*:—

SIR: Some of your contemporaries are doing their best to nullify the efforts of the Calcutta Tramway Co. to give us a good service, and, after reading suggestions emanating from various sources, I would bring the following model regulations to the notice of the Calcutta Corporation. They are framed with a view to the safety of the coolies who walk on the down track with their heads enveloped in sacks.

1. A man with a red flag and a tom-tom shall precede every car, walking backwards.
2. No electric car shall be driven at a greater speed than—
(*a*) 2¼ miles an hour on the Chitpore-road.
(*b*) 2⅝ miles an hour in Chowringhee.
(*c*) 3⅛ miles to Tallygunge, &c.
3. There shall be a timekeeper with a chronograph and a calculating machine on every car.
4. Every car shall stop at every pole and as often as may be required in between.
5. If two cars are about to pass one another, each shall stop dead till the other has passed.
6. If a ticca gharry runs into a tramcar, or if any passenger in a tramcar commits suicide by shooting, hanging or throwing himself out of the window or door, or if a cow runs into, or a hen under, any tramcar, the company and all the passengers shall be jointly and severally liable.
7. Every tramcar shall carry two complete ambulances with bearers, a fully-qualified doctor, a chemist's shop and a hospital nurse. If there is any room remaining passengers may be allowed inside.
8. Every passenger shall have a certificate from the Secretary of State that he is fit to travel on a tramcar.

Even more recently some no less foolish motor-car rules have been promulgated, and not even by the Municipality this time. One of them suggests, in all seriousness, that the lamps in front should make visible the owner's number on the back of the car!

In England, no doubt, the average policeman is becoming rapidly qualified as an official timekeeper, a profession which the Surrey reservist should bear in mind. But even there it is quite certain that the average man has no notion whatever of absolute speed. Everyone always walks 4 miles an hour except those who actually keep up that pace and call it 5¼. All tramcars go 10 miles—the rules say they may not exceed that, so, of course, they don't—while all trains out of Germany go at either 25 or 60 miles an hour—nothing between is known. And yet the average person's estimate of any actual speed from 2 to 60 miles an hour is sheer guesswork, often out by hundreds per cent. This alone shows the futility of prescribing maximum rates of 2, 3, 5, 6, 8 and 10 miles in different localities, more especially in a country where neither the hour nor the mile conveys anything to the mind of the native, be he driver, inspector or conductor, passenger or policeman. Then, again, the fact that a controller has only a certain number of running positions—two in Calcutta—is thought nothing of. Why not run on the first contact, or with the brake on? Both these suggestions have been made, amongst others equally foolish, and once in a way the traffic inspector finds a driver trying his hand at one or the other. Letters have recently appeared in the papers denouncing the terrible speed of cars on routes where the track is off the road on its own ground, and yet on these same routes the speed is certainly not much over 6 miles an hour on the average. With a packed trailler car the maximum speed is about the pace of a fast trapper, and as soon as it is reached some one wants to alight, so on go the brakes—*generally* after putting back the controller, but not always. It is handy to recollect that on ordinary straight 120ft. construction the speed is given by dividing 82 by the number of seconds per pole passed. I have noticed that a fast horse will pass by at least three and sometimes four or five poles while a car is stationary taking up or setting down one passenger. They do things better on the twopenny tube. Of

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course, passing country stations here one often sees out of the window of an express 50 or 60 sleeping figures awaiting the next train, may be 18 hours ahead. Time was made for Eastern nations, and they know how to make the best use of it.

There is another little absurdity to which some champion might usefully call attention by endeavouring to obtain a conviction—namely, Regulation A 17 of the Board of Trade or Regulation 20 of those for non-statutory undertakings. There are not a great number of aerial supply lines in England at present, but how many of those existing have anything like the factor of safety enjoined? The rule is clear, that not only must such a line stand a wind pressure of 50lb. safely, but with a factor of safety of 12. I recollect having seen some high-tension lines not a thousand miles from Chelmsford in which the factor of safety may have been 1—I hope it was—but could not have been much higher. Given a couple of suspending wires, a pair of B.O.T. high-tension 7/18 cables and a full complement of suspenders, and the area exposed to wind pressure on a 150ft. span is about 16 sq. ft., not counting the pole. Reducing this by a third to allow for the cylindrical cables, the area may be taken at 11 sq. ft., giving a wind pressure at 50lb. or 550lb. Now, the prescribed height in England is 30ft. at street crossings, and you cannot very well help adopting this height uniformly if crossings are plentiful. So the actual bending moment about ground level will be 16,500lb. feet. This takes no account of the very considerable addition for the pressure on the pole itself, which would bring the total up to not less than 20,000lb. feet. According to rule, therefore, a pole should be used which will not break with a less bending moment than $20,000 \times 12$ or 240,000lb. feet, in the absence of cross-stays on both sides, which are obviously impossible in towns. The conclusion is that coupled poles, placed transversly to the line, and extremely strong ones at that, are required in order to carry such a simple circuit as the above in accordance with the English regulation. Our rule demands a factor of safety of 4, which is feasible, and our overhead construction is capable of standing most things.

There is gentle irony in the British proviso as to an accumulation of snow which one would imagine to have been the draftsman's little joke had it not remained in for so many years. Crows by day and flying foxes by night here take the place of snow—and swallows—in the old country, but it is generally the bough of a tree that breaks the wires. The flying fox comes off second best owing to his inveterate habits of hanging head downward and holding both wires at once, and his refusal to learn by sad experience.

An interesting feature of the capital of Bengal is its lightning conductors, which would delight the eyes of Sir Oliver Lodge. Every public building has a complete set, and most private houses have one set at least. The former are veritable copper mines, with points in every conceivable position. They carefully conform to the artistic appearance of the buildings by closely following the maze of cornices, &c., and not running more direct than they need, and once in a way they terminate a few feet above ground level, but on the whole (though a shocking waste of good copper) they are well looked after. On the other hand, those on private houses are usually made of iron gas barrel. It is probable that those who put them up expected "the fluid" to run down inside instead of on the skin; but no matter! The separate lengths of pipe *usually* meet, and for convenience are run alongside the water supply, which is fixed outside the walls here. At the top there is a pointed iron rod, developing in the form of a kicking coil of three or four complete turns, evidently with a view to divert the discharge to the well-earthed water pipes. The lower end stops in the cement gutter, seldom penetrating to earth at all, so that this may be effectual in case the coil alone might fail. I heard of an instance where the resistance from a "conductor" to a water pipe entering the ground (*i.e.*, the cement) 6in. away from it was several hundred ohms in the dry weather, though Calcutta is water-logged only 3ft. below the surface. And yet "protected" buildings are hardly ever struck here, a fact which may be noted for what it is worth by the Lightning Research Committee, whose promised report we are anxiously awaiting.

THE TESTING OF ELECTRIC GENERATORS BY AIR CALORIMETRY.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers in connection with Prof. R. Threfall's Paper on the above subject. The Paper itself was published in our last issue:—

Mr. W. B. ESSON, who opened the discussion, remarked that, so far as he was aware, the method of testing was quite novel, and he was glad to see that it gave the results anticipated. He could not help thinking, however, that it was a method of testing which required a good deal of experience. No doubt, in the hands of an expert like Prof. Threlfall, the results might be confidently relied upon, but until he had had a good deal of experience he would regard the method proposed with some suspicion. So far as he could gather by reading the Paper, there appeared to be many difficulties, and it did not appear to be at all a practical way of testing. If he remembered rightly, Mr. Mordey some time ago tested a transformer by a calorimetric method which was on a par with this one, and he had discovered, much to his surprise and to the surprise of everybody else, that whereas the iron loss at full load was considerable, at no-load it disappeared altogether. The transformer became something like a freezing machine, and he could not help thinking that this method tested the operator working it as much as it tested the apparatus itself. Dealing with the matter to which he had made some reference in his recent Paper—viz., the iron loss at no-load and the iron loss at full load—he noticed that Prof. Threlfall found the iron loss at full load something like 10 per cent. of the output of the generator, while at no-load it was 7 per cent. of the output. The difference was 3 per cent., but he did not see how that extra loss occurred. Some eight years ago a case came before his notice in which an alternator tested on a Willans engine showed a very large unascertainable loss between no-load and full load. They could, of course, calculate out the iron loss at no-load, and knowing the law of friction of the Willans engine, it ought to be quite easy, by adding the copper loss at full load, to get the indicated horse-power. But the result showed a very great increase in the unascertainable loss, or, if the unascertainable loss was called iron loss, it was found to amount at full load to something like three times what it was at no-load. Prof. Threlfall showed that in the particular generator mentioned in the Paper the iron losses or unascertainable losses were 50 per cent. more at full load than at no-load. In the case of the Mordey transformer already mentioned, the testing machine was fitted with solid pole-pieces, but in connection with a second test the precaution was taken of completely laminating the poles. Then this unascertainable loss entirely disappeared. There was no increase in the iron loss—*i.e.*, the unascertainable loss—from no-load to full load. This tended to show, as Prof. Threlfall had pointed out, that the loss was in the poles of the generators and not in the core. It certainly did appear so, and he would like to hear from Prof. Threlfall whether the poles of the particular generator he had tested were solid poles or thoroughly laminated ones, or partly laminated poles.

Prof. THRELFALL said that the poles in the particular machine referred to were partly laminated.

Mr. ESSON, continuing, said the increased losses would then appear to be due to eddy currents in the poles, and it would seem to show that merely laminating the tips of the poles was not sufficient if very high efficiency or no difference in the iron loss between no-load and full load was aimed at. In conclusion, he pointed out that M. Bláthy, some time after he himself had experimented on the machine referred to, found the very same thing in testing continuous-current machines. There was an unascertained loss between no-load and full load which he (M. Bláthy) deemed to be due also to eddy currents in the poles.

Dr. R. T. GLAZEBROOK made one or two remarks with reference to the Pitot tube method of determining air pressures, this method being used for the past year or two at the National Physical Laboratory with great success. Prof. Threlfall had referred to Lord Rayleigh's work on the subject and to his Paper on the measurement of air pressure, in which Lord Rayleigh had arrived at a certain coefficient less than 0·5. This, of course, was quite true, but Lord Rayleigh went on to point out how the coefficient 0·5 could be obtained, and the method he suggested for it was the one adopted in the Pitot tube. Prof. Threlfall's result that the coefficient was close to 0·5 therefore bore out completely the value of Lord Rayleigh's theoretical work, and, as a matter of fact, Dr. Stanton, at the National Physical Laboratory, had arrived at very nearly the same coefficient. Suppose, for a moment, that one took a tube with a stream of air in it, and that attention was fixed upon a single stream line along the centre of the tube, and that P was the pressure and V velocity at one point, and P′ and V′ the pressure and velocity at another point. The kinetic energy per cubic centimetre at the first point was, therefore, $P + \frac{1}{2}\rho V^2$, ρ being the density of the fluid. The energy at the second point was $P' + \frac{1}{2}\rho V'^2$, and it follows from very simple and elementary principles that, if there were no forces acting on the fluid, these two quantities would necessarily be equal to one another—*i.e.*, $P + \frac{1}{2}\rho V^2 = P' + \frac{1}{2}\rho V'^2$. Supposing, now, the motion were stopped, so that $V' = 0$, then $\frac{1}{2}\rho V'^2 = P' - P$, and this quantity $P' - P$ was exactly what had been measured by Prof. Threlfall in his Pitot tube experiments. The facing tube measured the P′ and the gauge tube measured the P, and, therefore, this formula held good provided that the velocity of the moving stream of air was reduced to zero. Lord Rayleigh had pointed out that if an obstacle was put at this point the velocity was not completely reduced to nothing, and therefore the formula given was not exact, but if they took a little cup with very narrow edges pointing downwards towards the flow of the fluid, then the velocity of

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the air flowing into the cup was reduced absolutely to nothing at that point, and the theoretical equation was strictly correct. At the National Physical Laboratory the coefficient had not been found to be 0·5, but the slight difference was due to the considerable difference in the forms of the tube used, and also to the fact that the second gauge tube was placed here in the stream line as the measurement was being taken. But the important result remained that it had been shown by his own experiments, which were about to be described elsewhere, that the Pitot tube was a very accurate instrument for measuring streams of air, and, therefore, that kind of air calorimetry became much more easily feasible than it was before this result had been arrived at. With regard to the calorimetric result, he gathered that the stream of air which was drawn out by Prof. Thelfall was 2ft. 6in. in diameter. He should have supposed that there was a considerable difference of temperature between different parts of that stream, and he was not sure whether this had been looked into. Again, the efficiency of the machine was measured under a considerable stream of cool air coming in, so that he took it that the temperature of the whole machine was distinctly lower than it would be in practice, and that, therefore, the machine was not working under exactly the same conditions as if running on its usual load.

Mr. W. M. MORDEY said that anybody who had to do with the testing of the efficiency of alternating-current machines would welcome any new method. Old methods, even if correct, required as much expert attention as this method of Prof. Threlfall's. But he was, at the moment, more interested in this method, perhaps, on account of Prof. Threlfall's references to the measurement of the air than because of the measurement of the efficiency of the machine. The reason for this was that both his partner and himself—and no doubt a good many other people—were just now considering a question which would possibly become a very important one—viz., the measurement of the quantity of gas passing through very large pipes for the supply of very large gas engines—and he was glad, indeed, to have the results arrived at by Prof. Threlfall's investigations on the Pitot tube, as they showed that greater confidence could be placed in this method than appeared at first sight. With regard to Fig. 4 of the Paper, representing the distribution of the pressure of the air in the pipe, he would like to ask if this was taken on a vertical cross-section or a horizontal one. There was considerable difference between the values in the upper half and the lower half. He would also ask what precautions had to be taken as regards the inside surface of the pipes to which this method was to be applied. To what extent would the values obtained at one time be influenced by any changes that might take place in the surface: friction due to changes in the cleanliness, for instance. The method of measuring alternator efficiencies was extremely interesting, and its greatest usefulness would be in works. It would be easier to put up an apparatus of this sort in works and take it down again than to conduct the tests in a generating station, as had sometimes to be done at present. Perhaps an objection to it—as far as he understood it—was that it must necessarily take some time to get any reliable observations. If changes were made in the load changes would take place in the losses, and it must take a good while for the heat generated in the insides of the machine to get out and to influence the air current to such an extent that one could get a steady reading showing the actual value, and this, of course, was a very great objection. One of the causes for the very rapid progress that had been made in the construction of electric generating machinery had been that it was possible to measure very rapidly and ascertain the effect of changes in design, and so on, and, further, that it was possible to take the efficiencies very quickly at various loads, and so get knowledge that in many branches of engineering takes weeks, or even months, to arrive at. He hoped he was wrong in supposing that this method did not lend itself to the quick observation of ready readings which one had to rely upon in the necessarily hurried work that had to be done in generating stations. Perhaps the author would tell them how long it would take to ascertain the efficiency of a large machine that did not get to its full losses, in ordinary conditions, for perhaps 10 or 12 hours. How long would it take to get reliable figures of the efficiency at various loads from no-load up to full load or something higher? In the portion of the Paper dealing with "Engine Efficiency" the author began his column of results with "Gross Total Indicated Horse-power." He would like to ask whether he had proved that the indicated horse-power was ascertained with an accuracy of the same order as he represented had been obtained for some of the other figures; particularly, how was it possible to get the indicated horse-power when the engine was running very light. He should think there was probably quite as much to be done in getting accurate results in indicating the power of engines, as there was in ascertaining what became of the energy that came out of the engine. Reference had been made to the tests of M. Bláthy as to the very great increase in the losses when a load was put on to a dynamo. He quite agreed with the trend of Mr. Esson's remarks. He might mention that at the time M. Bláthy read that rather startling Paper on the enormous increase in these losses, he himself made some very careful tests on a Hopkinson machine with the Hopkinson method, and found that in the toothless armature there was no measurable increase in the loss. This loss, however, took place in machines with toothed armatures and in machines which had not laminated fields and was due entirely to the unequal distribution of the magnetism, to the toughening of the lines, to the increase of eddies in the field and to the hysteresis of the armature itself. He thanked Prof. Threlfall for giving them one more method, and an entirely new one, for their investigations.

Prof. THRELFALL, in reply to Mr. Esson, said that he had had originally a great deal more in the Paper about the results of the tests, but on the present occasion he wished to bring his method before the Institution, not the results, and had therefore laid more stress on the former. He hoped, however, at some future time to be in a position to bring more results before them. He did not now wish to obscure the main point by putting in detail, and, therefore, he would only briefly say that Mr. Esson's surmise as to the rôle played by the field magnets was extremely pertinent. Mr. Esson appeared to be scared somewhat by the appearance of difficulty which he was sorry to say the first presentation of the subject rendered inevitable. He did not feel justified in bringing this matter before the Institution without explaining at great length all the elaborate precautions which he had taken to satisfy himself, but having once satisfied himself he could assure them that it was not necessary to be anything like so elaborate in the matter of precautions as he had been in the account which he had presented in his Paper. Therefore, so far from the method being difficult, anybody who could read a thermometer could apply it; a careless man would get a wrong result whatever method he used. But the chief difficulty in the method was the ever-present one of measuring electric output with accuracy. The measurement of air was not so difficult as the correct estimation of the output electrically, and he should be extremely sorry if, through the great weight which Mr. Esson very deservedly carried with all of them, that anyone should go away with the impression that this method was a difficult one to carry out, or that it contained pitfalls which would trip up the unwary engineer, because such, he assured them, was not the case. Replying to Mr. Mordey, he admitted that it was not a quick test. The essence of the test was to wait until the temperature equilibrium was fixed, and in the case of the 300kw. alternator mentioned in the Paper it took about six hours in order to obtain the result of the consistency and accuracy put forward in the Paper. For a rough result it would not take so long.

Mr. MORDEY: Is that at one load?

Prof. THRELFALL: Yes, it is under absolutely fixed conditions. In these particular investigations he had to be well within 1 per cent., but it was not very often found necessary to be within this degree of accuracy, and if they did not mind being within 2 per cent. in the efficiency figure the test could be made quite quickly and easily, probably in an hour or two. With large materials and large quantities of heat, the thermal capacities of the materials were comparatively unimportant. Dr. Glazebrook had suggested that perhaps the generator was not working under its normal running conditions. One of the points about the method was that the speed of the fans was adjusted so that the engine casing was at the same mean temperature as the engine room. This was perhaps sufficient answer to Dr. Glazebrook. Referring to Mr. Mordey's question as to the curve in Fig. 4, this was taken on a horizontal diameter. There were considerable differences above and below the centre, but he selected that particular diagram because he had considered it to be the limit of irregularity that could be put up with in such measurements. He could get curves very much more symmetrical, but this was a shocking example which must not be exceeded in practice. With regard to Prof. Glazebrook's question as to the estimation of the temperature and the possibility of there being an error in the temperature of the outlet pipe, the temperature of the air leaving the generator was estimated while it was in wild and turbulent motion in the engine case itself, and not in the pipe. He was extremely interested in Prof. Glazebrook's remarks on the work being done at the National Physical Laboratory. He could only say he was sorry he did not know of it. With regard to Lord Rayleigh's work, he cordially agreed with everything Dr. Glazebrook had said, but he had not wished to introduce that in the Paper, and with the permission of the meeting he would reserve his remarks on the subject of the measurement of air and gases, which he had considered for three years very industriously, for another occasion when he would have an opportunity of dealing with that part of the subject.

A hearty vote of thanks was then accorded to Prof. Threlfall.

AN IMPROVED METHOD OF TESTING LARGE ALTERNATORS UNDER FULL LOAD CONDITIONS.*

BY B. A. BEHREND.

Most electrical engineers are familiar with the method of circulating power originated by Dr. John Hopkinson and published in *Philosophical Transactions*, 1886.† Dr. Hopkinson circulated power between a direct-current generator and a motor which were electrically and mechanically connected. Dr. Sumpner suggested a method of circulating alternating-current power between two transformers in *The Electrician*, Vol. XXIX., p. 223. Mr. William M. Mordey first suggested the circulation of power for testing alternating-current generators of the synchronous type by using a single machine and connecting the armature coils in opposition in such a manner that the machine was operated at full current and full magnetic flux. Mr. Mordey's Paper, which is extremely suggestive, is contained in the *Journal* of the Institution of Electrical Engineers 1893‡. Mr. Mordey's method, applied, for instance, to a single-phase generator having 20 poles on each side of his single-exciting coil, would be carried out by splitting the armature into two sections of eight and 12 coils respectively, and by connecting these sections in opposition, so that only four coils would be effective in regard to the circulation of current through the armature. The section of the armature which contains eight coils acts as motor, while the section containing 12 coils acts as generator. The current which circulates through the armature coils is almost in quadrature with the resultant E.M.F., and is, therefore, a wattless current.

* From the *Electrical World* of New York.
† See also *The Electrician*, Vol. XVI., p. 492.
‡ *The Electrician*, Vol. XXX., pp. 514, 545.

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Hence, the eight poles of the motor section of the machine will be strengthened by the armature current, whereas the 12 poles of the generator section of the machine will be weakened by the same current. This leads to a magnetic unbalancing of the machine, as the motor fields carry more resultant flux than the generator fields. In Mordey's machine this condition may not have caused trouble, as it does not contain iron in the armature, but in modern generators his method cannot be used on account of the magnetic unbalancing of the machine. Instead of dividing the armature into two sections and connecting these sections in opposition, it naturally suggests itself, especially on polyphase machines of the revolving field type, to split the field into two sections and to connect these sections in such a manner that the E.M.F.s induced in the armature are in opposition. The writer tried many years ago to use this method,

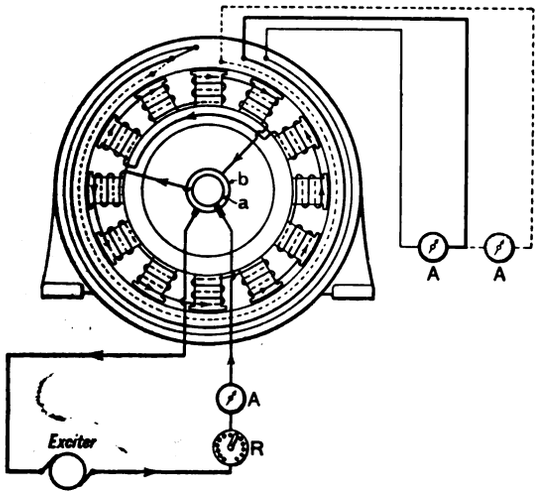

FIG. 1.—DIAGRAM OF MORDEY'S COMBINATION OF FIELD COILS FOR CIRCULATING POWER TEST.

but he failed, as undoubtedly others did, on account of the magnetic unbalancing of the machine. The reason of this unbalancing being once clearly understood, a very simple method suggested itself, which is described below.

Let us assume that we have a 12-pole alternating-current generator, as shown in Fig. 1. The fields are connected in such a manner that four field coils induce an E.M.F. in opposition to that induced by the other eight. The current in the armature strengthens the magnetism of the four poles as these act as the poles of the motor, and the same armature current weakens the eight poles which act as a generator. This is shown graphically in Fig. 2. The ordinates of the sinusoidal line A represent at a certain moment of time the induction in the air-gap as produced by the armature

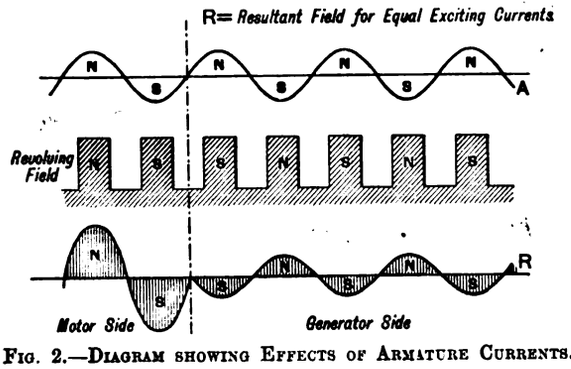

FIG. 2.—DIAGRAM SHOWING EFFECTS OF ARMATURE CURRENTS.

current. The poles of the revolving field are represented below this curve in their respective phase relations, the armature current being in quadrature with the E.M.F., and therefore in phase with the field. One can easily plot the curve of resultant magnetism, which is represented by the wavy line R. A glance at this line shows that the induction under the poles of the motor side is far in excess of the induction under the poles of the generator side, and it is, therefore, obvious that a machine connected in this manner must be subject to most violent vibrations. As a matter of fact, the writer tried this manner of connection on a 3,000kw. generator having 26 poles and operating at 231 revs. per min., having 10 poles connected in opposition to 16. The machine threatened to break to pieces under the tremendous strains produced by the unbalanced magnetism, and it became necessary to stop the test.

In thinking over the causes of this phenomenon, the idea occurred that it would be easy to overcome this difficulty of magnetic balance by using different exciting currents for the motor section and for the generator section of the revolving field, so that the resultant field produced by the interaction of the impressed and induced fields would be the same, or nearly the same, for each pair of poles. The machine was connected so that 13 poles were in opposition to the other 13 poles, and the exciting current in each section could be regulated by a rheostat in series of each section. Fig. 3 shows this manner of connection, the common point of the fields being connected to a slide ring. Instead of connecting this point to a separate slide ring, it can be connected to the iron of the fields and the shaft, or even the base of the machine may be used to introduce the current. Now let the reactions for this case be plotted

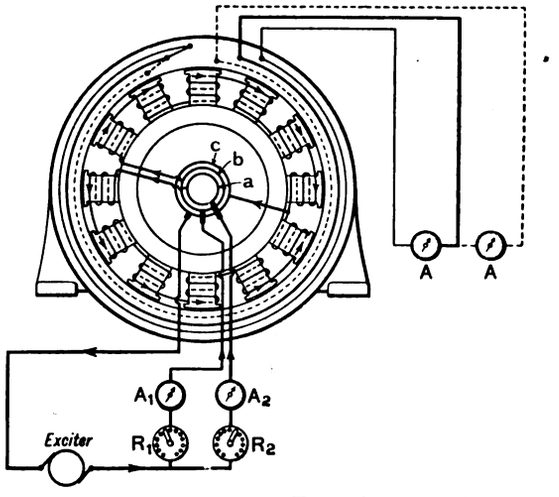

FIG. 3.—DIAGRAM OF COMBINATION OF FIELD COILS FOR CIRCULATING POWER TEST.

again. In Fig. 4 the sinusoidal curve A shows the distribution of magnetism as produced by the armature current. As the exciting current on the generator side is smaller than the exciting current on the motor side, neglecting local fields in the armature, the resultant field must be the same, or nearly the same, for both the motor and generator sides, thus obviating the trouble that arises from unbalancing.

In this very simple manner, power was circulated in the machine amounting to 4,500 kilovolt-amperes. Not only can a satisfactory heat run be obtained in this manner, but the inductive regulation of an alternator may also be determined with an accuracy in all respects equal to that obtained by operating two machines together,

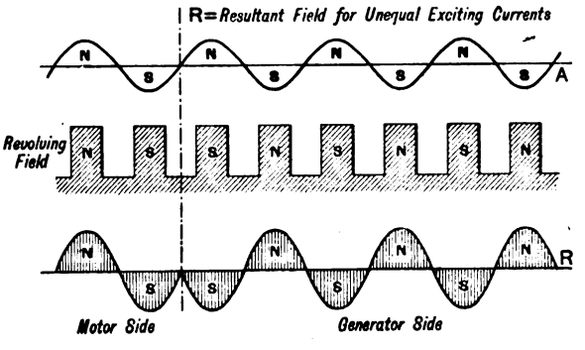

FIG. 4.—REACTION CURVES.

as described and used in the author's experiments as published in the *Transactions* of the American Institute of Electrical Engineers for June, 1903. This brief notice may suffice to call attention to a most useful and simple method of testing large machines. A fuller account of this method in its application to the determination of regulation will be given later in connection with the tests carried out on one of five Bullock 3,000kw. alternators, built and shipped from Cincinnati for the Kern Power Co., for the transmission of 15,000 kilovolt-amperes from the Kern river, 120 miles from Los Angeles, Cal., to that city.

The improved method of testing alternators by circulating power can be used to carry out with great accuracy all the tests that have to be performed in order to know the characteristics of the machine. It is evident that the heating of the armature coils and of the field

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coils can be tested accurately as regards the C^2R loss, as full-load current can be made to circulate through the armature coils and also full-load current is carried by half the number of poles. It is not so obvious that the core loss of the machine is the same as under normal load conditions. Considering that the loss through hysteresis and eddy currents depends on the maximum inductions, between which the cycle of magnetisation takes place, it appears reasonable to assume that the core loss with the fields in opposition according to the new method here described is dependent only on the induction produced by the poles which act as generator. In order to ascertain this point experimentally, and to dispel any doubts in regard to it, tests were made on two machines, first determining the core loss with the coils all connected in series, secondly with the coils connected in opposition, and a complete agreement was found between these two tests. It has thus become an experimental fact that the individual losses are the same in case the generator is carrying its full rated load under normal conditions or under the conditions as described in this Paper. The method is, therefore, immediately available as the simplest possible form for the determination of the temperature rise for any part of the machine, a test which is extraordinarily cumbersome on large units if carried out in the usual manner.

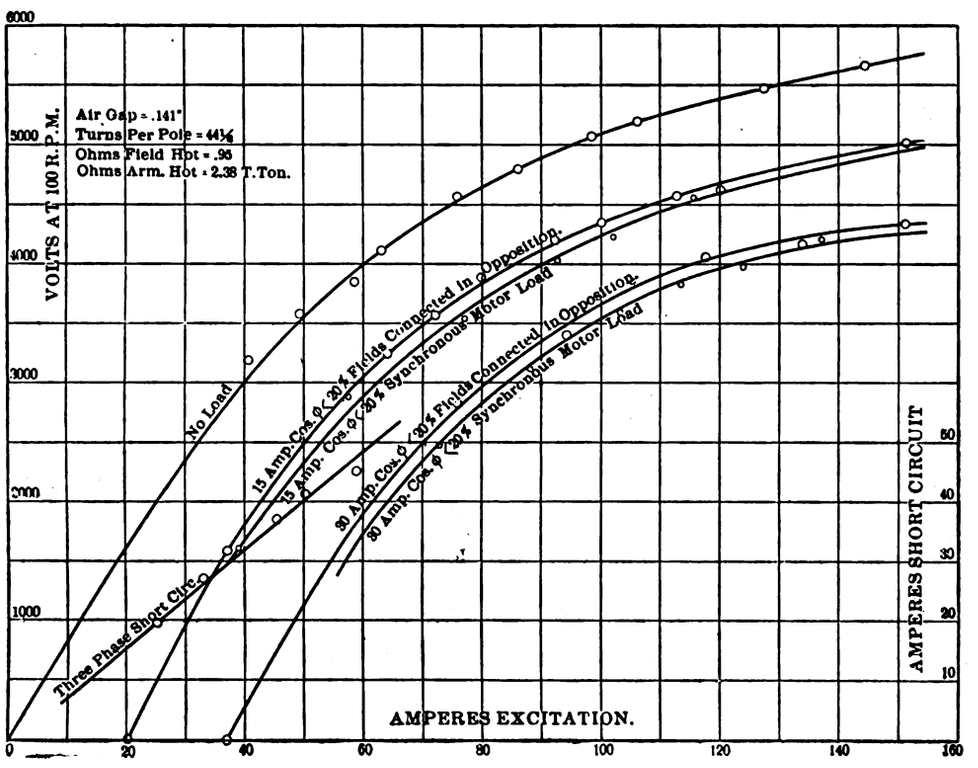


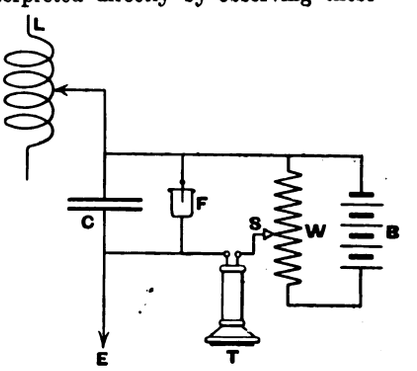
FIG. 5.—REGULATION AND SATURATION. THREE-PHASE, 3,800 VOLTS; 100 REVS. PER MIN.

In order to check the reliability of the method for the determination of the regulation of alternators at a low power-factor, the following tests were made:—A 72-pole alternator was operated as a generator on an under-excited synchronous motor and a load saturation was taken for different currents, as described at length in my Paper read before the Institute in May, 1903. The alternator was then operated upon itself by exciting 36 poles with a large current and the other 36 poles with a weak current, and by computing from the short-circuit current, and the exciting current in the 36 poles that act as motor, the terminal voltage of the machine, a set of curves was plotted (Fig. 5). The curves obtained by the former method lie slightly lower than the curves obtained by the latter method, which is due to the exceptionally large local fields in the machine experimented on, which was a 72-pole machine, the pole pitch being extraordinarily small on account of the small output and low speed of the machine. For this reason the generator was particularly fitted to test the method in regard to its accuracy. In both cases the power-factor was very low, practically zero, or at least equivalent to a zero power-factor as far as regulation is concerned. This method, therefore, yields at once the most simple way of determining the regulation of alternators on a power-factor zero, and it is, therefore, the most natural way of determining the regulation in alternators. In my Paper before the Institute, I recommended that the regulation of alternators should be tested on a power-factor zero, and we, therefore, have now the means of so doing without incurring the slightest difficulty.

A NEW DETECTOR FOR HERTZIAN WAVES.

Herr W. Schloemilch describes, in a recent issue of the *Elektrotechnische Zeitschrift*, a new detector for Hertzian waves, which is based on electrolytic principles. Although still to some extent in the experimental stage, its essential points may be gathered from this description. If a cell, consisting of platinum or gold electrodes immersed in dilute acid, be connected to a source of electricity, the E.M.F. of which slightly exceeds the back E.M.F. of the electrolytic cell, a small and constant current will traverse the latter, producing at its electrodes a feeble generation of gases. On electric waves impinging upon this cell an increase of the decomposing current is observed.

In order to increase the effect of the phenomenon, the surface of the positive electrode is made as small as possible, and it may be mentioned in this connection that the Gesellschaft für Drahtlose Telegraphie, the makers of the detector, employs electrodes only 0·001 mm. in diameter, and of a length of about 0·01 mm. The negative electrode, on the other hand, has seemingly no material bearing upon the phenomenon, and may consequently be used in any practical form or size. So far, the exact nature of the phenomenon remains unexplained, and it is not settled whether the cell acts as a capacity or as a resistance. The gas bubbles are more easily detached under the influence of the impinging waves, and with strong impulses this is marked to such a degree that the Morse signals sent may, it is stated, be interpreted directly by observing these fluctuations. If, however, the small electrode be changed over, so as to form the negative plate of the cell, the effect produced by the impinging waves is nearly nil, and it may be concluded, therefore, that the effect depends on the nature of the gas produced at the small electrode. It is necessary to adjust separately for each cell the applied E.M.F., because the sensitiveness of this wave detecting device is greatest at a certain rate of gas production, and diminishes both for a greater or smaller generation of gas bubbles.



L, Air Wire. C, Capacity.
E, Earth. F, Electrolytic Detector.
T, Telephone. S, Moving Contact.
W, Resistance. B, Battery.

DIAGRAM OF CONNECTIONS OF SCHLOEMILCH DETECTOR.

In special cases the auxiliary battery may be dispensed with by making the cell itself a primary battery, which can be done by choosing electrodes of suitable metals. In this form, however, the sensitiveness is less than in the former case. One of the diagrams of connection, which may be followed with good results, is shown in the illustration.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Calculating Scale: A Substitute for the Slide Rule." By W Knowles. (London: E. and F. N. Spon.) 1s.

"Proceedings of the Royal Society." No. 484. Vol. LXXII. (London: Harrison & Sons.) 2s.

"Transactions of the American Institute of Electrical Engineers" for October, 1903. Vol. XX. No. 8. (New York: The Institute.) 50c.

"The Production and Prediction of Magnetic and other Storms." By Hugh Clements. (London: W. Hutchinson & Co.) 1s.

"Geometry for Technical Students." By E. H. Sprague. (London: Crosby Lockwood & Son). 1s. net.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Spectrum of Glowing Radium.—Sir William and Lady Huggins pointed out already that at least seven lines in the spectrum of radium bromide glowing at ordinary temperatures agree with corresponding lines in the band spectrum of nitrogen. With a longer exposure they obtained further coincidences, some of the fainter single lines of the nitrogen spectrum coming out in the radium bromide spectrum. The presence of negative-pole bands in the spectrum of nitrogen when excited by radium naturally suggests whether the β-rays, which are analogous to the cathode corpuscles, may not be mainly operative in exciting the radium glow. On this surmise it would be reasonable to expect some little extension of the glow outside the radium itself. The authors were unable to detect any halo of luminosity outside the limit of the solid radium bromide; the glow appears to end with sudden abruptness at the boundary surface of the radium. It may be that it is only at molecular distances, and at the moment of their formation, that the rays can excite the nitrogen molecules. If, as suggested by Rutherford, the α-rays are connected with helium, the experiment seemed worth making of taking a photograph of the spectrum arising from their bombardment upon a zinc sulphide screen. It seemed possible, though not very probable, that the encounters of these bodies, at the enormous speed at which they travel, with the molecules of air, and their final collision with the screen, might on that hypothesis give rise to some of the radiations peculiar to helium and so produce its spectrum on the plate. The result of the experiment, so far as concerns helium, was negative; which must not, of course, be interpreted as excluding the presence of helium, but only as showing that, if present, the conditions are not favourable to the appearance of its spectrum.

[Sir W. and Lady HUGGINS, *Proc. Roy. Soc.*, November 21, 1903.]

Sensation of Light produced by Radium Rays.—W. B. Hardy and H. K. Anderson have investigated the sensation of diffuse light produced when a few milligrammes of a salt of radium are brought near the head in the dark, with the object of determining the place of origin of the sensation and identifying the particular rays which cause it. The sensation may be described as an appearance of diffuse light of steady intensity disposed in the external space in front of the head and filling that space fairly or quite uniformly. If the radium, covered, of course, with some opaque screen, such as, for instance, black cardboard, to cut off the pale light which it emits, be held in front of one eye, one notices that the intensity of the glow is considerably reduced by closing the eyelid. When the eye is open it is possible in a very general way to locate the radium from the fact that the sensation is strongest when the axis of vision is directed to it, and diminishes when the head is turned to one side. The sense of direction arises solely from variations in the intensity of the glow, and not from variations in its quality. When the eye is closed the sense of locality is completely lost. This is due to the fact that the glow is due to the β and γ-rays, and that the eyelid is peculiarly opaque to the former, stopping apparently the whole of them. The γ-rays, on the other hand, having a very great penetrating power, pass almost equally well through the eyelid or through the bones and other tissues forming the orbit. The rays produce no effect on the visual purple. The sensation is due, not to an action on the brain or the optic nerve, but on the retina. The latter probably does not respond directly to the radium rays, but to light rays, which are given out by the tissues of the eyeball—chiefly the cornea and lens—when they are traversed by the β and γ-rays. The fresh lens of a sheep, ox, or rabbit was found to glow strongly when exposed to the rays. The cornea and vitreous humour also glow, but to a less extent, and the retina itself gives a strong glow. The sclerotic, on the other hand, glows very slightly. The glow of the lens alone is so striking as fully to account for the sensation of light produced by the rays.

[HARDY and ANDERSON, *Proc. Roy. Soc.*, November 21, 1903.]

Loss of Potential in the Arc.—A timely investigation of the potential drop at electrodes composed of various metals has been made by G. Schulze, who has examined no less than 20 metals, and arrived at some interesting conclusions which corroborate the theoretical speculations of Stark. Owing to the rapid melting of most of the metals, they had to be held in a lower carbon electrode hollowed out to receive them. The metals of the alkalies and alkaline earths, as well as those of the iron group, with the exception of iron itself, acquired a crust of oxide at once. Bismuth, lead, tin, antimony, and silver furnished a metallic electrode, and iron furnished two arcs, one proceeding from the iron, and the other from the iron oxide. In these circumstances, it was only possible to compare metals belonging to the same group. It was then found that within the same group in the periodic series of elements the anode drop increased inversely as the atomic weight. The author maintains that quantities of electricity, such as are conveyed by strong currents, can only pass from a solid or a liquid into a gas when the body evaporates at one electrode and is precipitated on the other. This makes the passage of electricity through gases analogous to its passage through an electrolyte. At the point where the arc appears attached to the electrode the metal is boiling. On doubling the current strength the area of the point of attachment is not necessarily doubled, since, as it increases in size, a smaller proportion of the heat is conducted away by the surrounding portions, and the temperature has a chance of increasing.

[G. SCHULZE, *Ann. der Physik*, No. 12, 1903.]

Ionic Theory of the Arc.—J. Stark writes an elaborate essay on the electric arc from the point of view of the ionic theory which has hitherto been imperfectly applied to it. To simplify matters, he starts from the mercury arc, which is longer than the carbon arc, and shows more clearly the four constituent parts of the arc—viz., the brilliant brush issuing from the white-hot depression in the cathode, the dark space, the positive light column and the anode layer. The glow discharge does not necessarily involve the evaporation of the cathode, but the arc light does. It is not essential that the anode should emit vapour. In all gaseous discharges one has to distinguish between electrons, positive atomic ions and molar ions. In the Bunsen flame, the negative electrons play a very prominent part. In the arc, with its higher temperature, they are even more predominant. This is shown by the susceptibility of the arc to magnetic deflection and the readiness with which it follows every variation in the current, owing to the great mobility of the electrons. The impact of the electrons produces positive and negative ions from neutral molecules at the anode and in the positive light. The converse only takes place in the glow discharge, whereas in the arc the negative electrons are produced from the cathode by electrification, and not from the gas by ionisation. The ejection of electrons from the interior of the cathode is partly favoured by the presence of ultra-violet light, but most of all by the high temperature of the cathode. This high temperature produces in the interior of the metal an electric force driving the electrons towards the anode.

[J. STARK, *Ann. der Physik*, No. 12, 1903.]

Permeability of Iron Powder.—The magnetic permeability of iron wire in alternating fields is known to depend largely upon the frequency. At a frequency of a million per second it is about $\frac{1}{10}$ to $\frac{1}{30}$ of its normal value in a steady field. This is usually explained by supposing that at such high frequencies the magnetisation can no longer follow the field. But J. Zenneck has discovered that a similar inability is not shown by iron powder, whose permeability is nearly the same at a million per second as it is in a steady field. The author used two Leyden jars feeding two equal coils, in one of which the iron powder was placed. The difference of inductance between the two coils was measured by the spark potential between them. The powder was either used loose or embedded in paraffin. The greatest variation of the permeability observed amounted to 30 per cent., which is in marked contrast to the 90 or 96 per cent. found in iron wires.

[J. ZENNECK, *Ann. der Physik.*, No. 12, 1903.]

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TESTING LARGE DYNAMOS.

When, after a large dynamo has received its finishing touches in the shops, the time arrives for putting it to an actual working test, the engineer is once more reminded of the fact that the testing of a powerful dynamo is by no means the least difficult task connected with its manufacture. Although he is in a position to calculate to a nicety all electrical and mechanical details which combine to make an efficient dynamo, he is not able with equal ease to verify by actual experiment the soundness of his calculations and the extent to which his hopes have been realised. Previous to the ingenious calorimetric method described by Prof. THRELFALL in the Institution Paper which we published last week, a number of means had been advanced from time to time for conducting these tests efficiently and speedily. It is many years since Dr. JOHN HOPKINSON formulated his method for testing continuous-current machinery, a test which is now employed more frequently than any other. The difficulty in applying it to large alternators, however, is the very obvious one pointed out by Prof. THRELFALL, that two machines of the same size and output are not always available. Modifications of the Hopkinson test were put forward by Dr. W. E. SUMPNER (for determining transformer efficiencies), and by Mr. W. M. MORDEY who, in a Paper read before the Institution of Electrical Engineers in 1893, described several ways for determining experimentally the efficiencies of large alternators. By reason, however, of the unequal distribution of magnetic stresses around the armature, consequent upon one-half of the latter acting as motor and the other as generator, and each part re-acting differently upon the exciting field, a machine tested by this method is subjected to unbalanced forces, which may assume in modern machines such proportions as to render a test impossible. A modification of Mr. W. M. MORDEY'S method, due to Mr. B. A. BEHREND, and described on another page of this issue, eliminates this unequal distribution of magnetic flux around the armature, by splitting up the exciting field into two equal but opposing parts, and by adjusting the exciting current to each half in such a manner that the total flux, resulting from the field magnets and from the armature reaction, is uniform, or nearly so, at every pole. In the diagrams shown in Mr. BEHREND'S article, the total losses of the machine under test have to be made up by imparting to the dynamo the equivalent amount of power mechanically, but, if the required pressure and frequency are available, a better method will be to supply the extra power to the armature electrically.

Prof. THRELFALL'S method is to measure, not extra power which is supplied to compensate the losses, but the actual

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energy lost by the machine itself. Starting from the fundamental fact that all the losses in an electric machine are given off in the form of heat, he proposes to enclose the whole machine in a wooden case thickly carpeted with felt and hung with a bright wall-paper of tinfoil, and then to measure the heat by observing the rise in temperature it produces in a measureable quantity of air. Prof. THRELFALL'S Paper dealt at length with the distribution and measurement of air velocities and pressures in pipes, and several ingenious instruments of precision required for such determinations. These are of the utmost importance for carrying out the test with accuracy, but of even greater importance would be the necessity of placing the test in the hands of men possessing long experience in carrying out delicate scientific observations. This point of view was emphasied in the discussion by Mr. ESSON, who frankly admitted that he would not even trust himself to carry out the test with accuracy. Certainly, the method has the advantage of being direct, and a comparatively large error made in the measurement of the total losses will have but a small effect upon the efficiency calculated. Still, there are several sources of possible error, which, when combined, might appreciably affect the final result. First, it is obviously not easy to adjust matters so that the mean temperature in the casing is exactly equal to that of the surrounding air. In the figures quoted in this respect by Prof. THRELFALL, the differences between these two temperatures amount to several degrees centigrade, and in adverse conditions of weather and when the tests are carried out by less skilful experimenters than the author, larger differences are sure to ensue. Limits of temperature at various points of the machine are, as a rule, insisted upon in the specifications, and to carry out the corresponding measurements would require a separate test. Then, again, the cost of the testing equipment and the cost of the tests themselves would be serious items, the latter particularly if the test had to be repeated for determining the temperature rise. A rough calculation will show, in fact, that the price of the energy required to drive a fully-loaded dynamo during a run of several hours is well worth saving. Taking it that three tests of a 1,000kw. machine are made, one at full load, one at half-load and one at quarter-load, that a fourth test is required for checking whether the temperature rise was below the specification, and accepting Prof. THRELFALL'S estimate that a test takes six hours, the cost of energy at 1d. per kilowatt-hour comes out at £68.

OBITUARY.

SIR FREDERICK BRAMWELL.

It is with great regret that we have to announce the death of Sir Frederick Bramwell, which occurred on Monday in London as the result of cerebral hæmorrhage. Sir Frederick had reached the advanced age of 85 years, but his remarkable vitality to the very end impressed everyone who knew him.

The third son of Mr. George Bramwell, who was a partner in the firm of Messrs. Dorrien & Co., bankers, Frederick Joseph Bramwell when 16 years of age was apprenticed to John Hague, a mechanical engineer with whom he served his time, and where he had a large experience of steam locomotion as applied to road traction. Several steam carriages and omnibuses were at that time running in various parts. The Institution of Civil Engineers was formed in 1818, the year of Bramwell's birth, and by 1850 was assuming great importance; in 1856 he was elected an associate member, and a few years previously became a member of the then recently-formed Institution of Mechanical Engineers. By this time Bramwell was in business for himself as a civil engineer, and later became famous as an expert witness on the legal side of civil engineering. In 1862 he was elected a full member of the Institution of Civil Engineers, and in 1874 became president of the Institution of Mechanical Engineers. From this time onward his services were in great demand in all technical matters, such as arbitrations and lawsuits, and as an arbitrator especially he acquired a great reputation. Of notable interest to the electrical profession was his award in the arbitration between the London County Council and the London Street Tramways Co. in the early 90's, a decision which has since governed the acquisition of all tramways by local authorities from companies. In this particular instance the London County Council, after failing to come to terms with the London Street Tramways Co. upon which the lines in the south of London should be worked (including conversion to electric traction), decided to purchase that company's undertaking, and the matter went to the arbitration of Sir Frederick Bramwell. In accordance with the true legal interpretation of the Tramways Act of 1870, he awarded nothing for the goodwill of the undertaking except as regards the unexpired term of the company's powers, and in the result the company received but 10 per cent. of what it claimed. Another important tramway arbitration, which Sir Frederick conducted quite recently, was that of the Birmingham tramways.

Reverting to his earlier life, it should be mentioned that Sir Frederick Bramwell was knighted in 1881 and created a baronet in 1889. In 1884 he was president of the Institution of Civil Engineers, and in 1888 (at Bath) president of the British Association. He was also a fellow of the Royal Society, a civilian member of the Ordnance Committee, a D.C.L. (Oxford and Durham) and LL.D. (Cambridge and McGill), both these latter being honorary degrees. From 1885 Sir Frederick has acted as honorary secretary to the Royal Institution; he was also a vice-president of the City and Guilds of London Institute, and was chairman of the executive council of the Inventions Exhibition in 1884.

Sir Frederick Bramwell had the reputation of being perpetually genial, and possessed of a ready sense of humour, and those who heard him only last session at the Institution of Electrical Engineers enlarging upon the anomalies likely to be introduced by the adoption of the metric system quickly realised and appreciated these qualities. Deprived in his youth of any advantages of technical educational facilities, Sir Frederick was an ardent supporter of the movement in this direction which has manifested itself during the latter portion of his life. Another matter in which he displayed a large interest was the work of the Engineering Standards Committee, and he was one of the representatives of the Institution of Civil Engineers on the managing committee.

There will be a memorial service at St. Margaret's Church, Westminster, at one o'clock to-day, and the funeral at Hever, Kent, is fixed for the same hour.

LIEUT.-COL. F. PESCETTO.

The death is announced of Lieut.-Col. F. Pescetto, Local Honorary Secretary and Treasurer in Italy to the Institution of Electrical Engineers. The president of the Institution at the meeting on Thursday last week said that Col. Pescetto was known to a good many of the members quite apart from his technical knowledge. The friendly manner in which he received the members in Italy early in the year, and the great assistance he was to them, would never be forgotten by any one. He was an exceedingly kind and gentle man, and every one was sorry to lose him. Col. Pescetto was a director of the Stabilimento Elettrotecnico Gio Ansaldo, Genoa, and Professor of Electricity at the Ecole d'Application d'Artillerie du Génie, Turin.

Electrical Haulage.—The Commissioner of the Church Society for the Promotion of Kindness to Animals, appointed to institute inquiries respecting pit ponies, recommends the use of rope haulage, with steam or electricity as the motive power, instead of ponies.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 200.)

THE RADIATIONS FROM RADIO-ACTIVE SUBSTANCES.

It has been stated that the rays from the radio-active substances, with the exception of polonium, are complex, and three types, the α, β and γ-rays, have been distinguished. The earliest work on this subject was done by Rutherford (*Phil. Mag.*, V., 47, p. 109), who showed that the rays from uranium are complex by measuring the absorption produced by successive layers of metal foil of uniform thickness. Fig. 12 represents the curves obtained by plotting the intensity of the rays transmitted on the vertical, and the number of layers of aluminium foil of thickness 0·00012cm. on the horizontal axis. The curve for uranium oxide is quite different from the curve for thorium nitrate, the rays from the latter being more penetrating than those from uranium. It will be seen in the case of uranium that the radiation is quickly diminished to a few per cent. of the original value and after 15 layers of foil have been traversed remains constant at a minimum value. This shows that the radiation is complex and consists of an easily absorbed kind which was called the α radiation and a much more penetrating kind which was called the β radiation. The latter was about 100 times more penetrating in character than the former, the α-rays being reduced to half value by passage through aluminium foil 0·0004cm. thick, the β-rays by passage through

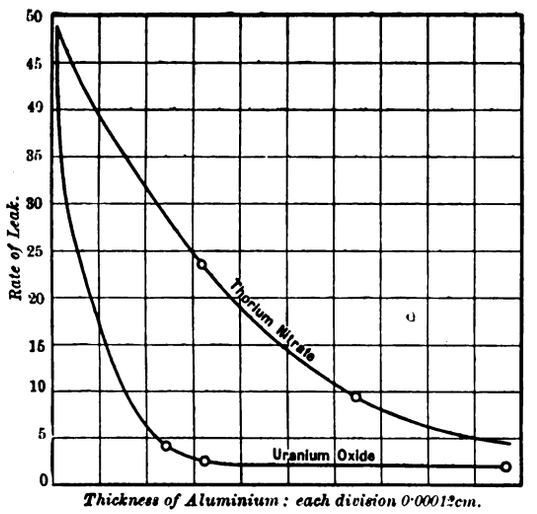

FIG. 12.

0·05cm. of aluminium. The existence of these two types of rays has since been observed for thorium and radium, and, in addition, a more penetrating type than either, known as the γrays, first noticed by Villard for radium, has been found to be emitted by both uranium and thorium. The γ-rays are, roughly speaking, about 100 times more penetrating than the β-rays, being cut down to half value by 6cm. or 7cm. of glass or aluminium.

In addition to their power of penetrating matter, the three types of rays are characterised by different behaviour under the influence of the magnetic and of the electrostatic field. The β-rays are easily deflected into circular paths, and in this respect, and in the direction of the deflection, they resemble the cathode rays. The α-rays, at first thought to be undeflected, have been shown by Rutherford this year (*Phil. Mag.*, VI., 5, p. 177, 1903) to be slightly deviated by intense magnetic and electrostatic fields, and the deviation is in the opposite sense to that of the β or cathode ray. The γ-rays remain quite undeflected. These facts have been conveniently represented by Mme. Curie by a diagram (Fig. 13) in which the rays are represented to be issuing from radium placed in a deep cavity in a block of lead under the action of an intense magnetic field at right angles to the direction of the beam and the plane of the paper. The thin pencil of undeflected rays represent the relatively feeble γ-rays. The intense pencil slightly deviated the α-rays, and the circular paths of varying radii the β-rays, deflected in the opposite direction to the α. It must be noted that the scale of the deviation of the α-rays, compared with that of the β, is enormously exaggerated in the diagram for the sake of clearness. It will be convenient to consider each type of radiation in turn for the various radio-active substances.

β-rays.—On account of their relatively intense photographic action and of their power of penetrating opaque screens of considerable thickness, the β radiation has been much studied. The existence of rays easily deviable in the magnetic field in the radiations from radium was discovered simultaneously by

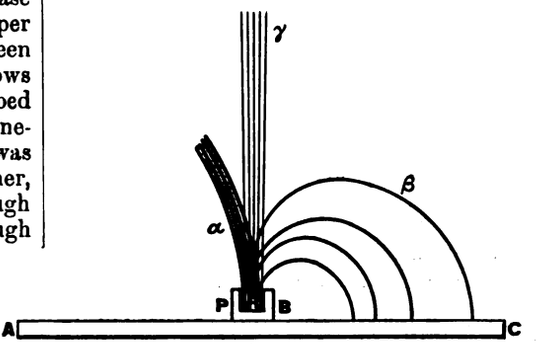

FIG. 13.

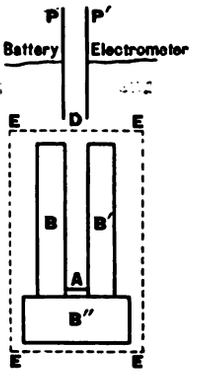

FIG. 14.

Giesel Meyer and von Schweidler and Becquerel. The latter subsequently (*Comptes Rendus*, 1900, 130, p. 1,584) showed the same to be true of the radiations from uranium. Rutherford and Grier (*Phil. Mag.*, 1902, VI., 4, p. 315) proved that thorium also gave out deviable rays, although the proportion of β-rays in the radiations of the latter is much less than in that of uranium. This explains the fact that, although the radio-activities of thorium and uranium are very similar when tested by the electrical method, the former is much less active than the latter to a photographic plate. In all cases it is the photographically active, penetrating β-ray which is deviated by a magnetic field. Curie (*Comptes Rendus*, 1900, 130, p. 73) using the apparatus shown in Fig. 14 showed that the easily-absorbed type of radiation from radium is not appreciably affected by a magnetic field, whereas the penetrating radiation was com-

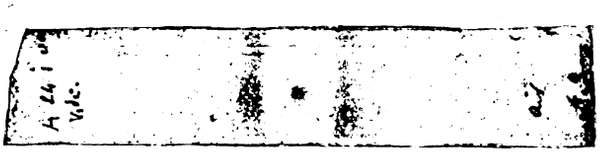

FIG. 15.

pletely deviated. A is the radium preparation, BB′ are blocks of lead of varying heights, PP′ plates connected to the electrometer and battery respectively between which the ionisation due to the rays is measured. If the distance AD is greater than 7cm., all the rays are deviated by a magnetic field, and are absorbed by the lead blocks. For smaller distances only a fraction is deviated. Under the conditions of experiment the effect of the γ-rays was too small to be detected. Becquerel investigated the magnetic deviation of the β-ray of radium by placing the substance in a metal capsule upon the sensitive film of a photographic plate wrapped in paper and placed in an exhausted space. Under these circumstances the rays formed a pencil proceeding normally away from the plate, and by applying a magnetic field they could be curved into circles cutting the plate at some distance from the point of origin. The disposition of the experiment is the same as in the diagram, Fig. 13, where AC is the photographic plate. Fig. 15

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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represents a negative so obtained by first applying the field in the one direction and then in the other. Becquerel (*Comptes Rendus*, 1900, 130, p. 809) showed that the β radiation of radium is complex, and different rays suffer different deviations in a uniform magnetic field. From the equation $H\rho = mv/e$ (compare p. 162), Becquerel found values for mv/e varying from 350 (for rays capable of penetrating 0·01mm. aluminium) to 2,600 (for rays penetrating 0·13mm. of lead). Becquerel identified the β-rays with the cathode rays by proving that they were deviated in the same sense as the latter by an electrostatic field. He deduced $v = 1{\cdot}6 \times 10^{10}$ cm. per sec. for the average velocity of the rays, and this is several times greater than the value found by Prof. Thomson for the velocity of the cathode ray. This fact explains the much greater penetrating power of the β-rays. The great variations in penetrating power of the β-rays of radium is due simply to the wide range of velocities possessed by different rays. The value of e/m was found to be the same as for the cathode ray—viz., 10^7, and the β-rays must, therefore, be regarded as negatively charged particles of mass one-thousandth of the hydrogen atom moving at speeds comparable with that of light. This conclusion has been confirmed by the direct determination of the negative charge carried by the β ray by M. and Mme. Curie (*Comptes Rendus*, 1900, 130, p. 647), using the apparatus shown in Fig. 16. The plate MM on

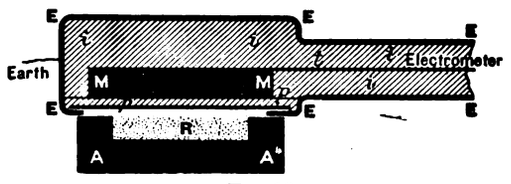

FIG. 16.

which the β-rays from the radium impinge is completely enclosed in paraffin and connected with an electrometer. In these circumstances any charge communicated to the plate will be retained, whereas if the plate were exposed bare to the strongly ionised air in the neighbourhood of radium it would tend to be discharged as fast as the charge carried by the rays were communicated to it. It is found that a negative charge is conveyed to the plate MM from the radium R *through the screen of thin metal, pp, connected to earth.* The charge is extremely feeble, and can only be determined for very active radium preparations. It is to be noted that it is, probably, only about the $\frac{1}{1000000}$th of the charge carried by the ions produced by the complete absorption of the rays in air.

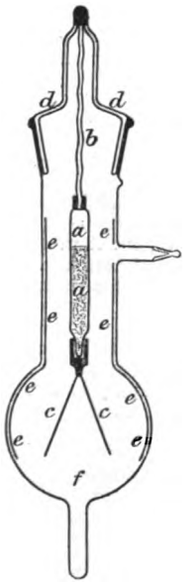

FIG. 17.

The existence of the negative charge carried away from radium by the penetrating rays has recently been shown as a lecture experiment by Strutt (*Phil. Mag.*, 1903, VI., 6, p. 588 and *The Electrician*, Vol. LII., p. 118) by the apparatus represented in Fig. 17. A tube, *a*, containing radium, is supported in a perfectly exhausted vessel by a quartz rod, *b*. To the lower end of the tube an electroscope, *cc*, is attached, and the surface of the tube *a* is made conducting with phosphoric acid. The positive charge left behind after the expulsion of the β-rays is communicated to the leaves, which diverge until they touch the sides of the vessel connected to earth. They then collapse and again commence to diverge, this cycle of operations being repeated indefinitely. In an apparatus constructed by the author, about 2 milligrammes of pure radium bromide was used, and the cycle of operations occupied about four minutes.

Kaufmann (*Nachrichten* der K. Gesells. der Wiss. zu Göttingen, 1901, No. 2) has measured both v and e/m for the more penetrating kinds of β-rays emitted by radium, and obtained for v values between $2{\cdot}36$ and $2{\cdot}83 \times 10^{10}$—*i.e.*, between 80 and 95 per cent. of the velocity of light, Now, it has already been pointed out (p. 163) that if the mass of the cathode ray is electrical in origin and due to the inertia of the moving charge, it should, theoretically, tend to increase as the velocity of light is approached, and become infinite when that value is attained. Now Kaufmann found that the ratio e/m decreased from $1{\cdot}31 \times 10^7$ when $v = 2{\cdot}36 \times 10^{10}$ to $0{\cdot}63 \times 10^7$ when $v = 2{\cdot}83 \times 10^{10}$, and these results are in good agreement with the theory that the mass of the corpuscle or electron—*i e.*, the negative atomic charge, which constitutes the cathode ray and the β-rays from radio-active substances—is wholly electrical in origin.

(To be continued.)

NOTES ON THE GERMAN HIGH-SPEED TRIALS.

The *Elektrotechnischer Anzeiger* publishes an interesting article on the recent high-speed railway trials between Marienfelde and Zossen. As is known, these trials have been carried out by the "Studiengesellschaft für Elektrische Schnellbahnen." On October 10, 1899, the company named was formed, the capital being contributed by the partners, as follows:—

Deutsche Bank, Berlin	150,000m.
Allgemeine Elektricitäts Gesellschaft	100,000m.
Friedr. Krupp, Essen	100,000m.
Siemens and Halske, Berlin	100,000m.
A. Borsig, Berlin	50,000m.
Delbrück, Leo & Co., Berlin	50,000m.
Phil. Holzmann & Co., Frankfurt	50,000m.
National Bank, Berlin	50,000m.
Jakob S. H. Stern, Frankfurt	50,000m.
V. D. Zypen and Charlier, Cologne	50,000m.
	750,000m.

Later on this capital was increased by the same firms by an additional 50 per cent. Preliminary trials and laboratory tests were then undertaken. Those with regard to air pressures at high velocities showed that a parabolic form offered the least resistance, this being about 90kg. per square metre at a speed of 200km. per hour. To reduce this item further, Messrs. Siemens and Halske gave the top of the car a tapered form, so as to appear like a hood. An important detail was the manner in which the weight of the epuipment was distributed. After various experiments and calculations, Messrs. Siemens and Halske chose the distribution indicated in the figure on p. 266.

Very little alteration appears to have been made in general design of either of the cars since our article describing them two years ago (*The Electrician*, Vol. XLVIII., pp. 46 and 122). The Siemens and Halske car affords seating capacity for 48 passengers, and is 22 metres (72ft.) long and 2·56 metres (8ft. 4in.) wide. On the other hand, the car of the A.E.G. has a length of 21 metres (69ft.) and a width of 2·8 metres (9ft. 2in.), and provides room for 40 passengers. Both are built as corridor cars. The bogies are mounted on springs, both spiral and flat springs being used. At the beginning of the tests a wheel base of 1·9 metres (6ft. 3in.) was employed, the wheels being 1·2 metres (4ft.) in diameter; afterwards these dimensions were increased as indicated in the diagram. Brakes—operated on the Westinghouse system and also by hand—act on every wheel, and an electric brake, actuated by current from an accumulator battery, is also provided. It is stated that if the brakes are applied when the car is travelling at 200km. (124 miles) an hour, it travels a distance of 1·5km. (nearly a mile) before stopping.

The live cables were placed underneath the floor and on the roof of the car. In the Siemens and Halske car all control operations are done by pneumatic means, the driver having, consequently, only light work to do. Mechanical means were employed by the A.E.G. for transmitting these operations to the various apparatus distributed at different parts of the car. For this purpose a main shaft runs along the ceiling of the car. Owing to the construction of the bogies, and also to the high speed of the cars, gearing between the motors and axles was neither possible nor desirable, and the 250 H.P. motors—two for each bogie—are mounted directly on the axle, and in the case of the Siemens and Halse car without the intervention of springs. The Siemens and Halske motor weighs 4 tons, and its rotor is fed with three-phase current at a voltage of from 1,150 to 1,850 volts, the voltage of the stator varying between 500 and 1,000. Arrangements are provided to connect the transformer at will, either in star or delta fashion. The A.E.G. motor is lighter, weighing only 3·2 tons. Its conductors consist of copper bars, the voltage of the rotor and stator being 325 and 435 volts respectively. A play of 30mm. (1·18in.) between the hollow axle of the motor and the car axle has been allowed by this firm, and a mechanical connection between the two is provided by means of a spring coupling.

Messrs. Siemens and Halske adopted metallic resistances—built up of metal strips—which were well cooled by being placed on the

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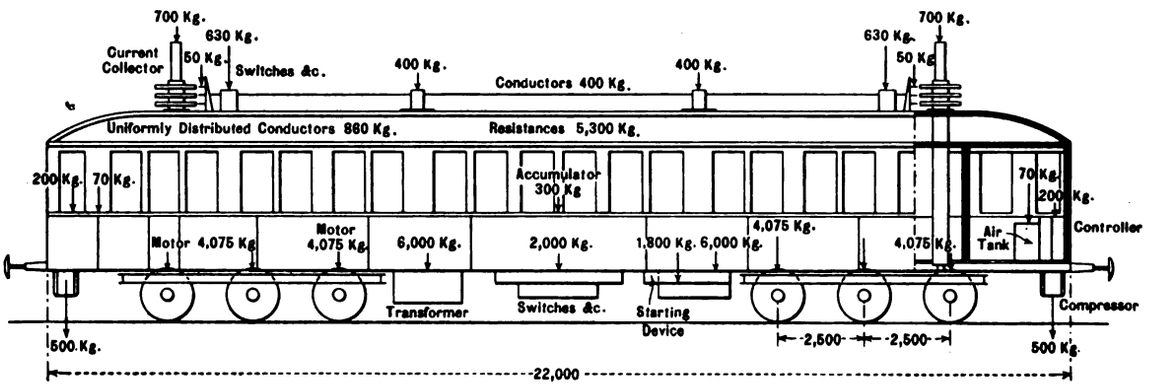
outside of the car. Liquid resistances with forced circulation were employed by the A.E.G. They possess the great advantage of gradually increasing and decreasing the working current. The transformers are mounted horizontally beneath the floor, and as their axes have the same direction as that of the car, efficient cooling by air presents no difficulties. In the A.E.G. car the air for cooling was collected from the roof and conducted through pipes to the transformers. A vertical iron pipe is mounted in the car, and through it all the cables are conveyed from the roof to underneath the floor. The current collectors of the Siemens and Halske car are essentially the same as described in *The Electrician*, Vol. XLIX., p. 1,023. Instead of mounting the three collector bows on one vertical hollow steel post, as Messrs. Siemens and Halske do, the Allgemeine Elektricitäts-Gesellschaft employs for each bow a separate pole. Of the total weight of about 93 tons of a car, 16·3 tons are accounted for by the motors, 12·3 by the transformers and 5·1 by the resistances. In the course of the trials, however, it became evident that the total weight might be reduced by several tons.

ensure a good contact between bow and wire. A distance of 1 metre (3ft. 3in.) separates the wires, which are vertically mounted one above the other. Every kilometre (0·62 mile) the overhead wires are anchored to resist horizontal stresses. At these points section switches are inserted in the line. If a high-tension wire should break, the line conductors are automatically short-circuited. This is performed by a loop of copper wire, which normally encircles a metal rod connected through the track rails to the common point of the three-phase system. When any one wire breaks, the loop is drawn together and comes into contact with the rod. As feeders, both cable (with a copper section of 70 sq. mm.) and bare copper conductors (section 50 sq. mm.) were employed. Suitable switches are interposed between the feeders and the line wires.

Electric energy is generated at the power station situated at Oberspree by a 2,500 H.P. three-phase alternator, delivering current at 6,000 volts. Two transformers, connected in parallel, raise the pressure to 14,000 volts.

After many preliminary tests and calculations, the actual speed



DISTRIBUTION OF WEIGHT ON SIEMENS AND HALSKE CAR.

Messrs. Siemens and Halske constructed the overhead equipment. At a distance of 2¼ metres (7·4ft.) from the centre of the track is the line of wooden masts. These are spaced 35 metres (38yds.) apart, and carry horizontal iron brackets, to which the overhead wires are attached by means of double insulators. A small horizontal play is thus secured to the wires, and this is said to

rials were commenced with on the line Marienfelde–Zossen, 23km. (14 miles) in length in 1901. Since the maximum gradients are but 1 : 200, and the smallest curves have a radius of not less than 2,000 meters (6,550ft.), this line is particularly suited for high-speed tests. The results of these trials and other particulars have been reported from time to time in our columns.

PHYSICAL SOCIETY.

At a meeting of the Physical Society, held November 27, 1903, Dr. R. T. Glazebrook, F.R.S., president, in the chair, Mr. HORACE DARWIN exhibited an

Electric Thermostat.

The thermostat shown at the meeting was made for Lord Berkeley, and is similar to one made for the spectograph of the 24in. refractor of the Royal Observatory, Cape of Good Hope. The vessel, the temperature of which is to be maintained constant, is surrounded by oil contained in a bath. In the oil are placed two heating coils. through which electric currents pass. By automatically controlling these currents the temperature of the oil, and consequently of the inner vessel, is kept very nearly constant. The control is effected by means of a Wheatstone bridge in the outer oil bath. This bridge has two opposite arms of copper and two of manganin, so that it is only balanced at some definite temperature. Its deviations from balance affect the position of a long horizontal boom attached to the suspended coil of a galvanometer. The position of the boom determines the greater or less descent of a "hit or miss" arm which is periodically raised by a rotating cam, and can only fall to its lowest position when the galvanometer boom is to one side and allows it to pass. This position of the boom corresponds to a fall of temperature of the controlling bridge. Thus the position of the "hit or miss" arm at its lowest position depends on the temperature, and it is the variation of this position which regulates the amount of current passing through the heating coils. When the "hit or miss" arm is at its highest position, the galvanometer boom is absolutely free to move to its position of equilibrium. We may call the two coils the intermittent and the permanent heating coils. At every rotation of the cam the "hit or miss" arm is lowered, and if it passes the galvanometer-boom a key is closed and a current passes through the intermittent heating coil. Thus the frequency of the intermittent current depends on the temperature of the oil bath. The duration of the time that the key is closed also varies—it may be long or very short. Every time the key is closed a movement takes place which increases the duration of the next closure of the key. The arrangement of the mechanism is such that when the temperature is steady the "hit or miss" arm will pass the galvanometer-boom as many times as it is stopped by it in a given time. The current passing through the permanent heating-coil is also automatically regulated; if there is not enough heat passing into the oil this current is gradually increased. This is done by cutting out resistance coils which are in series with the permanent heating coils. The cam which moves the "hit or miss" arm is driven by a worm-gear and any suitable motor, and the oil is kept thoroughly stirred by a fan.

Mr. W. C. D. WHETHAM asked what accuracy was aimed at in the instrument.

Mr. A. P. TROTTER said that the use of thermostats would become more and more important with the perfection of thermometers. It was possible to keep a temperature constant within $\frac{1}{100}$°C., but it was very difficult to determine the temperature to that degree of accuracy. In high-class resistance measurements with a Carey Foster bridge one of the greatest difficulties was with regard to the temperature, which must not only be constant but also capable of exact determination. In the constant-temperature room at the Board of Trade standardising laboratory the temperature varied by less than ½°C. from day to day, and he would like to know the greatest accuracy obtainable with ordinary devices in such a room before considering the introduction of the complicated instrument shown to the meeting.

The CHAIRMAN expressed his interest in the authors' communication, and said he had recently been trying to solve a somewhat similar problem by making use of a horizontal boom, attached to the suspended coil of a galvanometer, for making and breaking a current. His object was to regulate a current of the order of 50 amperes. Dr. Glazebrook asked if it was desirable or important to utilise all the adjustments in the instrument.

The AUTHOR, replying to Mr. Whetham, said the instrument had been made as sensitive as possible, but he was not aware within what limits it would maintain the temperature of the bath. The thermostat supplied to the Cape Observatory was capable of keeping the temperature within $\frac{1}{100}$°C. for a period of eight hours. In reply to the chairman, he said that, when working with small variations of the external temperature, it might be possible to dispense with one or other of the adjustments; but when the external variations were large it was necessary at times to supply a large quantity of heat to the oil bath, and in order to do this effectually he thought all the adjustments of the instrument were desirable.

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A Paper on

"The Occurrence of Cavitation in Lubrication"

was read by Mr. S. SKINNER. The experiments described in the Paper arose from an observation made when determining the refractive index of a liquid by means of Newton's rings. As Newton showed, the rings can be obtained when a liquid is run into the space between the lenses. If, when the liquid has been introduced the upper lens be rolled on the lower, the observer sees following the central dark spot a crescent-shaped space, very bright, provided the illumination be sufficiently oblique. This is a vacuous or vapour-filled space, for when the motion of rolling ceases the liquid flows into the space and completely fills it. The inflow of the liquid depends in some way on the viscosity, and the effects are more pronounced when a more viscous liquid is used. The most convenient mode of observation is to use a deeply-coloured liquid, and to look at the space by transmitted light. The author has found that a convenient liquid is a strong solution of fuchsin in glycerine. This red solution is so deeply coloured that even up to the point where the lenses are nearest some colour shows, and light is only brightly transmitted at the place where there is a break in the liquid. The cavities which are formed must be produced either by splitting the liquid itself, or by tearing the liquid from the glass surface. The effect may be described as a case of "cavitation." Some experiments were made to imitate the actual case of a fully lubricated axle rotating under a bearing. For this purpose, a thick disc with its edge worked to a spherical surface of curvature equal to the radius of the disc, mounted on an axle, was arranged so that the lower part of the disc dipped into an oil-bath, whilst a flat plate of glass rested on the upper edge of the disc. As the disc rotated oil was carried round, so that the point of contact of the disc and plate was maintained copiously lubricated. The disc represented the axle and the plate the bearing on it. What happened on rotation could be observed by looking through the glass plate with a magnifying glass. It was seen that during motion a cavity was formed on the side where the edge of the disc was moving away from the plate. The size of the cavity depended on the rate of rotation. In ball bearings completely immersed in oil, the experiments show that there must be a small cavity near the point of nearest approach of each ball to its neighbours and also to the surface on which it is running. As the friction of the bearing is the viscous friction of the oil, it follows that the friction must be considerably reduced by the formation of these cavities, which are filled with relatively non-viscous vapour. The high lubricating property of oils owes its origin not only to their superior viscosity, but also, possibly, to the facility with which cavities may be formed in them.

The author illustrated his Paper by a series of experiments showing cavitation produced by rolling lenses on plates.

Prof. J. D. EVERETT said it was interesting to note that cavitation had been observed and correctly explained by Newton. He (Prof. Everett) mentioned that a similar phenomenon was exhibited by a steam-roller working on mud, and gave an explanation of the production of pressure and tension respectively in the liquid near the contact of the roller and the mud. If the mud were sufficiently viscid cavitation might occur behind the roller.

Mr. W. A. PRICE said that the observations of the author could not fail to be of interest to engineers. He asked to what extent cavitation was going on in an ordinary round bearing, or in the slide-valve of a locomotive, and suggested that the views of engineers upon the subject of lubrication might require considerable modification in the light of the present Paper.

Mr. C. V. BOYS expressed his interest in the Paper and the experiments shown by the author. He said that, like Mr. Price, he had been thinking of the influence of cavitation upon machine bearings, but unlike him he had not come to the conclusion that our ideas on the subject should be changed. In the author's experiments cavitation was produced by the approach of two surfaces on one side of their line of contact and their recession on the other side. In the case of a cylindrical bearing the space between the shaft and journal was believed to be completely filled with oil, and if the shaft were truly concentric there would be neither approach nor recession. He thought that in the case of any cylindrical bearing the rate of approach and recession would never be great enough to produce cavitation. The case of ball-bearings, when using a thick lubricant, was different, and cavitation might occur. If it did it would occur behind the point of contact, and although the production of cavitation involved a loss of energy he questioned whether it did any appreciable harm. Mr. Boys referred to the dendritic patterns formed, when mixing paints, by lifting the muller from the plate, and suggested that their formation was a phenomenon of the same kind as cavitation.

Mr. R. APPLEYARD said there were two distinct cases to be considered: (1) A wheel on a plane, and (2) a shaft in its bearing. He agreed with Mr. Boys that the cavitation occurred behind the point of contact, and did not matter in the case of a ball bearing. But if cavitation occurred in a cylindrical bearing the cavity would form between the two surfaces which were next coming into contact. If the surfaces were smooth little harm would ensue, but if they were rough the occurrence of cavitation would be detrimental, for it would result in a direct contact.

Dr. A. GRIFFITHS asked the author if cavitation in lubrication was supposed to be an advantage or a disadvantage.

Mr. SKINNER, replying to Mr. Boys, suggested the construction of glass bearings to determine whether cavitation occurred in cylindrical shafts. He thought that cavitation in lubrication was an advantage as a rule, because spaces formerly filled with viscous material were then filled with something with small viscosity.

Prof. R. THRELFALL then exhibited and described the following instruments which he has used in the testing of electric generators by air calorimetry:—(1) A "hot-wire voltmeter" accurate to $\frac{1}{100}$th volt. The wire in this instrument is very fine, and special precautions are taken to keep the tension on it constant, so that the elongation measured is due only to the expansion of the wire caused by the heating effect of the current. (2) A "Pitot tube" for the measurement of air velocity, the velocity being proportional to the square root of the pressure produced in the tube. (3) A "manometer" for determining pressure-differences in Pitot tubes with accuracy. This consists essentially of two bottles containing coloured water, which are connected by a syphon, and the air space of each bottle is put in communication with its appropriate tube. The readings are taken by setting a pair of needle-points just to touch the liquid surface, and then measuring how they differ in level by micrometer screws, or by callipering suitable jaws. The instrument is reliable to 0·01mm. of water pressure. (4) A multiplying pressure gauge in which the motion of a float or ball is used to operate a finger moving round a dial. The dial is divided in such a manner that the square roots of the pressure-differences are read off. Air velocities are, therefore, given directly.

Mr. DUDDEL, referring to the voltmeter exhibited, asked if there was any trouble with regard to the temperature variation of the resistance of the wire. In using the instrument with large alternating currents it was necessary to use a standard shunt, and difficulties then arose because of the fact that the self-induction of a shunt, formed of straight bars and capable of carrying the necessary current, was comparable with its resistance. It might be possible to get a satisfactory shunt by doubling the bars upon themselves to reduce the self-induction.

Prof. THRELFALL said that there was no difficulty with regard to changes in temperature of the room, because they only altered the zero of the instrument. Referring to the possibility of constructing a low-resistance standard shunt, he said he had calculated the self-induction of the bars forming his shunts, and had come to the conclusion that it was negligible in his experiments. Experimentally, he had found that it could not produce an error of 1 per cent. It might be possible to so design a shunt that the mutual induction of its parts would balance the self-induction to a certain extent.

MOTOR HIRE-PURCHASE SYSTEM.

The electricity department of the Hackney Borough Council are untiring in their endeavours to improve their already large motor load, and have issued an excellent illustrated pamphlet on the subject of motor driving. It gives the intending power consumer all the information he is likely to require, and in addition gives particulars of the hire-purchase scheme which has been arranged with the Rhodes Electrical Mfg. Co. The following form of agreement, which is employed for this purpose, will doubtless interest some of our readers:—

FORM OF HIRE-PURCHASE AGREEMENT FOR ELECTRIC MOTORS.

AN AGREEMENT made the day of , 190 , between the Council of the Metropolitan Borough of Hackney (hereinafter called the "Council") of the first part, the Rhodes Electrical Mfg. Co. (hereinafter called "the owner") of the second part, and the occupier of the premises (hereinafter called "the hirer") of the third part.

WHEREBY it is agreed as follows:—

1. The owner agrees to let and the hirer agrees to hire the motor or motors with starting resistances, switches and fittings and all necessary wiring for the same between the motor and starting switch (hereinafter called the "motor installation") as specified in the schedule hereto, subject to the terms and conditions following.

2. The hirer shall prepare the necessary foundation for the motor in accordance with plans provided by the owner, whereupon the owner shall, as soon as practicable, and in a proper manner, and in accordance with the general conditions under which electricity will be supplied by the Council and with the regulations of the fire insurance companies, and free of cost to the hirer (except the rent hereinafter mentioned), furnish and fit up the motor installation on the said premises of the hirer.

The owner shall place the motor or motors wherever desired by the hirer unless in the opinion of the owner the positions selected are unreasonable, in which case an appeal may be made to the Council's electrical engineer whose decision on the question of unreasonable positions shall be final.

3. During one year, dating from the completion of the motor installation, the owner will repair and maintain the same (except such repairs as may be necessary through damage by fire or damage caused by the hirer or any person other than the Council or the owner).

4. The hirer will pay to the Council on behalf of the owner for the hire of the said motor installation the rent of £ : : per quarter for the period of quarters of a year, amounting to the total sum of £ : : The first of such payments to be made on the date hereof, and the subsequent payments to be made in advance, at intervals of three calendar

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months, reckoned from the date hereof, so long as the hiring continues. All payments to be made punctually on or before the dates named.

5. The hirer will keep the motor installation in good order and repair, damage by fire included, but fair wear and tear excepted.

6. The hirer will keep the motor installation in the hirer's own custody and possession at the above address, and will not remove, or suffer the same to be removed, without the previous written consent of the owner and the Council, and will allow the owner and the Council and their respective servants or agents to inspect the same at all reasonable times.

7. The hirer will keep the motor installation free and exempt from legal process, and will punctually pay all rent, mortgage interest, rates and taxes for the premises on which the machine may be placed, and will produce on demand to the Council or to the owner or their agents the last receipt for any such payment.

8. The hirer will keep visible upon the motor the label thereon stating that it is the property of the owner.

9. In case any of the said rent shall be in arrear, or in case the hirer commit, or suffer to be committed, any breach of this agreement, or in case the motor installation or any part thereof shall be seized or taken by any person other than the hirer or under colour or in pursuance of law, or in case the hirer shall cease to take a supply of electrical energy to the said premises from the Council, the owner, or the Council on the owner's behalf, shall thereupon, without any previous demand being necessary, be entitled to take and resume possession of the said motor installation (without prejudice to the owner's right to recover rent and damages for breach of this agreement). And the Council or the owner and their respective servants or agents may for that purpose enter into any building or premises of which the hirer may be or appear to be owner, tenant or occupier, and there search for and take the motor installation.

10. The hirer may at any time during the hire, provided that no rent is in arrear, terminate the hire by returning at the hirer's own risk and cost the motor installation to the owner, and by payment to the owner of 10 per cent. of the total of the unpaid rent.

11. The owner will thereupon allow to the hirer the unexpired proportion of the current quarterly rent, calculated from the date on which the owner receives the motor to the end of the current quarter.

Upon such return and payment as aforesaid, the hirer shall be exempt from any further liability under this agreement (except in respect of any breach of this agreement previously committed).

12. If and when the hirer shall have paid the said total sum of rent not later than the time above limited for payment of the last of such quarterly payments (and in this respect time shall be of the essence of the contract) the motor installation shall thereupon become the hirer's property. In the meantime the hirer shall be merely hirer and not owner of the motor installation, which shall remain the property of the owner unless and until paid for as above provided.

13. The hirer may at any time during the hire, provided that no rent is in arrear, pay the total of the said quarterly sums of rent not then due, and the owner will allow discount thereon at 10 per cent. per annum, reckoned from the end of the current quarter to the respective dates at which the said quarterly sums of rent would have become due, and will also allow the same rate of discount on the unexpired proportion of the current rent.

14. Should the Council or the owner take possession of the motor installation, the hirer shall, on payment within 14 days thereafter of all rent then due, and of the expenses of and incidental to such taking possession and removal, and the expenses of the reinstatement of the motor installation, have the right to have the same reinstated and the hire continued in accordance with all the terms hereof.

15. Any relaxation or indulgence which the Council or the owner may show to the hirer shall not in any way prejudice their respective strict rights under this agreement.

Signature of hirer .....
Full name.....
Address.....
Witness.....

ROYAL COMMISSION ON LONDON TRAFFIC.

The evidence of the London borough councils was continued on Friday last, November 27.

Mr. J. H. ROBINSON, alderman of the Stepney Borough Council, and chairman of the Works committee, objected very strongly to the powers of the borough councils over the public highways being curtailed in any way. If, as had been suggested, these powers should be transferred to one central authority, he failed to see that any good purpose would be served. Obviously, it would be necessary for such a central authority to refer to the individual borough councils for information as to the local needs, even as the London County Council had to do at the present time, and he maintained that the local authority was better acquainted with what was best for its district. A further illustration of this fact was afforded recently in connection with the proposed electrification of the tramways in the Mile End-road. The Highways committee of the London County Council reported that there would be very great difficulty in applying the conduit system to the horse tramways there. In answer to this, however, the Stepney borough engineer was able to prove that only in two places along the route was the available depth less than would be necessary to adopt the conduit system, and, of course, such alterations as were desirable could be carried out at a small additional cost. On the question of the breaking up of the streets by electric light and other companies, he maintained that the administration of such work had been carried out with efficiency; and he further urged that the whole of this work should be vested in the borough council, including the reinstatement of the streets. Really, there was no very great grievance on this matter, but possibly conference between the London County Council and the borough councils would result in the framing of bye-laws which would more effectively deal with this matter. Special cases arose at times, such, for instance, as the tearing up of the streets by the Charing Cross and City Electric Lighting Co. for the purpose of laying mains as part of an electric supply system which did not benefit the district in any way, inasmuch as the company had no powers to distribute electricity in Stepney. A memorial had been presented to the Council by the shopkeepers in the main streets as to the loss of business consequent on this. Under statutory powers the company was empowered to lay their mains down the main thoroughfares, a proceeding which the old Whitechapel Board of Works strongly opposed before Parliament. But, by a deficiency in standing orders this opposition was not upheld, and incidentally, therefore, he suggested a modification of Parliamentary Standing Orders in this respect. Coming to the question of tramway accommodation in Stepney, he pointed out that there were only a little over 7 miles, or 1 mile to every 42,657 inhabitants, and the Borough Council urged the extensions of electric tramways, provided the London County Council, who would reap the profits, defrayed the whole cost of the necessary street improvements. At the same time the Borough Council strongly favoured the retention of the local veto in respect to tramways, and opposed any alteration in Standing Order 22. Any difficulties which might arise owing to the local authority exercising this veto could, it felt, be submitted to arbitration at the instance of an independent tribunal representing the London County Council, the borough councils and the Board of Trade. The Stepney Borough Council was quite satisfied with the provisions of the Tramways Act of 1870, and in view of this, it disagreed with the suggestion that the London County Council should, as a tramway authority, be exempted from any obligation to comply with the provisions of the act.

The CHAIRMAN: What are your views as to the existence of an independent tribunal dealing with matters appertaining to locomotion in London?—I think there should be an independent authority—*i.e.*, one upon which representatives of neither the London County Council nor the borough councils should sit.

It should be in the nature of a permanent board of locomotion, elected by Parliament?—Yes.

Have you ever exercised your tramway veto?—Yes, we have stopped the London County Council from putting down the trolley system of tramways in Stepney.

Continuing: The Borough Council could have taken legal proceedings against the Charing Cross and City Electric Lighting Co. for undue delay in the laying of its mains, under sec. 11 of the Gasworks Clauses Act, 1847, which was incorporated in the Electric Lighting Act of 1882, but upon the attention of the company being drawn to this fact, they made every effort to satisfactorily complete their works, and it did not become necessary to complete the legal proceedings which the Borough Council had contemplated. Difficulties of a similar nature had arisen in connection with the conversion to electric traction of the tramway lines in the south of London, so that it would not be a good policy to invest the London County Council with the general powers suggested as to the highways.

Mr. J. RUSH DIXON, engineer and surveyor to the Shoreditch Borough Council, considered that, so far as this district was concerned, a large part of the street congestion could be obviated by road widenings, and he indicated in which direction he thought this could best be accomplished. Inasmuch as the congestion in all streets in which there were tramways was caused by the tramways, any expense in street widenings in these thoroughfares should be borne by the owners of the tramways. Another means of relieving congestion was to do away with all tramway or tube railway termini in the central part of London, and to have these in the suburbs. He also considered the construction of the following tube railways would facilitate traffic to the west and south-west, from the Shoreditch Borough Council's point of view:—(*a*) A line running from Shoreditch Church, under Old-street, Clerkenwell, and Theobald's-road towards Charing Cross. (*b*) From Tottenham and Walthamstow, joining at Shoreditch Church and proceeding under High-street, Bishopsgate-street, Gracechurch-street, Cannon-street and the Strand to Piccadilly. The former proposal was merely a suggestion of his own, but the second had already been put before Parliament by private promoters. The Shoreditch Council would be willing to surrender its tramway veto to an impartial and independent tribunal dealing with London locomotion. On the question of breaking up the streets for electric light and other mains, he suggested that the borough councils should have power to regulate the depth of these mains, to provide for continuous work and to have special supervision.

Mr. F. S. ROBINSON, town clerk to the Metropolitan Borough of Greenwich supported the previous witnesses in respect to the retention of the local tramway veto and also as to the granting of further powers over the public highways. He failed to see any advantage in surrendering the veto to a special tribunal, as even then the borough councils would be put to the expense of opposing schemes which they did not feel inclined to sanction. The chief objection to present methods was that every tramway scheme involved a scheme of street widenings to which the borough councils were asked to contribute. If it were not for this, something might be done in the way of waiving the right of veto. The Greenwich Council was also in favour of fixed stopping places. Outside the question of veto, an independent board of locomotion for London, he thought, would be welcomed by everybody.

Mr. GIBB: Why do you object to the abolition of the veto?—I am expressing my own opinion when I say that I think the road authority should have absolute veto.

In whose interests?—In the interests of the district. We would no doubt give our consent where the tramway was of value to the district.

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You really use your veto to avoid paying a contribution to the cost of the street widening?—We usually say, relieve us from a special contribution and we will remove our veto.

Therefore, even if you know the tramway would be a desirable thing for the district, you refuse to sanction it because of the street widening?—As a rule, we do not say whether it is desirable or not. We leave that to Parliament, provided we are exempt from any liability in respect of the street widening.

Therefore it is as I say?—The view of my Council was that it should have a veto. My own view is that, if we are not to pay any of the cost of the widening, we could leave the matter to Parliament. I contend that we always pay something to every improvement by means of our contribution to the county rate.

If the district benefits by the tramway, would you say that your Council should pay part of the street widening?—Yes, I suppose it should.

Lord RIBBLESDALE: If you get a tramway not absolutely necessary, and also a street widening at somebody else's expense, you would agree to the tramway if the widening was a necessary thing?—I have never heard of such a case arising.

In conclusion, witness said he considered the London County Council's policy on the question of tramways and street improvements of too cast-iron a nature. It was always that the borough council should pay one-third of the cost of the latter.

Thursday, December 3.

Mr. ARTHUR HARRISON, engineer and surveyor to the Southwark Borough Council, which also took part in the Conference of the London Borough Councils, confirmed the resolutions passed at that Conference, one of which was that the statutory powers now possessed by the borough councils over public highways should not be curtailed. He said that the dangerous state of the streets in Southwark had been considerably enhanced since the inauguration of the London County Council electric tramways, and especially so in London-road, Newington Butts and Kennington Park-road. Extra powers should also be given to the local authority with regard to the opening of trenches, both with reference to the position and time of opening, depths, &c., also as to the fixing of the boxes and inspection chambers, and the hours during which they should be used. Apart from other vehicles, no less than 1,500 tramcars passed along Walworth-road in one day, over 1,000 along the Blackfriars-road, a similar number passed the Bricklayers' Arms in the Old Kent-road, 1,500 along Newington Butts, 2,500 along London-road and over 500 passed St. George's Church in the Borough High-street. In the London-road also there were 77 footpath electric light and telephone boxes, whilst between St. George's Church and London Bridge there were no less than 172, which were always being made use of. He agreed with the previous witnesses on the question of the tramway veto.

The CHAIRMAN: What is your objection to giving up your veto?—We consider we know the requirements of the district best.

You may know the requirements of your own district, but not those of the other districts through which the line would pass?—Well, for instance, we have a case before us now. If the County Council were to construct the proposed tramway along Southwark-street to Southwark Bridge the traffic at Blackfriars-road would be absolutely blocked.

If there was a special authority dealing with locomotion, this could have been referred to it?—Yes, but we consider that the possession of the veto relieves us from expense of appearing before such a body.

Have you any opinions as to the formation of a tribunal of this nature?—I think it would be desirable.

Have you any idea as to its special functions or powers?—No, but we think it should consist of representatives of all the borough councils and the County Council.

You would have a very large body?—I do not think the number of members should be curtailed, but, of course, the question of the extent to which powers of the authority would extend must be considered.

Lord RIBBLESDALE: What is your objection to the London County Council as the sole tramway authority?—The County Council are inclined to look at these tramway schemes from the business point of view of the whole route, and overlook the needs of particular districts.

By Sir FRANCIS HOPWOOD: In Southwark there was no Tramways committee but a General Purposes committee which dealt with tramway matters. This did not confer with the County Council, but placed its views before it. There were no streets in Southwark which were suitable for subway tramways, but he thought a better plan would be to raise the level of the streets and make the existing one the subway, a sort of elevated railway.

Mr. R. M. PRESCOTT, town clerk to the Fulham Borough Council, dealt largely with the question of omnibus traffic. He confirmed the other views which had been expressed with regard to the tramway veto. As a matter of fact, the Fulham Borough Council had never exercised its veto, and at the present time was in entire agreement with the London County Council as to a fairly large scheme of electric tramways which would connect Wandsworth with Hammersmith. This involved considerable street widenings, to which the Borough Council had consented to contribute £30,000, the County Council paying the remainder.

Mr. THOMAS SCORGIE, engineer and surveyor to the Hackney Borough Council, said the traffic question had occupied the serious attention of the Council for many years. On the question of street openings, he agreed with previous witneses, as also with regard to the tramway veto. To abolish this latter would mean that the London County Council would proceed with any unwise scheme without consulting the road authorities. Uusually, the first official intimation the borough councils received of any tramway scheme was a request from the London County Council for permission to affix notices of their intention to apply to Parliament upon the lamp-posts when it was too late for any representations to amend or alter the scheme. Only in one instance had the Hackney Borough Council thought fit to refuse consent, and then only after careful consideration of the merits of the case. Against this the Borough Council had given its unqualified consent to other proposals. Again, in one instance, the London County Council had obtained powers years ago to construct certain lines, which had not been put into force, and such a delay might well result in the character of the particular neighbourhood becoming quite changed, and the necessity for the line undesirable. Dealing with the question of increased means of communication between the City and the North East of London, the overcrowding in Hackney pointed to the desirability of some tube railway scheme being passed by Parliament, such as the City and North-East Suburban Railway, which had twice been unsuccessfully promoted.

The Commission adjourned until to-day (Friday).

THE EFFICIENCY OF TELEPHONE CABLES WITH UNIFORMLY DISTRIBUTED SELF-INDUCTION.*

BY T. DOLEZALEK AND A. EBELING.

For a long time past endeavours have been made to minimise the detrimental influence of the electrostatic capacity of long-distance telephone lines by increasing their self-induction. An artificial increase of the self-induction may be obtained in two ways: First, by surrounding the copper conductor with magnetic material, such as iron, &c., or, secondly, by interrupting the line at certain distances and inserting in the gap coils of high self-induction. The excellent results obtained on the latter principle were recorded in a recent article (*The Electrician*, Vol. L., pp. 722 and 817). At the request of Messrs. Siemens and Halske, experiments were now undertaken to determine how far the damping of the current waves could be diminished by the first method and if this means of increasing the self-induction could successfully compete with the second method.

Experimental researches with regard to iron-covered cables have already been conducted by Breisig† and Krarup.‡ The former investigated different types of telegraph cables, wound in various ways with iron wire or iron strip, the best result obtained being a rise in self-induction per kilometre from 0·00235 to 0·00370 henry, an increase of 57 per cent. Krarup, by covering his conductor with thin iron wire, obtained much better values, the best being 0·010 henry per kilometre. Our measurements show that higher self-inductions may be obtained and put to a useful purpose. The cables tested were connected to a Wheatstone bridge, with a telephone as zero indicator. When measuring the self-induction, the go-and-return conductors were short-circuited at their distant ends and connected as one arm of the Wheatstone bridge. The adjoining arm contained a variable self-induction coil and a non-inductive resistance. When measuring the capacity, the far ends of the cable were not connected, and instead of the self-induction coil a condenser was inserted into the third arm of the bridge. The test to determine the self-induction is somewhat influenced by the capacity of the cable, this behaving itself—in the presence of the alternating measuring current—as a resistance possessing self-induction with a condenser in parallel. A very simple calculation results in the following equation, which gives the connection existing between the measured self-induction L_1, the real self-induction L, the capacity C and the resistance R of the cable, $L_1 = L - p^2CL^2 - CR^2/(1-p^2CL)^2 + p^2C^2R^2$, wherein p denotes the frequency of the measuring current multiplied by 2π. With the cables measured, the resistance R and the capacity C are relatively small, and only the term CR^2 exceeded 1 per cent., so that approximately $L = L_1 + CR^2$. This correction CR^2 attained in the most unfavourable condition the value of 15 per cent.

Two conductors of 2·5mm. in diameter were covered with several layers of iron wire, 0·7mm. in diameter, the iron wire being wound directly upon the copper. The two conductors were held apart at a distance of 31·5mm. After each layer had been applied, the self-induction was measured. In Table I. the results are reproduced:—

Table I.

—	Diameter over Iron. mm.	Self-induction in henrys per km.
Without iron.....	..	0·00152
One layer of iron wire....	4·0	0·0126
Two layers of iron wire ..	5·3	0·0200
Three layers of iron wire	6·7	0·0257
Four layers of iron wire..	7·9	0·0302
Five layers of iron wire ..	9·0	0·0342

In an incidental conversation with Prof. M. Wien he mentioned that, according to his experience, the magnetic properties of iron suffered on being wound around the conductor, and that, therefore, a subsequent annealing was necessary. This view was confirmed,

* Abstract of an article in the *Elektrotechnische Zeitschrift*.

† *Elektrotechnische Zeitschrift*, 1899, p. 844; or *The Electrician*, Vol. XLIV., p. 524.

‡ *Elektrotechnische Zeitschrift*, 1902, p. 345.

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for, after annealing, the self-induction of the cable loop, wound with five layers, rose from 0·0342 to 0·067 henry. A practical application of a layer of iron wire 0·7mm. thick is out of question, because the eddy current losses would be much too high. In fact, a measurement in this direction gave the apparent resistance per kilometre for an alternating current of 900 ∿ per second as 83 ohms, whereas, when measured with continuous current, the resistance was found to be only 5·5 ohms.

In a second series of measurements, a cable of the same dimensions as the first one tested was wound with two layers of iron wire 0·15mm. in diameter, and its self-induction was found to be 0·0121 henry per kilometre, the apparent resistance at the high frequency (900∿) being 6·3 ohms per kilometre. It will, therefore, be seen that a substantial increase in self-induction, accompanied by but a small rise in resistance, may be obtained by using thin wire, but for practical purposes smaller values of the self-induction have to be chosen on account of the increase in capacity. Table II. contain data referring to iron layers wound in various ways and with various thicknesses of iron wire :—

Table II.

	Per km. double line.				Apparent percentage rise in resistance at a frequency of 900 ∼
	Weight of iron. Kg.	Resistance. Ohms.	Mutual capacity. Mfd.	Self-induction. Millihenrys.	
Paper-insulated Cable with Copper Conductor 0·8mm. in diameter :					
Ordinary cable without iron	..	61·0	0·031	0·84	0
Conductor covered with iron wire 0·15mm. in diameter ; 610 turns per metre	0·5	63·4	0·034	1·41	0
With strand of four iron wires, each 0·15mm. in diameter ; 600 turns per metre	2·40	63·4	0·044	3·38	0
Stranded iron wire, consisting of 14 strands, each 0·15mm. in diameter ; 530 turns per metre..	7·60	65·0	0·042	6·77	0·5
Covered with iron wire, 0·5mm. in diameter, 820 turns per metre	9·64	59·4	0·045	7·49	1·6
Covered with iron wire, 0·5mm. in diameter, 1,350 turns per metre.	14·6	64·4	0·065	12·1	3·0
Paper-insulated Cable with Copper Conductor 1·5mm. in diameter :					
Ordinary cable without iron	..	17·64	0·044	0·63	..
Conductor covered with strand of 14 iron wires, each 0·15mm. in diameter; 500 turns per metre ..	11·10	18·46	0·054	5·06	1·5
Covered with iron wire, 0·5mm. in diameter ; 1,040 turns per metre	14·56	17·70	0·057	5·92	6·0

It will be gathered from these tables that the self-induction increases approximately with the weight of the iron surrounding the copper. The iron in these tests had not been annealed.

Lines with added inductance in the shape of coils distributed over their length possess the advantage that an increase in self-induction does not go hand in hand with an increase in capacity, as is the case in a marked degree with iron-covered conductors. Further, with the same quantity of iron employed in both cases, the increase in self-induction on the coil system is incomparably larger than in the other case. This result applies not only to land telephone cables, but also to submarine cables, and, since these are laid mostly in shallow waters, no insurmountable difficulty should be experienced in building the self-induction coils into the cable.

AUTOMATIC MOTOR STARTERS.

The following is a description—taken from the *Elektrotechnische Rundschau*—of two automatic starters, designed for either starting or stopping motors from a distance; they are manufactured by the German Lahmeyer Company, and are applicable for continuous and alternating-current motors. Both for stopping and starting the lever of the rheostat is actuated by the motor in question, but the speed of the movement of this lever is, of course, different for starting and switching off the current. In Fig. 1 A denotes the starting resistance. As soon as the motor begins to rotate, the lever *h*, by means of an intermediate crank, *k*, is set into a rocking motion. It carries two pawls, Z, Z_1, which are pressed by springs against the toothed disc S, fastened on the spindle of the starting lever. The meshing of either pawl is effected by means of a rod, *a*, and an electromagnet, *e*. As long as no current flows through the electromagnet *e*, the pawl Z is kept away from the toothed disc by means of a pin *s*. This is the position of the mechanism when at rest. If now the motor circuit is closed, no matter where, it is obvious, as seen from the diagram, that the electromagnet *e* is energised and attracts its armature. The pin *s* is lowered, and the upper pawl Z comes into contact with the toothed segment. Since the resistance on the first stop is so dimensioned that the motor receives sufficient current to start, the rocking lever *h* gradually cuts out the resistance, this lasting according to the length of the toothed periphery. Although the lever *h* continues to rock to and fro, the starting lever remains on the last stop. If the motor is to be stopped, the switch is opened, the armature of the electromagnet

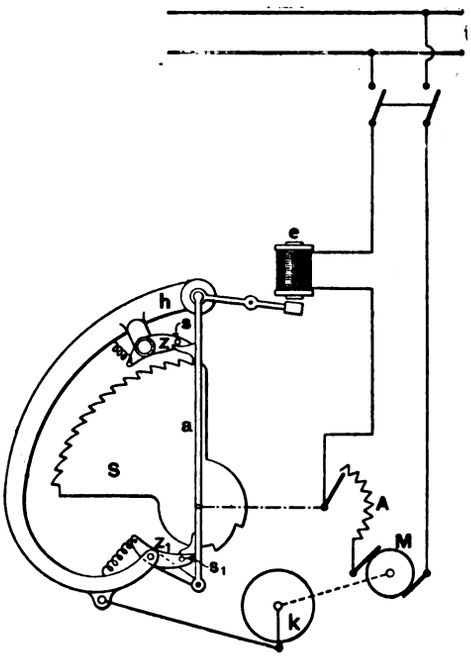

FIG. 1.—Diagrammatical Arrangement of Motor Starter.

being thereby released. The upper pawl is drawn away from the segment S by the pin *s*, and the lower pawl Z_1 now comes into contact with the teeth of the disc, rapidly bringing the starting lever back to its original position. In virtue of the momentum of the motor armature, the lever *h* will continue to rock for some time, without, however, causing any further movement of the disc S.

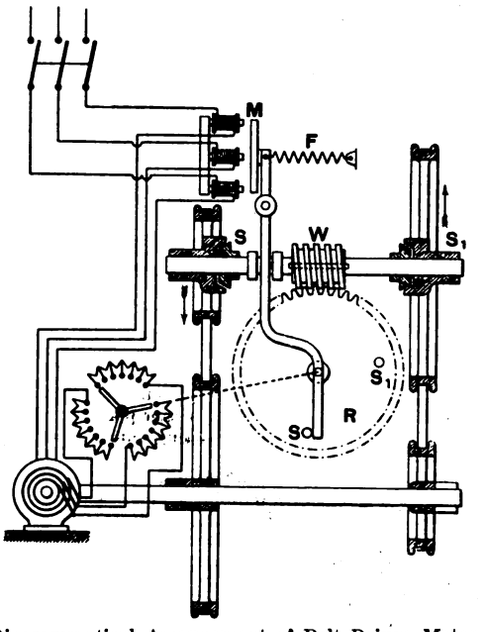

FIG. 2.—Diagrammatical Arrangement of Belt Driven Motor Starter.

Another arrangement is shown in Fig. 2, the chief difference between it and the former device being the adoption of a clutch instead of a pawl and ratchet-wheel. A worm-wheel, R, is attached to the lever of the starting box (shown in the sketch arranged for three-phase work) and is driven by a worm, W, in a clockwise or counter-clockwise direction, according as which of the two wheels S and S_1, rotating in opposite directions, is coupled to the shaft carrying the worm W. Both wheels are driven by the motor, but with different speeds ; the one for starting—*i.e.*, S_1—turns slowly as

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compared with the other one, S, which is employed for switching off the motor. On completing the motor circuit, the energised electromagnet M, in attracting its armature against the pull of a spring F, couples the worm W to S_1. The disc R begins to rotate, and resistances are cut out until the pin s_1, striking the lever, causes S_1 to become disengaged. On opening the circuit, the armature of M is released, and the tension of the spring F is sufficient to cause the left-hand clutch to engage, connecting thereby the worm W to the quickly rotating pulley S. The disc R is rotated until the pin s disengages the clutch.

CORRESPONDENCE.

STEAM TURBINES v. RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To continue my letter of last week regarding Mr. Morcom's comparison of turbine and reciprocating stations, I have a very high regard for the excellent tables published by our technical press on electricity station returns; the friendly rivalry inspired by them has done more to extend Messrs. Belliss and Morcom's and the business of the firm I have the honour to represent than even the excellency we both claim for our wares. They must, however, be used with judgment and care.

I am sorry Mr. Morcom does not allow an advocate to show that turbines are equal to engines without a charge of *quibbling* (an unkind word). However, I must appeal to your readers to judge my case. Let us first consider what we are trying to arrive at: The merits of steam turbines compared with reciprocating engines for electricity supply under *similar conditions*.

I resign my case unreservedly for three stations Mr. Morcom selects. Steam turbines cannot compete with reciprocating engines as regards economy of steam, unless they are, first, condensing, and secondly, of units over 200 H.P. On these grounds I am sure Mr. Morcom will allow me to strike out Blackpool and Morecambe from his list on the first ground, and Melton Mowbray on the second. I have been fortunate in obtaining a copy of the report of the meeting of the Newcastle-on-Tyne Electric Supply Co., which has the largest installation of turbines in this country, and from it I take the cost of coal, works costs and output. This brings the turbine stations up to five. The reciprocating stations must be reduced accordingly. I delete Halifax, corresponding to Blackpool, and as Salisbury is partly a *turbine* (water) station, I think I may omit that. Darwen is a continuous-current and battery station and hardly comparable with Scarborough. A watering-place of almost the same output is afforded by Yarmouth. I have added a column of figures, the value of which Mr. Morcom may not be aware—namely, load-factor—and omitted total costs, as management, rent, rates and taxes hardly concern steam engines.

Steam Turbines.

Station.	Units sold.	Coal.		Oil and stores.		Works costs.		Load-factor.	
Newcastle-on-Tyne	5,537,500	0·18	Aver. 0·586	0·03*	Aver. 0·046	0·38	Aver. 1·176	..†	Aver. 9·85
Newcastle and Dist.	1,619,671	0·69		0·12		1·22		11·66	
Cambridge	419,005	0·66		0·14		1·57		9·13	
Scarborough.....	431,777	0·85		0·08		1·61		9·34	
West Bromwich ..	285,848	0·55		0·11		1·10		9·27	
Steam Engines.									
Leeds	4,448,650	0·28	Aver. 0·672	0·03	Aver. 0·048	0·62	Aver. 1·13	12·31†	Aver. 16·63
Bootle	1,619,129	0·41		0·03		0·70		28·44	
Taunton	646,273	0·70		0·06		1·05		12·77	
Yarmouth.....	418,021	1·38		0·23		2·02		9·74	
Kings Lynn	286,679	0·59		0·09		1·26		15·58	

* Assumed. † Not available. ‡ Not included in average.

The result of my table is to show that a station which was all reciprocating and of a power of 3,000kw. in one year by adding 4,000kw. of turbo plant reduced its cost for coal from 0·48d. per unit to 0·18d., and works costs from 0·98d. to 0·38d., holding the record for all Great Britain. Of the remaining four stations, three turbine stations are superior in coal, whilst the load-factor of the corresponding four reciprocating stations is 68 per cent. better. The cost of "oil, waste, water and stores" is hardly comparable, including, as it does, boilers, dynamos and mains. The same may also be said of repairs and renewals.

I trust my quibble may be pardoned, and I think my reading of the published results of such turbine stations as exist, when compared with the same number of as nearly equal-conditioned reciprocating stations as I can find, 80 per cent. of which are also selected by Mr. Morcom, goes to prove that the distance ahead of the steam engine is undoubtedly uncertain, and is possibly represented by a figure with a minus sign in front.—Yours, &c., JOHN H. BARKER.

Loughborough, Nov. 30.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As managing director of the Cambridge Electric Supply Co. (Ltd.), and also of the Scarborough Electric Supply Co. (Ltd.), and as, therefore, in some measure responsible for the exclusive and continued use of steam turbines by these two concerns, I feel called on to draw attention to what appears to me to be the entirely misleading nature of the comparisons between the results obtained in steam turbine stations on the one hand and reciprocating engine stations on the other, recently published in your columns by Mr. Alfred Morcom.

For his purpose Mr. Morcom states that he has selected reciprocating engine stations which are "under approximately similar circumstances as to costs of labour, fuel, output, &c.," as the turbine stations. No doubt he has made this selection as fairly as is possible; but to show how unsuccessful he has been in this respect, it is only necessary to point out that among his reciprocating engine stations he has included Salisbury, where a portion of the electrical generation is carried on by means of water power, and where both fuel and works costs are, therefore, abnormally low. Again, though Mr. Morcom specially mentions the matter of output, his own figures show an average annual output of 1,464,907 units for his reciprocating stations and only 738,924 units for the turbine stations, a ratio of practically 2 to 1.

How greatly the mere quantity of output affects results may be seen from the following figures which show how the costs of fuel, &c., have decreased at Cambridge and at Scarborough as the output has increased in the last seven years:—

	Total units sold.	Fuel.	Oil, waste & stores.	Works costs.	Total costs.
Cambridge.					
1895	150,510	1·98	0·19	3·91	4·53
1902	419,005	0·66	0·14	1·57	2·40
Scarborough.					
1895	135,177	1·66	0·12	3·47	4·36
1992	431,777	0·85	0·08	1·61	2·65

Incidentally the above figures also go to show that the efficiency of steam turbines does not fall off with use, as has been suggested in some quarters.

Another most important omission from Mr. Morcom's figures is any consideration of the question of load-factor, which, as all station engineers are aware, has a greater effect upon costs than almost anything else. The following are the load-factors of the turbine and reciprocating engine stations selected by Mr. Morcom for the same years that he has given the other costs:—

Steam Turbines.		*Reciprocating Steam Engines.*	
Blackpool	14·32	Leeds	12·31
Newcastle District	13·67	Halifax	16·98
Cambridge	9·13	Bootle.....	28·44
Scarborough	9·34	Taunton	12·77
West Bromwich	9·27	Darwen	12·12
Morecambe	7·06	Kings Lynn	15·58
Melton Mowbray	11·11	Salisbury	11·49
Average	10·55	Average	15·67

As will be seen, the average load-factor of the reciprocating stations is practically 50 per cent. better than that of the group of turbine stations.

To recapitulate, the following are the points to which I desire to draw attention:—1. Among the reciprocating stations Mr. Morcom has selected there is one where, owing to the use of water power, the results are abnormal. 2. The average output of the reciprocating stations Mr. Morcom has selected is about double that of theturbine stations. 3. The former have, on the average, a 50 per cent. better load-factor than

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the latter. I think that most engineers will agree with me that, under these circumstances, Mr. Morcom's comparisons are of no value at all.

Lastly, I note that in Mr. Morcom's list of turbine stations he has left entirely out of account that belonging to the Newcastle-on-Tyne Company, which, if I mistake not, is now almost entirely run by means of steam turbines. Would it surprise Mr. Morcom to learn, what I am informed on good authority is the fact—namely, that the works costs of this station are now less than half the most favourable similar figure of 0·62d. per unit which Mr. Morcom gives for Leeds? Now, the cost of coal and labour at Newcastle and Leeds cannot differ very greatly, so this enormous difference must be due to matters of load-factor and output, and probably also to some amount of superior economy in steam turbines over reciprocating engines.

—Yours, &c., A. A. CAMPBELL SWINTON.

Westminster, Dec. 2.

RED SUNSETS AND MAGNETIC STORMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Regarding your recent interesting articles on "Magnetic Storms" (*The Electrician*, November 6th), is it possible that these are the result of a collision between the earth and a cloud of cosmic dust?

This would generate electric charges in the upper regions of the earth's atmosphere, and as these would be at first travelling rapidly through it, currents would be generated in accordance with Rowland's experiment which might have an effect on terrestrial magnetism.

With reference to the dust cloud, I assume this is part of what people here would call "the riddlings of creation." These clouds may either drift into our planetary system from outside or they might be looked for in the neighbourhood of the orbits of meteorites, &c. In the latter case, magnetic storms might be expected if the earth cut, or closely approached the orbit of a swarm of meteorites just after the meteorites had passed.

Recently, the sunsets in this locality have been particularly red with brilliant "after-glows," and "Bishop's Ring" has been observed in various parts of the country. If the current explanation of these phenomena is to be accepted, they mean that there is a considerable amount of dust in the atmosphere. The only satisfactory source of the dust seems to be outside the earth's atmosphere.

This hypothesis would at least account for the suddenness of a magnetic storm, which some of the others do not.—Yours, &c.

Dalry, Galloway, N.B., Nov. 25. W. H. F. MURDOCH.

THE QUESTION OF THE HOUR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be sorry indeed to misrepresent or misquote "G. R. N."; neither am I conscious of having done so, but those who challenge statements must expect replies. "G. R. N." shifts his ground. Now he maintains that, although a Protectionist, he is a more logical Free Trader than myself, because he has studied "the open book of facts." What facts are these? Where are they to be found? Certainly not in the Board of Trade returns—not in the income-tax receipts—not, above all, in the most recently issued Parliamentary blue-books; for those one and all show clearly our marvellous and steadily increasing prosperity as a nation under 50 years of a system which he would see destroyed. I can only conclude, therefore, that either "G. R. N." has not found time as yet to study the statistics of this subject, or that he ignores them.

With your kind indulgence, Sir, and as the discussion arose firstly through a "leader" in your columns, I, like "G. R. N.," will conclude by summarising my contention. The excellence of our manufactures and cheap production, as secured by Free Trade, enable us, prohibitive tariffs notwithstanding, to compete with advantage against protected countries, not only in our own markets, but in the far larger markets of the world. This applies to the vast bulk of our industries, including machinery and submarine cable manufacture. Owing, however, to the now-increased and only-to-be-expected competition of other countries, the margin of advantage in our favour is now but a small one. This margin Protection would serve to more or less wipe out by taxing the very articles the present free import and consequently low prices of which alone make profitable manufacture possible. The result would be to increase prices to home consumers and also cripple our great foreign trade.

Before proposing any change in a long-proved system like Free Trade, the necessity of such change must be demonstrated, not by any "open book of facts," but by the incontestable evidence of authorised and official statistics. If so judged, was there ever an agitation more unwarranted than this recurrent cry of the last few years for Protection, whether under the name of Fair Trade, Fiscal Reform, Retaliation or of any other title calculated to conceal the real object of a movement for helping inefficient industries at the expense of efficient industries?

"G. R. N." says that I ignore the causes other than Free Trade which contribute to our success. I presume he means our geograhical and natural and physical advantages. These, however, in no way affect my argument.

According to Protectionists, our long-continued excess of imports over exports means our impoverishment. And yet our national wealth still grows apace, and never was it greater than now. Strange this from the *fiscalist's* point of view!

I will not now further encroach, Sir, on your valuable space.

—Yours, &c., H C. D.

London, S.E., Dec. 2.

THE INVENTION OF THE DYNAMO-ELECTRIC MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Prof. Thompson's letter which appeared in your issue of the 27th ult., we are instructed by our client, Dr. Henry Wilde, F.R.S., to say that he considers it to be a matter for regret that Prof. Thompson should fall back upon the statements contained in his original letter of October 27th, after their incorrectness had been clearly shown in the subsequent correspondence.

Dr. Wilde also instructs us to say that this correspondence, which will possess an interest hereafter for electricians and electrical engineers far beyond the limits of the present discussion, will not be complete if we omit to point out that Prof. Thompson's quotation (in his letter of October 27th) from the Paper of Charles Brooke in the *Proceedings* of the Royal Society, 1867, is only a footnote to the principal statement in the body of the Paper dealing with Dr. Wilde's discovery and inventions, which note was apparently added subsequently to the reading of the Paper.

We have, therefore, to request that you will be good enough to permit us to reproduce this statement as embodied in the following paragraphs from p. 11 of Dr. Wilde's correspondence with the Society of Arts in 1900, on the occasion of the award to him of the Albert medal. (Copies of this correspondence, Dr. Wilde informs us, are to be seen in the Library of the Institution of Electrical Engineers and in the principal scientific libraries in this country and abroad.)

In a Paper communicated to the Royal Society, in March 1867, by Charles Brooke, F.R.S., the term "dynamo-electric machine" (since contracted to "dynamo") was used for the first time in the following paragraph:—"The dynamic nature of electric energy is clearly indicated by the dynamo-electric machine of Holtz, in which dynamic is directly converted into electric energy, and by the cognate machines of Wilde, Wheatstone, Siemens and Ladd, in all of which alike there is an intervening conversion of dynamic into magnetic energy. The enormous amount of current-energy evolved in Mr. Wilde's machine, when the power of a steam engine is employed to rotate the armatures, may be judged of by the fact that a long piece of platinum wire, 0·2in. in thickness, was seen to be disintegrated and partially fused."

Now the term "dynamo-electric machine" has never been used by electricians to denote the glass influence machine of Holtz, for generating static electricity, but is now applied exclusively to electromagnetic generators of the kind specified by Brooke, the inventor of the term. Moreover, as in the order of time my electromagnetic generator preceded those of Siemens, Wheatstone and Ladd by nearly a year, my claim to the invention of the dynamo-electric machine is clearly established by the direct statement of Brooke himself, as well as indirectly by the Counci in their award to me of the Albert medal for the discovery of the principle which formed the basis of my first dynamo-electric machine and of all subsequent dynamos.

We are also instructed by Dr. Wilde to point out that Faraday was the first inventor of the terms "magneto-electricity" and "magneto-electric machine," and that he specifi-

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eally limited the use of these terms to the evolution of electricity from permanent steel magnets. Also, that while it is abundantly evident from Faraday's first series of researches (§ 111) that he obtained electricity from copper helices, either alone or in conjunction with loose iron cores, excited by a voltaic battery, it is clear that in the production of electricity in this instance nothing in the form of a machine was employed as in the case of the famous disc experiment with permanent steel magnets. Dr. Wilde considers that electricians and electrical engineers who are interested in the history of their science and its applications will do well to obtain their information direct from original sources.

In conclusion, we may say that the inference which probably the majority of your readers would draw from Prof. Thompson's last letter—namely, that Mr. Justice Buckley and the Court of Appeal, after having heard our client's case against Prof. Thompson argued upon its merits, dismissed the action—is an erroneous one. The procedure which was adopted by Prof. Thompson took the form of what was formerly known as a demurrer, and debarred our client's counsel from bringing the merits of the case before the Court, and confined them to the argument of a preliminary point of law. Consequently, neither the Court of Appeal nor Mr. Justice Buckley has given or has had any opportunity, up to the present stage of the proceedings, of giving any decision whatever as to the accuracy or inaccuracy of the statements in Prof. Thompson's book.—Yours, &c., SLATER, HEELIS, WILLIAMSON & Co.

Manchester, Dec. 1.

[To make our correspondents' statement as to the recent judgments clear, we may re-state the facts. Dr. Wilde brought a libel action against Prof. Thompson with regard to certain statements in the latter's book. Prof. Thompson moved that the statement of claim in the action should be set aside, on the ground that the action showed no cause for proceedings, and that it was vexatious. Mr. Justice Buckley gave judgment in favour of Prof. Thompson, and in affirming this decision in the Appeal Court, Lord Justice Vaughan Williams said :—

With regard to the hardship which it is alleged is being done to the plaintiff, because his reputation as a scientific inventor might be damaged, although we know that inventors are a very thin-skinned, excitable class, I cannot understand even an inventor supposing that there is one word in defendant's book which in the slightest degree can injure his reputation. On the contrary, if you take the passages set out as a whole, they seem to me to recognise to the fullest degree the scientific reputation of the plaintiff.

On the question of priority of invention, our readers have now had the benefit of reading in these columns both Prof. Thompson's views and those of Dr. Wilde, who, as stated in the above letter, considers that electrical engineers would do well to obtain their information as to matters of history from original sources, but yet prefers to impart his particular version through a firm of solicitors. This correspondence is now closed.—ED. *E.*]

LEGAL INTELLIGENCE.

Knight v. Isle of Wight Electric Light and Power Co. (Ltd.).

The hearing of this case (briefly referred to in our last issue) was continued by Mr. Justice Joyce on Friday, Saturday and Tuesday. The action is for an injunction to restrain defendants from so carrying on their electricity works as to interfere with the enjoyment by plaintiff of certain premises known as St. Boniface College, Ryde, Isle of Wight, or to cause annoyance or danger to plaintiff or persons inhabiting or frequenting the premises. Damages and costs were asked for. Plaintiff was leaseholder (for 21 years) of St. Boniface College, and for three years had carried on a high school there. By the Ryde Provisional Order, 1899, the Corporation of Ryde were authorised to supply electric energy within the borough. It was provided by clause 69 that nothing in the order should exonerate the undertakers from any indictment, action or other proceeding for nuisance caused or permitted by them. In the early part of the present year defendants acquired land adjoining, on the east side, plaintiff's premises, and, purporting to act under the authority of the order, erected upon it extensive works for the generation and supply of electric energy, which was generated by gas-driven electric generators, and water gas was manufactured at the works for the gas engines. Defendants' works were 65yds. distant from plaintiff's dwelling house. The company commenced to work their machinery about Sept. 10 last, and immediately thereafter serious vibration was and still is felt at plaintiff's premises whereby the doors and windows of the house were made to rattle continually, and the noise and vibration had continued on occasions throughout the night in such a way as to seriously interfere with the proper rest and repose of the plaintiff and the inmates of her house. Defendants also were alleged to have caused or permitted objectionable and offensive smells of great intensity to be emitted from their works which were very injurious to plaintiff's health. Defendants' acts had seriously interfered with the enjoyment of plaintiff's premises, and they threatened to continue them unless restrained by the Court.

Defendants pleaded that the Corporation of Ryde, being under statutory obligation to supply electricity for public and private purposes within the borough, contracted with defendants for the erection, maintenance and working by defendants of the generating station, and the site of defendants' works and plans were submitted and approved by the Corporation. The works were not in operation until Oct. 1, 1903. In September some necessary tests and preliminary experiments were carried out at the works, and during those operations some noise and possibly escape of gas were unavoidably caused by the working of the new machinery, but the necessity and the cause of the same were explained to plaintiff and remedied as soon as practicable before the commencement of the action, and no injury or damage was caused to plaintiff. The works were of the most modern character, electricity being supplied, on behalf of the Ryde Corporation, for a number of public and private installations. Since Sept. 20 defendants' engines had never been running or working later than 11 p.m. or earlier than 8 a.m. Defendants did not admit that vibration had been felt on plaintiff's premises owing to their works, or that there was such noise as to interfere with the enjoyment of plaintiff's premises. They denied that they had caused or permitted offensive smells to be emitted from their works and said the enjoyment of plaintiff's premises was not interfered with.

Mr. Hughes, K.C., and Mr. Manning were counsel for plaintiff; Mr. Younger, K.C., and Mr. Waggett represented defendants.

After medical and other evidence in support of the claim had been given, the plaintiff (Miss Knight) was called and said she was the principal of St. Boniface College. Her teachers and pupils used the garden very much in the summer and studied there, whilst in winter they exercised in the grounds. Sept. 10 was the day she first noticed the noise, smells and vibration from defendants' works. These caused them great annoyance. Diaries were kept by witness, her partners and her teachers of the dates upon which this annoyance occurred. It was absolutely impossible to sleep on the nights from Sept. 16 to Sept. 19. The noises were thumping, puffing and occasionally a humming which nearly amounted to a shriek. Illness occurred amongst the pupils, which the doctor attributed to the smells from the works. On one occasion the servants complained that they could not sleep and were alarmed at the noise, which resembled miniature earthquakes, such as witness had heard in Japan, or trains running under houses in London. From the point of view of a schoolmistress the nuisance was a most serious matter, because the parents of the pupils were likely to take notice of it.

Cross-examined by Mr. YOUNGER: Witness said she was instrumental in getting up a petition against the erection of the works before they were built. She did so because she was warned that they would cause her great inconvenience. On the days when the representatives of defendants called at her house there was very little noise from the works, and she suggested that on those dates defendants purposely minimised the noise. She did not notice any smell on the dates of the visit, but she did not wish to imply thereby that defendants could manipulate the smell as well as the noise. The smells, however, were not continuous and never had been.

On behalf of defendants the following witnesses gave evidence:—Mr. PRICE CLERK, engineer, who said he examined defendants' works and the plaintiff's premises and noticed a smell, but did not find anything which would constitute a nuisance; Mr. F. H. MERRITT, resident engineer at Ryde works; Mr. J. G. W. ALDRIDGE, consulting engineer; Mr. A. A. CAMPBELL SWINTON, who said the works were satisfactory and well built. He had overhauled the works generally and they were as well built as they could be, and he could not see that any nuisance was likely to arise from them; Mr. W. B. TURNER, an engineer in the service of the Ryde Company, who was called to prove the working of engines on the various days mentioned, how long they worked on those days and the loads carried on each day, and who said the gas engine did not work very satisfactorily at the beginning, but it was all right now; Mr. J. C. WIGHAM, chief engineer of Edmundson's Electricity Corporation, and a director of the defendant company, who said the selection of the site for the works and the selection of the proper gas engine had received the most careful attention. Although there was some trouble with it at first, it was now all right.

Mr. YOUNGER then addressed his lordship on behalf of his clients, and the further hearing was adjourned till to-morrow (Saturday).

Hallett v. Galway Electric Co. (Ltd.).

This action came before the Master of the Rolls, in Dublin, last week, and occuped three days in hearing. The plaintiffs (Lilian Hallett and Thomas George Hallett) claimed an injunction to restrain the company from causing or permitting a nuisance and also £500 as damages. Plaintiffs were owners and occupiers of Weir House, Galway, situated on the River Corrib, and the company had for many years and still carry on the business of generating and supplying electricity from premises on the opposite side of the river. Defendants had enlarged their premises in September last, when new plant and machinery were introduced, and certain piles of timber which were placed by them in such position as lessened the noise caused by the defendants' works were removed. The noise caused was, plaintiffs' contended, very loud and continuous, and

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rendered their house uninhabitable, and they were forced to leave. The works of the company consisted of lightly-constructed sheets of timber, a structure unsuitable for powerful machinery, and the company had made no effort to deaden the noise. Plaintiffs had repeatedly written defendants, but the nuisance had not been checked or abolished.

Defendants pleaded that they were carrying on their business at the time plaintiffs came to occupy Weir House, and they were entitled to carry on same under the provisions of the Galway Electric Lighting Order, 1897. They also pleaded that any alterations or changes made by them in their machinery and plant were under the powers of the order, and that such caused no injury to plaintiffs. The company further said that there was no unusual noise created, and that their works were substantial and proper and well suited for the purposes of the company. Prior to the acquisition of the premises by defendant company mills were working from time immemorial, and the effect of the noise arising from defendants' business was greatly reduced by the vicinity of the river and the precautions taken by them to prevent injury or annoyance to anyone.

Plaintiffs having given evidence, a number of expert witnesses, including Mr. Binns, Mr. A. E. Porte and Sir Thomas Drew, were called for plaintiffs.

Ultimately defendants agreed to an injunction in the terms of the statement of claim. Stay of execution till March 13 to enable defendants to abate the nuisance.

Lloyd's Packing Warehouses Co. (Ltd.) v. Veritys Limited.

At Manchester Assizes, last week, Mr. Justice Jelf heard the commencement of an action brought by Lloyd's Packing Warehouses Co. (Ltd.) against Veritys Limited for breach of contract. Plaintiffs make up and pack goods of all kinds and also manufacture packing cases at Castlefield, Manchester. Defendants are electrical engineers, and it was alleged that they undertook to supply electric generating plant capable of dealing with the maximum load required by plaintiffs in their business, giving sufficient power to run the whole of their motors and machinery electrically. It was alleged that the plant, when completed, was found to be inadequate for the work and, in consequence, plaintiffs rejected it, or claimed the right to do so. They also claimed a return of moneys paid, and damages.

Mr. PICKFORD, K.C., for plaintiffs, said in April, 1900, plaintiffs decided to make their own packing cases, of which they used a very large number, instead of obtaining them from outside sources. They took works at Castlefield, in which they installed wood-cutting and other machinery driven by electric motors, for which current was supplied from Manchester Corporation mains. Defendants supplied the motors, and between April, 1900, and Oct., 1901, the E.H.P. of these motors was increased from 72 to about 100, and when defendants tendered in 1901, other machines were under order which would bring the total H.P. to 115. Their contract, plaintiffs maintained, was for electric plant which would drive the whole of these machines then working. Plaintiffs had been paying Manchester Corporation 1¾d. per unit before Oct., 1901, and it was a question whether they should continue this process or should have their own special plant installed. Defendants undertook that the plant so laid down should produce electricity at a cost not exceeding 1d. per unit. But, using producer gas to drive the engines supplied by the National Gas Engine Co., the energy developed was inadequate. One of defendants' contentions was that an estimate made in Jan., 1902 (substituting that of Oct., 1901), was the only contract between the parties, and that if their plant was in accordance with the specification of 1902 plaintiffs had no cause of complaint, although it would not drive their machinery. Plaintiffs, on the other hand, maintained that a letter of defendants of Oct. 1, 1901, which accompanied their estimate of that date, remained operative. They guaranteed that the machinery put down should be capable of doing the work required, and the guarantee extended to the estimates of November and January following. They were fully aware of the work for which the plant was required. Therefore, plaintiffs were entitled to say that there was an implied, if not an expressed, undertaking that the generating machinery and motors should be effective for the purpose. Defendants blamed the makers of the gas engine, which they contended was not powerful enough, but under their contract with plaintiffs, defendants assumed responsibility for the gas engine as well as for the electrical plant and apparatus. So far as could be judged, if the dynamo machine could be run by the gas engine it would be effective, but the plaintiffs were not sure of that. The installation had never taken the full load.

After a director of plaintiff company had been examined, the further hearing was adjourned to the Liverpool Assizes.

ELECTRIC LIGHTING, POWER AND TRACTION NOTICES.

We conclude this week our abstract of the Parliamentary notices for next session so far as they affect electricity supply, traction, &c. The total number of deposits made was 272, compared with 294 last year. There are 26 railway notices against 46 last year, 26 tramway schemes, compared with 38 last year, and 158 provisional orders (including 83 electric lighting), compared with 150 :—

Electric Lighting Notices.

The following additional notices of provisional orders have been given :—

CORPORATIONS.—Govan (for extensions), Maidenhead (for Taplow, Hitcham, Burnham, Cookham and Bray), Stratford-on-Avon, and Wishaw, N.B. Portpatrick Electric Supply Co. (for Portpatrick) ; District Electric Lighting Co. (for Uddingstone).

URBAN DISTRICT COUNCILS.—Caerphilly, Eastleigh and Bishopstoke, Whickham and Yardley.

RURAL DISTRICT COUNCIL.—Croydon (for Beddington, Coulsdon and Sanderstead).

COMPANIES, &c.—Messrs. H. Foote, L. Milne and E. J. Owen (trading as Southern District Electricity Corporation) (for Andover), Messrs. Whittaker Bros. (for Cannock and district), Messrs. Christie Bros. and Middleton (for Crediton) ; Mr. H. J. Almond (for Houghton-le-Spring), Kingswood Electric Supply Co. (for Kingswood) ; Penzance and District Electric Supply Co. (for Penzance and district) ; Isle of Thanet Electric Tramways and Lighting Co. (Ltd.) (for Ramsgate) ; Clyde Valley Electric Power Co. (for Barrhead, Bothwell, Clyde Valley, Eastwood and Cathcart, Johnstone, Kilpatrick, Lanark, Rutherglen, Renfrew, Shettleston and Vale of Leven).

National Electric Construction Co., for Dunfermline.

In the following cases procedure by bill has been decided upon:—

The Board of Trade, to alter and adjust existing areas of supply of electricity in London, &c.

North-Western Electricity and Power Gas Co., to acquire additional lands for generating stations, to remove restrictions as to erection of stations, to acquire electricity undertakings by agreement, &c.

A bill is to be promoted to incorporate a company to erect electricity stations and to supply electricity and power gas in the county of Chester, to acquire electrical undertakings by agreement, to enter into agreements with local authorities and others, &c.

North Wales Electric Power and Traction Co., to erect generating stations in Carnarvon, Denbigh, Merioneth, Anglesey and part of Flint, to dissolve limited company and transfer undertaking to new company, to purchase and use lands for electricity stations, &c., to enter into agreements with local authorities and others, to acquire powers of Portmadoc, Beddgelert and South Snowdon Railway Co., for further capital powers, &c.

St. Marylebone (London) Borough Council are promoting a bill for further borrowing powers for the purchase of the Marylebone undertaking of the Metropolitan Electric Supply Co. (Ltd.), for the construction of generating station, alteration of pressure and maximum prices, to authorise special charges, to make special provision in regard to the supply of premises having separate supply, to refuse supply in cases when payments are in arrear, to authorise provision and supply, by sale or letting for hire by Council or by contractors (by agreement with Council), of electric lamps, motors, meters, &c., and the fixing and repair thereof upon consumers' premises, and to exempt such fittings let on hire from distress or execution, to make and enforce bye-laws in regard to electric fittings and apparatus used in premises supplied with electricity, to alter date for making up electric lighting accounts, to make further provision for borrowing money for electricity supply, &c.

Application is to be made to incorporate a company to establish electricity stations in the counties of Lincolnshire and Yorkshire, to supply electricity for lighting and power, to acquire land in parishes of Market Rasen (Lincs.), St. Martin, Beverley and Easingwold (Yorks.), to exempt from distress or execution electrical fittings, &c., let on hire, to acquire electricity undertakings, to enter into agreements with local authorities for supply of electricity, &c.

Bridlington Corporation, to extend area of electricity supply, to enter into agreements to supply electrical energy to local authorities and others, to make special provision where consumers have separate supply, to refuse supply in certain cases, to provide, supply and let for hire and deal in electric motors and apparatus, and to exempt articles and things let for hire by Corporation from distress or execution, to allow discounts, to alter date for filing accounts, &c.

Isle of Thanet Electric Tramways and Lighting Co., to acquire lands, to enter into agreements for supply of electrical power, to amend light railway orders, &c.

Plymouth Corporation, for extension of borrowing powers, &c.

Basingstoke Corporation, to supply electrical fittings, &c., on hire, to allow discounts on electricity accounts, to make bye-laws as to electric wiring and fittings, to borrow money for electricity supply and to charge same upon whole of revenues of Council, &c.

Application is to be made for incorporating a company to establish generating stations and to supply electricity for power in parts of the counties of Mid and East Lothian, Peebles and Lanark, to enter into agreements with local authorities and others regarding the supply of electrical energy, &c., to acquire transfer of electricity undertakings, &c.

A bill will be promoted for powers to incorporate a company to supply electricity and power gas in Antrim, Down, Armagh and Londonderry, &c.

Ulster Electric Power Co. : to incorporate company, to establish generating stations for the supply of electricity for power, &c., in the counties of Down, Armagh, Londonderry, Antrim, Tyrone, Fermanagh, Monaghan and Cavan, and the county boroughs of Belfast and Londonderry in the province of Ulster, to enter into agreements with local authorities and others for the supply of current, to pay interest out of capital during construction period, &c.

Electric Traction Notices.

Provisional orders are to be applied for by the following :—

Plymouth, Rochdale and Sunderland Corporations : in each case to construct additional tramways, &c.

In the following instances bills are being promoted :—

Great Yarmouth Corporation, to construct tramways in Great Yarmouth and Caister, to run omnibuses, &c.

Portmadoc, Beddgelert and Snowdon Railway Co., further powers for construction of new railways and acquisition of lands, to extend time, to authorise sale or leasing of undertaking, &c.

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Mid-Cheshire Tramways Co., to incorporate company to acquire undertaking of Stockport and Hazel Grove Carriage and Tramways Co., to construct new tramways and reconstruct existing lines, to enter into agreements for supply of electricity, &c.

Preston and Lytham Tramroad Co., to incorporate company, to construct electric tramways and tramroad between Preston and Lytham, to enter into agreements with local authorities for working and maintenance of tramways and for supply of electric current, to vary purchase terms of Tramways Act, 1870, &c.

The Glasgow and South-Western Railway Co., to work railways by electric traction, &c.

In the bill of the Great Central Railway Co. it is sought to confer powers upon the Seaforth and Sefton Junction Railway Co. to construct new railways and works in Lancaster, &c., for running powers over the latter company's lines, to confirm agreement with Liverpool Overhead Railway Co., &c.

Harrogate Corporation is seeking power to construct a tramroad and other works in connection with their waterworks.

Baker Street and Waterloo Railway Co., for additional capital powers, to pay interest out of capital, to enlarge station tunnels, to acquire lands, &c.

Wakefield and District Light Railway Co., to incorporate company to construct and work electric tramways in the West Riding of Yorkshire (Normanton, Whitwood and Castleford), &c.

Dolter Electric Traction Co. (Ltd.), to construct tramways in Torquay, to modify terms of purchase of Tramways Act, 1870, &c.

Belfast Corporation, to construct electric tramways, to acquire existing tramways in Belfast and district, &c.

A bill is being promoted to incorporate a company for construction of an electric tramway between Belfast and Holywood (Down).

Strabane, Raphoe and Conboy Railway Co. are applying for an extension of time and the construction of additional lines, &c.

LIGHT RAILWAYS.

We give below a complete list of the applications lodged during the past month with the Light Railway Commissioners for new light (electric) railway projects. Altogether there are 17 applications, compared with 22 in May and 20 in November, 1902. In all the new schemes electric traction is scheduled The total length of new lines proposed is 62$\frac{1}{10}$ miles, and the proposed cost of construction is £454,483. The following table shows the number of applications for light railways since the passing of the Light Railways Act, 1896, the bottom line of figures representing electrical schemes:—

1903.		1902.		1901.		1900.		1899.		1898.		1897.		1896
Nov.	May.	Nov.	May	Nov.	May	Nov.	May	Nov.	May	Nov.	May	Nov.	May	Nov.
17	22	20	21	44	26	27	24	43	40	54	35	30	28	28
15	12	13	16	40	22	19	17	32	21	32	18	16	10	14

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Sanitary Commissioners of Gibraltar require an assistant electrical engineer. Salary £200, increasing by annual increments of £10 to £250 per annum. Applications by Dec. 16 to Mr. William Wallace Copland, secretary and engineer, Sanitary Commissioners' office, Gibraltar. See also advertisement.

An electrical engineer is required, capable of taking charge of drawing office and designing continuous-current and three-phase motors, generators and ship-lighting switchboard. See advertisement

Messrs. Harland and Wolff (Ltd.), Belfast, require a junior mechanical draughtsman, with knowledge of machine design, including high-speed toothed gearing; also a junior draughtsman, preferably with technical training and some works experience. See also advertisements.

Fulham Borough Council require a shift engineer for their electricity department. Applications to the borough electrical engineer (Mr. Arthur J. Fuller), Electricity Works, Townmead-road, Fulham, London, S.W., by Dec. 12. See advertisement.

Boston Corporation require a borough surveyor and electrical engineer. Salary £300 per annum. Applications by Dec. 18.

Mr. H. T. Donaldson, chief mechanical engineer at the Royal Arsenal, Woolwich, has been appointed Chief Superintendent of Ordnance Factories, in succession to Colonel Sir Edmond Bainbridge, K.C.B.

Mr. R. Garrat has been appointed clerk of works for the permanent way of the Derby electric tramways.

Aberdeen.—A conference between representatives of the Finance, Streets and Roads committees of the Council and the general manager (Mr. W. E. L. Gaine) and the local superintendent (Mr. Watt) of the National Telephone Co. was held here on Tuesday to discuss the present condition of the telephone service in the city, and particularly as to a reduction in tariff.

"African World" Annual.—The publishers of the *African World*, 34, Copthall-avenue, London, E.C., have prepared and issued their first Christmas number in the form of an "Annual." The mining section of the work has been compiled on original lines, and is of a particularly comprehensive character. The writers on various subjects of interest in connection with the African continent include all the best known writers on the subject—Mr. F. C. Selous, Sir Harry Johnston, Dr. Carl Peters, Prof. Ronald Ross, Mr. W. T. Stead, &c. There is also a fine map of the Transvaal gold and diamond fields. Altogether, the 172 pages of ably-written well-printed matter and illustrations in its coloured cover is not by any means the least successful of the Christmas numbers for 1903. This annual is of particular interest just now for traders.

Title.	County.	Promoters.	Engineers.	Mileage.	Gauge.	Agents.
					Ft. in.	
Aldershot & Farnborough (Amending). (Extension of Time, &c.).	Hants.	Power & Traction and Aldershot & Farnborough Light Railway Co.	.....	...	...	Baker, Lees & Co.
Brackenhill (Amending). (Extension of Time, &c.)	Yorks.	Yorkshire Dist. Lt. Rly. Syndicate (Ltd.).	.....	...	...	Day and Yewdall.
Cheltenham & District (Extension)	Gloucester...	Cheltenham and Dist. Light Railway Co..	Dodd and Dodd	$\frac{1}{10}$	3 6	Winterbotham, Gurney & Co.
Devonport and Plymouth	Devon	Devonport and District Tramway Co.....	S. Sellon	1½	3 6	S. Morse.
Dewsbury and Ossett	Yorks (W. Riding)	Yorkshire Elec. Tramways Const. Synd....	V. B. D. Cooper	3	4 8½	Ashurst, Morris, Crisp & Co.
East Cheshire	Chester.....	G. Pearson, L. H. Moorcom, J. Rudyard and others	J. M. Newton, A. Ward Thomas, J. W. Donalson, J. W. Welch	7¼	4 8½	J. D. Tetley.
Guildford	Surrey	West Surrey Light Railway Co.	Harrap, Hewitt & Duffield	2¼	4 8½	Bircham & Co.
*Hope Castleton	Derby	R. H. Ashton, C. Bramwell, C. Castle and others	R. Elliott, Cooper, Fowler and Marshall	3	4 8½	W. & W. M. Bell.
Leek, Caldon Low and Hartington (Amending). (Revival and Extension of Time, &c.)	Staffs...	N. Staffordshire Railway Co. and Leek and Manifold Valley Light Railways	C. J. Crosbie-Dawson.....	...	...	Burchells.
Maidstone & Faversham Junction (Amending) (Extension of Time)	Kent	Maidstone and Faversham Junc. Lt. Rlys.	.....	...	...	R. W. Cooper & Sons.
Morley and District (Extension)...	Yorks (W.R.)	Yorkshire Woollen Dist. Elec. Tramways ..	S. Sellon	2	4 8½	S. Morse.
Nidd Valley (Amending). (Transfer of Power)	Yorks.	Corporation of Bradford	.....	...	...	Baker, Lees & Co.
Plymouth Corporation	Devon	Corporation of Plymouth	J. Paton	1¼	3 6	Sharpe & Co.
Woking and Bagshot	Surrey	West Surrey Light Railway Co.	Harrop, Hewett & Duffield	13	4 8½	Bircham & Co.
*Lampeter and Aberayron	Cardigan ...	Col. H. Davies-Evans, J. C. Harford, W. Inglis-Jones and others	S. W. and A. L. Yockney..	13½	4 8½	E. W. J. Peterson.
*North Wales Narrow Gauge Rly. (Beddgelert Extension and Amendment Order)	Carnarvon ..	North Wales Narrow Gauge Railway Co. .	Harper Bros. & Co., Sir Douglas Fox & Partners	2	1 11½	Sherwood & Co.
*Snowdon and Bettws-y-Coed ...	Carnarvon ..	North Wales Power and Traction Co.....	Do.	13¼	1 11½	Do.

* Electricity or steam.

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Alleged Theft of Electricity.—At Bow Street (London) Police Court yesterday, G. W. Lawrence, described as an "electrical engineer," was charged with stealing 10s. worth of electric current from Messrs. Coon and Clarke, engineers, 401, Strand, London. Detective-inspector Drew stated that he went with Detective-sergeant Stephens to a room at the top of 401, Strand, occupied by prisoner, and saw an electric lamp burning. He asked prisoner where he got his supply of electricity from, and he replied that he had permission from his landlord (Mr. Bateman) to connect the lamp with his (Mr. Bateman's) circuit. According to his information, however, the lamp was connected with the circuit of Messrs. Coon and Clarke, who occupied the floor immediately below, and prisoner admitted that that was the case. Prisoner offered to pay for the current he had used. Remanded.

Asylum Lighting.—Lancs. County Asylums Board will expend £6,000 further upon the extension of the electric lighting and power plant at Prestwich Asylum.

The Metropolitan Asylums Board, who recently decided to light the Fountain Hospital electrically and to obtain current from the Grove Hospital generating plant, have now resolved to obtain additional generating plant for the Grove Hospital works from the contractors who supplied the present plant, and tenders are to be invited for wiring the Fountain Hospital.

Beckenham.—The Council have asked the British Electric Traction Co. to state upon what terms, if any, they will consent to the conduit system being adopted for the local tramways.

Belfast.—The question of working or leasing the projected municipal tramways was discussed at the Council meeting on Tuesday, when it was decided to insert a clause in the new bill providing that the leasing power shall not be exercised until a plebiscite of electors has been taken on the question.

Berlin.—In order to minimise the inconvenience caused by opening thoroughfares for laying service pipes, the Public Works Department has been charged with the laying and repairs of gas and water mains and underground electric wires and cables at the expense of the various undertakings concerned.

Bermondsey.—On Tuesday the Borough Council resolved to ask the London County Council to substitute electric light for incandescent gas in Southwark Park. A total of 21,660 8 c.p. lamps have been applied for by private consumers up to date, or, including public lighting, 24,512. This is 12,012 lamps in excess of the capacity of the present plant.

Birmingham.—At the City Council on Monday Mr. Middleton moved—

That; in the opinion of this Council, it is much to be regretted that the Tramways committee should have considered it necessary to purchase tram rails from abroad at a time when British industry needs encouragement and support. He contended that it was not necessary for the committee to go abroad for tram rails. He contended that if the rails were made according to one specification the English manufacturer would be able to compete successfully with his German rival. He was informed, however, that Birmingham omitted some of the tests usually applied to those rails, and that was an advantage to the foreigner. The saving in connection with the German rails purchased would not be more than 6s. per ton, and he thought the English firm which was that amount higher might have been asked to reconsider their tender before the contract was signed.

Ald. Beale, chairman of the Tramways committee, said the Corporation bought no rails on its own account until the summer of this year. Before that time the rails were bought on behalf of the companies that owned the lines. The committee did not want to buy foreign rails. It did so because it thought they were the cheapest and to the advantage of the tramway companies. No one regretted more than the members of the Tramway committee that the goods of British manufacturers were not so low in price as the foreign material.

The resolution was carried with two dissentients.

Bleach Manufacture.—It is stated that agreement has been made between the English, German and American bleach manufacturers for putting an end to the competition and cutting of prices of bleach. Already a considerable increase in price has taken place.

Bolton.—Representatives from Horwich District Council will attend the next meeting of the Electricity committee to discuss the proposal of Bolton Corporation to supply electricity in Horwich.

Bradford.—A satisfactory trial trip was made over the new tramway in Church Bank on Tuesday.

Brighton.—An inquiry was held here on Tuesday into the application of the Council for permission to borrow, among other sums, £175 for an extension of the battery at the tramway power station.

Burton-on-Trent.—The receipts for the first quarter's working of the municipal electric tramways amounted to £5,270. 6s. 1d., representing 1·11d. per passenger for a total of 1,147,751 passengers carried during the period. The receipts per car-mile were 11·90d.

Carnarvon.—Mr. T. P. Wilmshurst, the engineer who was called in to advise the Council upon the merits of the electricity supply schemes of the National Electric Construction Co. and the North Wales Electric Power Co., has presented his report, and stated that the proposals of the former company are somewhat more favourable in regard to price than those of the latter. The erection of a temporary generating station in order to prevent the Council's provisional order from lapsing will probably be an important factor in the ultimate decision, and as the latter company has offered to comply with the Council's requirements in this respect it is likely its scheme will be accepted.

Cawnpore (India).—A local firm has applied for a licence under the New Indian Electric Lighting Act to supply electricity for lighting, power and traction in Cawnpore and contiguous areas.

Chagford.—The Council have renewed the contract for the public electric lighting for another year.

City of London.—At the sitting of the Court of Common Council last week, the City Lands committee submitted a report concerning the supply of electric energy for lighting the buildings under their control, and recommended that they be authorised to enter into an agreement with the Charing Cross and Strand Electricity Supply Corporation for the supply of electric current at 3d. per unit for lighting and 2½d. for power on a contract for five years.

Mr. Deputy Wilkinson asked that the matter be referred back to enable the City of London Electric Lighting Co. to tender as well as their competitors, the Charing Cross and Strand Company. He deprecated any prejudice against the older company, which, he contended, was shown by some members of the Council.

Mr. B. Turner said the tender had been offered to the City of London Company, and they were asked to accept the lighting of certain buildings at a certain figure, but this they declined to do.

Mr. A. C. Morton, chairman of the Streets committee, said the result of competition in the City had been to lower the charge for electric current by over £300,000, and before the various orders expired they would save three or four millions sterling!

Mr. W. B. Horncastle, chairman of the City Lands committee, said the City of London Company had refused to make any concession upon their original quotation of 8d. per unit until it was too late.

After some further discussion, the report was referred back.

Clitheroe.—In the preliminary report by the consulting engineer (Mr. T. Barton) the estimated cost of the proposed municipal electricity works is put at £11,260. The Council are applying for borrowing powers for £12,000.

Customs Duties.—A recent decision of the Customs department of the Australian Commonwealth has fixed a duty of 12½ per cent. ad val. upon machinery and appliances employed in the construction and working of electrical searchlights.

Overhead trolley line equipments imported into Japan are subject to an ad val. duty of 20 per cent., ebonite plates of £1. 11s. per cwt.

Dartford.—Wilmington Council will not object to the Dartford Council extending its mains into the parish.

The District Council have appointed Messrs. Mordey and Dawbarn, consulting engineers to report as to the approximate cost of the projected electric tramway to Bexley Heath.

Devonport Dockyard.—A special electrical engineer's department has been organised at Devonport Dockyard, and Mr. Leky has been appointed electrical engineer-in-charge. Mr. C. Finch has been transferred to the same department as first-class writer.

Dunfermline.—Owing to the opposition of the Council, the National Electric Construction Co. have already withdrawn their proposed application for a provisional electric lighting order.

Eastbourne.—An inquiry was held on Wednesday into the application of the Corporation for permission to borrow £10,000 for electric lighting extensions and £4,398 for motor 'buses.

The Town Clerk (Mr. H. W. Fovargue) explained that four 'buses had been purchased at £750 each and delivered, and a Clarkson steam 'bus would be delivered this month at £664.

The Inspector (Col. W. R. Slacke, R.E.) to the electrical engineer (Mr. Brydges): Do you find these 'buses satisfactory?—We keep them running. We have stoppages the same as are experienced with most motor vehicles.

Are they running satisfactorily?—Yes; they keep to schedule time.

Mr. Allcock (borough accountant) explained that 12 per cent. was being charged for sinking fund and interest, and there was a profit on the 'buses up to the present of £115.

In reply to a question, Mr. Brydges said that the 'buses were a new thing, and, therefore, it was impossible to state what their actual life would be, but it was estimated at 10 years.

Councillor Climpson said that the cost of new wheels was included in the loan, and he submitted that all repairs should be paid for out of revenue. That was not done, as those in favour of the 'buses wished to show a big profit, so as to stave off the introduction of electric tramways. The 'buses were a failure, and the inhabitants favoured electric tramways.

Councillor Rowe, deputy-chairman of the Electric Light committee, assured the inspector that the 'buses were highly appreciated. He admitted they broke down occasionally, but explained that in one week only 12 hours were lost by all four 'buses from this cause.

In regard to the electric lighting loan, the borough accountant said the accumulated profit of the electricity undertaking to March last was £7,892. 12s. 4d., and £3,000 had been set aside for depreciation. The consulting engineer (Mr. W. C. C. Hawtayne) gave his opinion that the financial position was satisfactory and the reserve ample. There was no opposition.

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The electrical exhibition which has been organised under the auspices of the electrical department was formally opened by the mayor (Councillor Ashley Maude, J.P.) on Tuesday. There is a varied display of electric light fittings, telephones, cooking, heating and ventilating apparatus, electric motors, instruments, electro-medical apparatus, &c., and the borough electrical engineer (Mr. J. K. Brydges), upon whom most of the organisation work fell, is to be congratulated upon the success achieved.

Edinburgh.—During the five months ended Oct. 15 last the applications for electrical energy from private consumers were equivalent to 55,002 8 c.p. lamps, compared with 40,807 in the corresponding period of 1902.

Electric Lighting Provisional Order Transfer.—St. Albans Corporation notify their intention of transfering their order to the St. Albans and District Electric Supply Co. (Ltd.). The pecuniary consideration is the cost of obtaining the order (not exceeding £400), the Corporation reserving right to purchase at end of 14 or any subsequent period of seven years.

Electric Traction on Suburban Railways.—In a recent interview, the general manager of the London, Brighton and South Coast Railway (Mr. William Forbes), stated that the proposed electrification of their suburban lines was being carefully considered by a committee, which included Major Cardew, one of the directors, and Mr. Phillip Dawson, consulting electrical engineer to the company.

Electricity in Mining.—At Tamboin, the largest underground mine in Perak (Malay States), there is established an electric lighting service which enables mining operations to be carried on night and day. Large outputs of tin are obtained from the mines in this district.

Exhibition.—An international motor-car exhibition is to be held at Frankfort-on-Main from March 19 to 27, 1904. Herr Carl Geuber, Adler Fahradwerke, Frankfort-on-Main, is secretary.

Fenton.—The Highway and Lighting committee are considering an offer of Stoke-on-Trent Corporation to supply electricity in bulk in Fenton.

Forthcoming Book.—Messrs. Whittaker & Co. will publish next week "Electric Traction: A Practical Handbook on the Application of Electricity as a Locomotive Power," by Mr. J. H. Rider, chief electrical engineer to the London County Council tramways.

Glasgow.—The report of the Corporation tramways department for the half-year ended Nov. 28 states that during the six months 93,944,976 passengers were carried, an increase over the corresponding period of last year of 6,860,502. Receipts were £356,319. 3s., compared with £319,236. 3s. 9d., an increase of £37,082. 19s. 3d.

The sub-committee recently appointed to visit English towns where electric tramways with covered upper deck cars are in operation have presented their report, but it is pointed out that, owing to many bridges in Glasgow being too low, it would not be possible to use a top covering, such as that employed at Liverpool on more than two or three of the Glasgow tramway routes. However, an experiment is to be tried on the Paisley-road and Parkhead tramway route or the new route through Glasgow-green.

The Rutherglen-Cambuslang tramway route (2 miles double track) was opened for traffic on Tuesday.

Sir James Marwick, who has been town clerk of Glasgow for the past 30 years, retired from that position on Friday last.

The committee of management of the Clyde Navigation Trustees recently received a report from their mechanical engineer on the utility and economy of adopting electric working at Clydebank dock. While favourably disposed to electricity as motive power, the committee, having regard to the large expenditure involved, procured a special report on the subject from Mr. Walter Dixon, who advised the adoption of electricity as the motive power. The committee after careful consideration of the whole subject, agreed to recommend that electricity be the motive power for the dock, and for the hoists, cranes and other appliances.

The recommendations were adopted by the trustees, and the committee have been empowered to appoint an electrical expert to advise and be associated with their mechanical engineer in the carrying out of the work. The question of the trustees themselves providing the generating plant or obtaining current otherwise remains to be decided.

Gorton.—Application has been made to the Board of Trade for an extension of time for complying with the provisions of the Gorton Electric Lighting Order, 1899.

Halifax.—The extensions at present being carried out at the electricity works will be completed in about a fortnight, when it is anticipated that the new 1,200 I.H.P. Pollitt and Wigzell engine and 750kw. E.C.C. dynamo will be started.

Hamilton.—At a special meeting of the Town Council on Monday it was reported that Edmundsons' Electricity Corporation, the lessees of the electricity works, had arranged with the British Westinghouse Co. to remove the Bremer lamps and to fit up five 10-ampere Gilbert lamps as a test.

Hammersmith (London).—The borough electrical engineer (Mr. G. G. Bell) reported to the Council on Wednesday, that the feed-water heater had been at work some months, and had more than satisfied expectations:—

As the result of experiments he found that they would be able to still further increase the efficiency and saving if they arranged for the present electrically-driven circulating pumps to be supplemented by two steam-driven pumps, the exhaust steam being discharged into the heater, as at present there was not enough exhaust steam to heat all the water to the full temperature. It was not suggested to dismantle the present electric pumps but to leave them as stand-by so that they might be used when it was economical to do so. The estimated cost of the pumps would not exceed £150.

It was resolved to get the two pumps as suggested. The sixpence-in-the-slot electricity meter system was adopted for the new workmen's dwellings in Teldham-road, and Mr. Bell was instructed to obtain and fix 24 meters.

Ilkley.—A report on electricity supply has been prepared by Mr. F. J. Warden-Stevens.

Ipswich.—The proprietors of the *East Anglian Daily News* have prepared a handsome souvenir of the County Borough of Ipswich, its growth and progress. Amongst municipal matters which receive attention in this well-printed and illustrated souvenir is the work of the Electric Supply and Tramways committee. The progress of conversion of the tramways from horse haulage to that of electric is shown, and some well-executed junction work is illustrated. A fine view of the power station, the car sheds and the electric car which has been selected at Ipswich are given, and many other excellent illustrations and some informing text make the souvenir very complete.

Islington (London).—The Lighting committee have decided to lay low-tension distributing mains at an estimated cost of £825. An estimate of £1,100 for service lines, &c., required up to March 31, has been passed by the committee.

Keynsham.—The District Council will oppose a proposed application for a provisional electric lighting order, and will next year themselves apply for an order and take supply of current from Somerset and District Electric Power Co.

King Williamstown (South Africa).—The electricity works of the King Williamstown Electric Co. were formally opened on 20th ult. At the outset only current for public lighting will be supplied, but supply will shortly be available for private consumers. Mr. E. G. Jones is consulting engineer for the scheme.

Kings Norton.—Negotiations are at present proceeding between the Tramways committee and Birmingham Corporation in regard to the working of the municipal tramways in Kings Norton, whose Council have decided to appoint a consulting engineer to assist the committee in their negotiations.

Kirkcaldy.—The new electric tramway route was officially inspected on Saturday, and is now open for traffic. Workmen's cars are to be established over the entire system next week.

"Knowledge" Handbook, 1904.—In the preface to the fourth annual issue of the "Knowledge" Diary and Scientific Handbook, the publishers (326, High Holborn, London) refer to the favour with which the previous annual issues have been received. Many suggested improvements have been adopted, and the work has been amplified and brought up to date with a view especially to meeting the requirements of students and workers in the various branches of science. Some eminently practical articles are contributed to this issue, including "Practical Meteorology," by the secretary of the Royal Meteorological Society, Mr. William Marriott; "Physics," by Mr. E. Edser; "The Camera applied to Science in Natural History," "Microscopy and Astronomy," "Some Uses of the Microscope," &c. This useful work is published at 3s. net.

Leicester.—The official inspection of the permanent way of the municipal electric tramways took place on Thursday last week.

Leith.—Negotiations with the Edinburgh and District Tramways Co. for the working of the proposed Leith Corporation tramways have been broken off.

Light Railways.—The Board of Trade have confirmed the Dartford Light Railway (Extension) and the Barrowford Light Railway (Transfer, &c.) 1903 Orders, the latter transferring the District Council's 1901 Order to Nelson Corporation.

Plymouth Borough Council last week decided to apply for an order to authorise the construction of a light electric railway to Crownhill.

The promoters of the Bolton, Turton and Darwen light railways have decided not to proceed with the scheme.

A list of the applications lodged with the Light Railway Commissioners for light railway orders during the last month is given on another page.

Lincoln.—It was announced at the meeting of the Council on Tuesday that the price to be paid for the tramway undertaking would have to be settled by arbitration, as no agreement had been come to with the company.

The chairman of the Electricity committee (Ald. Harrison) stated, in reply to a question, that the arc lamps were as satisfactory at Lincoln as they were anywhere in the country. With regard to the failure of electricity supply on Thursday night last, it was impossible to state whether

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it would happen again. He referred in suitable terms to the prompt way in which the staff attended to the failure.

Liverpool.—The consulting electrical engineer (Mr. A. Bromley Holmes) has prepared a report for the Corporation on the present position of electricity supply in the city.

Mr. Holmes points out that the demand for electrical energy for power and lighting continues to increase steadily, and he estimates that the output of the supply stations for 1903 will exceed that of the previous year by the following percentages:—Lighting 20 per cent., power 60 per cent., tramways 5 per cent. The connections for lighting and power (exclusive of tramways) at the commencement of the current year were equivalent to 221,000 16 c.p. incandescent lamps, and it would be necessary for the Electric Supply committee to consider what extensions would be required to meet the anticipated demand in 1905 and 1905. No more steam plant could be installed in the existing power stations in the central districts, and no suitable site was there obtainable for another large steam station, by means of which the simplicity and economy of generation of energy at the pressure of distribution to the consumer could be secured. It was consequently necessary to bring in an additional supply at high pressure from Lister-drive.

Mr. Holmes recommends, therefore, as extensions for 1904: (1) An addition to Fairclough-lane sub-station and 2,000kw. transforming plant; (2) addition to Oldham-place sub-station and 2,000kw. transforming plant; (3) construction of sub-station at Rice-lane and transforming plant of 800kw.; (4) 800kw. transforming plant at Cobbs Quarry; and (5) 800kw. transforming plant at Smithdown-road. It would also be necessary to order boilers, engines, generators and accessories for the equipment of the second section of Lister-drive station. It was not anticipated that any addition would be required at Gateacre and Garston stations to meet the ordinary increase in demand for 1904, but should the Corporation decide on tramway extensions in these districts, further generating plant would be necessary.

London County Council.—At Tuesday's meeting the Highways committee recommended.—

(*a*) That the underground conduit system of electric traction, approved by the Council on Nov. 10, 1903, for the construction of the new tramways along St. John-street, St. John-street-road and Rosebery-avenue, be adopted for the reconstruction of the first sections, about 22¼ miles in length, of the Council's (northern) tramways.

Mr. Collins complained of the enormous cost of the conduit system, and said he thought it would be well if the Council appointed a small committee of experts to inquire thoroughly into its tramway policy. He complained of the inadequate way the tramway accounts of the Council were audited.

Mr. Benn explained that the accounts were audited by the Government auditors.

The recommendation was then adopted.

A report was also submitted by the Highways Committee recommending the expenditure of £64,000 for the acquisition of property for the Pimlico generating station.—Adjourned.

London County Council Tramways.—It is now announced that London County Council will not introduce an express electric tramcar service.

London Post Office Telephone Service.—The Postmaster-General has informed Hornsey Council that the question of extending the Post Office London telephone system to Hornsey has been under consideration, and it has been decided to open an exchange at Crouch End, to serve Crouch End, Hornsey, Highgate and Muswell Hill, as soon as the inner London districts now in hand have been dealt with.

Londonderry-Moville Electric Tramway.—The promoters of this scheme have obtained the sanction and approval of all the local authorities interested, and the engineer of the Board of Works has reported in favour of the scheme. The solicitor for the promoters (Mr. W. O'Doherty, M.P.) stated last week that although they had nine years for construction, the line would be laid as soon as powers were obtained.

Longford.—A committee of six has been formed by the District Council to consider and report upon an interesting scheme, prepared by Mr. S. G. Faser, for the generating and supply of electricity for lighting and power. It is proposed to utilise the water power of the Shannon at Tarmonbarry, about 4 miles distant.

Manchester.—At the City Council on Wednesday a motion to appoint a special committee to inquire and report as to the desirability of establishing a works department to carry out building and other Corporation works without the intervention of contractors was defeated by 37 votes to 18.

Middlesbrough.—The Electric Lighting committee recommend the Corporation to extend the plant at the electricity works and lay additional mains at an estimated cost of £15,000. The scheme has been prepared by the borough electrical engineer, Mr. H. M. Taylor.

Middlesex Electric Tramways.—It was announced at the meeting of the Alexandra Palace Trustees last week that the electric tramway which is to run direct into the Palace gardens will probably be in operation in June next.

Motor Van Association.—A Motor Van and Waggon Users' Association has been formed for protecting the interests and promoting the improvement and development of motor waggon traffic. The Local Government Board has decided to appoint a departmental committee to consider the application of the powers conferred by the act which comes into force on Jan. 1 so far as they refer to heavy motor vehicles. An expert committee, consisting of the Hon. A. Stanley, M.P., Sir John Thorneycroft, Col. R. E. Crompton, Mr. E. R. Calthrop, Major Lindsay Lloyd, Mr. W. Worby Beaumont, Mr. E. Shrapnell Smith, and Mr. T. W. Staplee Firth, has been appointed for nominating witnesses and collecting evidence to be submitted to the departmental committee.

Municipal Telephony.—Specifications for a municipal telephone system at Scarborough has been prepared by the consulting engineer, Mr. A. R. Bennett, and these are being considered by the borough engineer.

Musselburgh.—A special meeting of the Council was held on Wednesday for the purpose of adjusting the agreement with the National Electric Construction Co. for the erection and working of electricity works and electric tramways. Current for public lighting will be supplied at 2¾d. and for private lighting at 5 l. per unit. The company anticipate having a portion of the system working by August next.

Narvic.—This small Norwegian town, which is the terminus of the most northern railway in the world, was connected on Nov. 23, by telephone to Stockholm, distant some 1,000km. It is, therefore, now possible to telephone to the borders of the Arctic Ocean.

Natal.—The value of electrical fittings and telegraph and telephone material imported into Natal for the nine months ended Sept. 30, 1903, was £86,000, compared with £48,000 for the same period in 1902.

Nelson.—The accounts of the electricity department show a deficit of £516 for the past year, against a surplus of £15 for the previous year, this result being attributed to the reduction of 1d. per unit and the higher prepayment rate. Since the charges have been lowered, however, demand had increased considerably, the connections last year being equivalent to 6,428 8 c.p. lamps, compared with an average of 1,000 lamps per annum for the previous nine years. Total working costs for the year were £2,055, against £1,015, and receipts £4,382, against £1,894, showing gross profit £2,327, against £879. After meeting interest and sinking fund charges, the result was the deficit mentioned above.

New South Wales Tramways.—The report of the Commissioners of the New South Wales Railways for the September quarter shows increased earnings of £18,940 for the tramwayst, he receipts having risen from £166,900 to £185,840, the expenses at the same time increasing by £15,711. The tramways, comprising 125 miles of line, are mainly electric.

Newcastle-upon-Tyne.—The Tramways committee recommend the Corporation to increase the salary of the general manager (Mr. Le Rossignol) from £750 to £850, rising by annual increments of £50 to £1,000 per annum. Increases of salaries to the car sheds manager and the chief clerk are also recommended.

The Education committtee are considering the advisability of improving the lighting of the schools under their charge, and it is probable that electric lighting will be introduced.

The Tramways committee recommend application for sanction to borrow £192,516 for additional tramways. The tramways (40 miles of track and equipment) have already cost £1,061,632, but only £869,116 has been sanctioned.

Northfleet.—The Council has offered to assist in the promotion of a supplemental electric lighting order for the district, provided the undertakers refund to the Council the £250 spent in obtaining the Council's order in 1901.

Pacific Cable Troubles.—We are indebted to the Melbourne *Age* of Oct. 26 for particulars of an incident which shows how difficult it is for a new competitor in the field of telegraph enterprise to protect its customers from inconvenience and possible loss arising from the duplication of code indicators registered with different delivery administrations. It appears that on July 15 the Broken Hill Proprietary Co. (Ltd.) of Melbourne, a great Australian mining undertaking, despatched a cable message of 16 words over the Pacific cable to its office in London, advising some important information concerning the water supply at Broken Hill, a subject which is naturally of great concern to the shareholders in England. Request was made that this information should be imparted to the English shareholders at once. On the day following another message was despatched of 13 words, by the same route, advising the shipment of bullion by one of the P. and O. boats, and giving certain financial particulars which it was important London should have promptly. To the dismay of the Melbourne office of the Broken Hill Proprietary Co., a message was received from London on July 18 seeking the very information given in the two previously mentioned messages.

Urgent inquiries were made by Mr. Croft, manager of the Melbourne G.P.O. Telegraph Department, to America and Europe in quest of the missing messages, which in the meantime the Broken Hill Proprietary Co. repeated over the Eastern Extension Company's cables, the Broken Hill Company subsequently claiming from the Pacific route £4. 13s., the cost of the two lost messages. Mr. F. L. Outtrim, deputy postmaster-general of Victoria, who received the

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claim of the Broken Hill Company for this refund, declined to admit it because the repeated message had not been sent by the route which had sent the misdelivered messages, but "via Eastern." The Broken Hill Company replied to this refusal by announcing their intention not to use the Pacific cable again until the claim was recognised. The cause of the trouble was found to be that the messages had been delivered to a London firm having a similar code address to the Broken Hill Company. The correspondence between the parties ultimately came into the hands of Mr. C. H. Reynolds, manager of the Pacific Cable Board's undertaking, and the *Age* gives in full the following minute said to have been written on the subject by Mr. Reynolds :—

"If this gets into the press it must shake public faith (not altogether "too strong now) in the Pacific service. Both for our purse and our "reputation we had better concede this claim and pay up, rather than "allow it to be known that our American connections have similar indi- "cators registered with them belonging to transatlantic houses as are "in use by Australian firms. Mr. W. Knox, M.H.R., who is the only "defender of the Pacific cable in the House of Representatives, is a "director of the Broken Hill Company, besides being a vice-president of "the Melbourne Chamber of Commerce, which body has always been the "'friend at court' of the Pacific line, and in the present struggle it is "inadvisable for the Pacific Cable Board to lose its slightest friend. I "advise that the company's claim of £4. 13s. be paid at once."

The hint (says the *Age*) was taken, and the money refunded. Who is to bear the loss ultimately as between the telegraph Administrations is the point now to be decided.

Paddington (London).—The Borough Council, having reconsidered the question of constructing the Marble Arch–Cricklewood tramway scheme, will not now raise any objection provided the London County Council agree to bear the whole of the cost of street widenings in Edgware-road.

Personal.—Mr. A. J. Kelman, managing director of the City of Wellington Electric Light Co., is about to visit the company's property in New Zealand.

Pitlochry.—A public meeting will be held this (Friday) afternoon to consider a scheme of public electric lighting, which is being brought forward by Mr. J. Leonard, architect.

Plymouth.—The inquiry into the application of the Corporation for permission to borrow £258,152 for electricity supply, electric tramways, &c., was concluded on Friday, the tenth day of the inquiry.

In replying to the various objections raised, the town clerk (Mr. J. H. Ellis) said that for all practical purposes the application was an unopposed one. It was hoped that the inquiry would lead to a true understanding, the good of the town and peace among all the contending parties.

Pontypridd.—The Council have decided to adopt a system of "free" wiring of premises, and tenders are being invited for proposals.

Poplar (London).—Electricity is to replace gas for lighting the clock of the historic Bow Church.

Presentation.—A gold albert and a framed photograph of the Town Hall have been presented to Mr. T. Holme (who has been appointed manager of the Hull Municipal Telephone department) by the indoor and outdoor staffs of Portsmouth Municipal Exchange.

Railway Electrification in London.—In regard to an article which appeared in *The Times* of the 24th ult. on this subject, Mr. R. Stewart Bain, managing director of the London Electric Supply Corporation, writes to that journal as follows :—

With reference to your article on railway electrification, it may be of interest to you to know that, in about a month's time, this Corporation will be supplying electric power on a large scale for traction purposes, similar to those described in the article. The Deptford power station of this Corporation, one of the largest electric generating stations in the country, is situated in close proximity to three of the southern railways, and from that station it would be possible to obtain a supply of electric power to work the suburban traffic of any or all of these railways at a price less (owing to the variety and extent of the load at the station) than it could be produced for by these companies, separately or jointly. The saving effected in capital expenditure to these railway companies from such an arrangement is obvious.

Shoreditch (London).—The Borough Council have sanctioned the expenditure of £494 in extension of mains for supplying current to the Britannia Theatre, Hoxton, from which a demand for about 3,800 8 c.p. lamps is expected.

South Shields.—On Wednesday the Electrical committee reported to the Town Council that at the end of the September quarter there were 935 consumers, compared with 821 at the same period last year, the number of units consumed being 137,094, compared with 118,425, and the receipts £2,597. 4s. 9d., against £2,379. 18s. 10d. After taking into account meter rentals and public lighting revenue, the total revenue was £3,469. 13s. 8d., an increase of £296. 5s. 2d. over the corresponding period of 1902. The average price obtained for street lighting (arc and incandescent) is 1·4d. per unit. The gross receipts of the electricity department for the year ended March were £15,717, and, after paying working expenses, &c., of £6,117, the gross profit was £9,600, of which £8,404 was applied to paying interest and sinking fund, &c. The balance of £1,196 was supplemented by £500 received as penalties for delay in completion of contracts, and with the £2,110 from the previous year the total was £3,806, of which £2,700 was carried to reserve and £1,106 forward.

Speed of Electric Tramcars.—At the South-Western Police Court on Tuesday the 10 summonses issued against the drivers of the London County Council electric tramcars for exceeding the legal speed limit were adjourned *sine die* on the application of the gentleman at whose instance they were issued. It was stated that the Highways committee of the County Council had now reported upon the Motor Car Act, 1903, and professed entire agreement with the Local Government Board that "the expedients provided by the act for the reduction of the speed limit of motor cars to 10 miles an hour should not be resorted to."

Stone.—The District Council have withheld their consent to the application of the Southern District Electricity Corporation for a provisional electric lighting order.

Sunderland.—Current is now being supplied by the Corporation to the shipyard of Messrs. Wm. Doxford & Sons, Pallion. The whole of the machinery and tools at the yard are being driven electrically.

Technological and Scientific Dictionary.—Messrs. George Newnes, Southampton-street, Strand, London, announce that the first part of the new "Technological Dictionary," is unavoidably delayed until January. A complete prospectus of the new book will be sent on application.

Telephone Call-boxes at Railway Stations.—The principal stations on the North-Eastern Railway system are to be provided with telephone call-boxes early in the new year.

Trunk Telephone Extension.—The trunk telephone service is now available at night and during Sunday both at Barnstaple and Ilfracombe. It was only a few months back that Ilfracombe was connected with the trunk service.

Tunbridge Wells.—The mayor (Ald. Elvy Robb), who is also chairman of the Electric Lighting committee, made a statement as to the position of the electricity undertaking on Wednesday, and assured members there was no ground for alarm. Things were not as had been represented, and the position was no worse than that of any private company. The committee would bring the matter before a special committee at an early date Satisfaction was expressed at the mayor's reassurances.

It is reported that the Council have received an offer for the purchase of the electricity undertaking at £10,000 more than actual cost.

Underground Concrete Conduit.—Messrs. Berry, Skinner & Co. write as follows :—

In your valuable paper for Oct. 30 you notice the demonstration which took place at Neasden of our underground concrete conduit. We should like, however, to draw attention to a paragraph which reads as follows :— "Steam had to be applied twice to pipes of about 5yds. or 6yds. in length as cooling took place so rapidly that the wax solidified and prevented the withdrawal of the pipe until steam was passed through a second time. This being the case with short lengths, it is not difficult to imagine what would happen in the case of pipes 125yds. in length, which the promoters of the system claim to be able to work."

Our subsequent experience has shown that exactly contrary results have been realised with regard to the withdrawal of long lengths of pipe. We think this is particularly interesting, and we would account for it by suggesting that with short lengths the steam passed through the tubes too rapidly at the pressure we were using. We have recently withdrawn a great number of long lengths of 50yds. with absolute ease and without a single stop. In fact, actual experience has shown that up to the limit of 60yds., the longer the length the easier the tube is to withdraw. If you can find space to correct what might otherwise give your readers an incorrect impression, we should esteem it a favour. We should be happy to show the work in question to any of your readers who may be sufficiently interested.

Wireless Telegraphy in the Colonies.—The Government of St. Lucia has issued the following ordinance dated Oct. 30, 1903 :—

It shall not be lawful for any person whomsoever to establish, erect, maintain or use in the colony any apparatus or installation of any kind whatsoever for the purposes of wireless telegraphy without having previously obtained from the governor a licence on that behalf to be granted on such terms and conditions as the governor may prescribe.

Cricket Club Dinner.—The annual dinner of the members of the Brighton Corporation electricity works cricket club took place on Monday; the borough electrical engineer, Mr. John Christie, in the chair.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Bermondsey Metropolitan Borough Council invite tenders for supply and erection of two water-tube boilers and accessories, steam flues, overhead coal bunkers and coal handling plant, together with extensions of existing steam, feed and other piping. Specifications (after 7th inst.) from the Town Hall, Spa-road, Bermondsey, and may also be inspected at (but not obtained from) the offices of the consulting engineers (Messrs, Kincaid, Waller, Manville and Daw-

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son), 29, Great George-street, Westminster, S.W An advertisement contains further particulars. Tenders to the town clerk (Mr. Frederick Ryall), Town Hall, Spa-road, Bermondsey, before noon Dec. 15.

Walthamstow District Council invite tenders for (*a*) permanent way, (*b*) feeders, (*c*) switchboard and plant, (*d*) overhead equipment, bonding and pillars. Specifications, &c., as regards (*a*) from Mr. G. W. Holmes, A.M.I.C E., Town Hall, Walthamstow; and for (*b*), (*c*) and (*d*) from Mr. James Enright, A.M.I.C.E., 47, Victoria-street, Westminster. Tenders to Mr. Sydney Watson, clerk and solicitor, Town Hall, Walthamstow, by Jan. 1 See also advertisement.

Pontypridd Urban District Council invite tenders for the supply of tramcars, and for free wiring of premises. Specifications (after Dec. 7) from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster. Tenders, addressed to chairman of Electric Lighting and Tramways committee, Council offices, Pontypridd, by noon Dec. 24. See also advertisement.

Preston Corporation invite tenders for the supply and erection at their tramway power station of a traction switchboard and accessories. Tenders to the consulting and resident electrical engineer (Mr. Walter H. Tittensor) by Dec. 12. See advertisement.

Johannesburg Municipality invite tenders for two 500kw. steam alternators, 2,100 volts, 50 periods, phase, or alternatively two-phase or single-phase, new or secondhand. Particulars to the consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, London, S.W. See also advertisement.

London County Council invite tenders for supply, delivery and erection in the Greenwich electricity generating station of four 3,000kw. three-phase generators with exciters. Tenders to the clerk (Mr. G. L. Gomme) by 10 a.m. Dec. 8.

London County Council also invite tenders for wiring and fitting for electric lighting of five sub-stations and three car sheds in connection with the Council's tramways. Tenders to Mr. G. L. Gomme, County Hall, Spring-gardens, S.W., by 10 a.m. Dec. 8.

London County Council also invite tenders by Jan. 19 for six electrically-driven three-throw boiler feed pumps for their Greenwich electricity station; also Dec. 15 for 4,100 tons of steel slot rails and 1,490 tons of steel conductor tee rails. Tenders to clerk in each case.

West Ham Education committee invite tenders for wiring, &c., of Whalebone-lane higher elementary school, Stratford, and Shipman-road school, Custom House. Tenders to Education Department, 95, The Grove, Stratford, E., by 5 p.m, Dec. 14.

King's Norton and Northfield Urban District Council invite tenders for about 2 miles of electric cable for their tramways, including laying. Tenders to clerk (Mr. Edwin Dotker), 10, Newhall-street, Birmingham, by Dec. 10.

Stockport Gas and Electricity committee require tenders for about 1¼ miles of distributing cable. Tenders by noon Dec. 10.

Govan Corporation invite tenders for coal bunkers, conveyor and electric capstan. Tenders by noon of Dec. 28.

Warrington Electricity and Tramways committee invite tenders for one year's supply of earthenware ducts. Tenders by noon Dec. 14.

Bradford Corporation invite tenders, by noon 14th inst., for an electric lighting installation at the new baths.

TENDERS RECEIVED AND ACCEPTED.

Bermondsey (London) Borough Council received the following tenders for the supply of low-tension triple-concentric feeder cables, air circuit and pilot cables, and sundry connection boxes:—

Brit. Ins. and Helsby Cables (Ltd.)(*accptd*)	£5,285	4	2	Callender's Co.	£5,371	8	4
				and	5,280	0	2
Land und Seekabel-werke A.G.	5,732	13	7	W. T. Glover & Co...	5,331	16	6
				Siemens Bros. & Co..	5,278	18	0
St. Helens Cable Co.	5,542	10	3	Johnson and Phillips	5,071	14	10
and	*5,393	1	8	Western Electric Co..	4,967	10	0

* This latter tender was marked "Not to Specification."

The contract is to be completed in six weeks.

Bermondsey Borough Council have also accepted the tender of the British Insulated and Helsby Cables (Ltd.) for supplying and laying cables through the Surrey and Lavender Dock locks, the amounts being £463. 10s. 10d. for cables and £206. 10s. for laying. Tenders for this work were also submitted by W. T. Henley's Co., Callender's Co., and Siemens Bros. & Co.

The following tenders were received by Bermondsey Borough Council for the supply of cast-iron arc lamp standards and accessories, arc and incandescent lamps, switches-boxes, and sundry fittings for same:—

Crompton & Co. (*accepted*)	£983	5	0	Brockie-Pell Arc Lamp (Ltd.)	£1,051	15	0
Oliver & Co.....	1,170	14	0	Johnson & Phillips	1,018	19	6
Western Electric Co.	1,117	10	0	Drake and Gorham..	1,013	13	6
Brush Co.....	1,105	6	0	Sir Hiram Maxim			
1,035 15 0 and	1,361	6	0	Elec. & Eng. Co...	994	19	10
Improved Elec. Glow Lamp Co	1,060	4	0	Gilbert Arc Lamp Co.	981	14	6

Swansea Tramways and Electric Lighting committee on Wednesday accepted the tender of Dick, Kerr & Co. for the construction of permanent way, the supply and laying of rails and fish-plates, tie-bars, bolts and nuts and points and crossings and special work at £69,472. The material is to be of British manufacture. The lowest total of the sectional tenders was £68,902 for British rails, &c., and £68,086 for foreign goods. With regard to cables, the lowest British tender was £20,000, and German tenders were about £3,000 lower. In this case decison was deferred.

Gloucester Corporation have accepted the following tenders:—

Brush Company (10 tramcar bodies)	£2,680	0	0
Dick, Kerr & Co. (electrical equipment for 10 cars)	1,756	13	4
Callender's Company (distributing cable).....	298	9	7
Ditto (cable laying)	567	0	0
India Rubber Co. (converting booster into balancer)	160	0	0

Shoreditch Borough Council received the following tenders on Tuesday for 300yds. 1in. triple concentric lead-covered cables:—

British Insulated and Helsby Cables (Ltd.) (*accepted*)	£331	5	0
W. T. Henley's Co.	377	10	0
Siemens Bros. & Co.	370	0	0
W. T. Glover & Co.	345	0	0

The City of London Electric Lighting Co. has placed with the British Westinghouse Co. an order for another 1,800kw. direct current shunt-wound generator, mounted direct on shaft of driving engine. This machine will run at 75 revs. per min., and will be practically a duplicate of several other 1,800kw. machines, which the British Westinghouse Co. has supplied to the same station.

The British Westinghouse Co. has also secured the contract for a 100kw. steam dynamo for Gravesend Corporation. The set will consist of a Westinghouse generator (shunt-compound wound, giving 460/550 volts, according to arrangement of windings) driven by a Belliss steam engine of standard pattern, running at 475 revs. per min.

Sunderland Tramways committee have accepted the tender of J. B. Stott for the erection of new tramway offices at Monkwearmouth at £4,983.

The Metropolitan Asylums Board received 23 tenders for the installation of telephones at Darenth Asylum, varying in amount from the accepted (from Mr. P. Dewhirst) at £245. 10s. to £750.

Derby Town Council have accepted the tender of George Fletcher & Co. for steam piping at £167, and that of E. Morley for turbine and condenser foundations at £834.

Brighton Corporation have accepted the tender of Dick, Kerr & Co. for five electric tramcars at £5,110, and that of the Brush Company for a similar number of cars at £5,085.

Glasgow Tramways committee have accepted the tender of the Milnes-Daimler Motor Wagon Co. for a motor waggon for tramway repairs at £670.

Glasgow Corporation have decided to put down Harris-Anderson water purifiers at Pinkston power station at a cost of between £1,400 and £1,500.

Ilford District Council have accepted the tender of R. H. Steele for wiring Loxford and Horne schools at £370.

Kings Norton District Council have accepted the tender of W. H. Gibbs for the erection of car sheds, &c., at Cotteridge at £3,185.

Bruce Peebles & Co. have secured the contract for the complete equipment of 1,000 H.P. power house, overhead equipment for 19 miles of track, 60 complete electric equipments for double-deck tramcars, including cars, for the Sunderland and District tramways, of a total value of £81,000. The same company have also secured an order for an 800kw. traction and lighting generator for Paisley.

BUSINESS NOTICES.

Mr. W. H. Pretty having completed his term of service with Messrs. W. H. Allen, Son & Co., Bedford, is starting on his own account as a consultant upon mechanical, electrical and metallurgical questions arising in engineering practice. Mr. Pretty, before joining Messrs. W. H. Allen's staff, studied the subject of metallurgy and mining at the Royal School of Mines.

Messrs. Plutte, Scheele & Co., 18 and 19, Queenhithe, London, E.C., have been appointed agents for the United Kingdom for Messrs. Schmahl and Schulz, of Barmen, Germany, manufacturers of electric light accessories. Catalogues will be sent on receipt of trade card.

LIQUIDATIONS, BANKRUPTCIES, &c.

W. H. Hooley and J. W. Talbot (trading as Hooley, Talbot & Co), electrical engineers and contractors, Regent-street, Rugby, have been adjudicated bankrupt. The first meeting of creditors will take place on 7th inst. at the O.R.'s, 17, Hertford-street, Coventry, and the public examination on the same date at the County Hall, Coventry.

Geo. Neale, electrician, 2, Fulham Palace-road (formerly trading with another as the South-Western Electrical Contracting and Maintenance Co.), has been adjudicated bankrupt.

Cecil Wray, electrical engineer, &c., 16, Chevin-view, Eccleshill (formerly trading at 24, Simes-street), Bradford, has been adjudicated

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bankrupt. First meeting of creditors, Dec. 10, at 29, Tyrrel-street, Bradford. Public examination, Dec. 23, at County Court, Manor-row, Bradford.

A receiving order has been made against J. W. Storr, electrical engineer, 29, Grange-road, Dudley.

Claims against J. P. Child, electrical engineer, 150, Pow is-street, Woolwich, and 109, Piedmont-road, Plumstead, to be in by Dec. 15 to Mr. A. Mackintosh, 24, Railway-approach, London Bridge.

The Electric Installation Co. (Ltd.) is to be wound up voluntarily. Claims to Mr. R. V. Critchley, 6, St. James square, Manchester, by Jan. 13.

Sale by Auction.—Messrs. Edward Rushton, Son and Kenyon have been instructed by the liquidator of the Bridgewater Spinning Co. (Ltd.) to sell by auction, at 11 a.m. on Dec. 14, at Springfield Mills, Patricroft, near Manchester, two modern steam boilers fitted with Meldrum's furnaces, steam engines of 1,100 I.H.P., a Cameron pump, building ironwork and materials, &c. Further particulars are set out in an advertisement, and the whole may be viewed any day prior to sale. Catalogues from the auctioneers, 13, Norfolk-street, Manchester, or from the liquidator, Mr. William Kevan (Messrs. P. and J. Kevan, C.A.), 12, Acresfield, Bolton.

Plant for Sale.—The Newcastle-upon-Tyne Electric Supply Co. (Ltd.), owing to removal to their new power station, have for sale several Ferranti modern high-tension switch gear panels complete with latest type oil-break switches and fuses, 'bus bars, synchronising gear, high-tension voltmeters and synchronisers. Further particulars are given in an advertisement. Communications to the manager, 50, New Bridge-street, Newcastle-on-Tyne.

Messrs. Cannington, Shaw & Co. (Ltd.), Sherdley Glass Works, St. Helens, have for sale two Silvertown and one Mather and Platt dynamos. See advertisement.

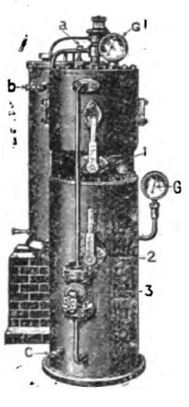
Mr. A. Underwood, 3, Queen-street, London, E.C., has for sale two Lancashire boilers, two Cornish boilers, four Willans-Siemens electric generating sets, switchboards, steam piping, Worthington compound pumps, &c.

Factory Premises for Sale.—A freehold manufacturing site, up to 50,000 sq. ft., without restrictions and within 2 miles from City and West-end, is advertised for sale in another column.

Glass Boxes for Sale.—The Chloride Electrical Storage Co. (Ltd.), Clifton Junction, near Manchester, have a considerable number of glass boxes (not being of standard sizes) for disposal. See advertisement.

Catalogues.—A list of patented machinery for covering all classes of electric cables with lead is issued by Messrs. John Wilson & Son, Vulcan Works, Johnstone, Scotland. The firm have a quantity of surplus tools and machinery for sale, of which particulars can be had on application.

The Lyon Patent Refrigerator (Ltd.) of Warrington have ready a wholesale trade list of electrical resistances, radiators, heaters, motor starters and controllers. This company owns the Lyon patent resistances, used largely in theatres for the production of stage effects. The special merits of this class of resistance are set out in the list under notice. The accompanying illustration represents one of the standard type of Lyon electric refrigerators operated by the direct application of electric heat, by means of the Lyon patent electric heater, also manufactured by this company. The lettering indicates the charging points of the machine to prepare it for its refrigerating work. It is started by means of a switch, and is claimed to be an economical refrigerator suitable for many classes of work, domestic and otherwise. In these days refrigeration is considered by some to be a very useful adjunct in many trades. The above company are also radiator specialists, and have several novelties in this class of apparatus.



A pamphlet dealing with "D" type dynamos for small outputs is to hand from Messrs. Mather and Platt.

A new catalogue of "Willesden" products is issued by the Willesden Paper and Canvas Works (Ltd.), Willesden Junction, London, N.W., who are specialists in all classes of canvas roofing and structures of a temporary or permanent character made of waterproof, weather-tight "Willesden" canvas. For telephone boxes and for many engineering, optical and electrical purposes, the various makes of this paper are extensively used. The new list is plentifully illustrated, shows an infinity of purposes to which "Willesden" canvas and paper can be supplied, and gives a good indication of the large demand for the company's manufactures.

A list of milling machines and milling cutters for large output reaches us from the Hess Machine Co., Philadelphia, U.S.A. Electric driving equipments are supplied by the same company for these machines, either for direct, alternating or multiphase motors.

Messrs. Estler Bros., 25, Laurence Pountney-lane, London, E.C., have ready two pamphlets dealing respectively with Harvey's patent signalling apparatus and the "Imperial" rail joint. The Harvey system of signalling was fully described and illustrated in *The Electrician* for Sept. 25 last.

Messrs. W. T. Glover & Co. are making effective use of the new pictorial postcards showing views of cable laying operations in which they are engaged in different parts of the country.

The Edison and Swan United Electric Light Co. have ready four further November leaflets, dealing with (*a*) small portable ammeters and voltmeters for stationery and portable accumulators and specially suitable for motor-car batteries, (*b*) "Liliput" arc lamp and accessories, (*c*) "Royal Ediswan" radiator lamps, (*d*) three-plate high-voltage ceiling roses, specially designed to obviate the necessity of having a large number of points in offices, factories, &c.

Pro-cycle Gas Engines.—Messrs. Mather and Platt have taken up the manufacture in this country of the two-cycle "Körting" gas engines, and a pamphlet just issued shows that, in principle and general design, the enginas have not been changed since the appearance of a description (in *The Electrician*, Vol. XLVI., p. 544) of a 350 H.P. engine made by the German firm. Larger sizes are now being built, however—up to 2,000 H.P. To ensure steady running, the engine is governed by altering the mixture of gas and air at variable loads. The engine is started by admitting compressed air into its power cylinder. For this purpose a starting valve, which can be put in and out of gear by a hand clutch, is provided. Water cooling is adopted not only for the cylinders, but also for the pistons and the metallic stuffing boxes.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Nov. 25 to Dec. 1, with the ports of destination:—

Africa—Alexandria, £76; Cape Town, £265 (including £20 telegraph material); Durban, £661; East London, £1,095; Port Elizabeth, £26. *Argentina*—Buenos Ayres, £230. *Australasia*—Brisbane, £27; Fremantle, £72; Melbourne, £1,812; Napier, £33; Perth, £48; Sydney, £3,542 (including £202 telegraph material); Wellington, £93. *Brazil*—Para, £5,320 (including £5,303 telegraph cable). *Canada* (via U.S.)—Montreal, £16. *Ceylon*—Colombo, £103. *Holland*—Amsterdam, £165; Flushing, £50. *Hong Kong*, £168 (including £95 telegraph material). *India*—Bombay, £38; Calcutta, £2,734 (including £310 telegraph material). *Japan*—Yokohama, £105. *Portugal*—Lisbon, £56. *Straits Settlements*—Singapore, £79. *Sweden*—Stockholm, £64. *Uruguay*—Monte Video, £104. *West Indies*—Trinidad, £25. *Zanzibar*, £22 (telegraph material). Total, £17,029, against £20,573 in the corresponding week last year (Nov. 26 to Dec. 2).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

September 23, 1903.

20,435 J. BUDGE and C. E. FORMAN. Coventry. Electric ignition.
20,443 E. HERMANN. Birmingham. Electric lamp.
20,450 F. W. E. SCHUER. Arc lamps.
20,497 J. VON KOWALSKI and I. MOSCICKI. Synthetical production of nitric products by discharges of electricity in gaseous mixtures.*

September 24, 1903.

20,517 C. MCCALLUM and J. MCGRUTHER. Glasgow. Fixing of pulleys, electric wires, &c., to ceilings.
20,528 A. EOKSTEIN and A. J. D. KRAUSE. Salford. Switches.
20,547 H. EHRET II. Berlin. Arm-supporter for telephone staff.
20,566 F. J. BEAUMONT. Maximum-demand electricity meters.
20,569 L. G. SLOAN. Liverpool. Pocket electric lighting devices. (Electrizitäts A.G. Hydrawerk, Germany.)
20,572 V. REICHENBERGER and E. WEIERSMULLER. Liverpool. Induction device for medical purposes.*
20,577 H. H. KNUTZEN. Magneto-electric machines.

September 25, 1903.

20,606 J. H. HOLMES. Newcastle-on-Tyne. Multipolar dynamo-electric machines.
20,611 M. WALKER. Manchester. Dynamo-electric generators.
20,633 and 20,634 E. J. CHAMBERS. Attaching insulators to brackets.
20,635 A. ALLEN and S. BENTON. Magnetic separators.
20,641 N. S. MCKINSEY and A. R. NELSON. Telephone selective systems and apparatus therefor.

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20,645 W. T. Upton, J. E. Elliott and H. B. Pratt. Arc lamps.
20,655 W. E. Evans. Electrolytic production of metals of the earthy alkalies, especially metallic calcium. (Elektrochemische Werke G.m.b.H., Germany).*
20,628 A. G. Ionides and A. C. Manuel. Overhead trolley lines.
20,662 A. H. Holmes and H. W. Holmes. Guiding trolley wheels at junctions.

September 26, 1903.

20,685 W. Simm and F. J. Denny. Resistance furnaces.
20,691 A. J. George. Cells of primary batteries.
20,700 G. Hall. Manchester. Trolley tramways.
20,709 F. Hilpert and F. Pauli. Manchester. Producing a coating of metal on paper, leather, &c.

September 28, 1903.

20,788 A. D. Jones. Arc lamps.
20,791 E. H. Ainsworth. Chelmsford. Terminals.
20,806 V. W. Delves-Broughton. Coherers.
20,820 H. Chitty. Electric machines.
20,825 W. C. Head and W. A. Snape. Electric lamps.
20,834 D. J. O'Brien and T. A. Rottanzi. Lamp casings and reflectors.
20,836 A. J. Boult. Disinfecting telephonic apparatus. (C. Fuchs and H. C. Kelterer, Belgium.)
20,838 L. G. Woolley and A. C. Cooney. Fire-alarm systems.*
20,845 A. Dey and J. Dey. Ribbon mechanism for time recorders.*

September 29, 1903.

20,875 J. T. Lambert. Huddersfield. Electric lamp holders and means for securing shades or globes thereto.
20,889 C. Kellner. Electrolysis of chlorides of alkalies.*
20,907 C. K. Jones. Telegraph systems.*
20,916 S. E. Page. Current regulators. (International Electric Controller Co., U.S.)*
20,921 J. A. Heaney. Insulated electric conductors.*
20,922 J. Buss. Magnetic separators.
20,926 A. R. Muller. Liverpool. Current converter.*
20,933 A. Domanski. Contact trolleys.
20,934 F. E. Dotchin. Switches, bell-pushes, &c.

September 30, 1903.

20,989 Bastian Meter Co. and C. O. Bastian. Electrolytic electricity meters.
20,997 F. C. Newton. Automatic starting switch.
21,004 H. H. Lake. Microphones. (J. A. Tounart, France.)
21,005 B.T.-H. Co. and H. S. Meyer. Alternating-current motors.
21,008 R. W. H. Hofstede-Crull. Mounting a number of electrical fittings or instruments upon a common base.
21,016 A. F. Berry. Alternate-current measuring apparatus.
21,027 W. Hamilton. Electricity meters.

October 1, 1903.

21,043 R. N. Eaton. Dublin. Electromagnetic trolley rope check.
21,054 H. M. Hobart and F. Punga. Rheostats.
21,055 F. J. Anson and J. W. Anson. Collecting currents in a conduit system of tramways.
21,067 J. H. Kaye. Halifax. Electric motors.
21,075 J. Inwald. Mercury and other incandescent vapour lamps.
21,078 H. C. Heidé. Party line telephone. (G. A. Lowry, U.S.)
21,088 H. Oppenheimer. Telephone connections on the party-line system. (A.G. Mix and Genest, Germany.)
21,090 A. J. Boult. Dynamometers. (M. E. Turner, U.S.)*
21,093 J. Porter. Switches (and their analogues).
21,104 A. Blackman and C. E. Warren. Electrolyte.
21,127 G. Forbes. Controllers for electric motors.

October 2, 1903.

21,140 M. G. Isdale. Glasgow. Engine telegraphs on board ship.
21,153 A. R. Dayson. Sunderland. Splicing fitting for trolley wires, &c.
21,173 P. J. M. Gasnier. Electro-mechanical arrangement for changing speed or for reversing the engine.
21,194 A. Battaglia-Guerrieri. Transmitting printing telegraphic messages over long lines and apparatus therefor.*
21,208 Compagnie Pour la Fabrication des Compteurs et Materiel d'Usines a Gaz. Alternate-current meters. (Date applied for Dec. 6, 1902, date of application in France.)*
21,216 D. M. Eader. Electric railway systems.*

October 3, 1903.

21,219 Sherard Cowper-Coles & Co. and Sherard Cowper-Coles. Secondary batteries.
21,227 W. A. Turner and G. A. D. Turner. Manchester. Life-guards.
21,240 A. W. Smith. Keighley. Starting switch and automatic cutout for series-wound motors.
21,261 G. H. Babb. Indicating device for trolleys of electric tramcars.
21,294 E. A. Fagerlund. Dynamo-electric machines.
21,302 B. Kungelmann. Automatic telephonic installations.
21,304 Siemens Bros. & Co. Driving electrical machines by steam turbines. (Siemens and Halske A.G., Germany.)*
21,305 Siemens Bros. & Co. Maintaining uniform speed in electric motors. (Siemens and Halske A.G., Germany.)*
21,306 J. B. B. Burke. Electric lamps.*

October 5, 1903.

21,315 W. E. Cable. Newcastle-on-Tyne. Steps for electric vehicles.
21,318 C. H. Davies. Birmingham. Switch holders or key switches.
21,320 C. F. Brodin and H. A. Schepeler. Electric signalling apparatus.*
21,324 J. T. Dawes. Liverpool. Magnetic separators.
21,328 S. de Stefani. Typewriting telegraphs and apparatus.
21,344 E. J. Wade. Staines. Storage batteries.
21,359 N. Köhler. Arc lamps for lanterns, cinematographs, &c.
21,363 J. E. G. Meran. Accumulators.
21,386 J. H. Mercadier. Electric fuses or cutouts.
21,404 Siemens Bros. & Co. Electricity meter for alternating currents. (Siemens and Halske A. G., Germany.)*
21,405 Siemens Bros. & Co. Electricity meters for motors. (Siemens and Halske A.G., Germany.)*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1902.

15,218 Prochaska. Electric safety apparatus for railways.
21,706 Armstrong and Obling. Telegraphic recording apparatus.
22,107 Siemens Bros. & Co. (Siemens and Halske A.G.) Sockets for safety fuses for electric leads, partly applicable also to sockets for glow lamps.
22,108 Siemens Bros. & Co. (Siemens and Halske A.G.) Safety fuses.
22,346 Bott. Apparatus for indicating leaks on electric circuits.
23,265 Bowell. Automatic fire alarm system.
23,797 Fell. Simultaneous telegraphy and telephony.
24,710 Carolan (G.E. Co., U.S.). Electrical measuring instruments.
25,578 Heap. Electric frequency and speed indicators.
25,658 Marconi's Wireless Telegraph Co. and Franklin. Apparatus for wireless telegraphy.
26,048 Carolan (G.E. Co., U.S.). Transformers.
26,050 Carolan (G.E. Co., U.S.). Magnetic clutches.
26,381 Carolan (G.E. Co., U.S.). Electric controllers.
26,448 McKinnon. Secondary batteries.
26,568 W. T. Henley's Telegraph Works Co. and Savage. Spirit lamps.
26,574 Carolan (G.E. Co., U.S.). Machines for removing impurities from foundry sand or like material.
28,414 Vickers, Sons and Maxim and Williamson. Regulation of electric motors.
28,762 Boult (Huff.) Railway electric signal systems.
28,943 Appleyard. Electrical measuring instruments.

1903.

162 Mismahl. Electric railway system.
258 Cie Générale d'Electricité. Rail bonds. (Date applied for, Jan. 6, 1902.)
2,483 Richmond and Carey. Electrically controlled lifts.
3,823 Reichwald (Firm of F. Krupp). Malleable cast-iron.
4,016 Crosta. Terminal box and cutout.
5,725 Pearson. Overhead equipment of tramways and cars therefor.
6,110 Salmony. Electric safety fuses.
8,491 Hjorth. Contacts for telephone and other signalling circuits.
10,384 Banco. Overhead line and trolley. (Date applied for, July 3, 1902.)
12,015 Justice (Controller Co. of America). Coin-controlled locks for telephone receivers.
16,258 Brookes (E.G. Alioth). Rotors for dynamos.
16,456 Hogge and Barrollier. Incandescent lamps. (Date applied for, April 8, 1903.)
16,939 Lake (Trolley Supply Co.). Trolleys.
17,057 Mathewson and Fielding. Steering gear for electric vehicles.
17,184 Krüger. Clamps for overhead conductors.
18,336 Murphy. Interrupting devices for currents, particularly high tension.
18,453 Macku. Dynamo-electric machines.
18,485 Wade (Rohman). Secondary batteries.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

DERBY ELECTRICAL CO. (LTD.)—Reg. Nov. 24, capital £1,000 in £1 shares, to acquire and carry on business of electrical engineers carried on by Mr. J. Hill at Derby, and to carry on the business of manufacturers of and dealers in motors, dynamos, lamps, cables, insulating materials, accumulators, telephones, electrical instruments, apparatus, &c. First directors, J. Hill, W. Shardlow and H. J. Furniss. Reg. office, St. George's Engineering Works, Wood's-lane, Derby.

KINGSWOOD ELECTRIC SUPPLY CO. (LTD.)—Reg. Nov. 26, capital £1,000 in £1 shares, to adopt agreement with Bristol Trust (Ltd.) and to carry on business of suppliers of electricity, electrical, mechanical and chemical engineers, contractors and manufacturers, electricians, &c. Reg. office, 46, Newman-street, Oxford-street, London.

STATUTORY RETURNS.

CONDUIT AND INSULATION CO. (LTD.)—In return to Aug. 26 the capital is £40,000 in £1 shares, of which 33,878 have been taken up. £15,878 has been received, and £18,000 is considered as paid. Mortgages and charges, nil.

LONDON ELECTRICAL FITTINGS CO. (LTD.)—The return to Aug. 25 was filed on Oct. 3, and gives the capital as £3,000 in £1 shares, 2,999 of which have been taken up. £1,299 has been received and £1,700 is considered as paid. No mortgages or charges.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC CAR CO. (LTD.)—£25,000 second debentures, created Nov. 6, 1893, have been registered. Property charged (as floating security), company's undertaking and property, present and future, including uncalled capital, subject to £50,000 debenture stock secured by trust deed dated June 17, 1903. No trustees.

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BRITISH PROMETHEUS CO. (LTD.)—£2,500 debentures, created Oct. 17, 1903, and dated Nov. 7, 1903, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

ELECTRICAL INDICATOR SYNDICATE (LTD.)—Debenture dated Nov. 18, 1903, to secure £200, charged on company's property, present and future, has been registered. Holder, W. H. Callow. Also issue on Nov. 18 of second debenture for £200, part of series created same date to secure £1,000, charged on same property. No trustees.

SHERARD COWPER-COLES & CO. (LTD.)—Issue on Nov. 13 of debenture for £100, part of series created by resolution of Dec. 3, 1901, and Feb. 7, 1902, to secure £6,500, charged on company's real and personal property, present and future, except uncalled capital. No trustees. Previously issued of same series, £6,400.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26½d. per oz. (Dec. 3). Consols 88⅛—88⅛ for money, 89¼—89¼ for account; 2½ per cent. annuities 88½—89 (Dec. 3). Consols Pay Day, Jan. 6; Stocks and Shares Continuation Days, Dec. 9 and 28; Ticket Days, Dec. 10 and 29; Pay Days, Dec. 11 and 30; Mining Share Carry-over Day, Dec. 8.

ARON ELECTRICITY METER LIMITED.—The directors' report for year ended Sept. 30 states that, after providing for depreciation and share of expenses and discount on issue of debentures, the net profit was £2,125. 18s. 8d., which has been carried to debenture sinking fund. The directors record a considerable change for the better in the affairs of the company, which (the report states) may be ascribed to (1) the apparent revival of the electrical industry on the Continent, which has created a proportionately larger demand for Aron meters, especially in Germany; (2) the completion of the factory at Schweidnitz, which has enabled the company to manufacture both cheaper and more advantageously; and (3) the manifest advantages of the Aron meter have created a reaction in its favour. The increased sales during last year led the directors to expect better results than have actually been attained; the economies effected in the manufacture have, however, so far not been sufficiently large to compensate for the required reduction in the selling prices. The directors have presevered in their efforts to stimulate business in England, and the expenditure incurred thereby has materially reduced the profits for the year. Prof. Aron has successfully completed his experiments in connection with the production of a new and cheap meter for alternating currents, which will shortly be placed on the market.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors have declared an interim dividend to Sept. 30 on the ordinary shares at the rate of 6 per cent. per annum, the same as in previous years.

BULLERS LIMITED.—The directors, in the report for year ended July 31, record further satisfactory progress in the business. Additional buildings and plant and machinery have again been required at both Hanley and Tipton to meet increased demands. The company has received large orders in connection with the electrification of railways and the transmission of electrical power at very high tension, and these promise to be important developments of the business. After paying directors' fees and managing directors' salaries, the profit was £40,058. 2s., which, with £775. 10s. 5d. brought forward, makes a total of £40,833. 12s. 5d. Interest on preference shares (£7,500) and dividends of 7½ per cent. on ordinary shares (£11,250) have been paid, leaving £22,083. 12s. 5d. It is now proposed to pay a further 2½ per cent. on the ordinary shares, making 10 per cent. in all (£3,750), to place £10,000 to reserve and to pay a bonus of 5 per cent. on the ordinary shares (£7,500) and to carry forward £833. 12s. 5d.

COMMERCIAL CABLE CO.—A quarterly dividend of 2 per cent. on the capital stock has been declared, payable Jan. 2. The transfer books will be closed from 19th inst. to Jan. 3 inclusive.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS (LTD.)—The directors' report for the year ended Oct. 31 states that the company's season consisted of 137 days, against 130 days last season. The mileage was 32,504·09, against 34,277·47 last year. No accident to life, limb or plant had occurred. Owing to unfavourable weather and other causes, the passengers carried numbered 192,031, against 204,699 last season. The gross earnings were £4,732. 11s. 10d., against £5,026. 3s. 3d. After deducting tolls payable to Douglas Head Marine Drive (Ltd.), the net passenger receipts were £3,943. 16s. 9d., and, with £23. 6s. 9d. sundry receipts, the total was £3,967. 3s. 6d., against £4,214. 3s. 9d. last year. The net profit was £1,952. 6s. 6d., against £2,042. 11s. 10d., and, after adding £70. 17s. from last year and deducting income tax, the disposable balance was £1,912. 2s. 11d., out of which the dividend on the 6 per cent. preference shares is recommended. The permanent way, plant, electrical equipment, buildings and rolling stock have been thoroughly overhauled and maintained in a high state of efficiency out of revenue. A workshop has been equipped at a cost of £456, and has proved of great service.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—At an extraordinary meeting last week resolutions passed on the 3rd ult. to increase the capital of the company and to alter the articles of association were confirmed.

MUNICIPAL ISSUE.—Johannesburg municipality are inviting applications for £1,500,000 4 per cent. inscribed stock at 95, which is to be applied in the erection of electricity works, the construction of tramways, &c.

PERFECTA SEAMLESS STEEL TUBE CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. G. G. Brodie) said the report showed considerable improvement over 1902. It had been decided that it was unnecessary for the current year to make any allowance for depreciation, as the plant and machinery were actually worth more than they stood at in the balance-sheet. The volume of trade in the past year exceeded that for several years past. Unfortunately, prices had been still further cut, and it had only been by the exercise of strict economy and the loyal and hearty support of the staff that they had succeeded in showing such a satisfactory result.

PROVINCIAL TRAMWAYS CO.—The accounts for the year ended Sept. 30, after setting aside £6,000 for depreciation at Plymouth and Grimsby, admit of payment of dividend on ordinary shares of 3s. per share, making 6s. per share, or 3 per cent., for the year. About £2,700 is carried forward.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend (payable Dec. 21) of 3s. per share (or at the rate of 6 per cent. per annum), tax free, for the quarter ended Sept. 30. The transfer books will be closed from 14th to 19th inst. inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Nov. 28	1,076	+ 237	26	32,750	+ 5,505
Ayr Corporation	...	...	...	...	...	...
Barnsley	,, 30	166	- 8	46½	6,384	- 80
Bexley District Council	,, 27	134	...	8	1,467	...
Birkenhead	,, 29	973	+ 63	...	...	...
*Birmingham Tramways	,, 28	4,966	+ 161	21	108,747	+ 3,065
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 26	293	+ 14	§34	86,528	- 183
Blackpool and Fleetwood	,, 28	160	- 28	22	20,033	- 138
Blackp'l, St. Anne's & Lytham	,, 26	126	+ 62	‡4	136	+ 270
Bolton Corporation	,, 29	1,685	+ 158	35	64,980	+ 7,858
Bournemouth Corporation	,, 25	778	...	35	36,984	...
*Bradford Corporation	,, 29	3,394	+ 588	34	133,612	+ 18,774
Brighton Corporation	,, 29	734	+ 36	39	33,239	+ 2,554
Brisbane Tramways	Oct. 14	2,361	+ 122	15	35,269	+ 507
*Bristol Trams & Carriage	Nov. 27	4,350	+ 227	1	4,350	+ 227
*Buenos Ayres & Belgrano	,, 1	3,188	- 25	2	6,254	+ 180
Burnley Corporation	,, 28	741	+ 87	35	36,058	+ 6,280
Burton Corporation	,, 29	301	...	17	6,480	...
Calcutta Tramways Co.	,, 28	R35,111	+R3,913	22	R727,607	+R133,921
Camborne-Redruth	,, 30	98	...	4	406	...
Cardiff Corporation	,, 28	1,794	+ 287	35	69,460	+ 19,150
Carlisle Tramways Co.	,, 28	173	+ 39	¶47	9,167	+ 759
Central London Railway	,, 28	6,951	- 141	22	139,010	- 6,860
Chatham and Dist. Lt. Rys.	,, 26	482	+ 173	47	25,506	...
City & South London Rly.	,, 29	3,310	- 167	23	58,060	- 9,026
Cork Electric Trams Co.	,, 26	406	+ 1	37	24,667	- 3,362
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 20	467	+ 121	46½	21,476	+ 1,344
Dover Corporation	,, 28	157	+ 11	‡35	8,308	+ 78
Dublin & Lucan Railway	,, 29	90	+ 2	22	2,856	+ 174
Dublin Southern District	,, 27	717	+ 22	¶21	23,182	+ 7,807
Dublin United	,, 27	3,570	+ 5	¶21	86,024	
Dudley—Stourbridge	,, 20	769	+ 40	46½	38,939	+ 3,669
Dundee Corporation	,, 25	788	+ 37	...	...	...
East Ham Council	,, 28	583	+ 167	‡35	23,857	+ 7,052
Gateshead & Dist. Trams	,, 20	900	+ 62	46½	40,799	+ 5,291
Glasgow Corporation	,, 28	18,160	+ 785	26	356,319	+ 37,083
Gravesend—Northfleet	,, 20	217	+ 47	46½	11,286	+ 1,171
Greenock & Port Glasgow	,, 20	463	+ 44	46½	23,505	+ 2,079
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 20	245	+ 34	46½	12,627	+ 787
Huddersfield	,, 28	1,119	+ 137	34	43,885	+ 6,753
Hull Corporation	,, 28	1,825	+ 125	‡35	65,667	+ 8,709
Ilkeston Corporation	,, 25	126	...	2	259	...
Ipswich Corporation	,, 28	264	...	1	264	...
Isle of Thanet Co.	,, 28	258	+ 1	22	21,406	- 1,041
Kidderminster & District	,, 20	96	+ 3	46½	5,980	+ 169
Kirkcaldy Corporation	...	...	...	...	...	...
Lanarkshire Trams Co.	,, 26	551	...	§15	11,729	...
*Leeds Corporation	,, 28	4,871	+ 351	34	195,064	+ 11,772
Liverpool Corporation	,, 21	9,465	+ 572	47	473,875	+ 15,552
*Liverpool Overhead Rly.	,, 29	1,560	+ 115	22	36,746	+ 2,428
London County Council	,, 28	9,089	+ 1,418	‡34	348,780	+ 65,063
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 28	10,969	+ 5,956	24	802,767	+ 159,249
Mersey Railway	,, 28	1,255	+ 255	22	29,184	+ 5,733
Merthyr	,, 20	184	+ 30	46½	9,261	- 60
Middleton	,, 20	250	+ 16	46½	14,864	+ 1,827
Newcastle-on-Tyne Corp.	,, 28	3,422	+ 448	22	77,014	- 2,780
*Newport (Mon.)	,, 28	446	+ 270	8	3,589	+ 1,644
Oldham, Ashton & Hyde	,, 20	511	...	46½	26,506	+ 1,579
Perth (W. A.) Elec. Trams.	,, 27	1,274	+ 227	§47	55,105	+ 6,268
Peterborough	,, 20	110	...	43	6,886	...
Poole and District	,, 20	224	+ 23	46½	14,198	+ 2,053
Portsmouth Corporation	,, 28	1,292	+ 90	‡35	64,787	+ 4,230
*Potteries	,, 20	1,659	- 51	46½	73,675	+ 3,562
Reading Corporation	,, 19	568	...	...	...	...
Rothesay	,, 20	96	- 3	46½	6,810	+ 1,603
Salford Corporation	,, 30	4,021	+ 1,265	35	94,563	+ 40,006
*Sheerness	,, 18	50	...	32	2,809	...
Sheffield Corporation	,, 29	4,259	+ 587	22	101,731	+ 8,112
*Southampton Corporat'n	,, 23	848	+ 8	...	...	...
Southend Corporation	,, 25	204	+ 48	34	12,058	+ 1,940
Southport Tramways	,, 20	249	+ 27	46½	14,681	+ 2,574
S. Staffordshire Trams.	,, 20	985	+ 367	46½	42,533	+ 7,249
*Sunderland Corporation	...	...	...	...	...	...
*Swansea Trams	,, 20	475	+ 35	46½	4,195	+ 2,027
Taunton Trams	,, 20	41	+ 1	46½	2,832	- 196
Tynemouth and District	,, 20	215	- 1	46½	14,671	+ 784
Tyneside Trams Co.	,, 28	284	+ 68	47	15,033	...
Wallasey District Council	,, 28	572	+ 66	‡35	25,082	+ 3,169
Weston-super-Mare	,, 18	36	- 1	46	5,616	- 514
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 20	354	+ 53	46½	18,176	+ 7,609
Wrexham	,, 20	115	...	33	4,695	...
Yorkshire Woollen District	,, 20	524	...	39½	15,234	...

(a) These comparisons are with the corresponding period last year.
* Partly electrical. ‡ Minus 3 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed. Dec. 2.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business, Week to Dec. 2 Highest.	Business, Week to Dec. 2 Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine 8h(1to260,007)5%Cm.Pf.	4½—4¾	5 5 3	April, Oct	4⅝	—
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	—	..
10	10 0	Barcelona Tramways Ord.	7¾—8¼	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	.. ..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	98 —102	4 9 6	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼—10½	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 1	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 —82	3 12 9	..	..	..
St.	5%	† Do. Pref. Ord. Stock	91 —94	5 6 2	..	92¾	92½
10	4/2½	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
4(	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅝	4 6 7	..	..	..
10	10/0	British Electric Traction Ord.	11¼—12	6 13 4	..	11⅞	11⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	11⅝—11¾	5 2 2	Feb, Aug	11⅞	11⅝
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	123	122½
5	..	Buenos Ayres and Belgrano Ord.	2⅜—2½	.. ..	..	2⅜	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5 —5¼	5 9 1	..	..	..
5	3/0	Do. "B"	4¾—5⅛	5 14 3	..	5⅛	5
St.	5%	Do. 5 per Cent. Debs.	106 —109	4 12 10	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	5 0 9	..	..	..
5	2 6	Calcutta Tramways	6¾—7¼	3 2 1	..	7	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 11	..	106	..
1	1/2½	Cape Electric Tramways Shares	1⅜—2	7 10 0	..	1⅜	..
St.	4%	Central London Ordinary Stock	92 — 95	4 5 4	June, Dec	93½	93⅛
St.	4%	Do. 4 per Cent. Pref. Stock	99 —102	3 18 10	..	100	..
St.	4%	Do. Deferred Stock	96 —99	4 1 8	..	96¾	..
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 11	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 —5½	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 5	..	100	99½
St.	2½%	City and South London Rly. Con. Ord.	49 —51	6 2 10	Feb, Aug	50	49
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 —129	3 18 7	Feb, Aug	..	..
St.	5%	Do. (1896)	123 —126	4 0 4	..	126	..
St.	5%	Do. (1901)	120 —125	4 1 1	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 0	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 —13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	3½—4¼	6 13 4	..	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 —98	5 2 0	..	..	..
10	8/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7¾—8¼	3 10 7	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	.. ..	..	..	..
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 3 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3⅜—4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 3	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4¾—5	2 10 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼—10⅝	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 6	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11¼—11⅜	4 5 1	..	11⅜	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 8	..	..	..
St.	..	Mersey Con. Ord. Stock	8 —11	.. ..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	.. ..	..	12	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	.. ..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1	.. ..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 4 1	..	..	..
5	..	New General Traction Ord.	⅛	.. ..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	.. ..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	100 —103	4 19 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8¼—9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	.. ..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	.. ..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	.. ..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 —94	3 9 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	.. ..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	.. ..	..	..	..
St.	15/0	Anglo-American	49 —52	6 1 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	92 —94	6 8 3	F,My,Ag,N	93⅞	93½
St.	1/0	Do. Deferred	7¾—8¼	0 12 6	F,My Ag,N	7⅛	7⅛
100	£2	Commercial Cable Capital Stock	145 —155	5 9 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	Jn Ap,Jy,O	92	90
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2¾—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	97⅝—101⅝	4 10 10	Jan, July	..	..
20	3/0	Direct United States Cable	10¼—10⅜	6 0 11	Ja,Ap,Jy,O	10½	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —102	4 8 10	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	122 —127	5 10 8	Ja,Ap,Jy,O	123½	122
St.	17/6	Do. 3½ per Cent. Pref. Stock	84 —87	4 0 11	Ja Ap,Jy,O	86	85
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	..	..
10	2/6	Eastern Extension	11 —11½	6 1 9	Jn,Ap,Jy,O	11⅛	11
St.	4%	Do. 4 per Cent. Deb. Stock	105 —108	3 14 9	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 —102	3 18 10	Feb, Aug	99½	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 11	May, Nov	..	..
10	5/0	Great Northern of Copenhagen	25 —26	4 16 2	Jan, July	25⅜	24½
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (rod.)	99 —102	4 8 4	June, Dec	..	..
25	12/6	Indo-European	37 —40	6 5 0	May, Nov	39	38¾
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..
2½	..	West Coast of America	⅛—⅜	.. ..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅞—⅞	.. ..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4 —5	.. ..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 17 7	Jan, July	..	..
10	5/0	Western Telegraph	11¾—12½	5 14 3	Mr,Jn,O,D	12⅛	11¾
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 8	..	100	99½
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5½	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	8¼—8¾	4 11 5	Ja Ap Jy O	8⅝	8⅜
10	3/0	Do. 6 per Cent. Pref.	12½—13	4 12 4	Ja Ap,Jy,O	12⅝	12⅞
8	4/0	Reuter's	6¾—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	116 —121	4 19 7	April, Oct	119	..

Share.	Last Dividend	Name.	Price Wed. Dec. 2	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business, Week to Dec. 2 Highest.	Business, Week to Dec. 2 Lowest.
		TELEPHONES.					
5	6/0	Chili Telephone (fully paid)	4¾—5¼	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	101 —103	5 18 9	..	102⅝	101
St.	5%	Do. Def. Stock	78 —81	6 0 6	..	80½	79
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5—5⅜	4 13 0	Feb, Aug	5⅜	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 —97	3 14 4	June, Dec	96½	95⅝
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 —104	3 17 5	..	..	..
1	0/7½	Oriental	1⅛—1⅜	7 2 0	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	.. ..	..	..	..
5	4/0	United River Plate	5½—6	5 16 8	July	5⅛	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 — 107	4 13 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅝—¾	.. ..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	116 —119	3 15 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½ - 13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 —11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	11⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 3	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—10¾	4 3 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10 —10½	3 6 8	Mar, Sept	10½	..
5	3 0	Calcutta Electric Supply Ord.	6½—7½	4 6 8	..	..	..
St.	4%	†Central Elec. Sup. Co. 4% Guar. Db. Stock	105 — 108	3 13 11	..	107¾	..
5	4/0	Charing Cross & Strand Electric Sup.	9 —9½	5 5 3	Feb, Aug	9⅛	8⅝
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	3 18 3	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	104 —106	3 16 2	..	106	..
5	2 0	Chelsea Electric Supply Ord	5½—6	4 3 4	March ..	5⅝	..
St.	4½%	* Do. 4½ per Cent. Deb Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10½—10⅜	6 19 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 —127	3 18 11	Jn, Dec ..	125	123½
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 9 5	..	105½	105
10	4/0	County of London & Brush Prov. Ord.	7½—8½	4 14 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	108 —111	4 2 8	..	..	..
St.	27/6	Do. Second Deb. Stock Prov. Certs.	99 —102	.. ..	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord	5½—6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
5	6/0	Kensington & Knightsbridge Ord.	10½—11½	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
3	..	London Electric Supply Ord.	1¾—2¼	.. ..	..	..	..
5	3/0	Do. 6 per Cent Pref.	5 —5¼	5 9 1	..	5⅜	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	4 0 6	Mr,Jn,S,D	100½	..
10	8 0	Metropolitan Electric Sup. Ord.	17½—18½	4 3 9	April, Oct	18⅛	17⅝
5	..	Do. 4½ per Cent. Cum. Pref.	4¼—4⅝	.. ..	..	4⅛	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 8	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	99 —102	3 11 7	..	..	..
10	6 0	Notting Hill Electric Ord.	12½—13½	4 8 11	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..
5	2 6	Oxford Electric Ord.	5½—5¾	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 6	..	..	..
1	..	Rand Electric	⅝—1⅛	.. ..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	99 —102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14 —15	4 16 8	Feb, Aug	14⅜	11⅛
5	3 6	Do. 7 per Cent. Pref.	7½—8½	4 2 4	Feb, Aug	8⅛	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —101	3 10 4	..	100	99½
5	2/6	Smithfield Markets Electric Sup. Ord.	3 —3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
£	1/9	South London Electric Supply Ord.	3½—3⅝	4 13 4	..	..	..
5	2 6	Urban Electric Supply Ord.	4⅞—5¼	4 17 7	..	4⅞	..
5	2 6	Do. 5% Cum. Pref.	4⅝—5⅛	4 17 7	..	4⅞	..
5	6/6	Westminster Electric Supply Ord.	11½—12½	5 8 4	Mar, Sept	12⅜	12
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—½	6 13 4	..	..	..
1	7½d.	Aron Electric Meter 6% Cum. Pref.	⅜—½	.. ..	Mar, Sept	..	..
5	4 0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (rod.)	103 —108	4 4 10	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	103 —105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	5⅜—5⅝	5 6 8	..	5⅜	5⅞
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	100 —102	3 18 5	..	..	..
2	..	Brush Electrical Engineering	¾—1½	.. ..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1⅛—1⅜	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	98½	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 — 89	5 3 6	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	11 —12	6 5 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	106 —110	4 1 10	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅜—½	6 17 2	..	1⅛	—
St.	4½%	Do. 4½ 1st Mort. Deb. (rod.)	91 —96	4 15 3	..	94½	..
1	0/7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2½	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	100⅝—104⅝	4 16 10	Jan, July	..	..
5	..	Edison & Swan United("A" Sh.) (£3 pd.)	¾	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	.. ..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 5 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6—6¾	5 3 8	H'lf-yearly	6⅛	6¼
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	..	6⅜	6⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 4	..	..	..
2	1/2½	Electric Construction Co.	1½—1¾	6 17 2	Jan, July	..	..
2	2 9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 3	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅝—¾	.. ..	..	..	..
1	7½	Do. 7 per Cent. Cum. Pref.	¾—1	.. ..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¾—10¼	4 17 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 —99	4 0 10	..	14	..
5	6/0	Henley's Telegraph Works Ord.	14 —15	6 13 4	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	18¾	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	84 —87	6 9 8	Mar, July	84⅜	84⅜
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	5 —6	5 8 4	Apr, Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	Apr, Oct	6⅜	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 5	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

We publish in this issue a report of the brief but interesting ceremony which took place at the Institution of Electrical Engineers last night, when the town of Colchester was presented with a fine historical painting in commemoration of the three-hundredth anniversary of Gilbert's death. It is fitting that twentieth-century electricians should show their keen appreciation of the early work of the "father of electricity" in the sixteenth century, and no more appropriate manner of doing this could have been chosen than the presentation of this picture to Gilbert's native town. With our reproduction of the picture on another page will be found extracts from Gilbert's famous work, and also some interesting notes by Prof. Silvanus Thompson, to whose exertions the revival of Gilbert's memory is largely due.

America also wishes to honour Gilbert and perpetuate his memory. A proposal will be placed before the electrical congress at the St. Louis Exhibition next year to give the name Gilbert to the C.G.S. unit of magneto-motive force. The name of the Danish physicist, Oersted, is chosen for magnetic reluctance, and the Maxwell, adopted at the recent Paris congress as a unit of magnetic field strength, is to be retained, it is suggested—so hat a Gilbert divided by an Oersted will represent a Maxwell. Another proposal is that a cadmium cell should replace the Clark cell as the recognised standard of E.M.F.—this proposition, it is hardly necessary to state, emanating from Prof. Carhart—and Dr. Kennelly has put forward an ugly system of nomenclature for absolute electromagnetic and electrostatic units which will hardly find favour in this country. He proposes to employ the prefixes "ab" and "abstat" to designate absolute electromagnetic and electrostatic units respectively, so that abvolt represents the electromagnetic unit of potential and abstatvolt the electrostatic unit. For euphony he suggests absohm rather than abohm for the electromagnetic unit of resistance.

All these propositions, strange to say, have been accepted by the American Institute of Electrical Engineers. Representative institutions in all other countries have been asked to consider them, and doubtless the subject will soon be opened for discussion at the Institution of Electrical Engineers.

It is to be regretted that Col. Rotton's resolution at the London County Council meeting on Tuesday, relating to the purchase of Belgian tram rails by the Council, was not passed without alteration or addition. The motion was to the effect that the Highways committee be asked to report on the number of hours per week worked by the workmen in Belgian firms from whom the rails are obtained; the rate of pay; and whether they had to work on Sundays. An amendment, moved by Mr. McKinnon Wood, provided that, in addition to the resolution, the inquiry should embrace foreign firms making rails for the Government and provincial Corporations as well as for the London County Council. The question as to the amount of mining royalties paid by foreign firms as compared with those paid in Great Britain is also to be investigated. Upon a show of hands, the motion, as amended, was carried. In attempting to cover so much ground it is to be feared that the ultimate object of the inquiry will be lost. All the information required would have been provided by an investigation according to Col. Rotton's original motion and the whole matter might have been settled almost immediately. Now, however, a considerable amount of time will be required to deal satisfactorily with the matter contained in the amended motion, and by the time the requisite information is forthcoming, buried in a voluminous report full of miscellaneous statistics, the whole affair will either have been forgotten or have lost most of its interest.

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THE plot is thickening about the N-rays. Their discoverer's latest discovery necessitates a revision of all the views hitherto advanced regarding their nature, and, indeed, a revision of the experimental results themselves. It turns out that much at least of their effects is subjective, in the sense that the primary effect is produced upon the humours of the observer's eye. M. BLONDLOT has found that for a dimly luminous object to be brightened by N-rays, it is not essential that the N-rays should strike the object, but that it suffices if they somehow penetrate into the eye of the observer. The humours of the eye acquire a kind of temporary phosphorescence, and under the influence of that phosphorescence the face of a clock on the wall may become distinguishable in nearly total darkness. This result is in itself highly interesting, and may lead to valuable physiological applications. But what we are more especially interested in is the bearing of the new fact upon our views regarding the N-rays and their relation to light. Beyond a mere description of the new facts, their discoverer does not enter into any discussion of them, and we are left to form our own opinion. Fortunately, we are saved from relegating the whole of N-ray phenomena to the sphere of physiology by the fact that the earlier accounts described an objective method of demonstrating their existence. It consisted in exposing a small flame or spark to the action of the N-rays, and photographing it with and without the rays. The arrangement of those experiments seems to exclude any effect upon the photographic plate corresponding to the phosphorescence of the human eye.

AT 10:30 a.m. last Saturday, just when the fog was at its thickest, an entire failure of supply took place at the Ecclestone-place station of the Westminster Electric Supply Co. The armature of a 225kw. machine developed a short-circuit, and before it could be switched off all the other machines pulled up, and the entire station had to be shut down. Some years ago each machine was equipped with a "minimum" automatic cut-out, but all the cut-outs opened simultaneously at 10 p.m. one Sunday evening, and ever since then they have been held up mechanically, in accordance with a practice now frequent. Fortunately, on that occasion the load was not very great, and the battery fuses were quite large enough to carry the out-going current. On Saturday, however, matters were very different, owing to the absence of either excess or minimum cut-outs on the generator panels. The station was fully loaded at the time—about eight bipolar, self-excited, shunt machines running—when a short-circuit occurred in an armature. Just at that moment the switchboard attendant happened to be at the end of the gallery remote from the switch controlling the faulty machine, and before he was able to open that particular switch the rest of the machines were pulled up.

THE battery being used almost entirely for balancing had been provided with only light fuses, and these naturally blew. For about half a minute the station was in complete darkness, until the emergency lights supplied by the battery came on. But by that time the mischief had been done, and as it was impossible to start up against full load all feeders were switched off, the undamaged machines started up and feeders switched on one at a time until the normal supply was resumed. Not only were the brushes and commutator of the machine on which the fault occurred very badly damaged, but those of some of the other machines were also fused, thus indicating the enormous current that must have been generated. The result of this was to delay somewhat the resumption of supply, but at the end of thirty minutes the entire network was once more alive. Immediate steps should be taken to prevent the recurrence of such a regrettable incident, and there is apparently no reason why the insertion of a maximum cutout in each generator circuit should not have the desired effect. With several machines in parallel there can be absolutely no risk that the cut-outs of the healthy machines will blow before that of the damaged one.

THE Paper on mechanical stokers, by Mr. GAY, which we reproduce in this issue, contains little that the experienced station engineer does not already know. Yet as a summarised description of the various makes of stokers it will be of considerable interest to some of our readers. It is especially in localities where cheap coal *is* cheap, and where it therefore pays to employ a fuel of low calorific value, that mechanical stokers have their greatest sphere of utility; but it will require more than the mere statement of a stoker manufacturer to convince us that, as was implied in the discussion, the employment of a mechanical stoker increases the useful calorific value of the poorer grades of coal to an equivalent of the very best.

The *Daily News* has discovered a new sensation in connection with the "octopus," our contemporary's name for the British Electric Traction Co., which, it says, with a fine confusion of metaphor, exploded one of its mines at Willesden on Tuesday night. The explosion in our contemporary was caused by its discovery, eight months after the event, that the Willesden Urban District Council has negotiated with the North Metropolitan Electric Power Distribution Co. for the sale of its electricity works on the understanding that the company should supply the Council "in bulk" with electric energy at a certain low tariff which was specified. "The sinister side of this matter," says our contemporary in its leading article, "consists in the fact that the public have heard nothing of the transaction, in accordance with the methods of the trusts. It has been done in the dark." In another article on the subjects it asks "Why this unseemly haste?" We may state, for the benefit of our contemporary, that the basis of the transfer of the undertaking was agreed upon in April last, and that the full report on the subject by Mr. RUTHVEN-MURRAY, the Council's electrical engineer, was published, together with our comments, in our issue of April 17th. Moreover, as the transfer had of necessity to be approved by Parliament, a Bill was introduced, naturally, with all the necessary publicity; in addition to this, however, the steps of its progress through Parliament were notified in our columns in due course. We may add that the meeting on Tuesday night was for the consideration of draft agreements for the transfer and subsequent sale of electricity "in bulk" approved by the officers of the Council, and that the Council accepted them after some discussion. Before the sale is actually concluded the present draft agreements have, of course, to receive the formal assent of the North Metropolitan Electric Power Distribution Co.

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THE extreme usefulness of wireless telegraphy under certain conditions, and when applied to certain purposes, was admirably illustrated on Tuesday, when the American steamer "Kroonland" from Antwerp to New York became disabled some distance west of the Fastnet, and had to put into Queenstown for repairs. Information of the breakdown was conveyed from the captain to the owners, and definite instructions were immediately telegraphed back. Passengers, also, were able to communicate with friends ashore, and assurances of safety were sent far and wide. It is not to be denied that when some sort of cogent regulations are applied to the working of wireless telegraph stations both ashore and afloat, the result will be an infinite boon to mankind, but in the meanwhile, much time and money is being wasted on attempts to cover long distances by methods which bids fair to impair the efficient working of the more useful ship-to-shore installations.

Correspondence.—Owing to pressure on our space, we are obliged to hold over until next issue an interesting letter by Mr. E. Graham Sheppard on "Photometric Tests of the Nernst Lamps."

University College, London.—It is announced that an anonymous gift of £50,000 has been made to University College, London, to be used for the promotion of higher scientific education and research at the institution. The donation has been sent through Prof. Starling.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Anjer—Kalianda	Aug. 2, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Paramaribo—Cayenne	Feb. 27, 1903
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903

Radium.—On Saturday evening Prof. H. Stroud delivered a lecture on radium at the Durham College of Science, Newcastle. After referring to the discovery of radium by Mme. Curie, the lecturer mentioned that less than one-quarter of a grain of radium bromide was used for demonstration purposes that evening. He then touched upon the work of Rutherford, Soddy, Becquerel, Thomson, Ramsay, Strutt and Crookes. Owing to several persons being turned away from the doors, the lecture will be repeated to-morrow (Saturday).

High-speed Railway Trials.—During the last few weeks the trials (according to the *Elektrotechnischer Anzeiger*) have been continued at speeds of 200km. (124 miles) per hour and above, the most notable new feature being the very satisfactory manner with which current is collected at highest velocities. Tests carried out with a sleeping car attached to a motor car proved that up to speeds of about 160km. (100 miles) per hour the trailer ran smoothly, but began to roll considerably at speeds of about 180km. (112 miles) per hour. The trials have—for the time being—been brought to an end, and speed trials with steam locomotives are soon to be commenced.

Paris-Rome Telephonic Communication. — The Italian Minister of Posts and Telegraphs, Sig. Stelluti Scala, has written to M. Trouillot giving his support to the proposition made by the French Minister in the matter of nominating an Italian-French commission with the object of studying the best means of securing the regular working of the Rome-Paris telephone line. Sig. Stelluti Scala has appointed as Italian delegates Sig. Rodano, divisional chief, and Sig. Angelini, director of the Rome telegraph station. Sig. Stelluti Scala proposes that the delegates should meet on December 15th at Turin, which is half-way between Rome and Paris.

Royal Institution.—The following are among the lecture arrangements at the Royal Institution before Easter:—Three lectures on Thursdays, January 14th, 21st and 28th at 5 p.m., by Prof. H. L. Callendar, F.R.S., on "Electrical Methods of Measuring Temperature"; six lectures on Saturdays, February 20th, 27th, March 5th, 12th, 19th, 26th, at 3 p.m., by the Right Hon. Lord Rayleigh, F.R.S., on "The Life and Work of Stokes." The Friday evening discourses will commence on January 15th, when the Right Hon. Lord Rayleigh will lecture on "Shadows." On Friday evening February 26th, Mr. Alexander Siemens will deliver a discourse on "New Developments in Electric Railways," and on March 25th a lecture on "Liquid Hydrogen Calorimetry" will be given by Prof. J. A. Dewar, F.R.S.

Personal.—Mr. S. L. Pearce, who until now has been deputy chief electrical engineer to the Manchester Corporation, has been chosen by the Manchester Electricity committee to succeed Mr. G. F. Metzger, who will act as consulting engineer for a fee of £150 a quarter, commencing on February 1st, until the extension scheme prepared under his specification is completed. Mr. Pearce was born in 1872, and, after being educated at Bishop's Stortford, was apprenticed to a firm of engineers. He subsequently obtained employment with Messrs. Richardson & Sons of Hartlepool, and, after gaining a certain amount of marine experience, became assistant engineer to the Metropolitan Electric Supply Co. For a short time he was then associated with the British Thomson-Houston Co., after which he was superintendent of the Central London Railway power house. In 1901 Mr. Pearce was appointed deputy chief electrical engineer at Manchester.

Rugby Engineering Society.—A new institution, which takes for its name "The Rugby Engineering Society," has been promoted by the staffs of the British Thomson-Houston Co. and of Messrs. Willans and Robinson, but all interested in engineering are eligible for membership. The Society already numbers some 350 members. The officers for the session 1903-4 are as follows:—

President, W. J. Larke; *First Vice-President*, C. H. Wingfield; *Second Vice-President*, F. Samuelson. *Council*: C. Morehead, J. T. Newman, E. A. Reynolds, D. P. Thomson, W. R. Watson, E. B. Wedmore, G. B. Wilson. *Hon. Recording Secretary*, E. R. Briggs; *Hon. Corresponding Secretary*, C. C. Wharton; *Hon. Treasurer*, J. T. Irwin.

The first ordinary meeting was held on November 5th, when an interesting Paper was read by Mr. F. Samuelson on "The Curtis Steam Turbine," the Paper being illustrated by curves showing the steam consumption, &c. The second meeting, on November 19th, was devoted to a continuation of a discussion on the above Paper, and a very able and complete reply was given by Mr. Samuelson. The third meeting was held on December 3rd, when a Paper was read by Mr. D. P. Thomson on "The Central London Railway."

Telegraphic Communication with the North.—The Association of Chambers of Commerce of the United Kingdom has received the following letter from the Post Office with regard to the question of underground telegraphs to the North of England and Scotland:—

Sir: In reply to your letter of the 16th Nov., I am directed by the Postmaster-General to give you the following information regarding the progress of the underground telegraph line to the North. The temporary wires in the pipes between Birmingham and Warrington are being replaced by a permanent cable. Seventy miles of this cable have been drawn in, and when the remaining 12 miles are drawn in there will be a permanent underground system between London and Birmingham, Manchester and Liverpool. There are already underground wires between Warrington and Manchester and Liverpool. The laying of the pipes north of Warrington to Carlisle is progressing, and the work will be finished this month. Temporary wires have been drawn in as far as Wigan, and will be continued to Preston. A permanent cable to Carlisle will be provided later. In Scotland it has not been possible at present to undertake more than one section of this work. That section is over the Beattock incline, where the overhead wires are much exposed, and the pipe work is completed. Pipes are also being laid north-eastward from Manchester to Leeds, and temporary wires will be provided, to be replaced later on by a permanent cable. This work will be completed before the end of the financial year.—I am, Sir, &c., A. F. KING.

Municipal Trading.—At Cheltenham on Saturday Sir Michael Hicks-Beach, in opening the new Town Hall, made some remarks concerning municipal finance, the responsibilities in connection with which he said were not always pleasant. In his opinion, the Cheltenham Corporation had not gone beyond the bounds of true municipal trading in embarking upon such schemes as electric lighting, sewage, municipal institutions, street improvements and the like. But it was

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vital in all these matters that the ratepayers should have periodically placed before them the fullest and clearest account of the assets of their several undertakings, of the profits or losses and of the provision made for the repayment of loans out of the rates. To secure this there must be a proper audit of municipal accounts conducted by qualified and independent auditors. Municipal credit had fallen considerably during the past few years, the reason being that the amount of Government and municipal loans that had been issued to the public in the last 10 years was simply enormous. The remedy for this was to curtail expenditure on new municipal undertakings, temporarily, to the lowest possible limit.

The late Sir F. Bramwell.—The funeral of the late Sir Frederick Bramwell took place on Friday at Hever. A memorial service was also held at St Margaret's, Westminster, at which the following were amongst those present:—Viscount Knutsford, Lady Bliss (daughter of the deceased), Sir A. Noble, Sir John Aird, Colonel Crompton, R.E., Mr. Fletcher Moulton, K.C., Mr. Bosanquet, K.C., Professor Dewar, Sir P. Magnus, and Mr. P. Watts (Director of Naval Construction). The Institution of Civil Engineers was represented by Sir William White (president), Sir George B. Bruce, Sir J. Wolfe Barry, Sir Douglas Fox, Mr. James Mansergh, Mr. Charles Hawkesley, and Mr. J. C. Hawkshaw (past presidents), Sir Guildford Molesworth, Sir Alexander Binnie, and Dr. Kennedy (vice-presidents), Dr. Tudsley (secretary), and almost the whole of the Council and staff. Deputations were also present from the Royal Society, the Institution of Electrical Engineers, and the numerous other societies with which the deceased was associated.

Fog Prevention by Electricity.—Mr. J. W. Bradley, city engineer of Westminster, wrote to Sir Oliver Lodge recently with reference to the prevention of fog by electricity, and asked if it would not be possible to devise an arrangement applicable to street arc lamps, so as to permit of a discharge of electricity at a large number of points in situations likely to be productive of most benefit, The following letter was received by Mr. Bradley in reply:—

The University, Birmingham, Dec. 4.

My Dear Sir: Your suggestion seems a practical one, and it would be a very good thing if something of that kind could be done. The difficulty is the insulation. If that could be guaranteed, the matter would be comparatively easy; but the potential is extremely high—say, 100,000 volts. The quantity is next to nothing, and very little power is sufficient, if only one could avoid leakage. Have you any ideas on this subject? I can tell you the kind of insulators that we employed for the single mast that I used in Liverpool, but it is a very different thing to try to distribute it over a number of street lamps. It is a matter very well worth consideration, however, and I am glad to find that your attention is called to the matter. In the Liverpool experiment I was using a potential higher than 100,000 volts; one could take sparks 4in. long. But a good deal smaller voltage would do if there are walls or other earthed surfaces in the neighbourhood. For a lofty isolated mast the potential must be higher in order to secure adequate discharge.

My view, of course, is that a town fog ought not to be produced; that it is very extravagant of a community to go to the double expense, first of producing a fog by incomplete combustion, and next of coping with it. But inasmuch as combustion reform will take some time, and meanwhile fogs are a nuisance, it is possible that something temporary might be done, even in a town. Fogs at sea and at harbours come in a different category, and it is quite appropriate to attempt to deal with them. There is, however, no more difficulty in dealing with one than another, and, in fact, the thicker the fog the more easily it is dealt with, if only adequate arrangements are made for the genuine supply of electricity into the air.—Yours faithfully, (Signed) OLIVER LODGE.

King's College Engineering Society.—The tenth annual dinner of this Society was held in the Victoria Hall of the Hotel Cecil last Saturday, the guest of the evening being Sir John Wolfe Barry, K.C.B., F.R.S. About 125 were present, including certain of the college staff and past and present students. Prof. D. S. Capper occupied the chair. The toast of "Our Guest" was proposed by Mr. B. G. Cooke, vice-president of the Society, and Sir John Wolfe Barry, in replying, said he thought that the profession of engineering was the most delightful in the world; out of no other could so much solid satisfaction be obtained. Referring to technical education, he deprecated "cramming" in any shape or form, and mentioned the professor who could "teach anybody anything if he only had two hours' start." He had every hope of the sandwich system; but he did not wish to commit himself in any way, and therefore reserved judgment. "The College and Staff" was proposed by Mr. H. G. Rowley, hon. treasurer to the Society, and replied to by Profs. W. Grylls Adams, F.R.S., and W. H. H. Hudson. The latter, who is shortly retiring after 21 years' service, said his speech might be looked upon in the nature of a farewell speech. Since the college would shortly enter upon a new era of prosperity owing to its connection with the University of London and other changes, he could only compare his position to that of the patriarch Moses, who was permitted to look upon the promised land, but never enter it. Prof. Capper then proposed the "Engineering Society," which was replied to by the President, Mr. F. W. Cramer Roberts, who called attention to the Society's prosperity and the fact that it now numbered more members than ever before. Various vocal and instrumental selections were given during the evening, including an excellently-rendered flute solo by Prof. E. Wilson, for which he was encored.

Faraday Society.—At the meeting of the Faraday Society on Tuesday the following two Papers were read in abstract: (1) "Total and Free Energy of the Lead Accumulator," by Dr. R. A. Lehfeldt (see *The Electrician*, Vol. LI., p. 975); (2) "Bitumen in Insulating Compositions," Part I., by Mr. D. A. Sutherland. In the discussion on the former, Dr. T. M. Lowry asked Dr. Lehfeldt to what extent he held to the view that lead sulphate was the normal product of discharge. He had always considered sulphate to be a disease of the lead accumulator. In reply, Dr. Lehfeldt said he thought the question largely depended upon whether an accumulator was charged and discharged fairly rapidly, or whether intervals of time were allowed between the two operations. Lead sulphate was a bad conductor and peroxide of lead a good conductor, and during discharge the particles of peroxide, and also the spongy lead, became covered with a very thin film of lead sulphate, which choked off the current. In ordinary use the effect of this was not noticed, but if the accumulator was left standing the sulphate formed over the working materials coagulated, as it were, and developing into larger crystals offered a higher resistance. Sulphating was nothing less than a process of gradually choking off the current by an accumulation of sulphates which hardened the plates. In his Paper Mr. Sutherland classified bitumen as follows:—Bitumen (proper): Trinidad pitch (or asphalt), Jew's pitch. Soft bitumen: Maltha, mineral tar, kir. Hard bitumen: Asphaltum. The objectionable features of crude bitumen showed that it was a mistake to employ unrefined pitch in joint boxes or troughs. The cheapness of brown coal or lignite was a temptation to use them, and electrical engineers should be very careful to see they were excluded as far as lay in their power. Bitumen was unquestionably a good insulator for low-pressure work but it did not appear to stand strains due to high pressures so well as many other insulating materials. In a great many of the so-called vulcanised bitumen compounds he had found bitumen to be conspicuous by its absence. Wooden bridges in cable troughing were frequently a source of weakness. Dr. O. J. Steinhart referred to the tremendous variation in the quality of bitumen. Some specimens he had tested contained 40 per cent. of carbonaceous matter, and others, apparently the same quality, only 16 per cent. Tests were necessary to determine the electrical resistance. Dr. M. Sheddon said that before bitumen could be universally adopted the question of regularity of chemical composition and regularity of physical properties would have to be settled. Mr. Sutherland kept the greater proportion of his reply for the Society's *Journal*, and a good many of the other queries he hoped to deal with in the second portion of his Paper, which would be read at another meeting. The question of the relative electrical resistance of pitch and refined bitumen he had gone into, and there was a difference of nearly 30 per cent. As a matter of fact, cable makers were quite against using pitch. Want of durability was the drawback.

Annual Dinner of the Institution of Electrical Engineers.—The fifteenth annual dinner of the Institution of Electrical Engineers took place at the Hotel Cecil on Wednesday evening, Mr. R. K. Gray, the president, being in the chair. Nearly 500 persons were present, including Lord Reay, Lord Monkswell (chairman of the London County Council), Lord Biddulph, Lord Claud Hamilton (chairman of the Great

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Eastern Railway), Hon. A. Brodrick, Sir W. H. White, Sir Norman Lockyer, Prof. S. P. Thompson, Lieut.-Col. Crompton, Sir W. Ramsay, Sir A. R. Binnie, Col. J. J. Mellor, M. E. Hospitalier (President of the Société Internationale des Electriciens), Prof. W. E. Ayrton, Sir J. Wolfe Barry, Sir W. de W. Abney, Sir G. L. Molesworth, Sir J. F. Bridge, Major-Gen. W. T. Shone, Major-Gen. C. E. Webber, Sir H. Mance, Mr. J. F. S. Gooday, Lieut.-Col. H. A. Yorke, Col. R. M. Ruck, Col. W. Pitt, Mr. R. B. Martin, M.P., Sir C. J. Owens and Mr. James Swinburne. After the loyal toasts had been honoured, Lord Monkswell proposed "The Institution of Electrical Engineers," and remarked that electrical engineers were the spoilt children of science. They had the advantage even of astronomers, for although the latter dealt with infinitely great things, yet they were utterly powerless to prevent terrestrial catastrophies; electrical engineers, on the other hand, were concerned with infinitely small things, and yet were able to exercise complete control over the forces which they studied. It seemed to him that they had conquered realms of science undreamt of and unknown even in the days of their fathers, and that the victories of Cæsar, Alexander, of Wellington, Marlborough and Napoleon could not be weighed for one moment in the balance compared with the triumphs of Kelvin and others. The president, in acknowledging the toast, said the manner in which the County Council had applied electricity to the tramways of the metropolis had met with warm approval from electrical engineers. He was afraid they could not be so hearty in their commendation of the smaller works which the County Council, in common with other bodies, undertook. The tendency to become universal providers was extending, and that had many drawbacks, because the extension narrowed the sources of production, and checked the spirit of invention and development. Great inventions had come from those who were untrammelled by too much standardisation, a thing to be most studiously avoided. The electrical engineer was invading the domain of the mechanical engineer to a large extent and was greatly responsible for the development of high-speed reciprocating engines and turbines. Mr. J. Swinburne proposed "Railways and Telegraphs," and referred to the transition now taking place in railway work. He complained of the difficulties which were put in the way when railways tried to obtain Parliamentary powers. There was a very large future before the telephone, and he should not be surprised if big dinners would not soon be conducted by telephone, each man dining in his own home. Sir C. J. Owens, in responding, said that the time was coming when electricity, instead of being the mere handmaid to railways, would become the sole motive power. He felt sure that a still closer alliance would be to their mutual good. Sir J. Wolfe Barry, whose name was also coupled with the toast, said it was a proud thing for this country that it had led the way in cable enterprise, and it still held the foremost place in the telegraph world. We had no less than 225,000 miles of cables in the world, of which considerably more than one-half were British. The capital held in this country in cable enterprises was no less than 30 millions sterling, and the international messages with Great Britain numbered more than 100,000,000 of words per annum, of which one-fifth were Press and Government messages. The reduction of rates which had taken place owing to the enterprise of British shareholders had amounted to between 60 and 70 per cent. within a very short number of years, and they were now carrying messages over 100 nauts for ½d. a word. He yielded to nobody in the interest which he took in the fascinating subject of wireless telegraphy and in honouring the names of those connected with it, but as to competition with cables he rather held his own opinions. The Eastern Telegraph Co. had five cables from Cornwall, and they had dealt occasionally with 15,000 words per hour. No less than 40 cables touched England, and if other cables were working at the same rate they had a total of 2,000 words, or 12,000 letters per minute. Let them fancy this discharge of words being bombarded into ether and encountering an equal bombardment from foreign countries. The prospect was appalling. The record of the cable enterprise since 1850, when the first little cable was laid across the English Channel, was a great one, and one of which they might well feel proud. Prof. S. P. Thompson, in proposing "Our Guests," said they had amongst them one they were delighted to honour. There had always been an *entente cordiale* between French and English electrical engineers since the exhibition of 1881, and M. Hospitalier's presence would tend to cement that feeling. He coupled the toast with the names of Lord Claud Hamilton, Sir William White and M. Hospitalier. Lord Claud Hamilton, in reply, said that railway chairmen were rather at sea with regard to electricity. It had made such strides in past years that they hesitated to carry out a project which, before it was completed, might be considered out of date. He hoped in future years he would be able to congratulate himself and the members of the Institution on the progress made in the electrification of British railways on a system which offered some prospect of permanence. Sir William White said he did not believe in a hard and fast separation between scientific societies and engineering societies. There was a distinction between pure and applied science, but a man who devoted himself to the application of science was equally as worthy of respect as the pure science man; and in connection with education matters engineers must not permit pure scientists to say what should be the training of the engineer. M. Hospitalier, who was accorded a very warm reception, expressed his great pleasure in having been for 22 years a member of the Institution of Electrical Engineers.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

To-day (FRIDAY), December 11th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "A Method for Mechanically Reinforcing Sound," by the Rev. T. C. Porter; (2) "The Simmance-Abady 'Flicker' Photometer," by Messrs. Simmance and Abady; (3) "Exhibition of a Conductometer," by R. Appleyard; (4) "A Model to Illustrate Various Properties of Wave Motion," by Prof. L. R. Wilberforce.

SATURDAY, December 12th.

GLASGOW TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

7:30 p.m. Meeting at 38, Bath-street. Paper to be read: "Steam Turbine Machinery," by A. A. Wynne.

MONDAY, December 14th.

INSTITUTION OF ELECTRICAL ENGINEERS: NEWCASTLE LOCAL SECTION.

7:30 p.m. Meeting at the Durham College of Science. Paper to be read: "Experiments on Eddy Currents," by Dr. W. M. Thornton.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION.

7:30 p.m. Meeting at Storey's-gate, Westminster. Paper to be read: "Main and Auxiliary Steam Pipes for Power Plants," by H. Baker.

TUESDAY, December 15th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER SECTION.

7:30 p.m. Meeting at Owens College. Paper to be read: "Electric Traction with Alternating Currents," by A. C. Eborall.

WEDNESDAY, December 16th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

7:30 p.m. Meeting at the University, when Prof. R. Threlfall will demonstrate his system of testing electric generators by air calorimetry already discussed in London.

ROYAL METEOROLOGICAL SOCIETY.

7:30 pm. Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. Meeting at the Royal Institution, Liverpool. Paper to be read "Polyphase Working," by H. W. Wilson.

THURSDAY, December 17th.

INSTITUTION OF ELECTRICAL ENGINEERS: LEEDS LOCAL SECTION.

7:30 p.m. Meeting in the Yorkshire College, Leeds. Paper to be read: "Methods of Charging for Electrical Energy," by E. H. Crapper.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "The City and South London Railway: Working Results of the Three-wire System," by P. V. McMahon.

FRIDAY, December 18th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "An Enquiry into the Working of VariousWater Softeners," by C. E. Stromeyer and W. B. Baron.

SATURDAY, December 19th.

JUNIOR INSTITUTION OF ENGINEERS.

3 p.m. Visit to the Walthamstow Municipal Electricity Works Train from Liverpool Street, 2:23 p.m.

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THE NEW ELECTRICITY WORKS AT EXETER.

The Exeter electricity works was one of the pioneer provincial stations, having been started in 1889 by the Exeter Electric Lighting Co. As the area is a large one, a single-phase high-pressure system was adopted, in accordance with the usual practice at that date, high-pressure continuous-current being employed for the arcs. The latter were supplied in series of 30 by Thomson-Houston arc lighters, and for the private lighting Mordey alternators were employed, driven by ropes from John Fowler engines. As these machines would not run in parallel, separate circuits were employed. It may be mentioned that the majority of the machines were still running on load until the starting of the new works a few days ago, and that in the Babcock boilers, which have been in operation since the start, none of the original tubes have had to be replaced. For the first two years the company was working under an electric lighting licence, but in 1891 it was deemed advisable to obtain a Provisional Order, and it was

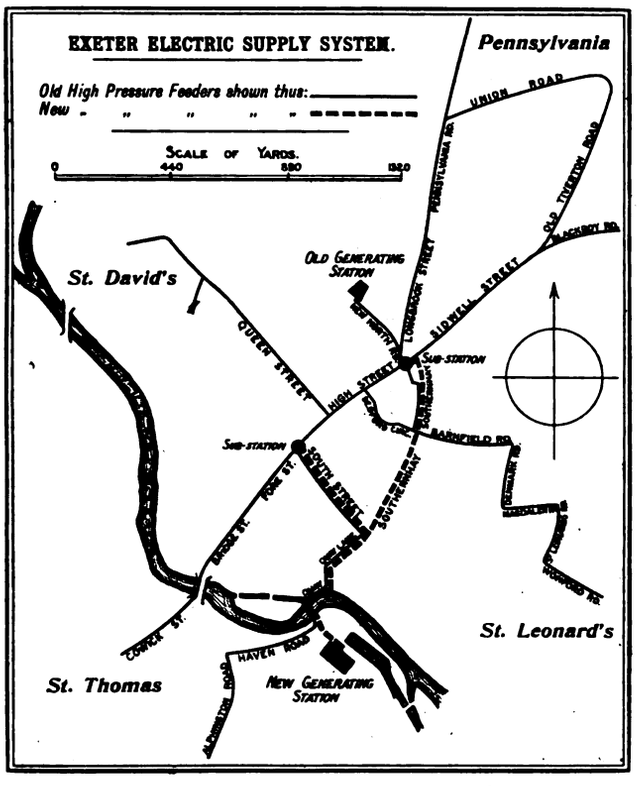

Fig. 1.—Sketch Map, showing Position of High-Pressure Mains.

also decided that the overhead network, which consisted of okonite wires supported on steel poles, should be replaced by underground cable. In the following year, therefore, a contract was entered into with the Fowler-Waring Cables Co. for the necessary high-tension feeders and low-tension distributors. At that time rubber-covered cable drawn into iron pipes was used almost exclusively for underground work, and there was some difficulty in overcoming the prejudice against the use of any other material as an insulator. Nothwithstanding this, the original high-tension cables, laid in 1892, which were insulated with impregnated cotton, lead-covered, and armoured with galvanised iron wires (the armouring being protected with compounded Hessian tape) are still in operation at their full pressure, and will form part of the new system which is now being completed.

Owing to the fact that the company started with insufficient capital, it did not pay its way, and in 1896 the company accepted an offer of the Corporation of Exeter to take over the works, two valuations having been made—by Prof. J. A. Fleming and the city surveyor (Mr. Cameron). Mr. H. D. Munro, who was then engineer-in-chief to the company, continued as city electrical engineer, in which capacity he still acts. He had succeeded Mr. T. P. Wilmshurt (now borough electrical engineer at Derby) in 1893, and Mr. Wilmhurst's predecessor was Mr. A. W. Jones (now of the British Thomson-Houston Co., who had been responsible for the original erection of the works). Dr. E. J. Domville, J.P., was the first chairman of the Electricity committee, and after seven years' service he was succeeded by Ald. William Wreford, J.P., who was followed by Ald. W. H. Reed, the present chairman of the committee. As a municipal works the system gradually grew, and the policy was continued of concentrating the house transformers into sub-stations. Additional generating sets had also to be added—viz., an Easton, Anderson and Goolden set, a Raworth (Universal)–Mordey alternator, and a Hick, Hargreaves–Ferranti set.

For some time past it was apparent that extensions were necessary, and in 1900 a report was prepared by Mr. H. D. Munro with estimates for building a new station on a site between the River Exe and the basin of the canal at the south end of the town. This report was submitted to Mr. T. P. Wilmshurst and received his approval. Specifications were issued in 1901, Mr. Munro being responsible for those for the electrical equipment and Mr. Donald Cameron, then city surveyor, being architect for the buildings. A two-phase system was decided upon in view of the development of the demand for motive power; this would naturally involve a smaller alteration in the present network than the adoption of a three-phase system would have done.

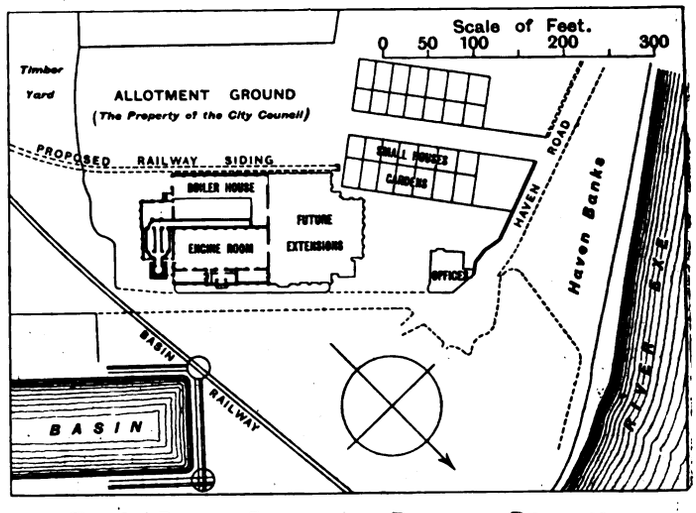

Fig. 2.—Plan of Site, showing Position of Buildings.

Tenders, together with Mr. Munro's report on them, were submitted to Mr. Robert Hammond, and after due consideration had been given to the opinions both of Mr. Hammond and Mr. Munro, the tenders of Mr. William Brealy, of Exeter, for buildings (£13,905), and the British Westinghouse Co. for the complete power house equipment (£29,707), were accepted. The latter tender was subsequently increased by £1,486 for chain grate mechanical stokers. Later on also, a contract for four main high-tension feeders from the new works to the two main sub-stations, as shown in the sketch map, together with 16-way Doulton conduits, was let to Messrs. Siemens Bros. & Co. for the sum of £2,450, which included the laying of the cables and ducts. The sub-contractors under the Westinghouse contract were Messrs. Babcock and Wilcox (boilers), Messrs. Belliss and Morcom (engines), Worthington Pumping Engine Co. (condensers), Messrs. E. Green & Son (economisers), Messrs. Willey & Co., Exeter (coal-conveying plant by the New Conveyor Co., ironwork for buildings, coal bunkers, pipe work, &c.) and Messrs. C. and A. Musker (travelling crane),

The arrangement of the buildings is shown in the small general plan of the site (Fig. 2) and in the plan and cross-

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section (Fig. 3). Mr. Cameron's design of the buildings combines usefulness with a handsome appearance. On entering the station by the main entrance access is at once gained to the engine room, and the offices are on the first floor on a level with the switchboard gallery, a cable room, stores, workshops, &c., being on the ground floor on either side of the main entrance hall. The engine room is lined with cream-coloured glazed bricks with a French grey and chocolate dado. Besides the windows in the roof, an excellent light is obtained from large windows at the temporary end of the engine room. The floor will be of the imitation mosaic known as terazzo. The general dimensions of the buildings can be gathered from the plan and section, which are to scale. The height of the chimney is 150ft., and its internal diameter 8ft. 6in.

Particular mention may be made of the scaffolding employed in building the chimney shown in Fig. 7, a patent of Mr. Burridge, foreman to the building contractor. It consists of a number of projecting square frames, as seen in the illustration, to which the platforms are fastened. The inner side of each frame is fastened to the chimney by a bolt at top and bottom, and when the scaffolding has to be raised a step higher, the lower of these bolts is taken out, and the frame is rotated a quarter turn round the upper angle so that the next side of the square comes against the chimney, and can in its turn be bolted to it. Another feature of the buildings is the basement, in which is the coal-conveying plant. This basement had to be made absolutely watertight, as it is below the bed of the river, and for this purpose a ¾in. thickness of cement to the inner side of the usual blue bricks has been found sufficient.

The coal will at first be obtained from a siding from the Great Western Railway, to be made just outside the boiler house, as shown in Fig. 2, and later on arrangements will be made for economical conveyance from the barges in the basin. Four shoots passing through the wall of the boiler house are

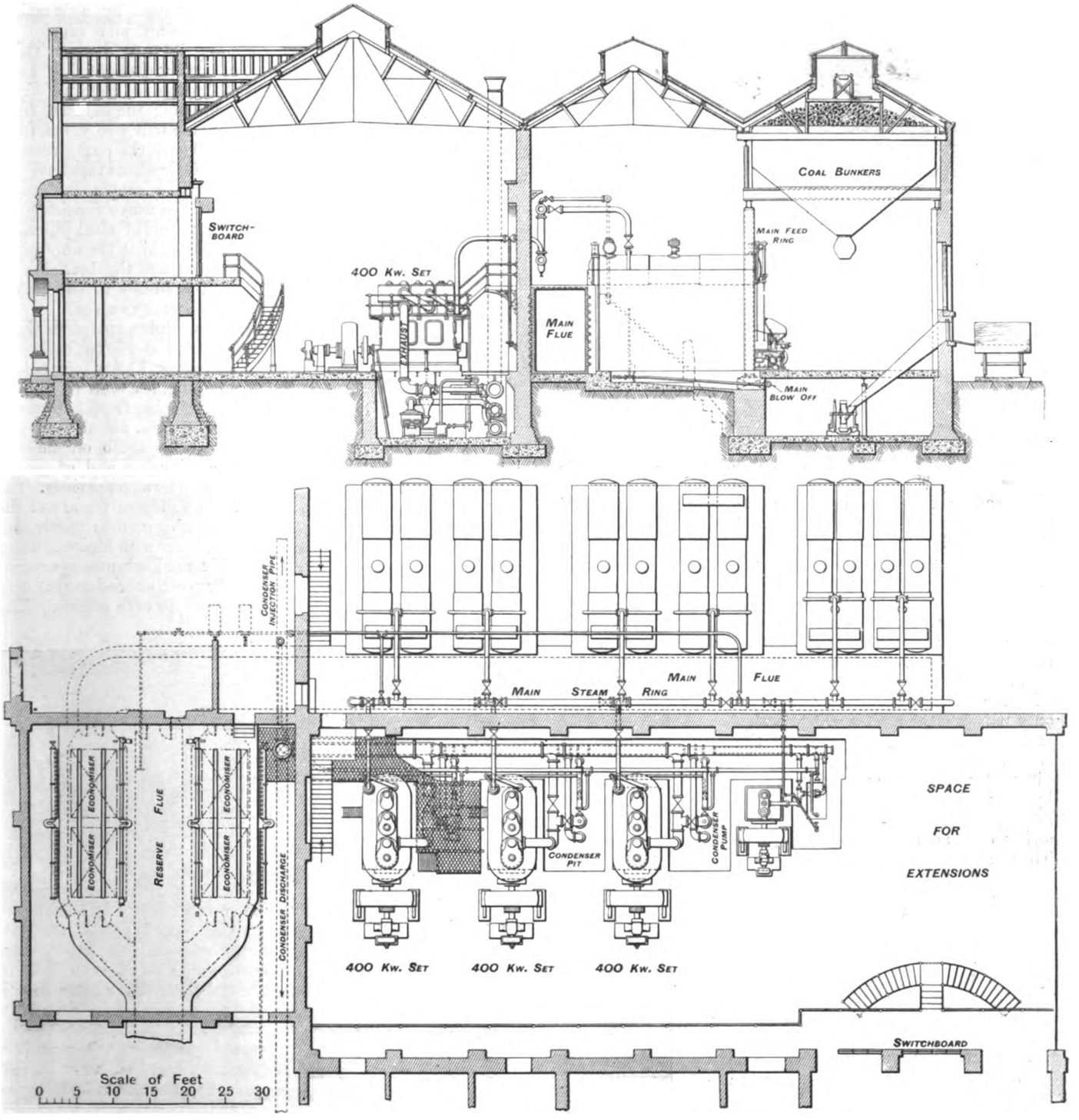

Fig. 3.—Cross-Section and Plan of Generating Station, showing General Arrangement of Plant.

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spaced at distances equal to a truck length, and coal will be shovelled from the coal trucks straight into these. Thence it will pass into a chain bucket conveyor driven through spur gearing by a two-phase motor, which takes it to the coal bunkers above the boiler house. The buckets are of the gravity type, and are hung at intervals of 2ft. They are built up of mild steel bottom plates with malleable cast side plates, and are free to revolve round 1¼in. mild steel pins. The coal from the side shoots is filled into the buckets through a portable filler which can be moved to any part of the basement, being mounted on wheels which run on outer rails, supported from the brackets which also carry the conveyor rails. The filler is of the Star pattern, having an opening in the centre through which the coal enters, and openings round the circumference through which it is discharged. These openings in the circumference coincide with the pitch of buckets, and as coal can only pass into the bucket which is directly underneath the filler, all chance of spilling is prevented. The coal is discharged at different points over the storage hoppers by the raising of a cam, which arrests the lower portion of the bucket, causing it to swing up, and so discharge its contents. There are six coal bunkers, their total capacity being 500 tons of coal, and there is also a small bunker on the same level which can take 60 tons of ashes shovelled into the conveyor by hand. Coal from the bunkers gravitates through measuring hoppers to shoots feeding the Babcock and Wilcox chain grates, the capacity of the measuring hoppers being a quarter of a ton each.

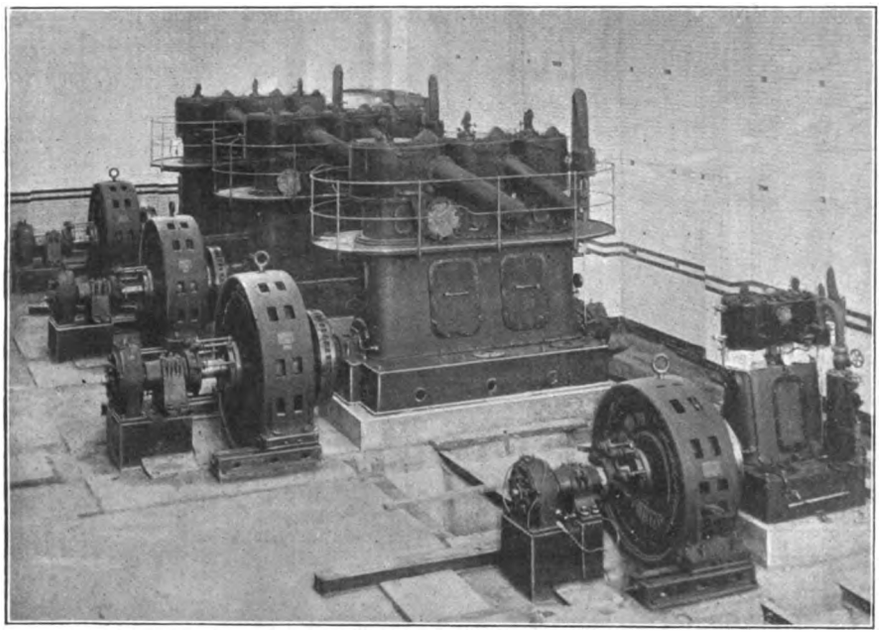

FIG. 4.—VIEW OF GENERATING PLANT.

Three Babcock and Wilcox boilers have been put in, each of 4,020 sq. ft. of heating surface and capable of evaporating 13,000lb. of steam per hour from and at 212deg. They are fitted with superheaters, with the usual fittings, but no injectors. Steam at only 150lb. per square inch pressure will be employed in order that the boilers from the old station may be utilised. These boilers will be fitted with chain grate stokers and superheaters also. Two 320 tube economisers, with top boxes of the new pattern fitted with internal and oval lids, have been put in; their scrapers are driven by a small 5in cylinder engine attached to the gearing frame of the economiser. At present town water is employed for feed purposes, but ultimately river water will be used. Although the basin is nearer than the river, water from this source cannot be employed as there is always a considerable amount of oil in it emanating from the warehouses of some large oil importers situated on the canal. The river water is soft and will merely require filtering to remove the sand. Two Worthington direct acting steam pumps have been put in, each with a capacity of 2,500 gallons per hour, and there is also a three-throw pump by the same makers driven by a Westinghouse two-phase motor and capable of supplying 3,900 gallons per hour. These feed pumps will be supplemented by some brought over from the old station. Feed-water heaters utilising the exhaust from the auxiliary engine will also come from the old works. Above the pump room is a feed tank of 10,000 gallons capacity. As seen in the drawing, a simple ring steam main is employed, the range consisting of 10in. diameter lap-welded steel pipes, all in the boiler house, so that the only pipes in the engine room are the branches to the engines. All branches to the boilers are fitted with non-return valves.

The engines are triple expansion, there being three sets rated at 400kw. each, and there is also a smaller 100kw. compound set. The larger engines seen in Fig. 5 are capable of developing from 570 B.H.P. continuously at 360 revs. per min., and at a pressure of 145lb. to 150lb. on the stop valve, running condensing, and of giving 25 per cent. overload for short periods. The three cranks are placed at 120deg. The slide valves are of the piston type, there is a shaft governor working on the throttle, and in all respects the machines are in accordance with Messrs. Belliss and Morcom's usual pattern. The governor guarantee is a variation in speed not exceeding 3 per cent. between no-load and full load

A Worthington jet condenser is fitted to each engine. The condensing water gravitates from the basin through an 18in. stoneware pipe to a large well, from which it is pumped by the Worthington pumps, forming part of the jet condenser sets, through a 15in. riveted iron main, the condenser discharge returning to the basin. Provision is also made for atmospheric exhaust in connection with the usual relief valve.

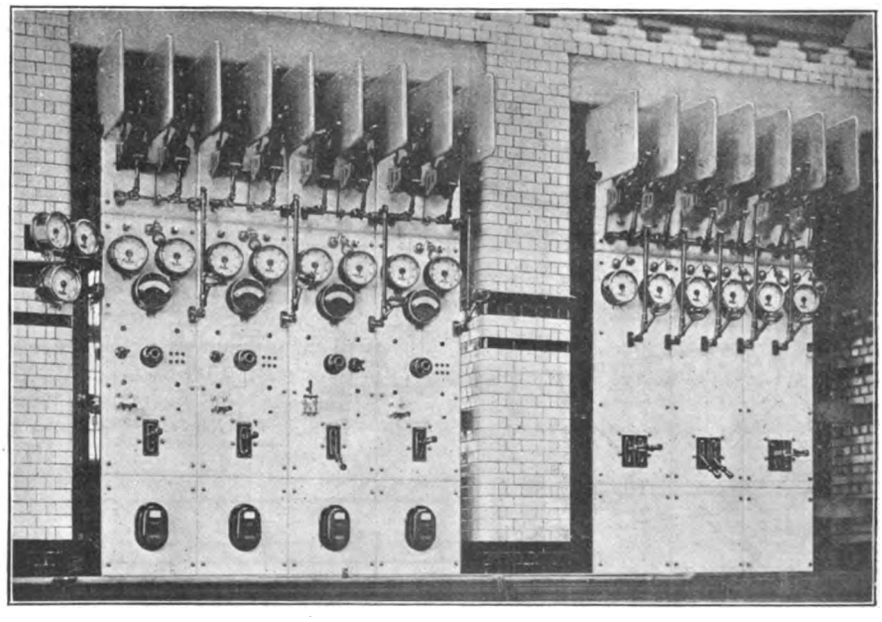

FIG. 5.—GENERAL VIEW OF SWITCHBOARD.

The larger generators have 20 poles, and run at 360 revs.

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per min., the frequency, therefore, being 60 ∽ per second. The smaller machine has 14 poles, and run at 514 revs. per min., the terminal pressure in both cases being 2,200 volts per phase. They have the usual two-phase windings, and are well ventilated. The exciter armatures are overhung beyond the outboard bearing, as seen in the photograph. The exciter current for the larger sets is 55 amperes at 100 volts when the generator is running at a power-factor of unity, and at 80 per cent. power-factor there is an increase of 20 per cent. in the exciting current. The pressure regulation guaranteed is that there will be a rise of 6 per cent. when full-load is thrown off at unity power-factor, and a rise of 24 per cent. when full-load at 80 per cent. power-factor is thrown off. The efficiency guarantees are 90¼ per cent. at half load, 93 per cent. at three-quarters load and 94 per cent. at full load, these efficiencies being based on the C^2R losses in armature and field coils and the armature iron loss, friction not being included. The rise of temperature is guaranteed not to exceed 32°C. at full load or 40°C. at 25 per cent. overload for 24 hours. The machines are also to be capable of generating 50 per cent. overload at a power-factor not less than 80 per cent. for one hour, with a rise of temperature not greater than 50°C.

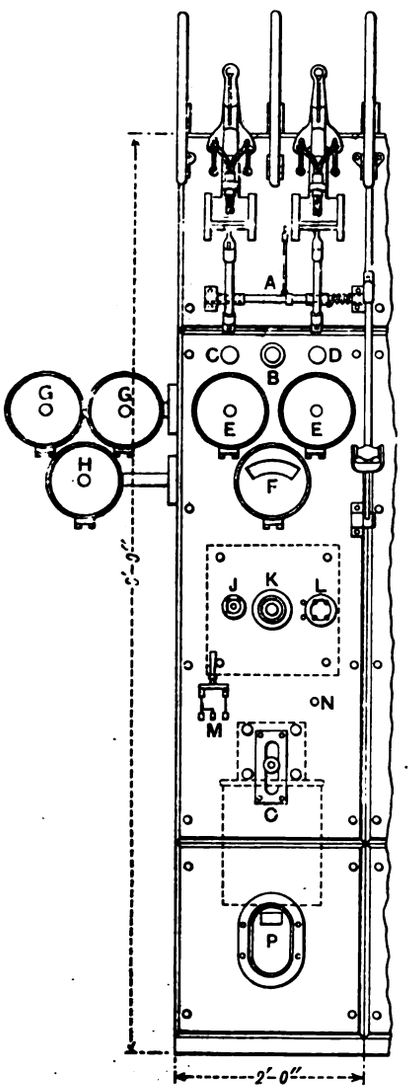

FIG. 6.—ARRANGEMENT OF GENERATOR PANEL OF SWITCHBOARD.
½in. = 1ft.

A 300-ampere 2 500-volt Non-Automatic D.P. Circuit-Breaker.
B Pilot Lamp.
C G.D. Lamp.
D Synchronising Lamp.
E 200-a. A.C. L.S. Am.
F 100-a. D.C. D.B. Am.
G 300-v. A.C. L.S. Vm.
H 3,000-v. A.C. L.S. Vm.
J G.D. Rec. and Plug.
K Combined Rheostat.
L Vm. Rec. and Plug.
M 100-a. D.P. S.T. G.B. Field Disc Switch.
N Syn. Rec. and Plug.
O 300-a. 2,200-v. D.P. D.T. Non-Automatic 'Bus-Bar Switch.
P 200-a. 3,0 0-v. Polyphase Integrating Wattmeter.

The switchboard, Figs. 5 and 6, has four main machine panels, as seen on the left, and three two-phase circuit panels, shown on the right. The arrangement of the board is clearly seen in the two illustrations, and it will be noticed that there is a switch to each panel to change over from the main 'bus bars to the hospital 'bus bars. These switches break under oil. The two phases are connected together at one terminal on the dynamos, and this is led to a common earthed 'bus bar, to which there are no connections on the switchboard. The usual shunt and main field rheostat is provided for each machine, the contacts for which are on the back of the board. These, in addition to the small transformers for the measuring instruments, tend rather to crowd the wiring at the back of the board, and it is not improbable that the rheostat will be moved. The resistances connected to the rheostats are behind the board, a few feet away. On the feeder panels the switches at the top of the board are fitted with cut-out coils, so that they act also as circuit breakers, but those on the generator panels act only as switches. In the cable room beneath the switchboard gallery on the engine-room floor level, the transformers for the arc lighting and power circuits are placed, as well as the earthed 'bus bar already alluded to. The engine room is spanned by a 10-ton hand travelling crane.

Leading from the works to each of the two sub-stations are two twin concentric paper-insulated lead-covered cables laid in Doulton ducts. Where the cables pass under the River Exe a different type is, of course, employed. For this purpose a special cable has been made, the two inners being first insulated and lead-covered and the outer conductor being laid directly on the lead. Over this comes its insulation and another lead covering, and the whole is armoured with galvanised and tarred iron wires 0·22in. diameter laid on in two layers. The section of the inner cores of all the feeders is 0·06 sq. in., the outers being 0·09 sq. in. The two feeders to each sub-station will be provided with Mr. Andrews' device, so that in the event of one breaking down it will be automatically switched off, and the supply will continue uninterruptedly through the other.

At present, the majority of the arc lamps are still being supplied from the old Thomson-Houston arc lighters, but every third lamp is connected on to the low-pressure alternating-current circuit. Ultimately, however, all the lamps will be supplied directly from the low tension alternating-current mains, the lamp pillars being fitted with two incandescent lamps and the usual automatic switch. The old 100 volts pressure is retained throughout, but probably special 400-volt two-phase feeders will be run from the main sub-station to certain points for the larger motors.

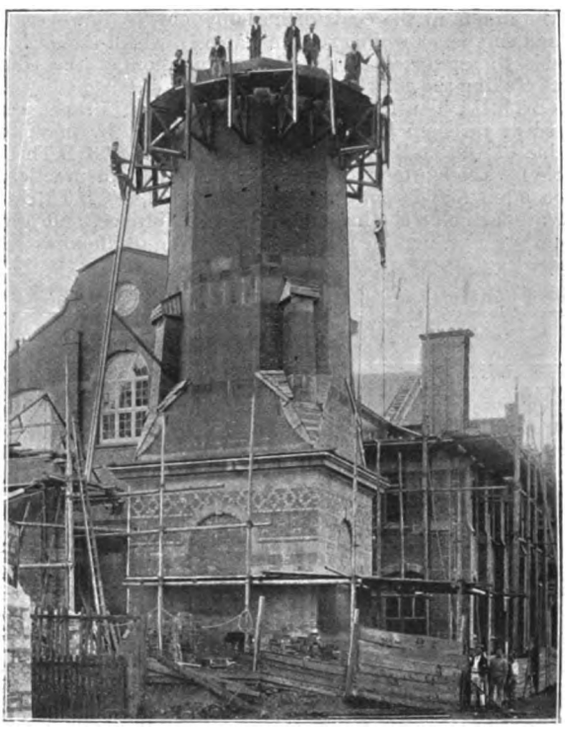

FIG. 7.—CHIMNEY DURING CONSTRUCTION.

Applications for additional lighting and a large demand for motors are coming in, and there is no doubt that part of the large space left available for extensions will soon have to be occupied. In addition to this, the works should ultimately have a large tramway load, as, under an Act obtained this year, the Corporation has power to build tramways outside its own boundaries. It may also be mentioned that an arbitration has just taken place with regard to the valuation of the old horse tramways within the city.

In the erection of the plant, Mr. C. A. Henderson has acted as resident engineer for the Westinghouse Company, and the entire work has been carried out under the supervision of Mr. H. D. Munro, the City electrical engineer. Our best thanks are due to Mr. Munro for the facilities given us to inspect the works, and for the large amount of information placed at our disposal. Although the building and the coal-conveying plant are not quite complete, the station is in operation, and everything running satisfactorily. The formal opening will take place in March, by which time the station will have been handed over by the contractors.

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STOKERS FOR ELECTRICITY GENERATING STATIONS.*

BY ALBERT GAY.

It is almost unnecessary to remind you that from the days of James Watt until the present time, engineers all over the world have been ceaseless in their endeavours to bring about greater economy in the utilisation of energy; and so keen has become the competition towards this desirable end that the number of patents for appliances invented with this object in view probably amounts to many thousands, the greater portion of which, not having fulfilled the expectations of the sanguine inventor, have sunk into oblivion. Amongst these, the records of our Patent Office include a large number of machines which, if they could operate successfully, would upset all our present ideas regarding the laws of the conservation of energy, and perpetual motion would be an established fact. We have of late heard a great deal about radium as an inexhaustible source of energy, but notwithstanding the gushing reports and brilliant forecasts of the daily press, the author prefers at present to pin his faith to those sources of energy to which he is accustomed—such as coal—rather than to radium. He proposes to confine his remarks in the present Paper to the consideration of one of the many types of appliances which have for their object increased economy in the raising of steam.

In the generation of electrical energy, loss is taking place all along the line from the coal to the lamp, chiefly, however, in the boiler and engine, as will be seen in Table I., which the author has been able to reproduce by the kind permission of the editor of *Power*. Taking the calorfic value of a pound of fair quality coal at 13,500 B.Th.U., it will be seen that less than 10 per cent. is delivered as mechanical energy to the dynamo. If, therefore, the full value of 13,500 B.Th.U. is obtained, only 1,273 B.Th.U. are available for use by the dynamo. Unfortunately, in practice, it is only too often found that nothing like the 13,500 B.Th.U. mentioned are actually obtained even in the furnace, and given a sufficiently careless or incompetent stoker, the results may be very low indeed.

Table I.—*Showing Loss from Furnace to Lamp.*

	Per cent.	B.Th.U.
Ashes	1·00	135
Boiler radiation	5·00	675
Chimney gases	22·00	2,970
Radiation in steam pipes	1·56	210
,, auxiliary pipes	0·22	30
,, ,, exhausts	1·40	190
,, engines	2·08	280
Loss in engine exhaust	57·31	7,737
Loss up to the engine	90·57	12,227
Balance (available energy)	9·43	1,273
	100·00	13,500
Loss between furnace and engine	90·57	12,227
Loss in engine	0·56	76
,, generator	0·36	48
Loss up to switchboard	91·49	12,351
Balance (available)	8·51	1,149
	100·00	13,500
Loss up to switchboard	91·49	12,351
Loss in distribution	1·24	167
	92·73	12,518
Total delivered to lamps	7·27	982
Total heat in coal	100·00	13,500

Perfect combustion is necessary to obtain the maximum value from the coal. The average boiler cannot be looked upon as an ideal apparatus for the economical generation of steam even when fired with the utmost care and skill, and, indeed, to obtain the highest calorific value from the coal, is a performance which can only be carried out under laboratory conditions. Tests carried out, however, under such conditions have given us with some certainty the thermal units which may be obtained from any given class of coal under varying conditions of combustion; and the more complete the combustion, the higher is the efficiency until perfect combustion is attained. The thermal value of coal and the quantity of air required in order to obtain perfect combustion are well known, and in the case of the coal previously mentioned having a calorific value of 13,500 heat units per pound, about 130 to 135 cubic ft. of air is usually given as sufficient. In actual practice in a furnace, however, this amount would have to be largely exceeded, much depending upon the construction of the furnace, so that how to apply the knowledge experimentally obtained in the laboratory to the construction of a furnace so that ideal results may be depended upon has yet to be discovered. It is evident that a perfect apparatus of the kind would have to be entirely automatic, as the idiosyncrasies of the average human stoker would render the results unreliable even with the best designed and constructed apparatus.

While not even the most sanguine inventor could go as far as to say that his apparatus fulfils the ideal conditions, there is no doubt that excellent results can be and are being attained, and great credit is due to those whose inventive ingenuity has been the means of attaining these results under the adverse conditions inherent in an average electric power station, even when watched by workmen who are able and willing to give the machinery a fair chance. The main object in life of the average human stoker when firing by hand appears to be to crowd on as much coal at a time as the furnace will hold—the bigger the lumps the better—then to shut the door and trust to luck. The principle of stoking a little at a time and often, at the same time regulating the draught and keeping a clear fire does not appeal to him. It is, therefore, not surprising that engineers should desire to replace the careless or incompetent stoker of the human variety with a machine of some kind which will even approximately fulfil the duties required of it. It is with this object in view that so many mechanical stokers have been placed upon the market.

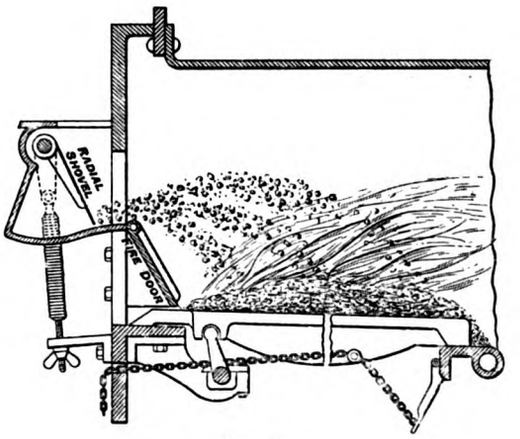

FIG. 1.

An ideal mechanical stoker should fulfil the following main requirements:—

1. Increased economy in fuel when compared with hand firing.
2. A smokeless furnace even with bituminous coal.
3. Few wearing parts.
4. Reliability.
5. Self-contained.
6. Small capital cost.
7. Small maintenance cost.
8. Small running cost.
9. Adjustable feed.
10. Automatic in action.

The various types of mechanical stokers derive their names from the methods adopted for feeding the fuel into the furnace. They may be divided generally under the following heads:—Over or top-feed, where the fuel is deposited above the firebars; and under-feed. The first type must be subdivided into two classes—viz., (*a*) sprinkler; and (*b*) coker. In the first case the fuel is thrown or sprinkled in small quantities at a time all along the furnace, and in the second case the fuel is dropped on or near the dead-plate just inside the furnace door, and moved slowly forward by means of moving firebars, rams or other mechanical devices, so that the gases are given off slowly and consumed by passing over the clear fire ahead.

The under-feed type, as its name implies, feeds the fuel into the furnace from below the bars by means of rams or screws or similar devices. In this case it is obvious that the whole of the coal has to pass through the fire before it can reach the top. The driving gear required to feed the fuel into the furnace, to oscillate or rock the bars in order to break up and remove the clinker, and also to regulate the quantity of fuel, varies in construction and application in different stokers. The main principles, however, are common to each type, so that a general description of any one of a type will, except in detail, convey a good idea of all.

Fig. 1 of the illustrations shows a longitudinal section of a portion of the mechanism of a Proctor's sprinkling stoker. By the action of the moving gear and a spring shovel and tappet, a small quantity of fuel is distributed to different parts of the fire—viz., the back, middle and front. This is effected by the tappet having three different

* Paper read before the Society of Engineers, November 30th.

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throws, the whole being adjustable without opening the fire doors. The fire-bars are of the movable type, so preventing the adhesion of clinker and keeping the air-spaces free. The clinker also, by the movement of the bars, is gradually shifted along and worked off the end of the bars into a clinker pit, from which it is removed when cold. The makers claim that they can regulate the quantity of fuel to be burnt by a simple adjustment of the regulating screw of the ram, which supplies fuel to the shovel from 2 cwt. per hour per furnace upwards. The shovel being made V-shaped throws the fuel out in the form of a fan, and so distributes it well up to the sides of the flues.

Fig. 2 shows a longitudinal section of mechanism of the E.S.E. stoker, made by the Smoke Preventer Co. It will be seen that this

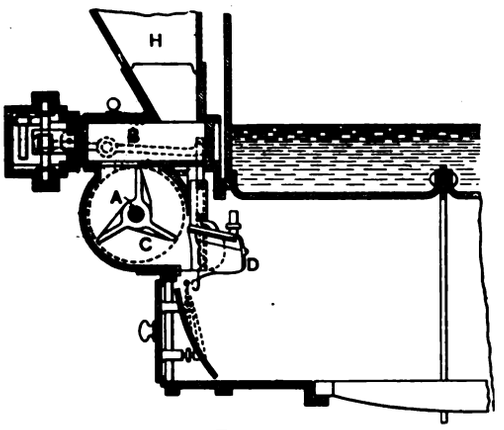

Fig. 2.

is also of the sprinkler type. A is the shaft carrying the fan or beaters; B, the fuel feed box which oscillates at right angles to the boiler front, and in doing so feeds the fuel from the hopper H through the opening above the fans, where it is caught by the vanes of the fan C, and projected into the furnace. Moving bars prevent adhesion of the clinker and carry it forward to the end of the grate, where it is deposited and removed in the usual manner. In order to regulate the amount of fuel delivered to the furnace the stroke of the fuel feed-box B is increased or diminished. With a view to producing equal distribution of the fuel over the whole furnace deflectors or distributing plates are provided, which deflect the fuel in the direction required.

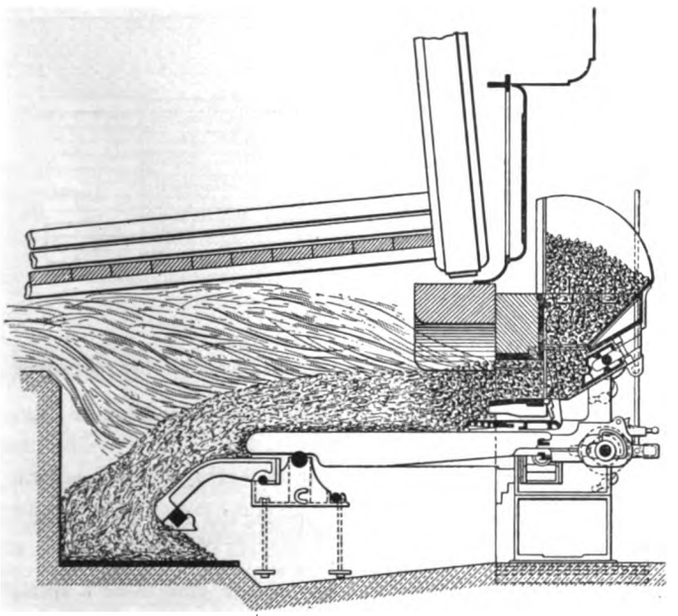

Fig. 3.

Fig. 3 illustrates a longitudinal section of a Vicars stoker. This is of the second class of the top-feed stokers, and is known as a coker, or coking stoker. The fuel is fed from the hopper into boxes, from which it is gradually pushed by reciprocating plungers or rams on to the dead-plate. From the dead-plate it is pushed on to the moving fire-bars, which slowly convey it to the rear of the grate. The partially-consumed coke, with the clinker and ash, is discharged (as shown) over the end of the fire-bars into the flue, where they act as a bridge and prevent the passage of free air directly into the flue. The feed is regulated by altering the rate of motion of the plungers. The motion of the fire-bars can also be regulated.

Fig. 4 shows a diagrammatic section of the ram and hopper of the "Koker" stoker made by Messrs. Meldrum. The ram in this case is made in the form of a sector working on a pivot, and the makers claim that with this arrangement less power is absorbed than with sliding rams. The moving fire-bars have an undulating

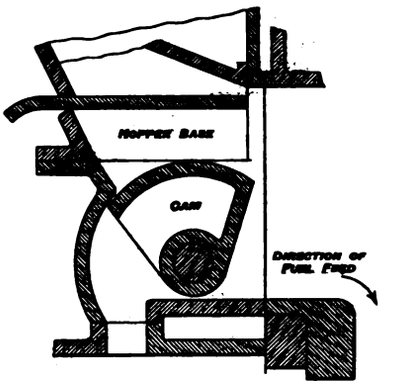

Fig. 4.

surface, so that the reciprocating motion of adjacent bars prevents the clinker adhering. The air spaces are also very narrow, to prevent loss of fuel by passing between the bars into the ashpit.

Figs. 5 and 5A show perspective views of the back and front ends respectively of a chain-grate stoker, as made by Messrs. Babcock and Wilcox. The grate consists of an endless chain of short cast-

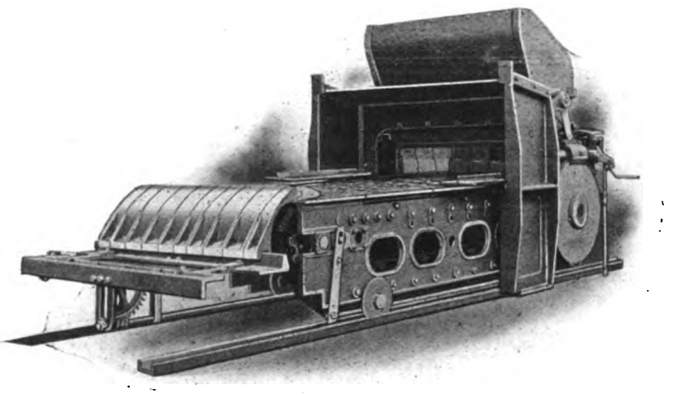

Fig. 5. Back View.

iron fire-bars linked together and operated by passing over drums at either end, the front drum being revolved by a worm and worm-wheel. The coal is fed over the whole width of the grate, and the thickness or depth of the fire is regulated by the adjustment of the fire-doors, which are lifted vertically. This, added to the fact that the rate of travel of the grate can also be regulated, is claimed by

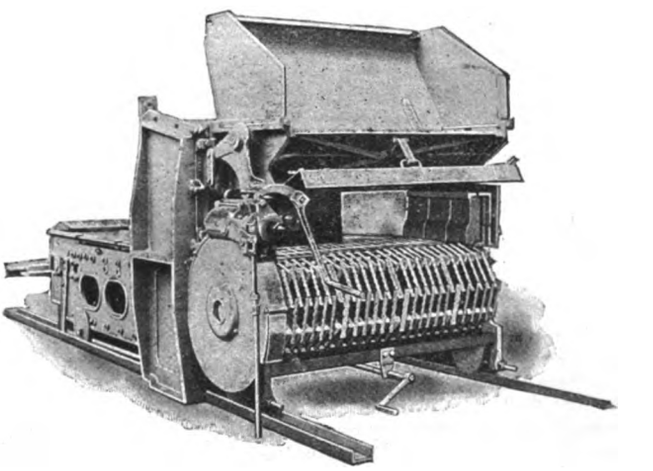

Fig. 5A.—Front View.

the makers as fulfilling all the requirements for various classes of coal and varying demands of steam. It is claimed that it is entirely self-clinkering, and, as the fuel is exhausted by the time it reaches the back end of the furnace, the ash and clinker drop automatically into the ashpit in the usual manner. The whole stoker runs on

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rails, and can be brought out clear of the boiler if required for examination or repair.

Fig. 6 shows a longitudinal section of an underfeed stoker by the Underfeed Stoker Co. In this case the fuel from the hopper is carried under the bars by means of a screw, and is forced up through a cavity in the middle of the furnace and then slides down on either side of the sloping fire-bars, the clinker and ash accumulating at the bottom on either side of the furnace. The feed-screw as well as the bars are actuated by means of a small reciprocating engine on each stoker, so that it is self-contained.

The two tests of hand-firing and underfeed stoker firing, respectively recorded in Table II., were conducted under the direction of the author.

Table II.

—	Hand firing.	Stoker.
Duration of test in hours	9	16
Coal consumed (in lb.)	8,372	9,218
Average per hour (in lb.)	930	576
Total water evaporated (in lb.)	74,075	78,937
Total ash (in lb.)	780	1,474
Actual evaporation of water (in lb.) per lb. of coal	8·84	8·56
Equivalent evaporation at and from 212deg.	10·12	9·85
Average cost of coal per ton	18s. 9d.	11s. 4d.
Average percentage of CO_2	..	11·5
Calorific value of coal in B.Th.U.	14,200	12,800

The small quantity of coal consumed by the stoker does not mean that the evaporative capacity of the boiler is reduced, but that no forcing was attempted and the firing was slow, as the demand upon the boiler at the time was small. This is proved by the fact that in subsequent tests the consumption sometimes equalled 1,000lb. per hour. It must also be remembered that, when forced, hand-firing would also show a greater consumption per hour. Tests made with other stokers show the results recorded in Table III. These figures have been supplied by the makers.

Table III.

—	*a.*	*b.*	*c.*	*d.*
Duration of tests in hours	5½	8	..	6
Coal consumed (in lb.)	9,243	10,656	..	14,784
Average per hour (in lb.)	1,760	1,332	No information.	2,464
Total water evaporated (in lb)	92,000	108,760	No information.	116,850
Total ash (in lb.)	..	538	..	3,030
Actual evaporation of water (in lb.) per pound of coal	9·95	10·20	..	7·9
Equivalent evaporation at and from 212°F.	11·96	12·39	11·3	8·8
Cost of coal per ton	..	..	..	..
Average percentage of CO_2	14·5	No information.	..	..
Calorific value of coal used in B.Th.U.	14,049	14,275	14,509	Smudge, say 12,000

In the foregoing, *a* and *b* were sprinkling stokers, and *c* and *d* were coking stokers. The average actual evaporation shown is for the three (*a*, *b* and *d*) 9·35, but the calorific value of the coal used in *a* and *b* is higher than in the tests in Table II. for the stokers. It would, therefore, appear that with coal having a calorific value of from 12,000 to 12,500 B.Th.U. per pound, the average evaporation with mechanical stokers is somewhere between 8lb. and 9lb. as shown in the test in Table II.

As regards the questions of reliability and cost of upkeep, the results are not always so satisfactory. The stokers under trial have been out of commisssion more often than is desirable, and the cost of maintenance is rather higher than the makers claim, amounting roughly to 10 per cent. per annum upon the capital cost.

Other devices not usually classed as stokers, but worthy of mention in this connection are :—Pulverised fuel furnaces; liquid fuel furnaces; and double grate furnaces. In the first case the coal is ground up to an impalpable powder and is driven by means of compressed air through nozzles and is then set alight. By a proper regulation of the quantity of air admitted in proportion to the coal dust, it is claimed that very perfect combustion and consequently a high efficiency results. It must be remembered, however, that the coal has first to be reduced to dust by mechanical means; and as far as the author knows, there does not appear to be conclusive evidence that the cost of pulverising the coal and the risk attendant upon doing so, is not prohibitive. It is, however, too early to express an opinion, and theoretically at least the idea is a promising one. The liquid fuel furnace is really a variety of that first named, and does not call for special comment. Instead of coal, crude hydrocarbon oil is forced into the furnace by means of compressed air, in the form of a fine spray, and then ignited. Economy and convenience are claimed for this apparatus. It has been suggested, however, that if largely adopted, the price of crude petroleum would probably rise rapidly and so destroy the main advantage claimed.

The double grate furnace, as its name implies, consists essentially of two grates, one above the other. The upper one is formed of tubes expanded into headers at either end, the latter being connected to and forming part of the circulating system of the boiler. Upon this grate the fire is placed, the fuel being fed by hand through the fire-doors in the usual manner. The only direction that the draught can take is downwards, that being the only path to the flue. When the fire has fairly started, the small particles of incandescent fuel fall between the bars, or rather tubes, of the upper grate, into another grate below, and there accumulating form an incandescent bed which immediately consumes any gases which may come through from above unconsumed. It is claimed that the admission of cold air into the furnace after the fire has properly started is impossible except when the fires are cleaned, as all the air admitted when firing the top grate has to pass down through the fire, and the middle door is only opened very occasionally for cleaning purposes. There should apparently be very complete combustion, but it would appear that the circulation in the tubes of the top grate would have to be exceptionally good to prevent overheating, and it would be interesting to know what happens in practice when hard water is used.

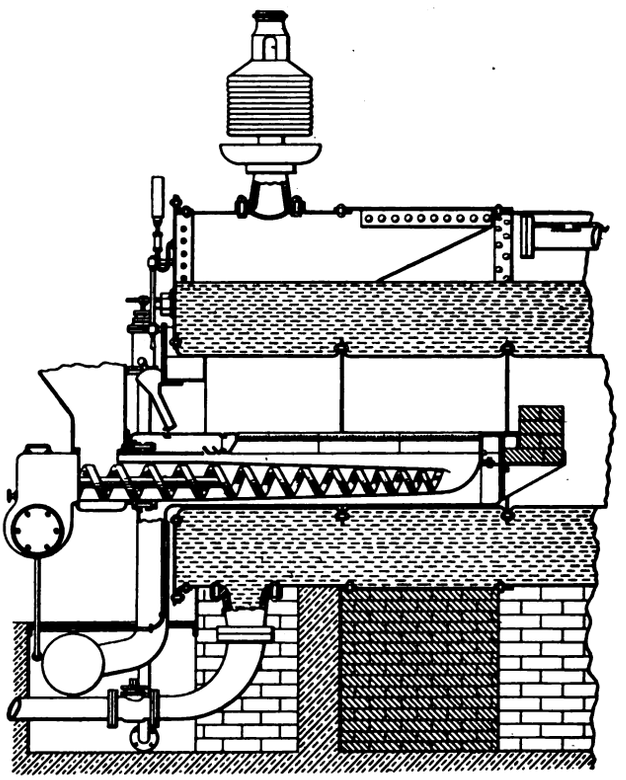

Fig. 6.

The chief advantages claimed by the makers of all these appliances are practically the same, viz.:—

1. That there is more perfect combustion than is possible in any other way, and consequent economy.
2. That a lower grade coal can be consumed.
3. That a smokeless furnace and a clear fire is always possible even with bituminous fuel.
4. That the necessity of frequently opening the doors and admitting cold air with all its attendant risks and disadvantages is removed.
5. That there is a saving in labour.

It is interesting to note that one maker puts in as a special claim—"The fewness of the working parts and their extreme simplicity," while at the same time he issues a detailed list of "spare parts," each illustrated and numbered from 1 to considerably over 100, all or any of which it is assumed may be required to be replaced periodically.

As a set-off against the advantages claimed by all makers (they are, of course, unanimous) it is only fair to give some of the disadvantages claimed by some users, who are not unanimous in this respect. In this, as in every question connected with engineering matters, there is a divergence of opinion, and necessarily so, for no piece of machinery can possibly give identically the same results when run in a different place and under different conditions. All appliances must be selected to suit the conditions existing, unless it is possible or rather practicable to alter the conditions to suit the

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appliances. The disadvantages claimed by some users will, therefore, be no surprise to anyone, and are as follows:—

1. There is no economy.
2. Lower grade coal is not worth burning, and it smokes anyway.
3. Cost of upkeep is excessive.
4. In an electric power station the mechanical stoker has to be supplemented by hand firing on account of varying load.
5. It is frequently out of order.
6. It reduces the capacity of the boiler.

The above represent the extremes of opinion for and against. It will be fairer, perhaps, to now give the opinions for and against of the chief engineers in some of the largest electric power stations in London and the provinces. Expressions of opinion were invited by the author in a series of questions, and they and the abbreviated replies are as follows, both being numbered consecutively.

QUESTIONS.

I. Have you had any experience with mechanical stokers in your work?
II. What type?
III. Are they satisfactory or otherwise?
IV. Principal defects, if any?
V. Are they still in use?
VI. If abandoned, for what reason?
VII. Additional information or expression of opinion.

REPLIES.—*London Stations.*

No. 1.—Question I. Yes, 4½ years. II. Top feed. III. Otherwise. IV. Less economical than hand-firing. Maintenance costs heavy. Boilers could not be forced to same extent as with hand-firing. Not smokeless. V. No. VI. Reasons given above. VII. Mechanical stoking does not pay in London, as a large proportion of the cost is swallowed up in carriage. Probably a saving may be effected if coal can be obtained at not more than 7s. 6d. per ton delivered.

No. 2.—Question I. Yes, over two years. II. Top-feed. III. Otherwise. IV. Not as economical as hand-firing. Did not prevent smoke. Unreliable. Upkeep expensive. V. No. VI. Reasons given above. VII. In London it pays to use the best coal you can get on account of high charge for carriage, and this does not do for mechanical stokers.

No. 3.—Question I. No, cannot recommend them.

No. 4.—Question I. No.

No. 5.—Question I. Yes, but only recently. Have given satisfaction up to now.

Nos. 6, 7 and 8.—Question I. No.

No. 9.—Question I. No, as from previous experience and that of others, I find they are usually abandoned after two or three years, or some shorter period.

No. 10.—Question I. Yes, several years. II. All types. III. All have given trouble, none are perfect. IV. Not specified. V. Most of them. VII. When working at full capacity, satisfactory, but with fluctuating loads prefer hand-firing. More efficient than hand labour, as it requires less wages and does not strike.

No. 11.—Question I. Yes. II. Both top and underfeed. III. Otherwise.

No. 12.—Question I. Just experimenting.

No. 13.—Question I. Yes, two years. II. Top feed. III. Yes. V. Yes.

No. 14.—Question I. Yes, but not long. (No information.)

No. 15.—Question I. Have tried several, but have none in use now.

No. 16.—Question I. Yes. (No information.)

No. 17.—Question I. Yes. II. Top feed. III. Fairly satisfactory. IV. Cannot force on load. V. Yes. VII. Type of stoker should suit class of coal.

No. 18.—Question I. Yes, 1½ years. II. Top feed. III. Entirely satisfactory. IV. No defects whatever.

No. 19.—Question I. Yes. II. Top feed. III. Yes. IV. (1) Liable to smoke; (2) heavy repairs.

No. 20.—Question I. No.

No. 21.—Question I. Yes. II. Under-feed. III. Otherwise. IV. Uneconomical, smoky, unreliable. V. No. VI. Reasons given. VII. Mechanical stokers not necessary in London, and do not pay for the capital invested in them.

Provincial Stations.

No. 1 (on the coalfields).—Question I. Yes. II. Top feed. III. Satisfactory. V. Yes. VII. Average price of coal, 7s. 3d. per ton.

No. 2 (on the coalfields.—Question I. Yes. II. Top feed. III. Quite satisfactory. IV. No material defects. V. Yes. VII. 9s. to 10s. per ton; coal used, washed slack and washed peas.

No. 3 (not on coalfields)—Question I. Yes, three years. II. Top feed. III. Otherwise. IV. (1) Limited the output of the boilers; (2) evaporation duty low; (3) high cost for maintenance (frequent renewal of parts). V. No. VI. For reasons given.

As already stated, the opinions differ, and while it would apparently be obvious that on or near the coalfields mechanical stoking would be almost essential, there appears to be a doubt as regards London.

It must be remembered that a fair grade of coal, say of 13,000 to 14,000 B.Th.U. per pound, would cost in Wales or in the North of England at the pit's mouth say 8s. or 9s. per ton; by the time it arrived in London its cost will have doubled, while its calorific value remains the same, or perhaps a trifle less. The cost per ton must now be taken as from 16s. to 18s., made up equally of intrinsic value and rail carriage. Now suppose we take a low grade of coal, having, say, a calorific value of 11,000 or 11,500 B.Th.U. per pound, which may cost, say, 5s. or even 4s. at the pit's mouth. By the time it reaches London the cost has gone up to 12s. or 14s. per ton, made up of 4s. or 5s. intrinsic value and 8s. or 9s. rail carriage. It would appear that it is the wisest course to pay for heat units rather than for rail carriage, and that, therefore, the higher the grade of coal burnt in London, the greater would be the resultant economy. The question is a debatable one and is worth ventilating, and it is hoped that expressions of opinion upon this point may be freely given by those present. It will be seen that two engineers in their replies give diametrically opposite opinions upon this question.

The author desires to thank those gentlemen who have so kindly assisted him by lending him lantern slides, diagrams and models. He also desires to express his deep appreciation of the honour conferred on him in being permitted, as a non-member of the Society, to contribute to its *Transactions* the present Paper. He further begs to tender his sincere thanks to his old friend and colleague, Mr. J. Patten Barber, the esteemed and able president of the Society, for his kindness in inviting him to prepare and read a Paper upon a subject of such importance to all electrical engineers.

The following is an abstract of the discussion:—

Mr. J. H. ROSENTHAL was of opinion that, with the present large-sized boilers employed, mechanical stokers were a necessity, because the work of coaling could no longer be done efficiently by hand. Troubles with these devices arose mostly through neglect, too little attention being paid to the mechanism. To illustrate the labour-saving qualities of such stokers, the speaker mentioned that the new power house of the District Railway was to be equipped with 64 boilers of an evaporative capacity of 20,000lb. of steam per hour each. While only 64 men were required in this case to attend to the stoking arrangement, eight times this number would have been required if hand-stoking with smaller units had been adopted. Hand in hand with the adoption of large units went the saving in space. As a sign of the favourable opinion prevailing with regard to mechanical stokers, Mr. Rosenthal recited the case of the Corporation of Exeter, which asked the opinion of the engineers of 30 stations thus equipped before deciding upon the adoption of mechanical devices for its own use.

Mr. W. H. BOOTH drew attention to the thinning of the fire—in certain mechanical stokers—towards the end of the grate, thereby offering to the air at this point a different resistance to that prevailing elsewhere. Unequal combustion and excess of air at certain points must ensue.

Mr. W. E. GOWER corroborated Mr. Rosenthal's remarks on the lack of intellectual attention given to the mechanism of the device. Touching upon the remark made by a previous speaker to the effect that gas would in time supplant steam, the speaker doubted very much that this would be the case, with the possible exception of chemical works, which could use residues for producing gas.

Mr. F. G. WATKINSON believed chain stokers to be most unsatisfactory, but stated that he had obtained good results from an underfeed stoker. He arrived at the best results when burning the cheapest coal.

Mr. E. BENNIS pointed out the advantages with regard to the length of boiler life which ensue from a temperature as uniform as possible at all its points. This could best be obtained by sprinkling the coal over the grate by means of an automatic shovel arrangement which distributed the coal in an appropriate manner, leaving air spaces between the small charges of coal thrown on the grate.

Mr. C. ERITH was of opinion that to get best results from boilers fitted with mechanical stokers, mechanical draught ought to be adopted at the same time.

Mr. ALBERT GAY replied briefly to the discussion, but touched upon no new points.

A hearty vote of thanks to the author concluded the meeting.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Ornamental Turning." Vol. I. By J. H. Evans. (London: Guilbert Pitman.) 3s. 6d. net.

"The Story of the Atlantic Cable." By C. Bright. (London: George Newnes.) 1s.

"The Reform in Mathematical Education." By H. E. Wimperis. Reprinted from *Engineering*. (London: Waterlow & Sons.) 1s.

"Science Abstracts," November. Section A, Physics; Section B, Engineering. (London: E. and F. N. Spon.) 1s. 6d.

"On the Resolution of Elementary Substances into their Ultimates and on the Spontaneous Molecular Activity of Radium." By Dr. Henry Wilde, F.R.S. Reprinted from the "Memoirs and Proceedings of the Manchester Literary and Philosophical Society." (Manchester: The Society.)

"Indirect Advantages of the Motor Car to Horses generally." By Hon. C. S. Rolls. Paper read before the Church Society for the Promotion of Kindness to Animals. (London: The Society.)

"Contrôle des Installations Electriques." By A. Monmerqué. 2nd edition. (Paris: Ch. Béranger.)

"Guide Pratique de Mesures et Essais Industriels." By J. A. Montpellier and M. Aliamet. Vol. II. (Paris: Vve. Ch. Dunod.) fr. 6.

"Traité Pratique de Télécommunication Électrique Télégraphie-Téléphonie." By E. Estaunié. (Paris: Vve. Ch. Dunod.) fr. 21.50.

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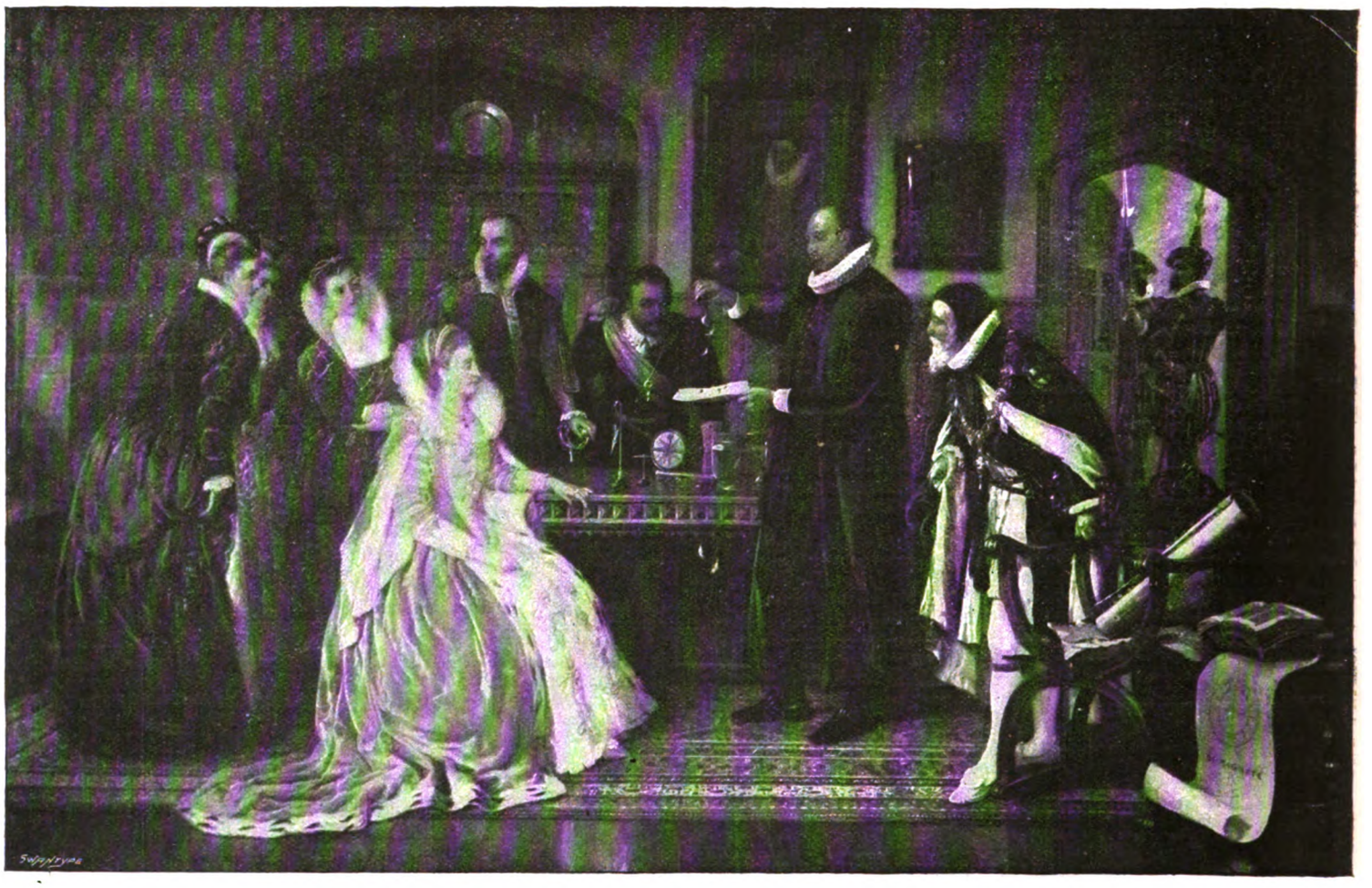
GILBERT OF COLCHESTER, FATHER OF ELECTRICAL SCIENCE.*

By the publication in 1600 of the *De Magnete* of Dr. William Gilbert the science of electricity was founded. To-day, December 10, 1903, is the three-hundredth anniversary of his death.

Born in Colchester, on May 24, 1544, William Gilbert was educated at Colchester School, and at St. John's College, Cambridge, where he became mathematical examiner and senior bursar. He graduated M.D. in 1569, and after three years of travel and study in Italy and elsewhere, settled down in London as a physician in 1573. He rose rapidly to eminence in his profession, and for 20 years took an active part in the administration of the Royal College of Physicians, of which in 1599 he became President. He was also in favour at Court, and was appointed in February, 1600-1, Physician to Queen Elizabeth, who conferred upon him various marks of distinction; and after her death he was continued as Chief Physician by James I. He died during a visitation of the plague December 10, 1603, and was buried in the Church of Holy Trinity, Colchester, where there is a monumental tablet to his memory.



Reproduction of a Painting by Mr. A. Ackland Hunt, presented to the Corporation of Colchester last night by the Institution of Electrical Engineers. The original picture measures about 6ft. × 4ft. A report of the speeches in connection with the presentation will be found on a later page.

Gilbert's renown rests not on his eminence as a physician, but on his achievements in the foundation of the twin sciences of electricity and magnetism He is beyond question rightfully regarded as the Father of Electric Science. He founded the entire subject of Terrestrial Magnetism. He also made notable contributions to Astronomy, being the earliest English expounder of Copernicus. In an age given over to metaphysical obscurities and dogmatic sophistry he cultivated the method of experiment and of reasoning from observation with an insight and success which entitles him to be regarded as the father of the inductive method. That method, so often accredited to Bacon, Gilbert was practising years before him.

It seems, therefore, fitting upon the occurrence of the Tercentenary of his death to recall Gilbert's achievements as the Father of Electric Science.

Gilbert's Magnetic Discoveries.

Gilbert's magnetic work has been so often described that a brief summary will here suffice. Trying the properties of loadstones in innumerable experiments lasting over many years, he was led to several notable discoveries, and to one generalisation of immense importance. He discovered the augmentation of the power of a loadstone by arming or capping it with soft iron cheeks. Gilbert called such a cap an *armatura*, the first occurrence of the term. This invention brought him much fame. In the "Dialogues of Galileo" (p. 369 of Salusbury's "Mathematical Collections," Dialogue iii.), Sagredus and Salviatus discuss the arming of the loadstone, and the increased lifting power conferred by adding an iron cap. Salviatus mentions a loadstone in the Florentine Academy which, unarmed, weighed six ounces, lifting only two ounces, but which when armed took up 160 ounces. Whereupon Galileo makes Salviatus say: "I extreamly praise, admire, and envy this Authour, for that a conceit so stupendious should come into his minde. . . I think him [*i.e.*, Gilbert] moreover worthy of extraordinary applause for the many new and true Observations that he made, to the disgrace of so many fabulous Authours, that write not only what they do not know, but whatever they hear spoken by the foolish vulgar, never seeking to assure themselves of the same by experience, perhaps, because they are unwilling to diminish the bulk of their Books."

Gilbert also discovered the screening effect of a sheet of iron; the method of magnetising iron by hammering it while it lies north and south; the destruction of magnetism by heat; and the existence around the magnet of an "orbe of virtue," that is to say, a magnetic field. He perfected the dipping needle of Norman, and other instruments of observation. He collected data as to the declination

* A reprint of part of the Chapter on Electrics from *De Magnete*, Lib. II., with notes by Silvanus P. Thompson, F.R.S. Distributed at the Institution of Electrical Engineers last night in commemoration of the Gilbert Tercentenary.

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and inclination of the compass in different regions. Using loadstones of many different shapes he observed their actions on one another and on compass needles. In particular he studied the magnetic properties of a globular loadstone or *terrella*, and found that compass needles were directed towards its poles, and dipped at various angles over its surface, just as compass needles do at various regions of the earth's surface. Generalising from small to large he advanced the entirely novel idea that the globe of the earth is itself a great magnet; thus laying the foundations of the science of terrestrial magnetism. He was particularly keen in disproving the many absurd fables that had grown up about the magnet, such as that the magnet refuses to act in the presence of a diamond, or if touched with garlic. The former he tested by surrounding a loadstone with 70 diamonds. Gilbert denounced the quackery of using loadstone medicinally or in plasters for the cure of wounds. He ridiculed the idea that the variation of the compass was due to imaginary loadstone mountains, like those described in the "Arabian Nights." He sought to explain it by the local irregularities of the earth's crust, and exemplified his theory by experiments on round loadstones of irregular outline as models. His book, over which he spent 18 years, was published in 1600, and for the next hundred years became the standard work on magnetism. Though denounced by the Church, the theory of terrestrial magnetism was by Gilbert thus firmly established on an enduring basis of fact, and remained a permanent acquisition in science. The publication of the book marked an epoch in scientific development. It was praised by Sarpi, by Galileo, by Kepler. Sir Christopher Wren proposed to erect a statue to its author, while Dryden sang of his enduring fame.

The Electrical Knowledge of the Ancients.

Prior to Gilbert's time the only electrical phenomenon known generally was the simple fact that the minerals amber and jet when rubbed will attract light bodies. This property of amber was, indeed, known to the ancients, and is mentioned by Theophrastus. The following quotations from early writers include practically all that was known:—

"Hee [*Niceas*] writeth also, that in Aegypt it [amber] is engendered. . . . Semblably in Syria, the women (saith hee) make wherves of it for their spindles, where they use to call it Harpax, because it will catch up leaves, straws and fringes hanging to cloaths. . . . To come to the properties that Amber hath, If it bee well rubbed and chaufed betweene the fingers, the potentiall faculties that lieth within, is set on work, and brought into actual operation, whereby you shall see it to drawe chaffe strawes, drie leaves, yea, and thin rinds of the Linden or Tillet tree, after the same sort as loadstone draweth yron."—(*Pliny, Natural History*, Book xxxvii., Chap. ii., p. 606, of the English version of 1601).

"Moreover to the intent to passe the large aboundance of sundry mettals (whereof Britaine hath many rich mynes on all sides), Here is store of the stone called Geate, and ye best kind of it. If ye demaund ye beautie of it, it is a black Jewell: if the qualitie, it is of no weight: if the nature, it burneth in water, and goeth out in Oyle; if the power, rubbe it till it be warme, and it holdeth such things as are laide to it; as Amber doth. The Realme is partlie inhabited of barbarous people, who even frō theyr childhoode haue shapes of divers beastes cunninglye impressed and incorporate in theyr bodyes, so that beeing engraued as it were in theyr bowels, as the man groweth, so growe the marks painted vpon him."—(*Julius Solinus, The Secretes and Providence of Nature.* Chapter xxiv. of *Britaine*; English version by A. Golding, 1587.)

Gilbert's Chapter on Electrics.

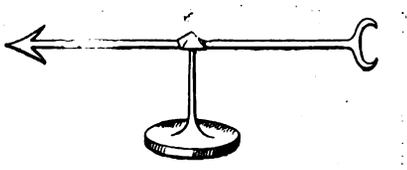
The contribution made by Gilbert to electrical knowledge is contained in the second chapter of the second book of his *De Magnete*, and constitutes a digression interpolated into the discussion of magnetic motions. Later portions of the same book make slight references also to the subject; but all that is essential in Gilbert's work is in this single chapter, here reprinted from the English edition of 1900, the version prepared by the Gilbert Club.

Book II., Chapter II.

On the Attraction of Amber, or more truly, on the *Attaching of Bodies to Amber.*

Celebrated has the fame of the loadstone and of amber ever been in the memoirs of the learned. Loadstone and also amber do some philosophers invoke when in explaining many secrets their senses become dim and reasoning cannot go further. Inquisitive theologians also would throw light on the divine mysteries set beyond the range of human sense, by means of loadstone and amber; just as idle Metaphysicians, when they are setting up and teaching useless phantasms, have recourse to the loadstone as if it were a Delphick sword, an illustration always applicable to everything. But physicians even (with the authority of Galen), desiring to confirm the belief in the attraction of purgative medicines by means of the likeness of substance and the familarities of the juices—truly a vain and useless error—bring in the loadstone as witness as being a nature of great authority and of conspicuous efficacy and a remarkable body. So in very many cases there are some who, when they are pleading a cause and cannot give a reason for it, bring in loadstone and amber as though they were personified witnesses. But these men (apart from that common error) being ignorant that the causes of magnetical motions are widely different from the forces of amber, easily fall into error, and are themselves the more deceived by their own cogitations. . . . The Greeks call it ἤλεκτρον, because it attracts straws to itself, when it is warmed by rubbing; then it is called ἄρπαξ; and χρυσοφόρον, from its golden colour. But the Moors call it Carabe, because they are accustomed to offer the same in sacrifices and in the worship of the Gods. For Carab signifies to offer in Arabic; so Carabe, an offering: or seizing chaff, as Scaliger quotes from Abohalis, out of the Arabic or Persian language. Some also call it Amber, especially the Indian and Ethiopian amber, called in Latin *Succinum*, as if it were a juice. The Sudavienses or Sudini call it *geniter*, as though it were generated terrestrially. The errors of the ancients concerning its nature and origin having been exploded, it is certain that amber comes for the most part from the sea, and the rustics collect it on the coast after the more violent storms, with nets and other tackle; as among the Sudini of Prussia; and it is also found sometimes on the coast of our own Britain. It seems, however, to be produced also in the soil and at spots of some depth, like other bitumens; to be washed out by the waves of the sea; and to become concreted more firmly from the nature and saltness of the sea-water. For it was at first a soft and viscous material; wherefore also it contains enclosed and entombed in pieces of it, shining in eternal sepulchres, flies, grubs, gnats, ants; which have all flown or crept or fallen into it when it first flowed forth in a liquid state. The ancients and also more recent writers recall (experience proving the same thing), that amber attracts straws and chaff. The same is also done by jet, which is dug out of the earth in Britain, in Germany, and in very many lands, and is a rather hard concretion from black bitumen, and as it were a transformation into stone.

. . . For it is not only amber and jet (as they suppose) which entice small bodies; but Diamond, Sapphire, Carbuncle, Iris gem, Opal, Amethyst, Vincentina, and Bristolla (an English gem or spar), Beryl and Crystal do the same. Similar powers of attraction are seen also to be possessed by glass (especially when clear and lucid), as also by false gems made of glass or Crystal, by glass of antimony, and by many kinds of spars from the mines, and by Belemnites. Sulphur also attracts, and mastick and hard sealing-wax compounded of lac tinctured of various colours. Rather hard resin entices, as does orpiment, but less strongly; with difficulty also and indistinctly under a suitable dry sky, Rock salt, muscovy stone, and rock alum. This one may see when the air is sharp and clear and rare in mid-winter, when the emanations from the earth hinder electricks less, and the electrick bodies become more firmly indurated; about which hereafter. These substances draw everything, not straws and chaff only, but all metals, woods, leaves, stones, earths, even water and oil, and everything which is subject to our senses, or is solid; although there are who write that amber does not attract anything but chaff and certain twigs; (wherefore Alexander Aphrodiseus falsely declares the question of amber to be inexplicable, because it attracts dry chaff only, and not basil leaves. But these are the utterly false and disgraceful tales of the writers. But in order that you may be able clearly to test how such attraction occurs, and what those materials are which thus entice other bodies (for even if bodies incline towards some of these, yet on account of weakness they seem not to be raised by them, but are more easily turned), make yourself a versorium of any metal you like, three or four digits in length, resting rather lightly on its point of support after the manner of a magnetick needle, to one end of which bring up a piece of amber or a smooth and polished gem which has been gently rubbed; for the versorium turns forthwith. Many things are thereby seen to attract, both those which are formed by nature alone, and those which are by art prepared, fused, and mixed; nor is this so much a singular property of one or two things (as is commonly supposed), but the manifest nature of very many, both of simple substances, remaining merely in their own form, and of compositions, as of hard sealing-wax, and of certain other mixtures besides, made of unctuous stuffs. We must, however, investigate more fully whence that tendency, and what those forces, concerning which a few men have brought forward very little, the crowd of philosophizers nothing at all. By Galen three kinds of attractives in general were recognised in nature: a First class of those substances which attract by their elemental quality—namely, heat; the Second is the class of those which attract by the succession of a vacuum; the Third is the class of those which attract by a property of their whole substance, which are also quoted by Avicenna and others. These classes, however, cannot in any way satisfy us; they neither embrace the causes of amber, jet, and diamond, and of other similar substances (which derive their forces on account of the same virtue); nor of the loadstone, and of all magnetick substances, which obtain their virtue by a very dissimilar and alien influence derived from other sources. Wherefore also it is fitting that we find other causes of the motions, or else we must wander (as in the shades), with these men, and in no way reach the goal. Amber truly does not allure by heat, since if warmed by fire and brought near straws, it does not attract them, whether it be tepid, or hot, or glowing, or even when forced into the flame.



. . . In the open air warm things cannot attract, not metals even or stones, if they should be strongly incandescent by fire. For a rod of glowing iron, or a flame, or a candle, or a blazing torch, or a live coal, when they are brought near to straws, or to a versorium, do not attract; yet at the same time they manifestly call in the air in succession; because they consume it, as lamps do oil. But concerning heat, how it is reckoned by the crowd of philosophizers, in natural philosophy and in *materia medica* to exert an attraction otherwise than nature allows, to which true attractions are falsely imputed, we will discuss more at length elsewhere, when we shall determine what are the properties of heat and cold. They are very general qualities or kinships of a substance, and yet are not to

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be assigned as true causes, and, if I may say so, those philosophizers utter some resounding words; but about the thing itself prove nothing in particular. Nor does this attraction accredited to amber arise from any singular quality of the substance or kinship, since by more thorough research we find the same effect in very many other bodies; and all bodies, moreover, of whatever quality, are allured by all those bodies. Similarity also is not the cause, because all things around us placed on this globe of the earth, similar and dissimilar, are allured by amber and bodies of this kind; and on that account no cogent analogy is to be drawn either from similarity or identity of substance. But neither do similars mutually attract one another, as stone stone, flesh flesh, nor aught else outside the class of magneticks and electricks. Fracastorio would have it that "things which mutually attract one another are similars, as being of the same species, either in action or in right subjection. Right subjection is that from which is emitted the emanation which attracts and which in mixtures often lies hidden on account of their lack of form, by reason of which they are often different in act from what they are in potency. Hence it may be that hairs and twigs move towards amber and towards diamonds, not because they are hairs, but because either there is shut up in them air or some other principle, which is attracted in the first place, and which bears some relation and analogy to that which attracts of itself; in which diamond and amber agree through a principle common to each." Thus far Fracastorio. Who if he had observed by a large number of experiments that all bodies are drawn to electricks except those which are aglow and aflame, and highly rarefied, would never have given a thought to such things. It is easy for men of acute intellect, apart from experiments and practice, to slip and err. In greater error do they remain sunk who maintain these same substances to be not similar, but to be substances near akin; and hold that on that account a thing moves towards another, its like, by which it is brought to more perfection. But these are ill-considered views; for towards all electricks all things move except such as are aflame or are too highly rarefied, as air, which is the universal effluvium of this globe and of the world.

. . . Thus then very many things are said to attract, the reasons for whose energy must be sought from other causes. Amber in a fairly large mass allures, if it is polished; in a smaller mass or less pure it seems not to attract without friction. But very many electricks (as precious stones and some other substances) do not attract at all unless rubbed. On the other hand, many gems, as well as other bodies, are polished, yet do not allure, and by no amount of friction are they aroused; thus the emerald, agate, carnelian, pearls, jasper, chalcedony, alabaster, porphyry, coral, the marbles, touchstone, flint, bloodstone, emery, do not acquire any power; nor do bones, or ivory, or the hardest woods, as ebony, nor do cedar, juniper, or cypress; nor do metals, silver, gold, brass, iron, nor any loadstone, though many of them are finely polished and shine. But on the other hand, there are some other polished substances of which we have spoken before, toward which, when they have been rubbed, bodies incline. This we shall understand only when we have more closely looked into the prime origin of bodies.

. . . Those substances which have received their chief growth from moisture, whether aqueous or fatty, or have taken on their form by a simpler compacting from them, or have been compacted from these same materials in long ages, if they have a sufficiently firm hardness, if rubbed after they have been polished and when they remain bright with the friction—towards those substances everything, if presented to them in the air, turns, if its too heavy weight does not prevent it. For amber has been compacted of moisture, and jet also. Lucid gems are made of water; just as Crystal, which has been concreted from clear water, not always by a very great cold, as some used to judge, and by very hard frost, but sometimes by a less severe one, the nature of the soil fashioning it, the humours or juices being shut up in definite cavities, in the way in which spars are produced in mines. So clear glass is fused out of sand, and from other substances, which have their origin in humid juices. But the dross of metals, as also metals, stones, rocks, woods, contain earth rather, or are mixed with a good deal of earth; and therefore they do not attract. Crystal, mica, glass, and all electricks do not attract if they are burnt or roasted; for their primordial supplies of moisture perish by heat, and are changed and exhaled.

. . . Those, however, which partake of the true earth-substance or are very little different from it, are seen to attract also, but from a far different reason, and (so to say) magnetically; concerning these we intend to speak afterwards. But those substances which are more mixed of water and earth, and are produced by the equal degradation of each element (in which the magnetick force of the earth is deformed and remains buried; while the watery humour, being fouled by joining with a more plentiful supply of earth, has not concreted in itself but is mingled with earthy matter), can in no way of themselves attract or move from its place anything which they do not touch. On this account metals, marbles, flints, woods, herbs, flesh, and very many other things can neither allure nor solicit any body either magnetically or electrically. (For it pleases us to call that an electrick force, which hath its origin from the humour.) But substances consisting mostly of humour, and which are not very firmly compacted by nature (whereby also they do not bear rubbing, but either melt down and become soft, or are not levigable, such as pitch, the softer kinds of resin, camphor, galbanum, ammoniack, storax, asafœtida, benzoin, asphaltum, especially in rather warm weather) towards them small bodies are not borne; for without rubbing most electricks do not emit their peculiar and native exhalation and effluvium. The resin turpentine when liquid does not attract; for it cannot be rubbed: but if it has hardened into a mastick it does attract.

. . . Electrical motions become strong from matter, but magnetick from form chiefly; and they differ widely from one another and turn out unlike, since the one is ennobled by numerous virtues and is prepotent; the other is ignoble and of less potency, and mostly restrained, as it were, within certain barriers; and therefore that force must at times be aroused by attrition or friction, until it is at a dull heat and gives off an effluvium and a polish is induced on the body. For spent air, either blown out of the mouth or given off from moister air, chokes the virtue. If indeed either a sheet of paper or a piece of linen be interposed, there will be no movement. But a loadstone, on the other hand, without friction or heat, whether dry or suffused with moisture, as well in air as in water, invites magneticks, and attracts them even with the most solid bodies interposed, even planks of wood or pretty thick slabs of stone or sheets of metal. A loadstone appeals to magneticks only; towards electricks all things move. A loadstone raises great weights; so that if there is a loadstone weighing two ounces and strong, it attracts half an ounce or a whole ounce. An electrical substance only attracts very small weights; as, for instance, a piece of amber of three ounces weight, when rubbed, scarce raises a fourth part of a grain of barley. But this attraction of amber and of electrical substances must be further investigated; and since there is this particular affection of matter, it may be asked why is amber rubbed, and what affection is produced by the rubbing, and what causes arise which make it lay hold on everything? As a result of friction it grows slightly warm and becomes smooth; two results which must often occur together. A large polished fragment of amber or jet attracts indeed, even without friction, but less strongly; but if it be brought gently near a flame or a live coal, so that it equally becomes warm, it does not attract small bodies because it is enveloped in a cloud from the body of the flaming substance, which emits a hot breath, and then impinges upon it vapour from a foreign body which for the most part is at variance with the nature of amber. Moreover the spirit of the amber which is called forth is enfeebled by alien heat wherefore it ought not to have heat excepting that produced by motion only and friction, and, as it were, its own, not sent into it by other bodies. For as the igneous heat emitted from any burning substance cannot be so used that electricks may acquire their force from it; so also heat from the solar rays does not fit an electrick by the loosening of its right material, because it dissipates rather and consumes it (albeit a body which has been rubbed retains its virtue longer exposed to the rays of the sun than in the shade; because in the shade the effluvia are condensed to a greater degree and more quickly). Then again the fervour from the light of the sun aroused by means of a burning mirror confers no vigour on the heated amber; indeed it dissipates and corrupts all the electrick effluvia. Again, burning sulphur and hard wax made from shell-lac, when aflame do not allure; for heat from friction resolves bodies into effluvia, which flame consumes away. For it is impossible for solid electricks to be resolved into their own true effluvia otherwise than by attrition, save in the case of certain substances which by reason of innate vigour emit effluvia constantly. They are rubbed with bodies which do not befoul their surface, and which produce a polish, as pretty stiff silk or a rough wool rag which is as little soiled as possible, or the dry palm. Amber also is rubbed with amber, with diamond, and with glass, and numerous other substances. Thus are electricks manipulated. These things being so, what is it which moves? Is it the body itself, inclosed within its own circumference? Or is it something imperceptible to us, which flows out from the substance into the ambient air? Somewhat as Plutarch opines, saying in his *Questiones Platonicæ*: That there is in amber something flammable or something having the nature of breath, and this by the attrition of the surface being emitted from its relaxed pores attracts bodies. And if it be an effusion does it seize upon the air whose motion the bodies follow, or upon the bodies themselves? But if amber allured the body itself, then what need were there of friction, if it is bare and smooth?

. . . It is probable therefore that amber does exhale something peculiar to itself, which allures bodies themselves, not the intermediate air. Indeed it plainly does draw the body itself in the case of a spherical drop of water standing on a dry surface; for a piece of amber applied to it at a suitable distance pulls the nearest parts out of their position and draws it up into a cone; otherwise, if it were drawn by means of the air rushing along, the whole drop would be moved. That it does not attract the air is thus demonstrated: take a very thin wax candle, which makes a very small and clear flame; bring up to this, within two digits or any convenient distance, a piece of amber or jet, a broad flat piece, well prepared and skilfully rubbed, such a piece of amber as would attract bodies far and wide, yet it does not disturb the flame; which of necessity would have occurred, if the air was disturbed, for the flame would have followed the current of air. As far as the effluvia are sent out, so far it allures; but as a body approaches, its motion is accelerated, stronger forces drawing it; as also in the case of magneticks and in all natural motion; not by attenuating or by expelling the air, so that the body moves down into the place of the air which has gone out; for thus it would have allured only and would not have retained; since it would at first also have repelled approaching bodies just as it drives the air itself; but indeed a particle, be it ever so small, does not avoid the first application made very quickly after rubbing. An effluvium exhales from amber and is emitted by rubbing: pearls, carnelian, agate, jasper, chalcedony, coral, metals, and other substances of that kind, when they are rubbed, produce no effect. Is there not also something which is exhaled from them by heat and attrition? Most truly; but from grosser bodies more blended with the earthy nature, that which is exhaled is gross and spent; for even towards very many electricks, if they are rubbed too hard, there is produced but a weak attraction of bodies, or none at all; the attraction is best when the rubbing has been gentle and very quick; for so the finest effluvia are evoked. The effluvia arise from the subtile diffusion of humour, not from excessive and turbulent violence; especially in the case of those substances which have been compacted from unctuous matter, which when the atmosphere is very thin, when the North winds, and amongst us (English) the East winds, are blowing, have a surer and firmer effect, but during South winds and in damp weather, only a weak one; so that those substances which attract with difficulty in clear

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weather, in thick weather produce no motion at all; both because in grosser air lighter substances move with greater difficulty; and especially because the effluvia are stifled, and the surface of the body that has been rubbed is affected by the spent humour of the air, and the effluvia are stopped at their very starting. On that account in the case of amber, jet, and sulphur, because they do not so easily take up moist air on their surface and are much more plenteously set free, that force is not so quickly suppressed as in gems, crystal, glass, and substances of that kind which collect on their surface the moister breath which has grown heavy. But it may be asked why does amber allure water, when water placed on its surface removes its action? Evidently because it is one thing to suppress it at its very start, and quite another to extinguish it when it has been emitted. So also thin and very fine silk, in common language *Sarcenet*, placed quickly on the amber, after it has been rubbed, hinders the attraction of the body; but if it is interposed in the intervening space, it does not entirely obstruct it. Moisture also from spent air, and any breath blown from the mouth, as well as water put on the amber, immediately extinguishes its force. But oil, which is light and pure, does not hinder it; for although amber be rubbed with a warm finger dipped in oil, still it attracts. But if that amber, after the rubbing, is moistened with *aqua vitæ* or spirits of wine, it does not attract; for it is heavier than oil, denser, and when added to oil sinks beneath it. For oil is light and rare, and does not resist the most delicate effluvia. A breath therefore, proceeding from a body which had been compacted from humour or from a watery liquid, reaches the body to be attracted; the body that is reached is united with the attracting body and the one body lying near the other within the peculiar radius of its effluvia makes one out of two; united, they come together into the closest accord, and this is commonly called attraction. This unity, according to the opinion of Pythagoras, is the principle of all things, and through participation in it each several thing is said to be one. For since no action can take place by means of matter unless by contact, these electricks are not seen to touch, but, as was necessary, something is sent from the one to the other, something which may touch closely and be the beginning of that incitement. All bodies are united and, as it were, cemented together in some way by moisture; so that a wet body, when it touches another body, attracts it, if it is small. So wet bodies on the surface of water attracts wet bodies. But the peculiar electrical effluvia, which are the most subtile material of diffuse humour, entice corpuscles.

. . . All electrical attraction exists through an intervening humour; so it is by reason of humour that all things mutually come together; fluids indeed and aqueous bodies on the surface of water, but concreted things, if they have been resolved into vapour, in air;—in air indeed, the effluvium of electricks being very rare, that it may the better permeate the medium and not impel it by its motion; for if that effluvium had been thick, as that of air, or of the winds, or of saltpetre burnt by fire, as the thick & foul effluvia given out with very great force, from other bodies, or air set free from humour by heat rushing out through a pipe (in the instrument of Hero of Alexandria, described in his book *Spiritalia*) then the effluvium would drive everything away, not allure it. But those rarer effluvia take hold of bodies and embrace them as if with arms extended, with the electricks to which they are united; and they are drawn to the source, the effluvia increasing in strength with the proximity. But what is that effluvium from crystal, glass, and diamond, since these are bodies of considerable hardness and firmly concreted? In order that such an effluvium should be produced, there is no need of any marked or perceptible flux of the substance; nor is it necessary that the electrick should be abraded, or worn away, or deformed. Some odoriferous substances are fragrant for many years, exhaling continually, yet are not quickly consumed. Cypress wood as long as it is found, and it lasts also a very long time, is redolent; as many learned men attest from experience. Such an electrick only for a moment, when stimulated by friction, emits powers far more subtile and more fine beyond all odours; yet sometimes amber, jet, sulphur, when they are somewhat easily set free into vapour, also pour out at the same time an odour; and on this account they allure with the very gentlest rubbing, often even without rubbing; they also excite more strongly, and retain hold for a longer time, because they have stronger effluvia and last longer. But diamond, glass, rock-crystal and numerous others of the harder and firmly concreted gems first grow warm: therefore, at first they are rubbed longer, and then they also attract strongly; nor are they otherwise set free into vapour. Everything rushes towards electricks excepting flame, and flaming bodies, and the thinnest air. Just as they do not draw flame in like manner they do not affect a versorium, if on any side it is very near to a flame, either the flame of a lamp or of any burning matter. It is manifest, indeed, that the effluvia are destroyed by flame and igneous heat; and therefore they attract neither flame nor bodies very near a flame. For electrical effluvia have the virtue of, and are analogous with, extenuated humour; but they will produce their effect, union and continuity, not by the external impulse of vapours, not by heat and attenuation of heated bodies, but by their humidity itself attenuated into its own peculiar effluvia. Yet they entice smoke sent out by an extinguished light; and the more that smoke is attenuated in seeking the upper regions, the less strongly is it turned aside; for things that are too rarefied are not drawn to them; and at length, when it has now almost vanished, it does not incline towards them at all, which is easily seen against the light. When in fact the smoke has passed into air, it is not moved, as has been demonstrated before. For air itself, if somewhat thin, is not attracted in any way, unless on account of succeeding that which has vacated its place, as in furnaces and such like, where the air is fed in by mechanical devices for drawing it in. Therefore, an effluvium resulting from a non-fouling friction, and one which is not changed by heat, but which is its own, causes union and cohærency, a prehension and a congruence towards its source, if only the body to be attracted is not unfitted for motion, either by the surroundings of the bodies or by its own weight. To the bodies, therefore, of the electricks themselves small bodies are borne. The effluvia extend out their virtue—effluvia which are proper and peculiar to them, and *sui generis*, differing from common air, being produced from humour, excited by a calorifick motion from attrition and attenuation. And as if they were material rays, they hold and take up chaff, straws and twigs until they become extinct or vanish away: and then they (the corpuscles) being loosed again, attracted by the earth itself, fall down to the earth. The difference between Magneticks and Electricks is that all magneticks run together with mutual forces; electricks only allure; that which is allured is not changed by an implanted force, but that which has moved up to them voluntarily rests upon them by the law of matter. Bodies are borne towards electricks in a straight line towards the centre of the electrick; a loadstone draws a loadstone directly at the poles only, in other parts obliquely and transversely, and in this way also they adhere and hang to one another. Electrical motion is a motion of aggregation of matter; magnetical motion is one of disposition and conformation. The globe of the earth is aggregated, and cohæres by itself electrically. The globe of the earth is directed and turned magnetically; at the same time also it both cohæres, and, in order that it may be solid, is in its inmost parts cemented together.

A Summary of Gilbert's Electrical Work.

To distinguish his original discoveries from things already known, Gilbert set in the margin of his book asterisks, large or small, in proportion to the importance of the matter. These have been preserved in the foregoing reprint; and it will be seen that he marked with large asterisks the discovery of the generality of electrifiable bodies, for which he coined the name *electrics*, and the observation that electrified bodies attract, not straws and chaff only, but equally attract metals, woods, earths and even oil and water. The logical outcome of this discovery was the invention of the versorium, or *electroscope*. The method of trying everything, instead of accepting statements on authority, is characteristic of the man: he must bring all to the touchstone of experiment. The authors who raised Gilbert's wrath by ignorantly copying out all the old tales about amber, jet and loadstone, instead of investigating the facts, were, as he says at the beginning of the chapter, some theologians, and some physicians. He seems to have taken a special dislike to Albertus Magnus, to Puteanus, to Paracelsus, and to Levinus Lemnius.

Electrical attraction by natural products other than amber after they have been rubbed must have been observed by the primitive races of mankind. Indeed Humboldt, in his *Cosmos* (Lond., 1860, Vol. I., p. 182), records a striking instance:—

"I observed with astonishment, on the woody banks of the Orinoco, in the sports of the natives, that the excitement of electricity by friction was known to these savage races, who occupy the very lowest place in the scale of humanity. Children may be seen to rub the dry, flat and shining seeds or husks of a trailing plant (probably a *Negretia*) until they are able to attract threads of cotton and pieces of bamboo cane."

The passage opposite the second asterisk in the second column of p. 290 very clearly sets forth the differences to be observed between magnetic and electric effects. Though Gilbert was the first systematically to explore the differences that exist between the magnetic attraction of iron and the electric attraction of all light substances, the point had not passed unheeded, for we find St. Augustine, in the *De Civitate Dei*, liber xxi., cap. 6, raising the question why the loadstone, which attracts iron, should refuse to move straws. The many analogies between electric and magnetic phenomena had led many experimenters to speculate on the possibility of some connection between electricity and magnetism. See, for example, Tiberius Cavallo, *A Treatise on Magnetism*, London, 1787, p. 126. Aepinus wrote a treatise on the subject entitled *De Similitudine vis electricæ et magneticæ* (Petropolis, 1758). This was, of course, long prior to the discovery, by Oersted in 1820, of the real connection between magnetism and the electric current. It is interesting to note in the last paragraph a suggestion of material *rays*, as the operation of electric forces seems to foreshadow the notion of electric lines of force.

Gilbert had imbibed the schoolmen's ideas as to the relations of matter and form. He had discovered and noted that in the magnetic attractions there was always a verticity, and that in the electrical attractions the rubbed electrical body had no verticity. To account for these differences he drew the inference that, since (as he had satisfied himself) the magnetic actions were due to *form*, that is to say to something immaterial—to an "imponderable" as in the subsequent age it was called—the electrical actions must necessarily be due to *matter*. He therefore put forward his idea that a substance to be an electric must necessarily consist of a concreted humour which is partially resolved into an effluvium by attrition. His discoveries that electric actions would not pass through flame, whilst magnetic actions would, and that electric actions could be screened off by interposing the thinnest layer of fabric, such as sarcenet, whilst magnetic actions would penetrate thick slabs of every material except iron only, doubtless confirmed him in attributing the electric forces to the presence of these effluvia. There arose a fashion, which lasted for over a century, for ascribing to "humours," or "fluids," or "effluvia" physical effects which could not otherwise be accounted for.

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In spite of his care to test everything by experiment, Gilbert fell into several errors. He denied the existence of electric repulsion, and, while he strenuously affirmed that the magnetic forces were mutual between the magnet and the iron, each being urged toward the other, he also affirmed that, in the case of the action of the electric on the object which moved toward it, the action was not mutual, but was a one-sided force—an impossibility in physics.

Gilbert's experimental discoveries in electricity may be summed up as follows :—

1. The generalisation of the class of *Electrics*.
2. The observation that damp weather hinders electrification.
3. The generalisation that electrified bodies attract everything, including even metals, water, and oil.
4. The invention of the non-magnetic *versorium* or electroscope.
5. The observation that merely warming amber does not electrify it.
6. The recognition of a definite class of *non-electrics*.
7. The observation that certain electrics do not attract if roasted or burnt.
8. That certain electrics when softened by heat lose their power.
9. That the electric effluvia are stopped by the interposition of a sheet of paper or a piece of linen, or by moist air blown from the mouth.
10. That glowing bodies, such as a live coal, brought near excited amber discharge its power.
11. That the heat of the sun, even when concentrated by a burning mirror, confers no vigour on the amber, but dissipates the effluvia.
12. That sulphur and shell-lac when aflame are not electric.
13. That polish is not essential for an electric.
14. That the electric attracts bodies themselves, not the intervening air.
15. That flame is not attracted.
16. That flame destroys the electrical effluvia.
17. That during south winds and in damp weather, glass and crystal, which collect moisture on their surface, are electrically more interfered with than amber, jet and sulphur, which do not so easily take up moisture on their surfaces.
18. That pure oil does not hinder production of electrification or exercise of attraction,
19. That smoke is electrically attracted, unless too rare.
20. That the attraction by an electric is in a straight line toward it.

Gilbert's list of electrics should be compared with those given subsequently by Cabeus (1629), by Sir Thomas Browne (1646), and by Bacon. The last-named copied out of Gilbert's list almost without change. Sir Thomas Browne's list is given in the following passage, which is interesting as using for the first time in the English language the noun *Electricities* :—

" Many stones also both precious and vulgar, although terse and smooth, have not this power attractive ; as Emeralds, Pearle, Jaspis, Corneleans, Agathe, Heliotropes, Marble, Alablaster, Touchstone, Flint and Bezoar. Glasse attracts but weakely though cleere, some slick stones and thick glasses indifferently : Arsenic but weakely, so likewise glasse of Antimony, but Crocus Metallorum not at all. Saltes generally but weakely, as Sal Gemma, Alum, and also Talke, nor very discoverably by any frication : but if gently warmed at the fire, and wiped with a dry cloth, they will better discover their Electricities." (*Pseudodoxia Epidemica*, p. 79.)

Gilbert was the first beyond question to extend the list of *electrics* beyond the class of precious stones, and his discovery that *glass*, *sulphur* and *sealing-wax* acted, when rubbed, like amber, was of capital importance. So was also his observation that electrical experiments succeed better in dry or frosty weather. Though he did not pursue the discovery into mechanical contrivances, he left the means of that extension to his followers. To Otto von Guericke we owe the application of *sulphur* to make the first electrical machine out of a revolving globe; to Sir Isaac Newton and to Hanksbee the suggestion of *glass* as affording a more mechanical construction. And both materials were discovered by Gilbert to be Electrics.

" Such," said Priestley in 1767, " were the discoveries of our countryman Gilbert, who may justly be called the father of modern electricity, though it be true that he left his child in its very infancy." To Priestley's quaint remark we may add that as electricity is no longer in its infancy, we who claim Gilbert as our countryman are all the more proud to acknowledge his just claims to its paternity.

THE EDUCATION OF AN ELECTRICAL ENGINEER.*

BY PROF. F. G. BAILY, M.A.

General Lines of Education.

To what extent should the education be purely mechanical engineering, and how far is a mechanical workshop training adequate? To what extent should electrical science be studied? What further experience is required, what should be its precise nature, and whence should it be obtained? How much can desirably be taught in a college? To what extent is work in a manufactory devoted solely to dynamos and motors advantageous? Is a contractor's or a manufacturer's business the better training ground for the final stages? Is a short period spent in a power station desirable for the majority? How does an exhaustive training in one shop, covering only a part of the subject, compare with a wider but less thorough training in several establishments with different classes of work?

Apportionment of Time.

How much time should be devoted to a theoretical and technical course at a college, and how should it stand chronologically with the workshop or practical training? Is a half-time or a sandwich system the better, or is a complete separation preferable to either? How long an apprenticeship or pupilage should be required, and what equivalent value should be allowed to those taking a college course of approved character?

Specific Subjects.

College Course and General Education.—Should a college course be confined to a study of pure science and the general principles of its application to engineering, or should it be extended to technical details, practical empiric formulæ, and commercial aspects? Is a knowledge of other modern languages of great importance to the generality of engineers? Is the " modern side " school with workshops and science teaching preferable to the standard classics and mathematics?

Workshop Course.—To what extent is manual skill essential, and is too much time devoted to its acquirement in the ordinary apprenticeship? Is it necessary to have a working knowledge and skill in pattern making, moulding, casting, forging, use of machine tools with hand and automatic, fitting and erecting? After a certain moderate skill in draughtsmanship has been acquired, is any adequate benefit derived from prolonged drawing-office work that cannot be better obtained elsewhere?

Electrical Work.—To what extent is a thorough knowledge of the following subjects necessary, and in what way can it be best acquired :—Details of manufacture of dynamos and motors? Use and care of dynamos and motors? Manufacture of switchboards and gear; erecting of switchboards? Design, construction and working of power stations? Design, construction and working of systems of distributing cables in towns and buildings? Manufacture of cables? Systems of electric traction and special applications of electric power?

Teachers, Teaching and Examinations.

What type of teacher is best suited for technical instruction? Assuming that the ideal teacher is a man with wide experience in teaching and organisation, a brilliant lecturer, possessing a profound knowledge of physical and mechanical science and of the principles and practice of electrical and mechanical engineering, with skill and originality in experimental and research work, and one who is at the same time an active participator in engineering practice, which of these qualifications should be considered of foremost importance in the event of the ideal not being obtainable? Also, should outstanding ability in some one or two qualifications be considered more desirable than moderate attainments in all branches? Is it advisable and feasible to obtain assistance in parts of the teaching courses from engineers in active practice? What are the proper uses of evening classes? Is it practically possible for evening classes to replace satisfactorily a full-day course at a college? Does electrical engineering require more extensive and deeper scientific and theoretical knowledge than do other branches of engineering, and what bearing has this on the uses of evening classes (1) for artisans, (2) for those with higher aims? Are public examinations in engineering of practical value, and, if so, should the matter be under wider control than that of the City and Guilds of London Institute? Are engineering degrees, apart from the personal recommendation and influence of the professor, of practical value? To what extent are the general arrangements of the universities suitable for the complete teaching of technical subjects, and how do they compare in this respect with the technical colleges? When existing side by side, to which of them should be given the public support necessary for their adequate expansion?

Outline Scheme of Education of Full Length.
Age at Start, 16 to 17.

First Year.—Six months' session at college, with courses on mathematics, physics, chemistry, mechanics, mechanical and hand drawing, laboratory practice, elementary mechanical engineering. Four or five months' instruction in handicraft in wood and metal, carried out in college workshops sepcially arranged for instruction.

Second Year.—Six months' session at college, with courses on mathematics, physics, mechanics, general principles, and important types of machines and methods in electrical and mechanical engineering, with machine drawing and laboratory practice in the electrical and mechanical engineering laboratories. Five months' work in a factory with a complete mechanical engineering department, in the pattern shop and foundry, with liberty to inspect work in other departments at stated times.

Third Year.—Seven months' session at college, with courses in mathematics, advanced electricity, thermodynamics, &c., advanced electrical and mechanical engineering, machine drawing and design, laboratory work on electrical machines, prime movers,

* Abstract of Paper read before the Glasgow Local Section of the Institution of Electrical Engineers last Tuesday.

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and testing of materials. Five months' work in the factory in the machine shop.

Fourth Year.—Spent in the fitting shop.

Fifth Year.—Spent mainly on outside erecting work.

Sixth Year.—Spent in the drawing office.

AGE AT FINISH, 22 TO 23.

If the factory does not give good opportunity for outside work and drawing-office work in electrical engineering, it will be preferable to change to an electrical engineering factory, or to a contracting business, or to a consulting engineer's office, for the fifth and sixth years. The previous years will be as profitably spent in a mechanical engineer's shop as in that of an electrical engineering firm. At the end of this time a great benefit would be obtained by a prolonged tour of some three months or more to various engineering establishments, power stations, and examples of work in progress, in this and in other countries. During the fourth, fifth, and sixth years special branches of study may be taken up at evening classes, where circumstances permit; but a capable man should be competent to study by himself to a large extent.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

New Method of Preparing Argon.—H. Moissan and A. Rigaut prepare argon in the following manner:—100 litres of atmospheric nitrogen are prepared by eliminating the oxygen by means of heated copper turnings, and dried by means of sulphuric acid and potash. The gas is then passed through iron tubes containing a mixture of five parts of powdered quicklime and three parts of magnesium powder free from oil and aluminium. After being in contact with the heated mixture for two hours, the gas is found to have shrunk to one-tenth of its original volume, and it then contains 10 per cent of argon. The gas is collected in a rubber sack, and passed through a heated porcelain tube containing 70 grammes of the mixture of lime and magnesium, a heated glass tube containing 70 grammes of the same, a third tube containing oxide of copper and two drying tubes containing sulphuric acid and potash respectively. After this treatment the gas only contains 5 to 10 per cent. of nitrogen. Finally, the gas is circulated over metallic calcium, which absorbs the last traces of nitrogen and hydrogen. The apparatus requires two persons to work it and is capable of turning out 1 litre of argon in 12 hours. The argon obtained shows no traces of nitrogen bands in its spectrum. The new method marks a considerable advance upon its predecessors.

[MOISSAN and RIGAUT, *Comptes Rendus*, November 16, 1903.]

Effect of N-Rays upon the Eye.—R. Blondlot has made another remarkable discovery in connection with N-rays. He happened to have his eyes fixed on a small feebly-illuminated band of paper at a distance of about 1 metre. A brick, which had been exposed to sunlight, was brought near his face from one side, with the exposed surface towards him. He at once saw the band of paper brighten up. The effect disappeared on removing the brick, or on turning its unexposed side towards his face. But it was not affected by enclosing the brick in a box closed with black paper. A simple experiment is to darken the room until the face of a clock on the wall is only feebly visible. On bringing a solarised brick or pebble near the eye, the face of the clock becomes sharper in outline, and possibly the hands are seen. This was surprising considering that N-rays are known to be absorbed by moisture, and could, therefore, not affect the retina through the humours of the eye. But the author has found that saline solutions do not absorb the rays, and that a freshly-prepared ox's eye transmits them freely in all directions. Moreover, saline solutions, especially of hyposulphite of soda, store up the rays, and may be used as sources of N-rays in the place of a Nernst lamp. The author supposes that the rays play a hitherto unknown part in the economy of animal and vegetable life.

[R. BLONDLOT, *Comptes Rendus*, November 23, 1903.]

Magnetic Properties of Revolving Electrons.—J. J. Thomson discusses the magnetic field due to a number of negative electrons situated at equal intervals round the circumference of a circle, and rotating in one plane with uniform velocity round its centre; and the effect of an external magnetic field on the motion and periods of vibration of such a system. The discussion is intended to elucidate the theory that the atoms of the chemical elements are built up of large numbers of electrons revolving round the centre of a sphere filled with uniform positive electrification. The author confirms Voigt's conclusion that the magnetic properties of bodies cannot be explained if we suppose that the force is proportional to the distance from a fixed point. The same result applies as long as the force is central and there is no dissipation of energy. But if the motion of each particle is resisted by a force proportional to the velocity, a collection of such particles will be paramagnetic, the particles tending to fall to the centre of the orbit. Suppose the atoms of a substance, like the atoms of a radio-active substance, were continually emitting electrons, but with insufficient velocity to carry them clear of the atom. They would then fall back into the atom with but little energy, and a system consisting of such atoms would be paramagnetic. The temperature of the body would rise at the expense of the atomic energy, and the temperature in the centre of a mass of iron should be permanently higher than the temperature at the surface. The author hopes shortly to test this point.

[J. J. THOMSON, *Phil. Mag.*, December, 1903.]

Measurement of Electric Waves with the Bolometer.—C. Tissot measures the energy of electric waves by means of a bolometer and a galvanometer having a sensitiveness of 5,000 to 6,000 megohms. With such a galvanometer, he is able to discover waves over a distance of 40km. In his measurements, he operated, as a rule, over a distance of only 2km., and with a sensitiveness of 2,500 megohms. He then obtained deflections of as much as 250 scale divisions. He made a comparison between the transmission by the direct method—*i.e.*, with the antenna and earth directly connected with the balls of the exciter—and the indirect method—*i.e.*, with the Blondlot or Tesla device. The coherer and the bolometer show a very marked difference of behaviour with regard to the two systems. The coherer is more easily influenced by the direct system, whereas the bolometer receives more energy in the case of indirect emission. The phenomena of resonance are very clearly exhibited in the bolometer, especially when an indirect system is employed, which is only slightly damped. The most favourable wave length is nearly four times the length of the antenna. With multiple antennæ, the maximum is still more accentuated. The author gives the following observations with four antennæ:—

Capacity	1	2	3	4	5	6
Deflection.....	16	26	185	69	30	20

The author finally points out that the problem of syntony is chiefly a question of a suitable detector, and that the bolometer is greatly superior to the coherer in this respect.

[C. TISSOT, *Comptes Rendus*, November 23, 1903.]

Measurement of Small Inductances.—W. Stroud and J. H. Oates have devised an apparatus which, though not quite so sensitive for the measurement of small capacities as Prof. Fleming's, is better adapted to the measurement of small inductances. The essential feature of their method consists in the employment of what is substantially an electro-dynamometer with laminated iron cores, or it may be briefly described as a movable coil d'Arsonval galvanometer, in which the permanent magnet is replaced by an electromagnet, with a laminated iron core, actuated by a 100-volt alternating current. The solid iron core inside the moving coil of the ordinary d'Arsonval is in this instrument also replaced by a laminated one. The instrument is used just like an electro-dynamometer when it is arranged for measuring the conductivity of electrolytes. The field magnet is placed across the mains, and the highly-insulated movable coil is used to replace the galvanometer in the bridge. The key must be in the battery circuit, and under no circumstances must it be in the galvanometer circuit. The apparatus may be used for measuring an inductance with certainty to something well under one-tenth of a millihenry. By adopting a specially-sensitive arrangement the authors succeeded in reading down to 2 micro-henrys.

[STROUD and OATES, *Phil. Mag.*, December, 1903.]

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THE PARLIAMENTARY SESSION OF 1904.

In point of interest, as well as numbers, the Private Bills which will be introduced into Parliament next year promise to keep the session well up to the average in regard to electrical matters. Particulars of those Bills which are of interest to electrical engineers have been given in our last two issues, and it will have been seen that the main tendency this year is a desire to increase largely the powers at present held by municipalities in respect of electricity supply. The falling off in applications for electric lighting Provisional Orders, to which we directed attention last year, is again pronounced, without doubt for the same reason—viz., the inclusion of the smaller towns in the districts allocated to the "bulk" supply companies. In fact, applications for extensions of areas and routes form a considerable proportion of the applications for electric lighting and tramway Provisional Orders.

An important interest attaches to the municipal combined lighting, power and traction notices. From these it will be observed that a number of local authorities seek powers to supply electricity (either "in bulk" or in detail) outside their own areas. If the large municipalities are to make good their claim of being able to supply electrical energy as cheaply as the large power companies, it is evident that they must still further increase their output, and, what is even more important, obtain a more uniformly-distributed load throughout the 24 hours. In any cases in which these enlarged powers would come into conflict with those of the neighbouring power companies, the companies will, doubtless, take steps to protect their interests. Manchester, for instance, asks for new powers of an unusually wide and comprehensive nature.

In practically all the municipal "omnibus" Bills which contain clauses relating to electricity supply, provisions are inserted permitting the local authority to wire consumers' premises free, hire out motors, &c.; but in view of past experience with local contractors on these points, the intention is, we presume, not that the local authority should do the work itself, but that the contracts should be let out to wiring firms, as has already been done in many towns. This should be distinctly stated in the Act, however, otherwise these powers should not be granted; and the fate of the London County Council Bill last year will be a powerful precedent to bring forward in opposition. There are one or two other details in these notices worthy of attention. The Electric Lighting Acts prescribe that a supply can be demanded by any person, but quite a number of municipalities are asking for a suspension of the general law in their favour, so that they may refuse to supply in certain circumstances. In some instances the circumstances in which this provision would operate are

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specified as "to persons in debt to the corporation," and presumably also stand-by supply will come into consideration in this connection. We may warn those concerned, however, that, unless the clauses in question are drafted with unusual care, there is reason to doubt whether a special Act of this nature could over-ride the provisions of the general Electric Lighting Acts. Failing an alteration, too, in the law relating to the repayment of loans, Local Authorities are in some cases seeking the fixation of equated periods for the repayment of their loans both for lighting and traction, and others for a postponement of the first payment to the sinking fund until after the works are in operation. Another feature of the municipal Bills is the power to attach brackets to buildings for either lighting or tramways. This would appear to contemplate the use of overhead wires on a comparatively large scale, which, coming with the projected extension of supply areas, may not be without importance. The practice which began to get fashionable last year to legalise discounts is again to the fore; and the Rotherham Bill and some others endeavour to make the robbing of prepayment meter money boxes a criminal act. Some Bills seeking wide powers include the term "to construct" dynamos and other electrical apparatus; this word will doubtless be struck out. It is to be regretted that clauses of such widely varying nature can be inserted in an "omnibus" Bill, which, in the House of Commons committee stage, will only come under the consideration of the Police and Sanitary Committee and, therefore, possibly not receive the public attention they deserve.

The interest of gas companies in general electric supply will once more be prominent, for quite a number propose to obtain powers which will enable them to make applications for electric lighting Provisional Orders. So far, the Board of Trade has set its face against granting orders to gas companies. More than one company, also, will revive the contest as to the injury resulting to their mains from electrolytic action due to electric cables, and the imposition of the "Bermondsey" clause will, no doubt, be again attempted—unsuccessfully, we trust—judging by the experience of last session.

No tube railway bills could be deposited owing to the proceedings of the Royal Commission on London Traffic not having yet concluded. There is, however, one proposal to incorporate a company to construct an electric railway under the River Thames between north and south Woolwich. The District Railway Co. wishes to adopt a system of fares similar to that on the Central London Railway.

The London United Tramways failed last year to obtain permission to run a tramway line over Hammersmith Bridge, and now desires to cross beneath the river. The same company also proposes large extensions in the west and south, no less than three counties coming within the range of operation of the scheme. The London County Council, which was sorely offended last session when a Parliamentary Committee granted a piece of new tramway in London to a company (a portion of the Bexley undertaking which is to be leased to the British Electric Traction Co.), is now endeavouring to acquire that line compulsorily. The Dolter Electric Traction Co. also gives notice of a Bill for a tramway on the surface-contact system in Torquay; but as the negotiations between the company and the Corporation have been broken off, presumably the application will not be proceeded with.

The Power Bills are interesting, though, perhaps, not numerous. One proposes to supply electric power in the County Borough of West Ham and adjacent portions of the counties of London and Essex. The county of Chester, which last session was cut out of the area of the North-Western Electricity and Power Gas Co., is now threatened with a separate company having similar objects. Portions of the counties of Lincolnshire and Yorkshire are also scheduled in another Bill, and an electricity and power gas scheme is contemplated in the north of Ireland. Another company promotes a scheme which involves the supply of electricity for lighting and traction on a large scale in the north of Wales. Several existing companies seek permission to pay interest out of capital during construction.

There are also a few miscellaneous Bills which deserve passing notice. The Glasgow and South-Western Railway Co. seeks powers to use electric traction on its system; and, of course, all railways without special acts authorising electrical equipment have now powers to "electrify" under this year's Railways (Electrical Power) Act after obtaining approval of the Board of Trade. To terminate the lengthy sequel to the famous arbitration award, the St. Marylebone Borough Council has deposited a bill of a general character, including a provision for obtaining a loan to purchase the Metropolitan Electric Supply Co.'s undertaking in Marylebone. The North Staffordshire Railway Co. asks for powers to provide electric tugs on their canals and also to apply electricity to their railways.

Of Government measures, little can be said of a definite nature. We would, however, express the hope that the Light Railways Bill, which was introduced last session and dropped, will be re-introduced in a more comprehensive form, and also that the Electricity Supply Bill, which was similarly treated, will be introduced again; for the need of reform of the present law of electric lighting, traction and power distribution gets more urgent with the flight of time. The Board of Trade, for the third time, will bring in its Bill to readjust the area of the London electric lighting undertakings in conformity with the London Government Act of 1899, and it is stated that a Bill to legalise the adoption of the metric system will be introduced in the House of Lords.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Handbook for the Electrical Laboratory and Testing Room. Vol. II. By J. A. Fleming, F.R.S. (London: "The Electrician" Printing and Publishing Co., Ltd.) 14s.

It is only two years since the first volume of this work appeared; now we have 600 pages more of industrial produce.

The author begins this volume with the measurement of quantity and energy, and treats of the ballistic galvanometer—essentially a laboratory instrument—and goes on to meters. The description of meters is fairly complete, the only question is whether more notice should not have been taken of what goes on in other countries. For instance, the Stanley meter is not described. The two-phase and multiphase motor is really due to Bláthy, or one of the Ganz engineers; but anyone reading the book would ascribe it all to Shallenberger. These are trifling matters which it is customary to mention in a review to give the impression that the critic has read the book carefully and knows much more than the author. There is no real fault to be found.

The next chapter on capacity and self-induction is rather a mixture of the academic and the useful. By the way, Dr. Fleming calls self-induction inductance, and uses some of Heaviside's nomenclature only. Why not measure capacity as faradage, or call it permittance, or whatever the right term is? The ordinary electrical engineer will have little to do with accurate measurements of small capacities; but the question of multiphase cables is here treated well, as its importance deserves. The sections on measurement of self-induction or henriage are rather academical, but it is well to have all the material at hand. The discussion of ways of measuring self-induction with bridges and capacities seems to have a great attraction for some minds. It may rank higher than games of patience or bridge.

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The book is well worth having for the chapter on photometry alone. Dr. Fleming is a specialist in many things—he is a special specialist in photometry. Why does he not use his influence to abolish such terms as "candle-foot"?

The remarks on Lambert's, or as it is generally, perhaps wrongly, called, Snelus's or Snell's law of cosines, are scarcely up to date with regard to modern views of light. He ought to have discussed the thermodynamics of radiation, and explained how the law of cosines can hold, theoretically, for a perfectly black body only. The radiation of a perfectly black body is independent of the nature of the body, and of the direction of emission.

This statement is made because it is impressive, and might lead a guileless reader to suppose the reviewer was far better up in advanced modern optics than Dr. Fleming. Really, the only perfectly black body, so far, is a hole. But this is the orthodox way of reviewing. Again, there is no appreciable error. It is the conventional thing for reviewers to say things like that, and one must always be absolutely conventional. It would be much better if books were reviewed professedly by students. A book is read by students, by which I do not mean young men at college, they are not often students; but men of any age and position who read the book to learn, metaphorically sitting at the feet of the author. It should, therefore, be reviewed by a student, who would be able to tell them whether he learned much or little, and whether the difficult matters were explained clearly. The orthodox review is nearly always absurd in the assumption of superiority on the part of the reviewer. Anyone who has ever written a book, or even a paper, knows what frightful labour it was, and how absurdly easy it is to pick holes. I will, therefore, pick no more pinholes, but will write broadly of the rest of the book from a student's point of view. If any misprints or inadvertencies are detected they will be duly notified to the author. The chapter on photometry is certainly exceedingly complete. Considering that the avowed object of most electrical engineering until lately was the production of light, it is astonishing what a little attention is given to photometry. Even now we take no trouble about it. We have little doubt the lamps in Dr. Fleming's house run at about a tenth of a "candle or other unit" per watt.

Magnetic testing begins with a little treatise on magnetics. This is useful. It is to be found elsewhere, but not put better; and unless one is constantly working in one direction he forgets which is susceptibility and which retentance, and he mixes reluctance and inductance, and wastes time thinking it all out again. The chapter on iron testing is very full, and the only trouble one has is that there are so many methods given that he would not know which to employ.

Dynamo and motor testing form the concluding chapter. The first sections are interesting from a student's point of view, historically and educationally, though perhaps not always quite accurate historically. Dynamos are hardly ever tested alone now here, though they are abroad. Here the engine and dynamo have to be tested together. Students, though thankful for what they have got, would be still more grateful if Dr. Fleming described the Foucault brake used at Charlottenburg, designed, I think, by Dr. Feussner.

In conclusion, Dr. Fleming's whole book contains everything that can be wanted. The explanations are always clear and simple. The mathematics used are not advanced, though they go as far as most engineers can follow. J. SWINBURNE.

Polyphase Currents in Electrotherapy. By GEORGE HERSCHELL, M.D. (London: Henry J. Glaisher.)

This short treatise is divided into four parts. The first deals with the nature of polyphase currents, the second with the physiological effects of three-phase currents, the third with the necessary apparatus for the application of such currents in practice, and the fourth with methods of application and their results. On electrical science the author is by no means sound, and in one instance the impression is conveyed that by decreasing the speed of the generator the wave form of the E.M.F. is "flattened," but at the same time the actual value of the voltage is not altered. On the purely therapeutical part of the book we have no criticisms to offer, but it certainly appears that the treatment has been beneficial in more cases than one.

RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 200.)

α-rays.—These are given out by all radio-active substances, and, although the least striking, are by far the most important of the three types, representing, in each case, as Rutherford has shown, over 99 per cent. of the total energy radiated. Their power of penetration is always very small, but varies considerably for the different radio-active substances. The following diagrams were given by Rutherford and Miss Brooks (*Phil. Mag.*, 1902, VI. 4, p. 1), and show the penetrating power of the α-rays of uranium, polonium, radium, thorium, together with that of the "imparted radio-activities" produced by the radium and thorium emanation. In each case the vertical axis represents the rays transmitted, while

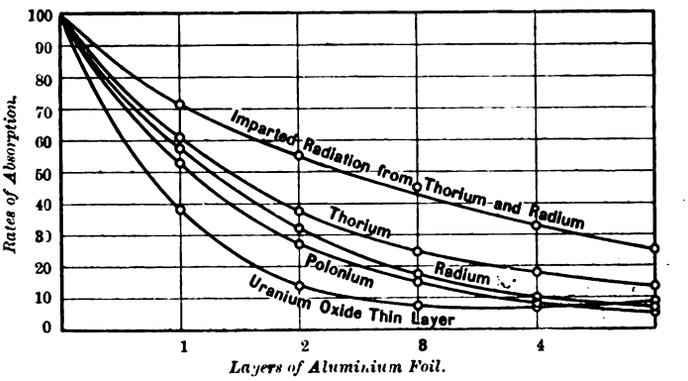

FIG. 18.

the horizontal axis represents the thickness of matter penetrated, this being, in Fig. 18, made up of successive layers of aluminium foil, and in Fig. 19 the thickness of air in millimetres. It will be seen that the order is the same for the different rays in the case of aluminium and air, those from uranium being the least and from the imparted activities the most penetrating. The "Density Law," that the absorption of the rays by various substances is proportional to the density of the latter, holds fairly generally for the rays from radio-active substances. For the α-rays, however, tin furnishes an exception, its opacity being about the same as for aluminium. The same metal is, however, nearly three times as opaque to

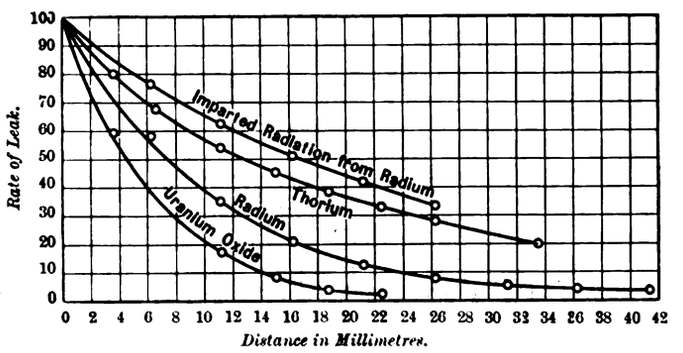

FIG. 19.

the β-rays as its density would lead us to expect, while lead is twice as opaque (compare Rutherford and Miss Brooks, *Phil. Mag.*, 1902, VI., 4, p. 1).

A very characteristic property of the α rays is that they are absorbed the *more* readily the greater the thickness of matter traversed (compare Mme. Curie, "Thesis," Chap. III.; Rutherford, *Phil. Mag.*, 1903, VI., 5, p. 114). The apparatus employed by Mme. Curie for the investigation of the α-rays of polonium is shown in Fig. 20. The object of the experiment is to

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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measure the current due to the rays between the plates PP, P'P' from a polonium preparation at A when the distance AT was varied. When AT is over 4cm. no current passes, indicating that the rays are all absorbed in the thickness of air. The appearance of the rays between the plates is manifested somewhat suddenly as the distance AT is reduced. If successive layers of foil are placed over the polonium, the absorption caused by the second layer is greater than that produced by the first.

These considerations and the general existence of this peculiarity led Rutherford (*Phil. Mag.*, 1903, VI., 5, p. 177) to regard the α-rays as consisting of projectiles, and to examine them carefully in the most intense magnetic fields under con-

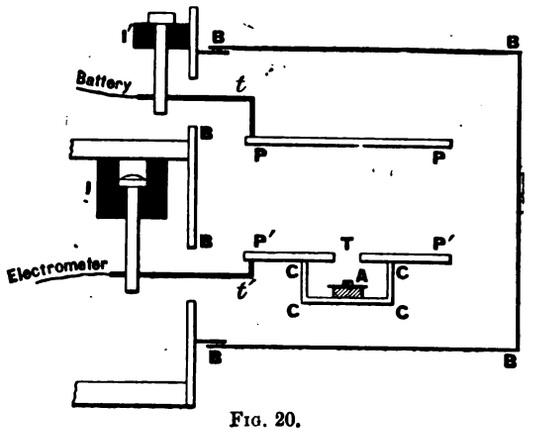

Fig. 20.

ditions where the slightest deviation could be detected. His apparatus is represented in Fig. 21. The radium rays pass upwards through a series of very narrow slits placed between the poles of a very powerful electromagnet and emerge inside the gold-leaf electroscope placed above. A current of hydrogen is kept flowing through the electroscope and the slits in a downward direction, and this serves to prevent the diffusion of any emanation from the radium into the electroscope. It also greatly reduces the absorption of the α-rays in passing through the slits and so increases the effect to be measured in the electroscope. The effect due to the β and γ-rays is, on the

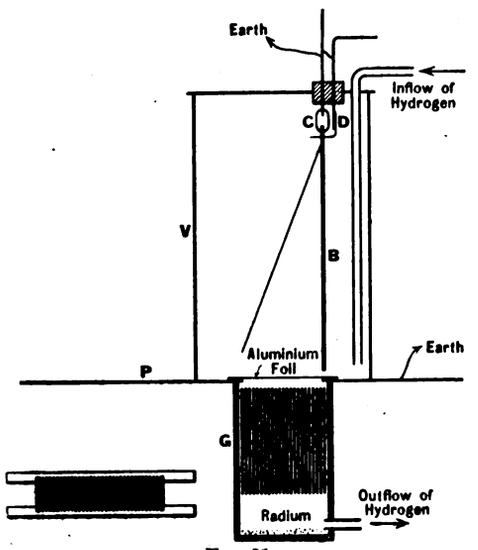

Fig. 21.

other hand, very much diminished by using hydrogen owing to the ionisation in the latter gas being much less for a penetrating radiation than it is in air. The ionisation due to the α-rays is not reduced because there is a sufficient thickness of gas to ensure their complete absorption inside the electroscope. The plan of the experiment was to measure the rate of collapse of the leaves when the radium salt was bare and when covered with a sheet of mica sufficient to absorb the α-rays, both with and without the magnetic field. In this way Rutherford found that the α-rays were completely deviated by passage through slits 4·5cm. long and 0·55cm. wide placed in a uniform magnetic field of 8,400 C.G.S. units. Deviation was also obtained by an electrostatic field; and the direction of deviation in each case is opposite to that suffered by the cathode ray or the β-ray of radioactive substances. The direction of deviation was determined by using the device shown in Fig. 22, in which the openings of the slits are half covered from the one side by metal plates, so that a greater deflection is necessary in the one direction than in the other if no rays are to enter the electroscope. From a combination of his results for both the electrostatic and electromagnetic deviation, Rutherford has deduced that the velocity of the charged particle $v = 2{\cdot}5 \times 10^9$cm. a second, while the ratio of the charge to the mass $e/m = 6 \times 10^3$. If e is assumed to be the "atomic charge" and equal to the charge carried by the hydrogen ion in electrolysis, the mass of the projected particle is thus nearly twice that of the hydrogen atom. The value of $H\rho$ in these experiments was 390,000, and this result may be expressed differently by the statement that the α-rays would be coiled into circles of 39cm. radius under conditions which would coil the cathode rays into circles of 0·01cm.

The magnetic deviability of the α-ray of radium has since been confirmed by a photographic method by Becquerel (*Comptes Rendus*, 1903, 136, pp. 199, 431 and 1,517), and he also shows that the α-ray of polonium is deviated to a similar extent. Des Coudres also (*Phys. Zeitschr.*, 1903, p. 483) working by a photographic method in vacuo, has confirmed both the electrostatic and electromagnetic deviation, and obtained a value of e/m in close agreement with that given by Rutherford.

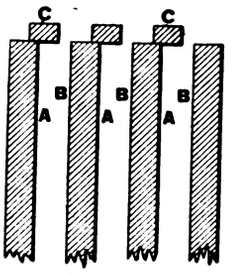

Fig. 22.

Since the α-rays of all radio-active substances are very similar in type, there is strong evidence for considering them all as consisting of positive-charged particles of mass about twice that of the hydrogen atom travelling with a speed one-tenth of that of light. Their large size compared with that of β-ray accounts for their small penetrating power, and their great kinetic energy for their very great ionising action, while their projection character well accords with the property already mentioned of being more easily stopped the greater the thickness of matter penetrated.

This view of the discrete nature of the α-radiation has recently been confirmed by an experiment of Sir William Crookes' (*Chem. News*, 1903, 87, p. 241), which was discovered simultaneously in Germany by Elster and Geitel (*Chem. News*, 1903, 88, p. 37), that the phosphorescence of a zinc sulphide screen under the action of the α-rays consists, when viewed through a lens, of a number of momentary flashing points of light or scintillations, presenting the appearance of an incessant bombardment of the screen by a rain of projectiles from the radium, each impact being marked by a separate flash of light.

We thus see that the rays of radium have furnished most striking and unexpected evidence of the correctness of the views adopted by Prof. J. J. Thomson, as the result of his investigations of the relations between electricity and matter. The α-ray has been shown to be a positively charged particle of atomic dimensions, the β-ray a negatively charged particle of corpuscular dimensions, in accordance with the corpuscular theory of electricity which requires that positive electrification does not exist apart from matter, whereas negative electrification is composed of discrete charges of far smaller mass than the lightest atom of matter. In addition the β-ray of radium has afforded a welcome means of putting to experimental test one of the most fundamental consequences which follow from the view that an electric charge possesses inertia and, therefore, mass.

γ-rays.—These were first noticed by Villard for radium (*Comptes Rendus*, 1900, 130, p. 1,010) and have since been shown by Rutherford to exist also in the radiations of thorium (*Nature*, 1902, 66, p. 318) and later of uranium (*Phil. Mag.*, 1903, VI., 5, p. 580) although considerable quantities of the feebler radio-elements, especially the latter, must be employed to detect them. They are characterised by extraordinarily great penetrating power, being able to pass through 7cm. of lead, 19cm. of iron, and 150cm. of water before they

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are reduced in intensity to 1 per cent. of the original. The density law holds, approximately, for the absorption of the γ radiation, although, as in the case of the β-rays, the absorption is nearly twice as great as it should be by this law for lead (compared with other substances, as copper, iron, glass or water). Rutherford sought to determine the nature of the γ-rays—*i.e.*, whether they resemble the cathode rays, and consist of projected particles, or the X-rays, which are ether pulses, by determining the absorption of the γ-rays in different gases. Now, the absorption produced by dense gases—as, *e.g.*, sulphuretted hydrogen—for X-rays is far greater than for β or cathode rays. In the latter case, the absorption is very approximately proportional to the density of the gas, whereas, for the X-rays, sulphuretted hydrogen is nearly four times as opaque as its density would lead us to expect. γ-rays, however, are not specially absorbed by this gas, and Rutherford concludes they are nearer in character to the cathode rays than to X-rays. Strutt (*Proc.* Roy. Soc., 1903, p. 208) has recently concluded a very careful comparison of the ionisation produced in different gases by different radiations by an examination of the γ-rays. He finds that the γ and β-rays behave alike in all cases, and are quite differentiated from the X-rays. The latter produce far larger ionisations than the former in the heavy gases and vapours like sulphur dioxide, chloroform, methyl iodide and carbon tetrachloride. For these gases the density law holds for the β and γ-rays, but not for the X-rays.

The γ-rays have not yet been studied to nearly the same extent as the α and β-rays, and their origin and nature is still unelucidated. It is only their extraordinary power of penetrating matter which renders them important, for they represent an almost negligible fraction of the total radiation, by whichever method it is examined.

(To be continued.)

THE BURTON-UPON-TRENT ELECTRIC TRAMWAYS.

In 1900, Mr. J. E. Waller, of Messrs. Kincaid, Waller, Manville and Dawson, in conjunction with Mr. George T. Lynam, the borough surveyor of Burton, drew up an exhaustive report on the system of tramways to be adopted, and in the earlier stages there was a considerable local feeling in favour of the closed conduit system, as against the trolley system which Mr. Waller recommended. The capital expenditure on the work which has eventually been carried out amounts to approximately £80,000 and the loan is for a period of 30 years. It is estimated that the car-mileage will be about 450,000 per annum. The power house is situated on the banks of the River Trent, and is used for both lighting and traction purposes, the former being commenced in 1894. Additional plant has been put in to meet the traction load, that for steam raising consisting of three Yates and Thom Lancashire boilers, each 26ft. by 8ft. and designed for a working pressure of 180lb. per square inch. The requisite steam and water piping for coupling the boilers to the engines was also supplied by Messrs. Yates and Thom. An economiser, consisting of 192 tubes, each 9ft. long, arranged eight pipes wide and in two groups, coupled together by copper expansion elbows, has been put in by Messrs. Green & Son. In the engine room there have been installed three Willans three crank compound engines, each developing 180 I.H.P., at 450 revs. per min. The high-pressure cylinders on these engines have a diameter of 260mm. and the low-pressure 440mm., while the stroke is 150mm. Each engine is designed to carry a 25 per cent. overload for periods not exceeding two hours, and is known as Messrs. Willans and Robinson's standard 3-0 type. Automatic expansion gear is fitted and heavy flywheels are carried on the shafts. Directly coupled to the engines are three 100kw. 500 volts continuous-current dynamos by the British Thomson-Houston Co. The switchboard was also manufactured by the same firm.

There are, altogether, about 8¼ miles equivalent single track of 3ft. 6in. gauge. The rails are of the girder type, 90lb. to the yard, and the maximum gradient is 1 in 11; the sharpest curve has a radius of 40ft. Messrs. R. W. Blackwell & Co. erected the overhead equipment, and the trolley wire consists of 000 hard-drawn copper, supported by side poles and span wires. Lead-covered cables, by the British Insulated and Helsby Cable Co., laid in Sykes conduits, are employed for conveying current to the feeder pillars, and the rails, together with one insulated copper conductor, are employed for the return.

At present the number of cars in service is 20, and five of these cars are fitted with slipper brakes for work on an exceptionally hilly route. They are of the reversible staircase type, and have seating accommodation for 43 passengers—20 inside and and 23 outside. Each car is equipped with two 25 H.P. motors, and has an overall length of 24ft. 6in. Tidswell life-guards are fitted, and all cars are provided with hand and emergency electric brakes. Messrs. Dick, Kerr & Co. were contractors for this part of the undertaking.

Between the hours of 5:30 a.m. and 8 a.m. (the latter limit being adopted instead of 7 a.m. as a concession to shop assistants) the through fare for any distance on any route is 1d., and the same charge prevails between the hours of 5 p.m. and 6:30 p.m. No cars set aside entirely for workmen are run, the reduced fares being for any passenger; children under 12 are carried half-price, and special concessions are made to school children. All parcels of a bulky nature are charged 1d. for any distance, and parcel traffic at present brings in 35s. per week. Weekly workmen's tickets, giving 12 journeys on any day in any week at the above hours of cheap fares, are issued for the sum of 10d. Owing to the extended area of the Corporation, it is anticipated that there will be a good scope for parcel traffic, which is to be considered shortly.

The Ashby-de-la-Zouch light railway, which serves the coal and pottery districts of Gresley, Swadlincote, Woodville, Moira and Newhall, will have running powers over the Burton system, and will probably take energy from the latter's generating station.

Messrs. H. W. Couzens and H. C. Bemrose, under the consulting engineers, Messrs. Kincaid, Waller, Manville and Dawson, have been intimately connected with the scheme. Mr. P. J. Pringle, borough electrical engineer, is also tramways manager.

THE SLOW REGISTRATION OF RAPID PHENOMENA BY STROBOGRAPHIC METHODS.

THE "ONDOGRAPHE" AND THE "PUISSANCEGRAPHE" (WAVE-RECORDER AND POWER-RECORDER).*

BY E. HOSPITALIER.

The object of the "ondographe," and of other instruments derived from it, is to register within a resonably long period of time (of the order of from 15 to 60 seconds) a periodic phenomenon of so rapid a nature that the period may be as short as one-thousandth of a second, or even less. Before entering, however, upon the description of the apparatus, it will be necessary to refer to certain general considerations. The observation of a rapidly variable phenomenon may be effected with the aid of apparatus based upon two very different principles—viz., *Direct Observation* and *Indirect Observation*.

DIRECT OBSERVATION.

The method most commonly employed consists in designing the instrument so that it has a small moment of inertia, a very short natural period of oscillation, compared with that of the phenomenon to be recorded, and a degree of damping as nearly as possible critical—that is to say, it is so damped that the apparatus, when disturbed from its position of equilibrium, tends to return to that position in the shortest possible time and without over-shooting.

The first condition is realised in practice when the period of oscillation peculiar to the system of the measuring instrument is about 50 times as short as that of the phenomenon to be observed. This condition is readily satisfied when the frequency of the phenomenon under examination does not exceed from six to eight per second. Beyond 500 periods per minute, the disturbance caused by the inertia of the moving parts, and the excessive or insufficient damping, render the indications illusory, unless special arrangements are made. The theoretical study of the conditions to be fulfilled has led to the development of instruments, such as the oscillograph of

* Paper read before the Institution of Electrical Engineers last night. Slightly abridged.

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M. Blondel and that of Mr. Duddell, which the members of the Institution have had the opportunity of seeing in this room.

The second method, which is at present represented only by Mr. Abraham's rheograph used in studing the characteristics of variable currents, involves the use of an observing instrument in which the moment of inertia is high and the natural period of oscillation is much greater than that of the phenomenon to be observed. Under these conditions the instrument would indicate something different from the phenomenon which it is wished to observe. However, it is not submitted to the action of the phenomenon itself, but to that of one more complex, which has been previously regulated in such a way that the disturbing effects due to inertia and to damping of the oscillating system are compensated. In this way the same result is obtained as with an instrument without inertia; but these compensations at present only appear to be possible for the observation and measurement of electric currents.

Indirect Observation.

Indirect observation, based upon stroboscopic principles, is effected by reproducing the phenomenon with a much longer period, obtaining the record of the whole of its phases by taking them successively from a large number of periods. The period of oscillation peculiar to the apparatus may, in this case, be very long as compared with that of the phenomenon observed, provided that the duration of the total number of periods from which the different phases are collected is itself very great relatively to that of the oscillation peculiar to the recording instrument.

Notwithstanding the elegance of the direct methods, and the results which have already been attained with instruments based upon them, the author is of opinion that the industrial future is reserved to the indirect methods, which have a wider field of application, and which permit of the direct recording of the phenomenon to be studied upon a strip of paper, in a way that is not possible with the direct methods, in which recourse is always had to photography. In order to understand the principles of the stroboscope, as applied to the observation and recording of periodic and rapidly-varying phenomena, the most simple of all the periodic movements may be considered—namely, that of uniform rotation. At the end of every revolution the rotating system attains the same relative position that is occupied one complete turn earlier. Suppose, now, that the system is illuminated for a very brief instant once in each revolution at the moment at which it passes a certain position, which is regarded as the initial position. The rotating system will then appear at rest. If, now, the periodic illumination be slightly retarded, so that the successive flashes follow one another at an interval of time a little longer than the period of the revolution itself, the system will be illuminated in its various phases in turn, and will appear to revolve slowly in the sense of its actual rotation. If, on the contrary, the flashes follow at shorter intervals, the system will appear to be turning in a sense inverse to that of its real rotation, since at every revolution it will be illuminated an instant before it attains the same position as on the preceding revolution. In this way the apparent velocity of rotation will have been reduced in a proportion which depends only on the acceleration or the retardation of the successive illuminations of the system.

The simplest means of obtaining these successive flashes consists in using a disc pierced with a slit as a shutter in front of a projector. The same result may be obtained by means of the sparks caused by interrupting the current through an inductance, or with alternate-current arcs, &c., but the sharpest effects are obtained with the revolving stroboscopic disc.

In order to obtain a variable difference in the periods or slip, it is possible to use an electric motor of which the speed is capable of variation—or a synchronous motor if the system is driven by a synchronous machine—which determines the measure of the slip, or a train of wheels as in the ondograph, or (the most rational of all) a differential gearing of which one of the axes is controlled by the system to be studied, whilst the other actuates the stroboscopic disc and the crown containing the intermediate wheels between them receives from an outside source a more or less rapid movement of rotation which defines the slip. This disposition offers the great advantage of allowing the phenomenon to be apparently stopped in any specially interesting position.

A.—Stroboscopes.

Stroboscopes, of which the number is infinite, do not, properly speaking, constitute apparatus, but rather experimental arrangements which are susceptible of modification depending upon the material at the disposal of the observer, and upon the research that he has in view. By way of example, reference will be made to those which the author has used for the examination of alternate-current arcs and of machinery in motion.

The Arcoscope.—A very simple experimental arrangement has been designated by this name (which is at once French and Greek), an arrangement intended to facilitate the examination of the variation in the luminosity of an alternate-current arc during a single period—variations which it is impossible to observe directly because of their great frequency. It consists, in principle, of a small *asynchronous* single-phase alternate-current motor, having on its axis an opaque disc provided with narrow slits placed at regular intervals, the number of the slits being equal to the number of pairs of poles of the motor. Thus, for a motor with four poles, the disc would have two slits, placed one at end of the same diameter. This motor is driven by alternate current taken from the same source as that traversing the arc under examination.

This disc, which is rotated by the motor at quasi-asynchronism, is placed in the path of the luminous rays emitted by the arc, which latter is projected by a lens upon a screen. The image of the arc is thus allowed to fall on the screen for one instant during each period, and in consequence of the slight slip of the motor when running light, the phenomena of the arc may be observed during a complete period, and this period may thus be prolonged to as much as from 10 to 15 seconds. By applying a braking action to the motor the slip is increased, and the apparent duration of the oscillation of the light of the arc is reduced. It is possible to observe the arc directly through the slits in the disc, but the result is less clear than when a projection is used and the image of the arc is magnified. If the same disc be made to carry a series of sectors, alternately white and black, the number of each kind being equal to that of the poles of the motor, and if it be illuminated by an arc or incandescent lamp served by the same current as is the motor, the slip of the motor may be observed and directly measured by observing and measuring the apparent inverse rotation of the disc mounted on its shaft.

In this way it is in some degree possible to analyse the light of the arc and to judge the influence of the form of the current curves, of the nature and quality of the carbons, of the frequency, the conditions of regulation, &c. It is also practicable to cinematograph the phenomenon in order to be able to study it at leisure. This can be done by controlling the cinematograph by means of an asynchronous motor and photographing the arc, either directly, or after projecting it upon a screen.

Stroboscopic Transmission Dynamometer.—If a driving-shaft, A, actuates a working shaft, B, through the medium of a spring-coupling between the two shafts, the product of the torsional couple or torque transmitted by this spring, multiplied by the angular velocity, is equal to the power transmitted by the shaft A to the shaft B. A large number of arrangements have been devised to determine this torque, which generally shows itself in practice by a relative angular displacement of the two shafts proportional to the torque. A simple means of reading this consists in mounting a disc on each of the shafts, and in placing the rims of the two discs close together and marking on them graduations proportional to the couple exerted in each of the relative positions of the discs. When the system is in motion, the relative displacement of the two shafts can be read off on the graduations, just as if the discs were stationary, by illuminating the system once in each revolution at the same instant in each period. For this purpose the stroboscopic eyeglass can be used with advantage.

Stroboscopic Eyeglass.—A small electric motor, driven by two accumulators, actuates a disc pierced with radial slits. The system in rotation is viewed through these slits with one eye, the other remaining closed. With the aid of a rheostat the disc may be caused to revolve at various speeds, so regulated that the system, illuminated permanently from an external source of light, appears to be either stationary or revolving very slowly. The stroboscopic eyeglass, so arranged, when brought to synchronous speed, permits the graduation of the above-described dynamometer to be observed and read with ease. If it revolves with a certain amount of retardation, it allows of the observation of rapid phenomena as readily as if they were produced at a slow speed, which can be regulated at will. All the phases of an explosion engine may, for example, be thus observed: The lifting of the valves, the contact and the ensuing vibration of the ignition cam, the formation of the stitch in a sewing machine, the starting of a part having an independent movement, &c.

Differential Stroboscope.—For the study of thermal engines, MM. Malicet and Blin have constructed for the author a special differential stroboscope in which the motor is illuminated only once in every two revolutions. This result is obtained by providing the stroboscopic disc with only one slit and mounting the disc on the crown of the differential gearing. One of the shafts of the gearing is connected by a flexible shaft to the motor engine under examination, and the other shaft, in order to produce the stroboscopic effect, may be rotated slowly by means of an endless screw controlled by a small handle turned by hand. The apparent velocity of rotation of the engine is varied by turning the handle more or less rapidly. On stopping the handle the apparent movement is also arrested.

Examples could easily be multiplied, but those which have been given suffice to show the important part that can be played by stroboscopic methods—confined, so far, to the laboratory of the physicist—in taking their places in the test-rooms of the great mechanical and electrical industries.

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B.—Strobographs.

The name "strobograph" is applied to all forms of apparatus employed to record phenomena (whether rapidly or slowly variable), if they utilise the principle of the stroboscope or of successive phases.

The Ondograph.—The object of the ondograph is to inscribe or to register directly upon a band of paper, by means of ink, the representative curves of periodically and rapidly variable electrical phenomena (E.M.F.s, currents, differences of potential, power, &c.). In principle it is based upon a combination of Joubert's method of successive points, stroboscopic methods, and electrical recording apparatus. Fig. 1 shows the general arrangement of the actual apparatus as made by the Compagnie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz. It comprises as essential parts:—

1. A synchronous single-phase alternate-current motor actuated directly by the source of electrical energy of which the periodically variable elements are to be recorded.

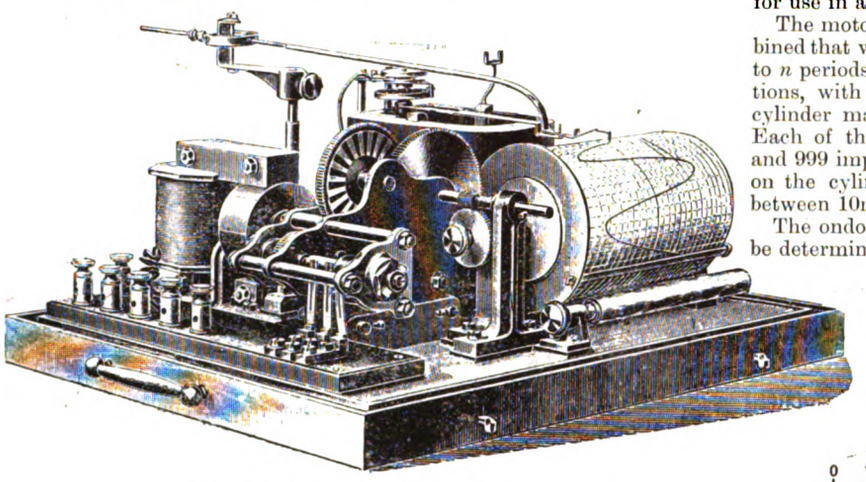

Fig. 1.—General View of the Ondograph.

2. A train of gearing of which the object is to impart to a revolving contact-maker or commutator such an angular velocity that when the motor has made a certain number of revolutions, the commutator will have made an equal number (or a multiple), increased or diminished by 1. This retardation or acceleration, which is essential to the system, obviates the necessity of rotating the brushes of the motor.

3. A contact-maker or automatic commutator, consisting of a cylindrical block of insulating material carrying a tube of brass suitably cut to shape, with *three* brushes resting upon it. The object of this device is to put a condenser successively in connection with: (*a*) two points in the circuit in which the variable periodic phenomena to be recorded take place; (*b*) a measuring apparatus. During the first operation the condenser becomes charged, and is discharged through the measuring apparatus in the second. For the power-curve the contact-maker is reduced to a simple conducting bar which, once in each revolution and by means of two brushes, closes the circuit through the fine-wire bobbin of the recording apparatus. Fig. 2 shows the connections of the apparatus in the case in which a condenser is used.

4. *A Condenser*, of which the capacity may be either constant or regulated at will by means of plugs, in order to regulate the sensitiveness of the apparatus.

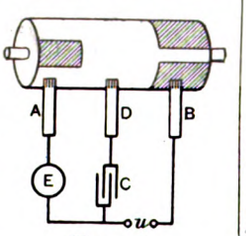

Fig. 2.

5. *A Recording Measuring Apparatus*—suitable to the phenomenon to be examined. For differences of potential and currents, the recorder is a moving-coil instrument of the Meylan type, mounted horizontally.

For power-curves, the recorder is an ordinary wattmeter; the main current passes continuously through the fixed primary bobbin, whilst the movable fine wire bobbin is placed in the circuit which is periodically connected by the rotating contact-maker to the difference of potential which determines the second factor of the power. Regulation is effected by introducing resistances into the fine-wire circuit (see below, under Power-recorder).

The direct method may also be applied equally well to the registration of differences of potential or currents, and in this case the use of the condenser is dispensed with. The condenser, however, offers distinct practical advantages in regard both to regulation and sensitiveness. So also the wattmeter may be used for recording the curves of P.D.s, if a constant current from a battery of accumulators is passed through its fixed coils.

In all the above cases the moving part of the recording apparatus receives a series of impulses the frequency of which is equal to that of the current to be registered. The moving coil has a moment of inertia and damping so calculated that its position at any moment is that which it would be caused to take by the action of the mean current corresponding to the quantity of electricity passing through it during a single period.

6. *A Recorder*, either cylindrical or continuous, driven at a convenient speed directly by the synchronous motor. The record is traced by means of a pen.

The four-pole synchronous motor runs with a P.D. of 110 volts at frequencies ranging from 25 to 100 periods per second. The motor is started up by means of hand gearing, and, when synchronised, is thrown into circuit. The precise moment at which the current should be switched on is determined by the stroboscopic effect of the apparent stoppage of a disc revolving with the motor and carrying a suitable number of black and white sectors painted alternately. After the motor has been started, the hand gearing is disengaged automatically by an arrangement similar to that adopted for use in automobiles.

The motor actuates the commutator by a train of gearing so combined that when the motor has made $n/2$ revolutions, corresponding to n periods the commutator will have made only $(n-1)/2$ revolutions, with a regular and uniform retardation. The recording cylinder makes one complete revolution for every three periods. Each of the three curves registered corresponds to 1,000 periods and 999 impulses. One complete period takes up a length of 96mm. on the cylinder. The amplitude may be made to vary at will between 10mm. and 50mm. by altering the P.D. and the capacity.

The ondograph allows the frequency of an alternating current to be determined with accuracy. To affect this it is only necessary to determine by means of a chronometer the time occupied by the recording cylinder in making one complete revolution. As this time corresponds to 3,000 periods, this number divided by the duration of one complete revolution in seconds gives the frequency in periods per second. Fig. 3 is a plan of an ondograph, drawn to a scale of one-fifth, showing the arrangement of the apparatus. A narrow case, about 10in. long, contains the accessories—viz., long pointer, stand, handle, red and black ink, oil, alcohol for cleaning the pen, spare pen, paper, &c.

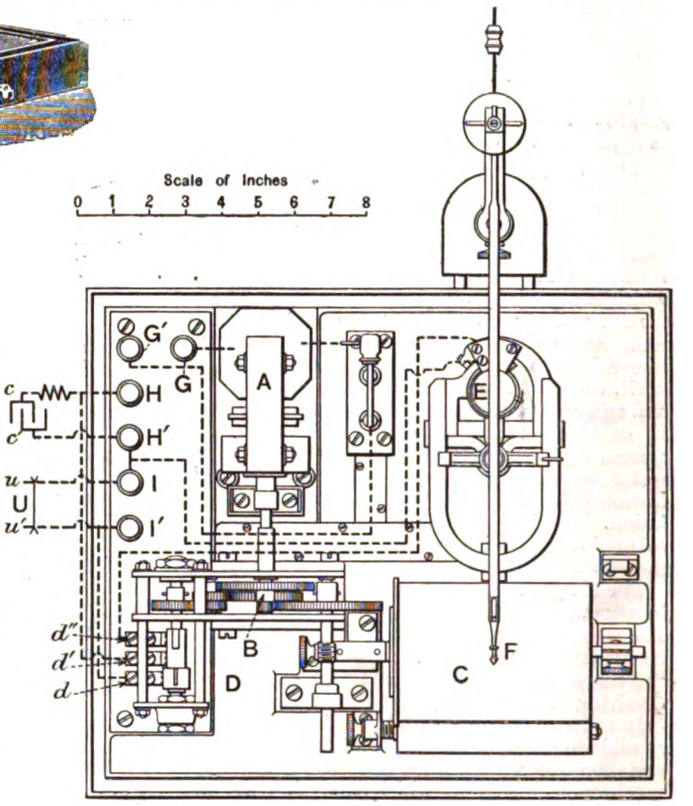

Fig. 3.—Plan of the Ondograph.

In most recording instruments in which direct tracing is effected, it is necessary to reduce the length of the pointer that carries the pen in order that the friction of the pen on the paper may not sensibly falsify the record. The use of a short pointer in the ordinary way, necessitated by the smallness of the directing force and the friction of the pen, gives rise to several inconveniences.

1. The curvilinear ordinates have a relatively short radius of curvature, and the curve recorded, therefore, is subject to a deformation that is often troublesome.

2. The curvilinear trajectory of the pen prevents it from accurately touching with equal accuracy at every point of the recording

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cylinder, of which, if the radius were infinite, it should describe a generatrix. Under these conditions a pen correctly regulated only records by points in certain positions, presses strongly upon the paper in other positions, and, again, does not rest upon the paper at all in positions corresponding to the longest ordinates.

3. The arm carrying the pen should be both rigid to enable its direction to be controlled well, and flexible to facilitate its record; it is difficult to combine these two opposite qualities in the same mechanism.

In order, in a large measure, to reduce these difficulties, the author has adopted an arrangement which consists in principle in the separation of the mechanisms for guiding the operator and for recording, without impairing their capability of joint action; and in obtaining, with a guiding system of short radius, a record in which the radius of the ordinates is so great that the record approaches sensibly to that which would be afforded by a registering pointer of which the pen would describe an arc of a circle having an infinite radius.

The recording apparatus comprises two distinct parts: the directing arm and the recording pen. The former is a rigid lever attached to the measuring apparatus, with the extremity the more remote from the axis of rotation terminating in a pin which works in a groove provided upon the lever carrying the pen. This pen, during the recording process, describes the path that would be taken by the pen of an ordinary recording instrument during the rotation of the cylinder carrying the paper.

The recording pen consists of a lever of great length, so arranged that one of its extremities turns upon an axis parallel to that of the recording instrument, but removed from it by a distance approximately equal to the difference in the lengths of the two levers. The other extremity is provided with a groove engaging with the pin of the directing arm, and carries the recording pen at a point a little beyond the groove. In the actual ondograph, the directing arm is 18cm. long, whilst the lever carrying the pen is double this length—namely, 36cm.

It will be understood from this that whilst the pin describes an arc of a circle with a short radius, the pen describes one of long radius. By giving sufficient length to the lever the arc may, within the limits of the width of the cylinder, coincide sensibly with the tangent at the middle point of the arc. Thus, the point of contact of the pen with the paper is but very slightly removed from a generatrix of the cylinder, and the registration is effected with perfect regularity throughout the whole extent of the cylinder. The pen and its lever can, therefore, be proportioned so as to satisfy all the necessary conditions as to flexibility and regulation of the recording mechanism, and of this part of the apparatus only, since the pen is directed by another mechanism to which in turn it is easy to impart all the rigidity necessary to fulfil this function satisfactorily.

The lever is attached at its point of support by a Cardan joint which allows the pen to move freely and to exert upon the paper a constant pressure regulated by its own weight, in part counterbalanced by a screw-counterpoise movable at will. The vertical axis allows for the movement caused by the directing arm, whilst the horizontal axis permits the slight vertical displacement resulting from that of the pen moving over the recording cylinder. The curve is thus inscribed almost exactly on the generatrix of the cylinder, and the pen, which acts independently and is easily regulated, is not liable to fail in its record.

The ondograph may also be used to study rectified or continuous currents. To accomplish this the synchronous motor is replaced by a direct drive, effected by establishing an unyielding mechanical coupling between the ondograph and the shaft of the machine to be studied. The apparatus has been designed with a view to facilitating and expediting the work of removing or replacing the motor; the motor having been removed, a flexible shaft is placed in position with one of its ends attached to the ondograph, and the other upon the machine under examination.

Non-periodic Phenomena.—The application of the ondograph, or, speaking more generally, or stroboscopic methods, is not limited to periodic phenomena. It can be extended to all phenomena of short duration, provided that the phenomenon can be reproduced identically in such a manner that it is periodic by repetition. By way of example, reference may be made to the curve of discharge of a condenser through a self-induction, a discharge which is of an oscillatory character. The duration of each semi-oscillation is about $\frac{1}{400}$th of a second. By means of the differential-movement ondograph, permitting the retardation at will of the period recorded, it is easy to register phenomena occupying from $\frac{1}{2000}$th to $\frac{1}{3000}$th of a second, obtaining the record by means of a pen upon a strip of paper—a result which has never hitherto been obtained.

Differential Ondograph.—In the apparatus which the author has just described, the slip of retardation which allows of the registration of the curve bears a fixed relation to the frequency of the phenomena to be recorded. It is characterised by the number 1,000 in all the apparatus made by the Compagnie pour la Fabrication des Compteurs. That is to say, when the frequency is 25 per second, the record is effected in 40 seconds ($25 \times 40 = 1{,}000$); when the frequency is 50 per second, the record requires 20 seconds ($50 \times 20 = 1{,}000$), and so on. The recording cylinder, of which the circumference is 288mm., corresponds to three periods, each occupying 96mm. along the axis of time.

In a new type, which is styled the "Differential Ondograph," in order to indicate the principle upon which it is based, the period of registration is no longer connected directly with the frequency. On the contrary, it is entirely independent, and, further, the drum registers only two periods, so that each of them is 144mm. long. This increase of the axis of time facilitates the determination of the phase-difference between the different curves representing the characteristic factors of the phenomenon recorded.

The apparatus still consists of a synchronous motor and a commutator, arranged coaxially, and between them is a differential gear, the crown of which is rotated around the axis common to the motor and commutator by means of an endless screw, turned more or less rapidly by hand. The shaft carrying this endless screw is also provided with a second endless screw, which rotates the recording cylinder with an equal angular velocity.

Under these conditions, remembering the well-known properties of the differential gearing, it will be understood that if the crown is stationary the motor will drive the commutator at synchronism. If the crown be subjected to a displacement in either direction, the commutator will be accelerated or retarded accordingly in proportion to the amount of this displacement. The apparatus is so arranged that the direction of rotation suitable to recording upon the drum produces retardation. This retardation will correspond to one complete revolution of the commutator; that is, to one period, for each half-revolution of the crown and each half-turn of the recording drum. By the time that the crown of the differential gear has completed one revolution the commutator will have suffered a retardation equal to two revolutions, and the recording cylinder will have made one turn, and in doing so will have recorded two periods. As the slip of the contact and the retardation of the drum are controlled by hand, the record of a single period may be produced as slowly as may be required without being correlated with the frequency of the phenomenon under examination.

It is possible to dispense with hand control by employing either an auxiliary motor driven electrically, or by means of a spring, or by using direct control by means of gearing, or a series of stepped pulleys, by which different speeds may be obtained by the shifting of a cord which passes over two of the corresponding pulleys.

This type of ondograph does not, in the author's view, lend itself for industrial use, but is rather an instrument for use in the laboratory or for research. The author has employed it in studying commutation in continuous-current dynamos in such a way that he could follow the smallest variations—variations for which the period traced with 999 points for 1,000 periods did not afford a sufficient approximation.

Puissancegraphe (Power Recorder).—In order to trace the curve of the instantaneous power supplied in any circuit by means of the ondograph, a Thomson meter used as a wattmeter is substituted for the moving-coil galvanometer. The spindle of the meter is controlled by two special springs, which act as conductors through which the current flows in and out of the movable armature, thus avoiding the use of brushes. The main current traverses the fixed coils, and the movable fine-wire coil is connected by means of the commutator and the brushes as a shunt to the P.D. determining the power to be measured, for a very brief interval, once during each period. For this purpose the rotating commutator consists of an ebonite cylinder in which is embedded along a generatrix a plain strip of brass of suitable width.

The duration of contact is governed by the width of the strip. It may be modified at will by shifting the points of contact of the two brushes with the strip. The regulation of the period of contact allows of a change in the sensitiveness of the apparatus, an effect which may also be obtained by introducing a variable resistance into the fine-wire circuit of the wattmeter. The coil, under the influence of the successive impulses which it receives from the intermittent currents passing through it and from the main alternating current, is deflected from its position of equilibrium through an angle, proportionate to the power at each instant of the period determined by the position of the commutator; either directly or indirectly the coil guides the pen of the recorder.

This proportionality results from the fact that the angle described by the moving coil around its position of equilibrium never exceeds from 10 to 12deg. on either side of zero. Under these conditions the drum-wound armature of the wattmeter may be considered as having suffered no practical displacement as far as electro-dynamic forces are concerned.

The aluminium damping disc of the meter serves to give to the system the inertia and damping necessary to the normal working of the apparatus. This normal working corresponds on the one hand to the critical damping, and on the other hand to the time of oscillation of the armature, being comprised between the periodic

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time of the phenomenon to be recorded and the time occupied in recording a complete period.

The "puissancegraphe" has enabled the author to obtain on the same sheet of paper curves showing the instantaneous values of the P.D. and the current, and also their product—the instantaneous power—in an alternating circuit. This was accomplished as follows:—It has been shown that the "puissancegraphe" traces out the instantaneous power by joining (for a very short time during each period) the P.D. to the moving-coil of a wattmeter the fixed coil of which is traversed by the alternating current. The impulse is proportional to the product vi of the difference of potential at that instant (v) multiplied by the instantaneous value current (i), and the instrument traces the curve of instantaneous power. In order

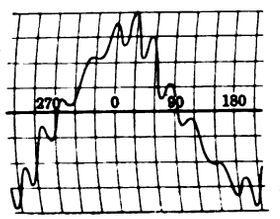

FIG. 4 (one-third scale).—Alternator working on Cable Mains.
Kilowatts = 220.
Amperes = 110.
Cos ϕ = 0·66.

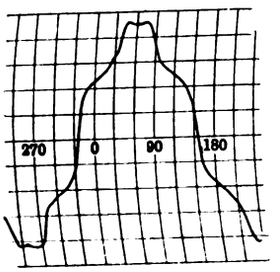

FIG. 5 (one-third scale).—Berlin (Siemens and Halske) old Alternator, Nov. 7, 1903.

to trace the curve of i it is sufficient to connect the commutator to a constant P.D., V. The impulses are then proportional to Vi, or that is to i, since V is constant. To obtain the curve v, a constant current from one or two accumulator cells is passed through the fixed coils, and the commutator is connected to the difference of alternating potential v. The impulse is then proportional to Iv—that is, to v, since I is constant.

APPLICATIONS OF THE ONDOGRAPH.

Alternators.—Alternators should, in principle, give a sine curve, or approximately a sine curve, as free as possible from higher harmonics, so as to avoid those resonance effects which are so prejudicial to cables. The curves reproduced in Figs. 4 to 7 prove that this is far from being the case. Some of them show the influence of the shape of the pole pieces, which introduce the third and fifth harmonics, whilst others exhibit the effect of the teeth. A careful study of these curves makes it possible so to alter either the

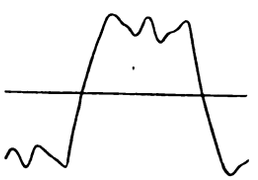

FIG. 6 (one-third scale).—Three-phase Oerlikon Inductor Alternator; with two slots per period per phase, and laminated pole-pieces.

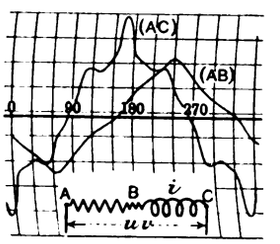

FIG. 7 (one-third scale).—Monocyclic Alternator working on a Self-induction.
(AC) Difference of Potential.
(AB) Current in the Self-induction.

pole-pieces or the number or shape of the teeth that these objectionable distortions are greatly reduced. These curves are, of course, of an exceptional shape, and selected mainly for illustration of the registering qualities of the ondograph.

Reaction of the Alternating Current on the Excitation.—It is well known that the armature current in an alternator reacts on the field and produces in it a varied magnetisation, with a frequency double that of the alternator. This effect is exhibited in Fig. 8, which shows the P.D. between the terminals of a Siemens alternator with an ironless armature, when working on an inductive circuit and producing a current with a lag of about one quarter of a period. The wavy line, representing the exciting current, would be straight were it not for the reaction of the armature. This effect becomes more pronounced with an increasing lag of the current behind the E.M.F. of the alternator.

Rotary Converter.—Fig. 9 shows the variation in the difference of potential between the terminals of a two-phase rotary converter. This curve has been repeated five times to demonstrate that the small changes caused by hunting do not alter the general appearance of the curve.

The Synchronous Motor of the Ondograph.—This little motor works as a variable self-induction motor having a very large difference of phase, well shown in Fig. 10, which gives the difference of potential v and the current i at each instant.

Brush Machine.—The current given by a very old Brush machine is shown in Fig. 11, which was obtained by driving the ondograph direct from the machine with the aid of a flexible shaft. This

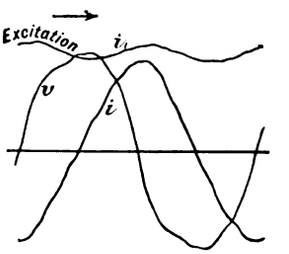

FIG. 8 (one-third scale).—Siemens Alternator (Armature without Iron) supplying an Inductive Circuit.
P.D. (v) = 112 volts; current (i) = 16 amperes.
Self-induction (air-core) = 0·0175 henry; resistance = 0·6 ohm.
Frequency = 50 ~ per second.
Machine excited from accumulators without any resistance in series—
Exciting current = 23 amperes; resistance of circuit = 0·4 ohm.

figure exhibits the amplitude of the variations in the E.M.F. caused by the passage of each elementary coil under the pole-tips. The machine was supplying arc lamps.

The Determination and Recording of Harmonics.—It may be admitted in principle that an alternating wave-form contains all the odd harmonics with larger or smaller amplitudes, and zero amplitude for those that are absent. The first problem to be solved consists, therefore, in discovering the order of the highest harmonic present. Calling the pulsation of the fundamental wave $\omega(\omega = 2\pi$

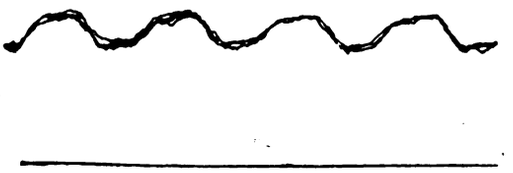

FIG. 9 (two-thirds scale).—Difference of Potential between the Terminals of a two-phase Alioth Rotary Converter on Open Circuit. Secteur de Neuilly. Curve repeated five times.

frequency) and the order of the harmonic n, it is required to determine n, that is to say, to discover the order of the highest harmonic.

Determination.—The author employs two methods, the one based on the properties of a circuit having capacity, the other on those of an inductive circuit.

Capacity Method.—As large a capacity as possible is connected to the periodic P.D. to be analysed, and the curve of the charging current of the condenser is recorded by connecting the ondograph to the terminals of a non-inductive resistance included

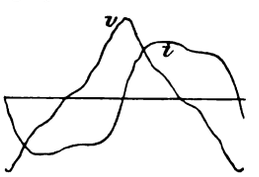

FIG. 10 (one-third scale).—P.D. (v) and Current (i) Wave-forms of the Ondograph Synchronous Motor.

FIG. 11 (one-third scale).—Current given by Brush Machine supplying Arc Lamps.

in the circuit through which flows the charging current of the condenser. This resistance should be as small as possible. Designating the effective (R.M.S.) difference of potential corresponding to the nth harmonic V_n, the corresponding effective current, I_n, for this harmonic may be expressed thus—$I_n = n\omega CV_n$. Hence, by this method, the nth harmonic is magnified in proportion to its order n, and an intended curve is obtained in which the number of teeth indicates the order of the highest harmonic with the greatest clearness. Fig. 12, for example, shows very clearly the discovery of the 15th harmonic in the Secteur de la Rive gauche, a harmonic that the sinusoidal-looking P.D. would not have enabled one to predict.

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Self-induction Method.—A circuit, formed of a highly-inductive coil, having as long a time-constant as possible, and a non-inductive resistance, is connected to the terminals of the difference of potential to be analysed. The difference of potential V_s between the terminals of the inductive coil may be approximately expressed as follows, if its resistance may be neglected as compared with its self-induction—$V_s = n\omega \,.\, L \,.\, I$. By using the ondograph to record the instantaneous values of the P.D. between the terminals of the self-induction, an indented curve is obtained analogous to that given by the charging current of the condenser, and the order of the highest harmonic is readily deduced from this curve.

Record.—When the order n of the highest harmonic is once known, it is easy to trace the fundamental wave and all the harmonics with their several amplitudes, actual or enlarged in a given proportion, as well as their difference of phase relative to the curve under analysis. The method employed by the author is that given by Prof. Pupin* in 1894. It consists in forming a reasonating

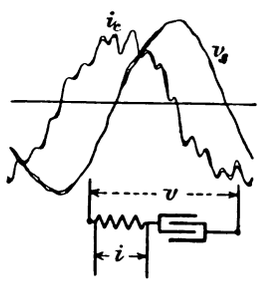

Fig. 12 (one-third scale).—Charging of a Condenser.
Capacity = 16 microfarads.
P.D. = 110 volts.
Resistance in circuit = 20 ohms.

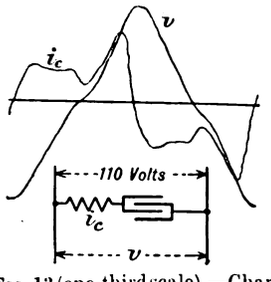

Fig. 13 (one-third scale).—Charging of a Condenser (Zipernowsky machine, without slots).
Capacity = 16 microfarads.
P.D. = 110 volts.
Resistance in circuit = 20 ohms.

circuit for each of the harmonics, using the recognised relation $n^2\omega^2 LC = 1$, with a variable condenser and capacity connected in series and as a shunt to the difference of potential to be analysed. If the resistance R of this circuit is sufficiently low when resonance is obtained for a harmonic of the order n, the impedance offered by the circuit to all the other harmonics is considerable, and the current passing through the circuit is exactly due to the nth harmonic, defined by the relations—$V_n = RI_n$; $\tan\phi = 0$. With an ondograph that has been calibrated beforehand, the instantaneous values of I_n can be recorded, and from them V_n may be deduced. In order to make sure of the reasonance of the harmonic, a determination is made of the theoretical value that must be given to the product LC, corresponding to the frequency; L and C are then added to satisfy this; finally, L and C are varied slowly in the neighbourhood of the theoretical value, until a thermal amperemeter placed in the reasonating circuit indicates the maximum current.

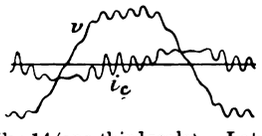

Fig. 14 (one-third scale).—Labour Alternator (old type), with 18 teeth per cycle, Ring.
P.D. between the terminals (v) = 95 volts.
Capacity current = i_c.
Capacity = 3·5 microfarads.
Resistance in circuit = 50 ohms.

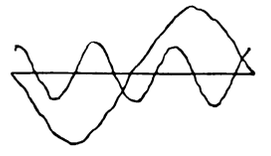

Fig. 15 (one-third scale).—Resonance of Third Harmonic.
Capacity = 2·45 microfarads.
Resistance = 6 ohms.
Self-induction = 0·76 henry.
Frequency = 40·4 ~ per second.

With the aid of the ondograph this resonance is confirmed by the amplitude and regularity of the sinusoidal curve, a curve which becomes deformed by the interference of the next harmonic. To show the lower harmonics, of which the amplitude is usually sufficiently great, the ondograph may be connected to the terminals of a non-inductive resistance placed in the resonating circuit. The curve traced by the ondograph is in phase with the harmonic.

The sensitiveness would not be sufficient for higher harmonics of small amplitude. It is, therefore, augmented by means of a device which consists in recording the difference of potential between the terminals of the self-induction instead of between those of a resistance placed in the circuit. Under these conditions a much greater P.D. is obtained, and the curve traced by the ondograph shows a difference of phase in advance from the actual harmonic to an extent defined by the relation $\tan\phi = n\omega \,.\, L\, R$. In practice, $n\omega L$ being very large and R comparative small, tan ϕ is also very large, and the curve recorded is thrown out of phase, showing a lead of a quarter of a period. It is therefore important to keep this phenomenon in mind when it is desired to reconstruct the fundamental curve synthetically.

It would also be possible to obt in a record of the higher harmonics by connecting the ondograph between the terminals of a capacity, in which case the curve traced would show a lag of a quarter of a period. It is, however, preferable to connect the instrument between the terminals of the self-induction in order to avoid the sparking at the brushes of the apparatus at the moment when the measuring capacity is shunted upon the resonating capacity, which charges it too suddenly.

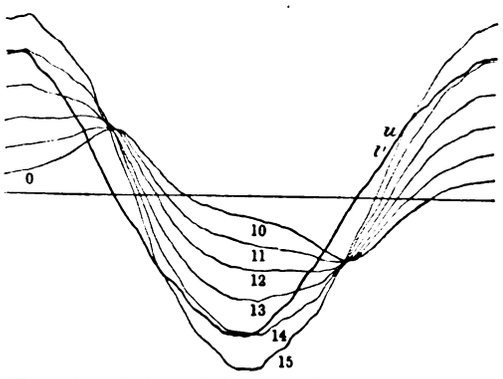

Fig. 16 (scale two-thirds).—Gaulard Transformer.

Figs. 12, 13 and 14 relate to the determination of the highest harmonics of a difference of alternating potential by means of the charging current of a condenser connected to that difference of potential. It will be seen from Fig. 13 that only the third and fifth harmonics are present, whereas the curve shows the 15th harmonic. Fig. 15 shows the third harmonic resonated, and so accentuated.

Transformers.—Fig. 16 illustrates the variations in the primary current of a Gaulard transformer, of which the secondary is connected through a gradually diminishing non-inductive resistance. The successive curves show the increase in the primary current accompanying the increase of charge in the secondary, as well as the diminution in the difference of phase.

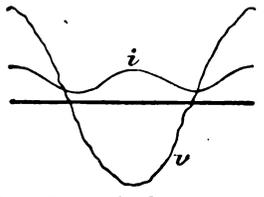

Fig. 17 (one-third scale).—Electrolytic Rectifier, connected up as a Wheatstone Bridge, supplying current to a resistance. Supplied by Secteur Rive Gauche.

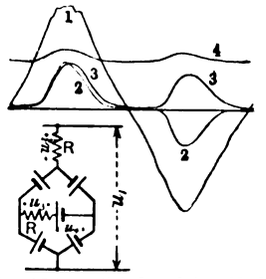

Fig. 18 (one-third scale).—Nodon Valve connected up as a Wheatstone Bridge, charging accumulators.
1 = P.D. of supply.
2 = Current.
3 = Current, rectified.
4 = P.D. of accumulators.
R.M.S. current = 11 amperes.
Mean current rectified = 9 amperes.

Electrolytic Rectifier.—Fig. 17 refers to a Nodon valve arranged as Wheatstone's bridge and working on a circuit consisting of a simple resistance. v is the difference of alternating potential supplied to the valve, and i the rectified current supplied by it. Fig. 18 relates to a valve feeding a circuit consisting of a battery of accumulators. Curve 1 is the primary P.D. and curve 2 the primary current. Curve 3 is the secondary current as rectified, whilst curve 4 is the P.D. between the terminals of the accumulators during the charge. From this it will be seen that charging takes place twice during each period.

It would be easy to multiply the number of curves showing the application of the ondograph to the study of the Wehnelt interrupter, the continuous-current arc, rectifiers, the oscillatory charge and discharge of condensers, polyphase currents, the simultaneous record of P.D., current, and power in an alternating circuit, &c.

Liner Struck by Lightning.—The Aberdeen Line steamer "Sophocles," whilst crossing the Bay of Biscay last week was struck by lightning, the main mast being damaged and the lightning conductor carried away.

* I. Pupin, "Resonance Analysis of Alternating and Polyphase Currents," Am. Inst. E.E., May 17, 1894.

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CORRESPONDENCE.

SINGLE-PHASE MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find in *The Electrician* of November 27th, p. 216, the complete specification of a British patent of Messrs. Winter and Eichberg, dated October 24, 1902, which relates, as you state, to the motor of the new system of single-phase traction introduced by the Union Elektricitäts Gesellschaft. I desire to correct this erroneous impression by remarking that this motor is none other than my single-phase series compensated motor referred to in *The Electrician* of July 24, 1903, p. 575. It is superfluous to examine the patent specification 23,288 to seek for the *compensated* single-phase motor. It suffices to refer to the *Industrie Electrique*, 1902, p. 220, first column, last paragraph, where I describe very clearly the excitation of a rotor provided with a commutator by means of a single-phase alternating-current (see French patent 306,229 of December 12, 1901) whenever two auxiliary brushes short circuited on one another are placed at right angles to the two brushes introducing the line current into the rotor.

In addition, my single-phase compensated motor, of either the series or the shunt type, admits of such a simple and brief description that I could not understand the reasons for elaborating a series of claims of such a general and varied nature as those of British patent 23,288, if the compensated single-phase motors were really intended to be covered by this patent. It is certain that my single-phase motor is interesting only because it is a *compensated* motor, and if this special quality is not desired, the simple repulsion motor (see *Electrician* July 10, 1903, p. 490) suffices to obtain all speeds without the use of external resistances.—Yours, &c., M. LATOUR.

Paris, Dec. 3.

STEAM TURBINES v. RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My friend Mr. Morcom has given you a table, of which I fail to see the value. He compares steam turbines with Belliss engines in respect of the cost of coal per unit, but he omits to state the cost of coal per ton, the calorific value of the coal, the kind of boilers in which the coal was consumed and the load-factor of the station. Under these circumstances it would seem to me to be almost as reasonable to saddle the dynamos with the differences of coal costs, and ignore the engines altogether.—Yours, &c., HENRY LEA.

Birmingham, Dec. 7.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to the bulk of Mr. Wilkinson's letter in your issue of November 27th, we need only refer to the previous correspondence. For the rest, we can assure Mr. Wilkinson that we have had a very large and satisfactory experience with high superheat in our reciprocating engines during recent years, and, as our customers know, have done a great deal of hard work in assisting to make the advantages of superheat practically possible.

We omitted Shipley, as we found that they were receiving steam gratis from the destructor works.

Mr. Wilkinson's suggestion that a trial should be made with the best examples of reciprocating engines and steam turbines, under ordinary central station conditions as to superheat and vacuum, is, in our opinion, a good one. The difficulty is to get such a prolonged trial made under impartial and useful conditions, but if any of the leading engineering associations are prepared to take the matter up in the interests of their members, we should be very pleased to lend an engine for the purpose.

Mr. H. Barker says that Mr. Parson's table for vacuum effect in turbines is wrong. Possibly Mr. Barker is wrong. We used the table given in Mr. Wilkinson's Paper to refute Mr. Wilkinson's conclusions, but the point is a fine one, and does not affect the position. Mr. Barker and Mr. Campbell Swinton, in your issue of the 4th inst., attack the examples given by us to show the great inferiority of the steam turbine in actual work, and Mr. Barker constructs a table by inserting some excellent figures which he has obtained from the Newcastle-on-Tyne Company, to which Mr. Campbell Swinton also refers. We presume these figures are for the 12 months' work up to date, and are not yet available to the general public. But surely it is unfair to make such a comparison, as both these gentlemen must know very well that returns for the same period from the bulk of the reciprocating engine stations will show improvements, and possibly equally great improvements, as compared with the last published returns. We have, however, now obtained a copy of the Newcastle-on-Tyne return, and it is interesting to compare it with the return for about the same period of one of the best-equipped and managed reciprocating engine stations—namely, Leeds. The figure given by Mr. Barker—viz., 0·38—if correct, is for the station costs per unit generated, but all the figures for costs in the *Electrical Times* analysis are per unit sold. This is a very different matter, there being a difference of nearly 20 per cent. on the average between these figures.

The figures from the returns and the chairman's speech are as follows:—

	Total units sold.	Cost of production.
Newcastle-on-Tyne	5,011,300	£12,587 5 8
Leeds	4,448,650	11,524 5 4

To this should be added the cost of distribution for Newcastle-on-Tyne to the extent of 2,412,318 units. Adding the above percentage for distribution to the Newcastle costs above, we get a figure of works cost 0·706 for Newcastle, against 0·62 for Leeds.

When it is taken into account that the Newcastle-on-Tyne load-factor (which Mr. Barker takes care not to mention) is probably double that of Leeds, it will be apparent to the majority of electrical station engineers that the Leeds results are much the better of the two. Moreover, a large portion of the work covered by the Newcastle return will have been done by reciprocating engines, about equal in power to the steam turbines, which latter have only recently been set fully at work in the station.

Mr. Barker's table, as it now stands, includes this unpublished semi-reciprocating engine station result on his own side, and drags in Yarmouth to compare with Scarborough to blacken the reciprocating engine record on the other. From the "Central Station Directory" we abstract the following:—

Yarmouth—Welsh coal through and through used for fuel.

Scarborough—Steam coal and smudge used for fuel.

And yet Mr. Barker objects to our use, in a general sense, of the word "quibbling." We were quite aware of the inequality in the load-factors pointed out by Mr. Campbell Swinton, and surmised that it might be due to anxiety on the part of the turbine stations to hold a big margin of spare plant to meet the risks due to stripping of the blades and other difficulties inherent to their system. They appear, anyhow, to have been able to develop a special maximum power on some particular occasion considerably in excess of their average power, but the load-factor, as calculated from the tables, has no very close bearing on the relative economies, as anyone can see by a careful study of the tables. For example, take the two stations—Cambridge and Scarborough—referred to in Mr. Campbell Swinton's table (in fact he is the managing director of both). Cambridge has the smaller output and the smaller load-factor, and although it has probably to use as dear a coal as Scarborough, its consumption runs out to 0·66 only, as compared with 0·85 for Scarborough.

We took trouble with our table to put the matter reasonable fairly on both sides, and, as we have said before, we might have given 38 reciprocating engine stations showing an average of 0·41 for fuel cost, instead of the seven selected stations with 0·51 cost. There is, however, no reason for your readers to accept our table or that of any other interested person. At the cost of a few pence they can buy an electrical paper with the full tables in, to draw their own conclusions from. In doing so we would ask them to bear in mind that steam turbines are at their best when new, and that there is a very quick limit to the possible improvement in the design of the steam turbine, though the machine itself is still very experimental. In this connection Mr. Wilkinson's remark that "every steam turbine station in our list, except one was, at the

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time covered by the figures given, employing obsolete turbine plant" is a very ominous one, especially as our list included nearly all the stations using steam turbines. The clearance difficulty is very real, especially with plant under 2,000 H.P. or 3,000 H.P., and the experience with larger plant is very limited at present. The fact that two immensely wealthy American firms have adopted steam turbines as their standard for high-speed running only shows that America has hitherto had no effective standard high-speed engines, and have probably assumed that in the steam turbine they will secure an engine capable of considerable improvement. They may very easily be mistaken. The 200,000 H.P. or 300,000 H.P. ordered only shows that these two firms have large financial control, and are able to secure orders. The wise man will wait till the experience comes.

In first cost, the temptation to take the steam turbine for large sizes is great, but in the end the machine may prove much more costly than the well-tried reciprocating engine.

In conclusion, we can only say that, if in the opinion of your readers we have argued too strongly in favour of the reciprocating engine, we have done it without any manufacturing bias, as we are prepared to build steam turbines of any size, as soon as we have determined that it is advisable in our own interests (which include satisfaction to our customers) to do so.—Yours, &c., ALFRED MORCOM, Managing Director.

Birmingham, Dec. 8. (Belliss and Morcom, Ltd.).

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Wilkinson states in his letter, published in your last issue, that "it is an undoubted fact that turbines give no trouble when working with superheated steam," and further on he mentions West Bromwich as a station where the turbine plant has the distinction of being not obsolete. Now, I have information that at a station not very far from West Bromwich about a fortnight ago about one-fourth of the total number of blades were stripped off one of the turbines, that the trouble was attributed to superheated steam, and that the blades are to be replaced by others of a metal specially adapted to withstand the effects of superheat. I also know of the same thing having happened not long since at another station, the failure being again attributed to the use of superheated steam. At this station reciprocating engines were in use as well as steam turbines, and when subsequently, extension sets were required, reciprocating engines were installed. I have also heard of the blades being stripped off a large turbine in the States where superheated steam was in use.

Those sort of experiences are not, as a rule, published in the papers; indeed, it seems almost indecent to drag them into light, but if without any special sources of information I have heard of three different instances of trouble with superheat, no doubt others have occurred which have not come to my knowledge.

Perhaps Mr. Wilkinson might say as to experiences he has had with blades being stripped off the turbines at his station.—Yours, &c., RECIPROCATING ENGINE.

Dec. 8.

[We have made inquiries and learn that our correspondent's statement is correct. All but 17 rows of blades were stripped off one of the turbines at the West Bromwich electricity works, and 23 rows were stripped off another machine at the same station.—ED. *E.*]

THE GILBERT TERCENTENARY.

Yesterday was the three-hundredth anniversary of the death of Gilbert, the eminent Elizabethan physician and philosopher. Largely by the efforts of Prof. Silvanus P. Thompson, F.R.S., his work, "De Magnete," was translated from the original Latin and published by the Gilbert Society, and our readers are already familiar with the nature of this classic and of Gilbert's investigations into the phenomena of electricity and magnetism from our review of this book and our report of a lecture recently delivered by Prof. Thompson before the Royal Geographical Society this year (*The Electrician*, Vol. XLVIII., p. 697 and Vol. L., p. 1,021). Last night, to commemorate the tercentenary, a fine painting by Mr. A. Ackland Hunt was presented by the Institution of Electrical Engineers to the Mayor and Corporation of Colchester, Gilbert's native town. It represents Dr. Gilbert (who was President of the Royal College of Physicians, and physician to Queen Elizabeth) showing his electrical experiments to the Queen. This picture was exhibited in the Manchester Exhibition in 1876, and a private subscription was promoted this year to buy the picture and present it to the town of Colchester. Prof. Thompson and Mr. Conrad W. Cooke acted as honorary secretaries, and contributions were given by present and past members of the Council of the Institution of Electrical Engineers.

On p. 288 of this issue we publish a reproduction of the picture and also extracts from Gilbert's book, with notes by Prof. Thompson, which were presented to members attending the meeting last night. In addition to these, an interesting biographical pamphlet has been prepared by Prof. Thompson, in which many interesting notes with regard to Gilbert himself and his life are included. This pamphlet has been distributed to a number of medical men who are interested in Gilbert as one of the earliest physicians who helped to raise the medical profession to its proper status by his championship of the experimental method and his vigorous denunciation of shams and quackery.

The Mayor of Colchester (Mr. E. H. Barritt) and three ex-Mayors, Aldermen Marriage and Laver and Councillor Benham, with the Town Clerk (Mr. H. C. Wanklyn) were present on behalf of the town to receive the painting at the hands of Mr. Robert Kaye Gray, the President of the Institution. The Mayor of Westminster, Sir Wm. Huggins (President of the Royal Society), Sir Dyce Duckworth, M.D. Treasurer of the Royal College of Physicians (of which Dr. Gilbert was at one time President), and Dr. Larmor, F.R.S., of St. John's College, Cambridge (Dr. Gilbert's college), were also present, in addition to nearly all the Members of Council of the Institution and a large attendance of members as well as other guests.

In opening the proceedings, Mr. Gray said:

They had met that evening to ask the Mayor of Colchester to be kind enough to accept, in the name of the Institution, the picture which was before them. They all knew something about Dr. Gilbert, but he would leave it in the hands of somebody else—Dr. Silvanus P. Thompson—to more adequately explain the circumstances of the presentation. Both Dr. Thompson and Mr. Conrad Cooke, who were secretaries of the Gilbert Society, had worked very hard in commemorating the work done by Gilbert.

Dr. SILVANUS P. THOMPSON, F.R.S., first read a portion of a letter he had received from Lord Kelvin, who regretted having been detained in Scotland, and he sent his apologies to all. He also stated that Mr. Ackland Hunt, the painter of the picture, wished it to be made known that he had spent many years in the work of the picture as a labour of love, and that he had worthily laboured to be faithful even to the best that could be done in the way of portraiture to bring back the episode it commemorated. Continuing, he said that electricians owed an enormous debt of gratitude to Dr. Gilbert. There were many great men famous in the time of Queen Elizabeth, but for electricians, Gilbert stood pre-eminent. There were statesmen before Cecil, naval heroes before Drake, explorers before Rayleigh, dramatists before Shakespeare, poets before Spenser and philosophers before Bacon, but before Gilbert there was no electrician. He was the absolute founder of the science, and he claimed admiration not only as the founder of electricity, but also as the founder of another science—viz., terrestrial magnetism, upon which he had spent £5,000, according to Harvey (or, according to Decarte, 5,000 crowns), and the greater part of his activities. Prof. Thompson then showed the identical copy of Gilbert's book on the subject, which the author had presented to Lancelot Brown, another royal physician to Queen Elizabeth. In his theory of terrestrial magnetism, Gilbert had set forth the new and unheard of idea that the earth was itself a great magnet, and during his experiments he stumbled upon amber. Further, not only did he found the science of terrestrial magnetism, but another science, astronomy, owed much to him. Therefore it was fitting that there should be present members of these societies whose sciences Gilbert had advanced. These representatives they were delighted to see. One fact must not be forgotten. Like Lancelot Brown, Gilbert was a Fellow of St. John's College, Cambridge. He was even mathematical examiner and senior burser. There was ample evidence on this point. Anything would be incomplete without saying that Gilbert was born at Colchester on May 24, 1544, at 2:30 p.m., in a house which was still standing, and to which he returned in his later years, and for aught we knew, died there. That house was the very Mecca to which all electricians would make a pilgrimage, and within a short distance of it lay his bones. In the new church there was a fine heraldic monument

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to his memory which recorded his virtues and his career. In conclusion, Prof. Thompson said he had tried to tell the tale of the hero at whose shrine they worshipped, and he hoped many of them would have the opportunity of repairing on a pilgrimage to Colchester, that they might worship at Gilbert's tomb.

The PRESIDENT then made the presentation withthe following words:—"Mr. Mayor of Colchester, I have now to ask you, in the name of the Institution, to be kind enough to accept and keep in your safe keeping for your town and Corporation, the picture which you see before you."

The MAYOR of COLCHESTER (Mr. Baritt), in thanking the Institution in the name of his town, said that 27 years ago (at the age of 13) he learnt to reverence the name of Gilbert, and obtained a prize for electricity and magnetism. He remembered his first revolving plate electrical machine, and had taken even more interest in watching the glass plate revolve than in watching the large wheel of the 550kw. generating set at the Colchester electricity works. He remembered his first Leyden jar, his difficulty in fixing the inner coating of tinfoil, and how he finished the apparatus with a wire and wooden knob covered with foil. He remembered his battery of six Leyden jars, he remembered his first shock from them, and then for a time he remembered little more. He little knew how all these things played their part in qualifying him for the post of chairman of the Electricity committee, and that finally, as Mayor of Colchester, he should take part in the ceremony of that evening. Colchester had learnt to reverence the name of Gilbert, and the painting should find a fitting place on the walls of the Colchestor town hall, which henceforth should become its home.

After a few words by the Mayor of Westminster and Sir Dyce Duckworth (treasurer of the Royal College of Physicians), the proceedings terminated, and M. Hospitalier read his Paper on the "Ondograph," which will be found elsewhere in this issue.

LEGAL INTELLIGENCE.

Knight v. Isle of Wight Electric Light and Power Co. (Ltd.).

In the Chancery Division Mr. Justice Joyce resumed the hearing of this action, which was brought by Miss A. E. Knight for an injunction to restrain defendant company from so carrying on their works at Ryde, Isle of Wight, as to interfere with her business or to cause a nuisance to plantiff or the persons inhabiting or frequenting St. Boniface College. Damages and costs were claimed. The facts of the case appeared in our last issue.

Mr. WAGGETT, following Mr. Younger, K.C., for defendants, submitted that the Court would not interfere where the nuisance was connected with the construction of public works, and was of a temporary and occasional character only.

Mr. Justice JOYCE: Do you consider your evidence has proved there must necessarily be a nuisance occasioned until the works have been in operation, say, for six months.? Of course, you cannot be justified in doing anything which is a nuisance except it be necessary.

Mr. WAGGETT said the evidence showed that what had been done was incidental to construction and the Electric Lighting Act of 1882 gave defendants an indemnity as to that. The evidence was very conflicting—what plaintiff called a maddening noise, witnesses for the defence described as the "hum of a bee in a battle."

Mr. Justice JOYCE: Are you entitled to disturb Miss Knight with the hum of the dynamo?

Mr. WAGGETT said his case was that the plaintiff did not hear the hum of the dynamo except by listening for it, and that the smells emitted from the works were of a very faint character, and had now been practically cured.

Mr. Justice JOYCE said that the smells which had been cured must have been caused by the ignorance of the defendants, and that was their mi fortune.

Mr. WAGGETT said they were unavoidable in connection with the starting of the works, and everything had been done by the defendants to diminish them as speedily as possible. The plaintiff must submit to the sound of lawful works being conducted in a proper way. She was not entitled to the quiet of a cloister. The engines of the defendants were not yet out of the hands of the makers, and whatever noise there was would be cured next week.

Mr. Justice JOYCE: My present impression is that these works can be carried on, if you will only go to the expense, without causing the nuisance. It must be taken there was annoyance at one time. Why could not the nuisance have been avoided in the way that has been done since?

Mr. WAGGETT said the engine was of a new type, and defects which could not have been foreseen made themselves known from time to time, and had to be cured by degrees. If during the construction of the works there was annoyance to the plaintiff, he submitted it was of such a character that the plaintiff had no relief by injunction. It was suggested that his lordship could make an order declaring that it was a proper action for an injunction, but that as the nuisance complained of had been abated since proceedings had been instituted, no injunction should be granted, but that plaintiff should have liberty to apply at any time should the nuisance be renewed. At the conclusion of his address Mr. Waggett, at the request of his lordship, handed up a list of the alterations made and proposed to be carried out at the electricity works.

The case was then adjourned until Tuesday, Dec. 15.

Re Ferranti Limited.

In the Chancery Division on Saturday, Mr. Justice Joyce had before him the action of Poole v. Stirling and Ferranti Limited, which came on as a motion for judgment.

Mr. VERNON, for plaintiff, said the action was brought by debenture stockholders to enforce their security. The defendants, Messrs. Stirling and Jones, were trustees for stockholders. Parr's Bank was second encumbrancer, and held a debenture for £30,000, ranking after the debenture stock. Messrs. Stirling and Jones consented to judgment, as did the bank, but the company had not put in a defence. The debenture stock (£100,000) was issued in November, 1901. The security had not yet become enforceable, and no interest was in arrear, but the company was insolvent and unable to pay its debts.

His Lordship made a declaration that the trusts of the debenture stock deed should be carried into effect, and directed the usual accounts and inquiries to be taken.

Geipel v. Manchester Corporation,

In the Chancery Division, on Wednesday and Thursday, Mr. Justice Swinfen Eady commenced the hearing of this action, which was for damages for an infringement of plaintiff's patent for improvement in steam traps. The alleged infringing articles are said to have been used at certain electricity generating stations in Manchester. The defence was that plaintiff's letters patent were invalid, and that the invention was not new at the date of the letters patent.

After technical evidence had been taken his lordship reserved judgment until to-morrow (Saturday),

Commission Agencies and Trade Custom.

At Bradford County Court, last week, before Judge Bompas, Mr. T. W. Mitchell, trading as T. Mitchell & Co., agonts and consulting engineers, at Bradford, sought to recover £25 from Messrs. Whitehead Bros., Farsley, commission alleged to be due upon the sale of certain furnace bars. Plaintiff also claimed to have an account taken between himself and defendants with respect to commission due to him on the sale or on the repeat orders of all furnace bars made by defendants in Yorkshire. For some time plaintiff was agent for defendants for the whole of Yorkshire, and he received a commission for all work done through his agency in the county, direct or indirect. In June last his engagement terminated, and he claimed commission on all repeat orders in Yorkshire obtained through his introduction and since the termination of his engagement. It was argued that trade custom gave an agent a right in perpetuity (unless the contrary was stipulated in an agreement) to commission on all business obtained through his introduction, and several local commission agents gave evidence in support of this contention. Plaintiff contended that he initiated the business, but defendants asserted that, as plaintiff did not carry the negotiations far enough to establish relationship between buyer and seller, the claim for commission could not be sustained. As a matter of fact, that relationship was established through the efforts of defendants themselves.

His HONOUR held that the work was executed after the termination of the agreement between the parties, and that the claim could not be sustained. He gave judgment for defendants, and declined to make the account asked for.

National Telephone Co. v. Phelps.

Before Mr. Justice Farwell, on Friday last, Mr. UPJOHN, K.C., said in this case an injunction had been granted ex parte to be continued until that day, and it was now proposed that it should be continued till the trial. The defendant claimed the right to disconnect a cable of the National Telephone Co., which served some 66 subscribers, and if that were done considerable public inconvenience would arise.

Mr. JENKINS, K.C., for defendant, suggested that the case should be put in the witness list. The only issue was whether plaintiffs were entitled to maintain a certain cable and any apparatus that might be connected therewith upon certain premises.

The case was ordered to be set down in the witness list.

Smith v. Cheltenham Light Railway Co.

At Cheltenham County Court last week a local solicitor (Mr. H. H. Smith) sued the Cheltenham and District Light Railway Co. for £1, fare paid and damages for inconvenience and annoyance caused through breach of contract to carry him. It appeared that plaintiff took a tramcar to go to the top of Cleeve Hill on Nov. 11, but, owing to a breakdown, the car did not get beyond Prestbury, and plaintiff had to continue the rest of the journey (2¼ miles) on foot. For the company the breach of contract was admitted, and 3s. 5d. was paid into court, with a denial of further liability; it was contended that damages for mere inconvenience could not be recovered.

Judge ELLICOTT upheld this view, and non-suited plaintiff, the money in court to be returned to the company, and plaintiff to pay costs.

Smithfield Club Show.—This important annual agricultural fixture, which attracts the country gentleman and the principal members of the farming class to North London, remains open at the Agricultural Hall, Islington, till to-day (Friday). There is little at the show of special interest to our readers, but we may mention as exhibitors the following:—Crossley Bros., stand No. 3, ground floor; John Fowler & Co., stand 27, ground floor: Newton Electrical Works, stand 18, ground floor; S. E. Norris & Co., stand 264, Berners gallery; Ransomes, Sims and Jefferies, stand 5, ground floor; and W. H. Willcox & Co., stand 221, arcade gallery. In each case a good show of the manufactures of these exhibitors is made. The almost complete absence of anything electrical at the show is very noticeable.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Sanitary Commissioners of Gibraltar require an assistant electrical engineer. Salary £200, increasing by annual increments of £10 to £250 per annum. Applications by Dec. 16 to Mr. William Wallace Copland, secretary and engineer, Sanitary Commissioners' office, Gibraltar. See also advertisement.

An electrical engineer is required, capable of taking charge of drawing office and designing continuous-current and three-phase motors, generators and ship-lighting switchboard. See advertisement

A cable jointer is wanted by the County of Durham Electrical Power Distribution Co., Gateshead, accustomed to three-core cables laid solid. Applications to power station, South Shore-road, Gateshead. See advertisement.

Two shift engineers are wanted to take charge of an eight hours shift, with experience in continuous-current three-wire station Application to Mr. John H. Wray, manager, Electricity Works West Bromwich. See advertisement.

Fulham Borough Council requires a shift engineer. Applications to Mr. Arthur J. Fuller, Electricity Works, Townmead-road, Fulham, London, S.W., by Dec. 12.

Boston Corporation require a borough surveyor and electrical engineer. Salary £300 per annum. Applications by Dec. 18.

Mr. S. Whitehouse of West Bromwich has been appointed substation assistant at Walsall, in place of Mr. B. Walker, resigned.

Mr. A. Kettles, superintendent of the instrument room at Glasgow Post Office, has been appointed chief superintendent of telegraphs at Glasgow in place of Mr. Boldchild, who retired from the service last month.

Capt. R. S. Walker, R.E., has been appointed Professor of Experimental Science at Royal Military Academy, Woolwich, from Jan. 25, in succession to Major W. P. Brett, R.E., who has been ordered to India to take over the command of the corps of submarine miners.

Mr. C. Dale has been appointed engineer-in-charge at the Belfast electricity works.

Acton.—Two notices of intention to apply for provisional electric lighting orders have been received by the Council, one from the Metropolitan Electric Supply Co., who propose to supply current from their Acton works. The Council have also received a communication from the Metropolitan Company's solicitors (Messrs. Barlow and Barlow), in which the advantages to be derived from entering into an arrangement with the company for the supply of energy are pointed out. After discussion, it was last week decided by the Council, by eight votes to four, to open up negotiations with the Metropolitan Company, and a sub-committee was appointed, in conjunction with the consulting engineer, Mr. W. H. Trentham, to conduct the negotiations.

Army Traction Engines.—Messrs. R. Hornsby & Sons have received official intimation from the War Office that their engine has won the first prize of £1,000 and bonuses amounting to £180 in the open competition for military tractors. (Full particulars as to the tenders for these engines have appeared in *The Electrician.*)

Messrs. Hornsby were the only firm to produce an engine that could accomplish all the War Office requirements. Their engine is an oil tractor, propelled by an oil engine of the Hornsby-Akroyd type, constructed on the lines of an ordinary traction engine, spring-mounted at both ends, and fitted with the usual speed change gears. Its weight with fuel and water does not exceed 13 tons. During the trials the tractor hauled a gross load of 25 tons a distance of 40 miles at an average speed of 3 miles per hour, over ordinary roads and hills, without a fresh supply of fuel or water. The engine also acquired a speed of 8 miles an hour, and actually travelled 58 miles without renewing its supply of fuel and water. The bonus of £180 was secured, with a margin of £10 per mile over the 40 miles stipulated in the War Office conditions.

Ashton-under-Lyne.—Negotiations are proceeding between the Tramways committee and the Stalybridge, Hyde, Mossley and Dukinfield Joint Electricity and Tramways Board for reciprocal running powers over the electric tramways in these districts.

Balby-with-Hexthorpe (Yorks.).—The District Council have asked the Yorkshire Electric Power Co. to quote terms for supplying electric current in the district for lighting and power.

Barking.—The accounts of the electric lighting department for the year ended March last have been issued and show capital expenditure £40,447. 17s. 10d., an increase of £11,506. 5s. 6d. during the year. The revenue from sale of current for private lighting was £2,969. 8s. 8d., public lighting £2,269. 6s. 4d., and, with meter rental and miscellaneous receipts, the total was £5,648. 5s. 5d. Generation expenses were £2,102. 3s., cost of distribution £133. 18s 9d., maintenance of public lamps, &c., £581, rents, rates and taxes £203. 2s. 9d., management expenses £453. 18s. 10d., and with special charges of £33. 11s., the total was £3,507. 14s. 4d., leaving gross profit £2,203. 0s. 8d. Interest absorbed £1,065. 5s. 6d., sinking fund instalments £1,105. 14s. 2d., and after wiping off bad debts (£12. 18s. 9d.) there was a balance profit of £19. 2s. 3d., compared with a deficit of £273. 12s. 7d. in the previous year. 443,684 units were generated, 167,146 supplied for private lighting, 182,478 for public lighting and 71,978 used at works. The total maximum demand was 250kw.

Battersea (London).—On Wednesday the Council decided to apply to the London County Council for a loan of £3,845 for electric lighting extensions. Battersea Council have offered to supply electricity to Wandsworth Council for lighting the eastern portion of Nightingale-lane at £16 per arc lamp per annum.

Bethnal Green (London).—The Council have decided to take up a loan of £15,750 at £3. 15s. per cent. for acquiring a site for electricity supply work.

Bournemouth.—The net profit on the municipal electric tramways for the September half-year amounted to nearly £7,000.

Brighton.—On the recommendation of the Tramways committee to accept the tender of Dick, Kerr & Co. for 10 tramcars at £5,100, and that of the Brush Co. for 10 tramcars at £5,085, a discussion arose last week. It was stated that the Brush Co.'s original tender was not to specification, and that the company had submitted an amended tender. Ultimately it was decided to give the order for the whole of the 20 cars to Dick, Kerr & Co.

The expenses in connection with the recent issue of £600,000 Corporation Redeemable Stock amounted to £11,568. 7s. 4d., and the actual sum received, owing to the issue at a discount, was £548,972. 17s., the cost of raising the sum needed thus being £51,027. 3s.

Buenos Ayres.—The Municipal Council have granted a 50 years' electric tramway concession to Messrs. Doll and Salazar, on condition that current is taken from the proposed municipal generating station.

The Municipality are experimenting with electric in place of horse ambulances for the Assistencia Publica. The car on trial is of United States make.

It is reported that the National Government has submitted a bill to Congress for placing telephone companies under the jurisdiction of the Post Office, which will have a right to intervene on the question of tariffs. The Buenos Ayres Municipality also proposes to intervene in the tariff question, which seems to be exciting some local interest.

The Corporacion Comercial Sud-Americana has offered, on behalf of certain London bankers, to make a loan of $16,000,000 gold to the municipality of Buenos Aires for erecting municipal electricity works. The loan is to be provided by the issue of bonds (bearing 6 per cent. interest and amortisation of 1 per cent.) at 85. The directors of the corporation, which was formed locally with a capital of $100,000 gold, are Messrs. J. S. Dillon, M. G. Fortune, J. Etchegaray, W. C. Hoard and W. T. Damon.

Camberwell (London).—The Board of Trade have upheld the appeal of the County of London Electric Lighting Co. against a decision of the Borough Council imposing the following conditions in reference to placing a transformer box :—

Subject to any disturbance of the footway or roadway being made good to the satisfaction of the borough engineer, and subject to an undertaking by the company that, should the site or any portion thereof or the works connected therewith be required for public purposes, the company will pay the cost of removal or of any alterations.

These conditions have, therefore, been disallowed.

The Council on Wednesday agreed to consent, if the London County Council take over the London Southern Tramways, to the working of the lines on the overhead system, and to the doubling of the track where necessary. A contribution of one-third of cost of requisite street widenings is also to be made in connection with the proposed tramway from Lordship-lane to Forest Hill.

Canal Lighting.—The Deputy Minister of Canadian Railways and Canals (Mr. Collingwood Schrieber) recently announced that the Government proposed to light the Welland Canal by electricity from end to end.

Cardiff.—The Cardiff Railways Co., who are considering the question of supplying their tenants at the Docks with electric current for lighting and power, have distributed circulars to ascertain the probable demand.

Chesterfield—In moving the adoption of the minutes of the Electric Light committee on Tuesday, Councillor C. P. Robinson said they recommended that the scheme of the borough electrical engineer (Mr. R. L. Acland) for the extension of the works at an estimated cost of £5,680 be carried out :—

The demand for current was steadily increasing, and the maximum demand on the previous Saturday was 325kw., compared with 266kw. on the corresponding day last year. They were told that they might soon expect it to be 350kw. The total units sold for the year ended March were 209,000, while this year Mr. Acland estimated they would amount to 350,000. As they had the tramways to provide for, they recom-

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mended putting down an additional 400kw. of plant If they put down this plant the capacity of the station would be 1,000kw., and would have cost them about £50,000, which worked out at £50 per kilowatt. At Sheffield it was £120, and at Nelson, a town similar to Chesterfield, £100. There were very few towns where the capital cost was less than at Chesterfield. It was decided to promote in Parliament the Chesterfield Corporation Tramways and Improvements Bill.

Clacton.—The Council have obtained an extension of 12 months for complying with the terms of their provisional electric lighting order 1900.

Crete.—In the Crete *Official Gazette* of Sept. 28 tenders were called for the establishment of a telephonic system on the island, which were to be sent in by Oct. 23. This time has been found insufficient, and the matter is therefore in abeyance.

Customs Decisions.—A duty of 12½ per cent. ad val. has been fixed by the Australian Commonwealth on imported zinc plates cut to size for electrical purposes.

Dumfries.—As the result of a further discussion on electricity supply, the Council have decided to invite offers from companies for the purchase of the Dumfries electric lighting order, 1899.

Ealing.—In the last report of the business manager (Mr. Lewis) it is stated that the output of the electricity works for the September half-year showed a considerable increase over the corresponding period last year, and that the total costs for the half-year were 0·23d. per unit lower, despite the increase in rates from £198 to £617. The financial result for the half-year ended Sept. 30 compared favourably with that for 1902.

Eastbourne.—The borough electrical engineer (Mr. J. K. Brydges) has been instructed to report as to the cost of laying electric lighting mains to Willington. At the end of the September half-year, the equivalent of 59,610 8 c.p. lamps was connected to the mains, compared with 50,872 at the corresponding period last year. The units sold were 419,443, compared with 314,418.

Electric Lamps.—At a meeting of the London Association of Foremen Engineers and Draughtsmen on Saturday, the president (Mr. A. W. Hill) in the chair, two Papers were read. The first was by Mr. A. E. Angold on "Arc Lamps," and the second by Mr. J. Harrington on "The Manufacture of Electric Incandescent Lamps." The latter Paper gave a general survey of present and prospective methods of electric lighting.

Mr. Angold traced the early history of the arc lamp up to the present time, and gave a detailed account of the new "Maxim" arc lamp. Some of the complete lamps were shown running besides various detached portions.

Dealing with the manufacture of incandescent lamps, Mr. Harrington described this process from the mixing of the cellulose to the stamping of the lamp. By the aid of diagrams the many highly-interesting details in the manufacture of an incandescent lamp (as carried out by the Sir Hiram Maxim Electrical and Engineering Co. at their Gillingham-street works) were explained. Accounts were given of trials made upon various types of electric lamps, finishing with a display of vacuum tubes containing various gases.

Electric Railway Signalling.—Some time ago we gave a full technical description of the Miller system of railway signalling. The British Miller Signal Syndicate have now prepared a small pamphlet for general distribution, which will prove of interest to electrical engineers and others taking an interest in this branch of electrical work.

Electric Traction in Australia.—The Royal Commission appointed in March to inquire into the working of the South Australian Railways recommend the Government to obtain a report and estimate of the cost of electrifying the suburban railway services from a competent electrical engineer.

Exhibition.—Preliminary steps have been taken for organising an exhibition in Dublin in 1906, and an endeavour is to be made to find guarantors for £200,000, which is the sum estimated to be required.

Fire.—At midnight on Dec. 2 a fire was discovered at the new works at Beeston, Notts., of the British L. M. Ericsson Mfg. Co. (Ltd.), by which considerable damage was done to the works, which were on the point of completion, and to their contents. No delay will, however, occur in the despatch of orders in hand, as the conflagration was chiefly confined to the works department, and did not reach the large stock of manufactured goods. All contracts in hand will consequently be dealt with expeditiously. The cause of the fire has not yet been discovered. It is anticipated that the greater portion of the works will be in full running order by the end of next week. No accident or loss of life occurred.

Foundry Lighting.—Messrs. Lowdon Brothers & Co., Dundee, have supplied electric lighting plant to Hillside Foundry, Cupar Fife.

Fulham (London).—At the Council meeting on Wednesday, the electrical engineer (Mr. A. J. Fuller) reported that the output of the station is now double that of a year ago.

German Electrical Engineering Amalgamation.—We have already referred to the absorption of the Union Elektricitäts Gesellschaft, of Berlin, by the Allgemeine Elektricitäts Gesellschaft. The capital of the latter company is to be increased to £3,500,000 to carry out the purchase, and shareholders of the Union Company are to receive two Allgemeine shares for every three Union shares.

Glasgow.—The Electricity committee recommend an extension of the generating stations at Port Dundas and Pollokshaws-road.

Golcar (Yorks.).—The Council formally resolved on Tuesday to proceed with their application for a provisional electric lighting order.

Greenwich (London).—The Borough Council resolved on Wednesday to object to the proposals of the London County Council to erect a generating station abutting on Old Woolwich-road and Hoskins-street.

Heckmondwike.—For Christmas illuminations the Council will supply electric current to tradesmen at 3d. per unit.

Halifax.—The borough electrical engineer (Mr. W. M. Rogerson) has been authorised to make arrangements for supplying electric current to Messrs. Jaggers Bros.' stone quarries at Crow Point, Queensbury, for both lighting and power.

Hove.—The Council have decided not to enter into negotiations with the British Electric Traction Co. for the extension of the tramway system of the Brighton and Hove Co. from the existing terminus at Hove boundary and Aldrington to the railway station at Hove.

Hucknall Torkard.—A special committee has been appointed to report upon the question of erecting electricity supply works.

Huddersfield.—On Tuesday the Corporation decided to apply for a provisional order to supply electricity in Golcar.

Hull.—The Tramways committee, who have been making inquiries into the most suitable type of cover for the electric tramcars, have decided to fit 15 with the Kennington collapsible car cover.

Infirmary Lighting.—Messrs. Falconar, Cross & Co., Newcastle-on-Tyne, recently completed the contract for the electric lighting of the new Newcastle-on-Tyne infirmary. The work has been executed to the specifications of Messrs. Dolby and Williamson.

The installation includes, besides motors for driving the various machinery, over 2,000 incandescent electric lamps, a complete system of telephones, electric bells and fire alarms, electric clocks, and electro-medical appliances. Current will be supplied by the Newcastle and District Electric Lighting Co. The laundry, kitchen and other machinery will be driven electrically, as will be also the lifts, and there will be a complete system of ventilation by electric fans. The whole of the wiring is being done in smooth-drawn welded steel tubes, fixed together with screwed unions. Most of the tubes are sunk beneath the plaster work. The electro-medical appliances include apparatus for the electric treatment of various diseases by the application of X-rays and light. There will be about 50 electric clocks spread over the building, all controlled from a master clock.

Islington (London).—At last week's meeting of the Council a communication from the Finance committee of the London County Council drew attention to the desirability of a sinking fund for renewing and replacing machinery being provided by those bodies who had taken up loans for electricity supply for 42 years. £388,081 had been borrowed for that period by Islington, and up to March 31 last only £20,646 had been paid off. Under those circumstances the committee regarded the creation of a reserve fund as desirable in the interests of finance, and invited the opinion of the Borough Council on the subject. It was agreed to refer the matter to the Lighting and Finance committee for report.

Application has been made to the County Council for a loan of £1,100, estimated cost of service lines, &c., up to March 31 next. Various extensions of the electric lighting mains to give supply for power were authorised last week.

The Works committee, which had had under consideration the system of traction to be adopted on the North London tramways, recommended the Council to adhere to their decision in favour of the conduit. Finsbury, Hackney, Shoreditch and Stoke Newington Councils were said to hold the same view upon this question.

Kirkcaldy.—The proposed extension of the Corporation tramway system from Dysart terminus to the town of Leven is under consideration.

Lecture.—Prof. T. Hudson Beare, of Edinburgh University, will deliver the Watt lecture on Jan. 22.

Leeds.—The Traffic sub-committee of the Tramways committee propose to equalise the length of tramway stages throughout the city, so as to bring the fare to 1d. for 2 miles.

London County Council.—At Tuesday's meeting loans for electric lighting were granted Hampstead (£14,145), St. Pancras (£10,000) and Stepney (£1,902).

Pimlico Generating Station.—The Highways committee recommended an expenditure of £64,000 for the purchase of property at Pimlico as the site for an electricity generating station for the working of the tramways in the western portion of London.—Agreed.

Westminster Electric Supply Corporation.—The Building Act committee recommended, and the Council approved, the plans of the Westminster Electric Supply Corporation for the erection of a motor-generator station (with an Italian terrace and garden on the roof) on a site abutting on Balderton-street, Hart-street, Duke-street and Brown-street, Mayfair.

New Electrical Tramways.—In all probability the electrical working of

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the New Cross and Greenwich tramways will be commenced by the end of 1903.

Motor Car Act.—The Highways committee were authorised to settle the colouring and arrangement to be adopted for any general identification marks which may be assigned to dealers and manufacturers under sec. 2 (4) (*b*) of the Motor Car Act, 1903.

Belgian Rails.—Col. ROTTON moved—"That it be referred to the Highways committee to ascertain and report to the Council (*a*) the number of hours of labour per week worked by the men employed by Belgian firms in making rails for London tramways, and (*b*) the rate of wages per hour paid to such men, and if they do any work on Sundays in connection with the manufacture of such rails." Col. Rotton said that, had the work of manufacturing these rails been given to an English contractor, it would have meant the employment of nearly 500 men for a year at 30s. per week. He quoted the wages paid the Belgian workers, which, he said, the Council would not have allowed in England.

Mr. BENN said the motion meant that the Council was to pay 20 per cent. more for its materials than the companies. If they were put under that obligation it would be impossible to make their municipal trams pay. The real reason why Belgian rails were cheaper was that there were no royalties in that country, while in England the royalty on steel was 5s. 6d. per ton.

After discussion, the motion was agreed to, with the addition of words to extend the scope of the inquiry to foreign rails generally, and the question of the amount of royalties paid in England as compared with foreign countries.

Systems of Electric Traction.—Replying to various questions, Mr. BENN said the Highways committee had considered the surface-contact system as adopted in Paris, and also the Kingsland system. They had further considered the side-slot system, as used at Bournemouth, which might be useful for narrow streets, but for the wide streets the system they were at present using was, in their view, the best.

London United Tramways.—Richmond Corporation on Wednesday decided to allow the London United Tramways to extend its system over Kew Bridge on condition that the Kew to Richmond line is completed within 12 months. The company is seeking powers to connect up Hammersmith with Barnes, Mortlake and Richmond.

Loughborough.—The Council have adopted the proposal to establish electricity works at an estimated cost of £28,000. The consulting engineer is Mr. C. H. Gadsby.

Marylebone (London).—A deputation of ratepayers, headed by the Hon. H. C. Gibbs, waited upon the Council last evening to present a petition urging that the purchase of the electric lighting undertaking in the borough should not be carried out, as only heavy loss to the ratepayers would result; urging, further, that the Council come to an understanding with the Metropolitan Electric Supply Co. to relieve the borough from its "present arrangement."

The signatories to the petition numbered over 900, and comprised many very influential names, including the Earl of Crawford, Earl Latham, Earl Roberts, Earl Shaftesbury, Lord Arthur Butler, Lord Bingham, Sir Francis Jeune, Sir Arthur Kekewich, Sir S. Ponsonby Fane, Lord Stanley, M.P., Hon. Humphrey Sturt, M.P., Hon. M. White Ridley, M.P., Hon. Herbert Gibbs, M.P., Col. Geo. Kempe, M.P., Mr. H. S. Cautley, M.P., a long array of K.C.s, influential members of the medical profession, many of the great traders in Oxford-street and district, the leading ecclesiastical notabilities of the neighbourhood, &c.

After this deputation had been duly received and its presenters had retired, the Council discussed at great length the motion by Mr. Councillor Edward White, J.P., "that a committee consisting of the Mayor, Mr. Councillor J. Watson, and Mr. Councillor Edward White, be appointed to confer with the Metropolitan Electric Supply Co., with the view to an arrangement being arrived at to remove the present deadlock." This was met by an amendment by Col. Hopkins that such committee should consist of the Mayor, the ex-Mayor and Mr. E. R. Debenham, chairman of the Electric Supply committee.

This amendment being subsequently carried, a further amendment by Ald. Dennis to amend the original motion was submitted and carried, and later the following resolution was put to the meeting and carried practically unanimously.

> That a committee, consisting of the mayor, the ex-mayor and the chairman of the Electric Supply committee, be appointed to confer with the Metropolitan Electric Supply Co. and to report to the Council upon what terms and conditions the company would agree to set aside the award.

Middlesbrough.—On Tuesday the Corporation decided to apply for sanction to a further loan of £15,000 for extensions of the electricity works recommended by the borough electrical engineer, Mr. H. M. Taylor.

The Electric Lighting committee have accepted tenders for boiler and engine house plant, but those for condensing plant and cooling tower have been deferred to next meeting.

Mr. Taylor has been instructed to prepare a report upon the cost of electric street lighting.

Municipal Telephony.—In our issue for Nov. 27 (p. 195) we announced the impending retirement of Mr. A. R. Bennett as general manager of Glasgow Corporation telephone department. Last week the Telephone committee's recommendation that Mr. Bennett continue as general manager of the department to the end of the financial year, and thereafter act as consulting engineer, was approved. Mr. John Macfee, at present assistant general manager, was duly appointed general manager, and Mr. John MacCallum, at present cashier, was appointed assistant manager and cashier, both appointments to date as from June 1 next.

We have received the following from the Glasgow Corporation telephone department, under date Dec. 7:—

The Telephone committee at their last meeting had under consideration criticisms of the telephone accounts, which recently appeared in certain electrical and engineering journals (reprints of which, together with pamphlets, have been extensively circulated in Glasgow anonymously). After consulting the auditors, it was decided to take no action in the matter, the view taken being that the accounts, having been drawn up in the form recommended by an eminent and independent firm of auditors (who certified them as correct, and, after reading the criticisms in question, had no amendments to suggest), and having been adopted, after careful consideration, successively by the Finance sub-committee, the Telephone committee and the Corporation called for no defence "against articles written in such obvious ignorance of the conditions which prevail in Glasgow, and with such apparent bias and purpose."

The report of Brighton Corporation Telephone committee last week referred to the recent correspondence between the general manager of the National Telephone Co. (Mr. W. E. L. Gaine) and the Mayor concerning Councillor Carden's action at Burgess Hill and alleged unfair preference. It was recommended that the Postmaster-General be informed that the Council endorse the observations contained in the Mayor's letter to Mr. Gaine (see *The Electrician*, Nov. 27, p. 228) of Nov. 17, and in addition to point out that the terms offered to subscribers in the Brighton area are the same as those given by Portsmouth, Glasgow, Swansea and other towns where municipal telephone services have been established and by the Post Office telephone department in London.

New Club.—In February last the Municipal and County Club was formed and is now firmly established in permanent quarters at Whitehall-court, London, S.W. The president is Mr. G. Lawrence Gomme, F.S.A., clerk to the London County Council, and the general committee comprises a large number of well-known names in metropolitan and provincial municipal circles. Sir Samuel Provis, K.C.B., secretary of the Local Government Board, was the guest of the evening at the first house dinner of the club on Monday. Mr. Gomme presided. The club promises to become a central rendezvous for municipal officers, and to fill a place not previously occupied by any of the existing London clubs.

Newquay.—The District Council have decided to engage an electrical engineer to report upon the application of the Southern District Electricity Corporation for a provisional order.

Obituary.—Don Rafael Monares, Director-General de Comunicaciones (Spanish Posts and Telegraphs), died on the 3rd inst. at Madrid. Señor Monares was appointed to this post when the Conservative party, which has recently resigned office, came into power.

Patent Amendment.—Mr. Valère A. Fynn, 18, Apsley-crescent, Manningham, Bradford, Yorks., seeks leave to amend the complete specification in connection with his application for Letters Patent No. 22,712 of 1902 for "Improvements in and connected with alternate-current motors." Particulars of the proposed amendment were set forth in the *Illustrated Official Journal* (Patents) of Dec. 2, and notices of opposition may be given within one calendar month from that date.

Pay of Telegraph Clerks.—The committee recently appointed to inquire into the wages paid to postal officials is taking evidence, and last week

Mr. R. G. DAVIS (Edinburgh) said an efficient youth of 19 only got 18s. a week, and rose by annual increases of 2s. a week to 40s. Resignations from the service had been general and numerous. He submitted that the scale for provincial telegraphists should be £72. 16s. a year after five years' service, rising to the maximum salary of £200.

Mr. F. E. MARKIN (Manchester) said he had 18½ years' established service, and now received 49s. 7d. per week. The stagnation of promotion was becoming pronounced throughout the telegraphic service. It was inconceivable that it was intended to pay for operating duties in London a maximum of £190 a year, and in the larger provincial offices (where the duties were practically identical) £130 only, and he thought the two classes should be merged into one, having a common maximum of £190 per annum. The scales of pay given by the cable companies to their employés in the United Kingdom were much higher than those paid by the Department, although the companies paid dividends and had to face competition. He agreed that the minimum salary should be £72. 16s., to be paid on the completion of five years' service or prior attainment of 21 years of age, proceeding by annual increments of £6. 10s. for five years, and thence by annual increments of £8 to a maximum of £200 per annum.

Personal.—Mr. Thomas Mason, I.S.O., telegraph traffic manager at St. Martin's-le-Grand, retires at the end of this month. Mr. Mason was superintendent of the special staff for 30 years.

Perth.—On the motion of Dean of Guild M'Nab, the Town Council have resolved to appoint a consulting engineer, at a fee to be afterwards agreed upon, to report generally upon the reconstruction of the existing tramway system, to draw up specifications and to report on tenders. The actual work of reconstruction will be undertaken by the burgh surveyor (Mr. R. McKillop) and the electrical engineer (Mr. John Lambert).

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Pitlochry.—At the meeting of ratepayers on Friday the question of erecting electricity supply works was discussed. Mr. W. E. Townsend (Middleton and Townsend) said it was proposed to utilise the water power of the Falls of Tummel. He thought from 150 H.P. to 200 H.P. would meet the requirements of the district. Underground conductors would be used. Provided the right to use the water power could be obtained, his firm would supply electrical energy at about half the present price of gas, or equivalent to gas at 3s. 3d. A motion in favour of electric lighting was passed unanimously.

Pontypridd.—The District Council have been asked to supply electric current in Cilfywydd, but before the mains are extended, a canvass is to be made.

The amount of the purchase price to be paid for the Pontypridd-Hafod tramways is to be settled by a Board of Trade arbitrator.

Presentation.—At the meeting of Lowestoft Council on Tuesday, the mayor made a presentation to the borough electrical engineer (Mr. G. A. Bruce) on the occasion of his marriage.

Railway Station Lighting.—The Sneyd Colliery Co. have been negotiating with the North Staffordshire Railway Co. for supplying electricity for the lighting of Cobridge railway station, but Burslem Council have informed the former company that they object to their supplying electricity for any purpose or to any person outside their works. There is no indication, we understand, in the Council's communication to the Sneyd Company how they propose to enforce their objection.

Ramsgate.—A further discussion on electric lighting took place at the Council meeting last week, when it was decided to adhere to the decision to support the application of the Ramsgate and District Electric Supply Co. for a provisional electric lighting order, in opposition to the proposed application of the Isle of Thanet Electric Tramways and Lighting Co.

Reading.—A resolution to apply for electric lighting powers was defeated at the last meeting of the Council by 10 votes to six, the majority of the members advocating the purchase of the undertaking of the Reading Electric Supply Co.

Rotherham.—The price of electric current for motive power has been reduced to 1½d. per unit for the first two hours per day and 1d. after.

Salford.—The Corporation have decided to take over the Prestwich provisional electric lighting order, and application has been made for sanction to a loan of £5,000 for laying electric lighting cables to that district.

Sheffield.—On the recommendation of the Electric Light committee, the following re-arrangements of the staff of the electric supply department have been made:—

Mr. A. Doxey, at present acting chief assistant engineer and deputy manager of the electric supply department, to be electrician to the department; Mr. J. W. Beauchamp, at present manager at the factory, to be chief assistant engineer and deputy manager of the electric supply department at £260 per annum, the engagement to be determinable by one calendar month's notice on either side.

These changes were approved by the Corporation on Wednesday, when certain increases in the salaries of the staff of the department, amounting to £43. 8s. per annum, were also sanctioned.

For the position of general manager of the Corporation tramways nearly 70 applications have been received, and a sub-committee appointed to deal with the applications has reduced this number to seven. It is thought probable that the new manager will be appointed on the ground of commercial experience, and should this prove correct, the present assistant electrical engineer, Mr. H. E. Yerbury, will be appointed chief electrical engineer of the tramways department.

Ship Lighting.—The new steel screw steamer "Frankby," built for the Palace Shipping Co. by Messrs. Charles Connell & Co., is fitted with electric lighting plant supplied by Messrs. W. H. Allen, Son & Co. of Bedford.

South Africa.—The *British and South African Export Gazette* states that—

The exports from the United States to British and Portuguese Africa during August last included electrical machinery of the value of £2,953 (decrease £2,419 compared with August last year), and scientific apparatus and telegraph and telephone apparatus £5,133 (increase £176).

The imports of telegraph and railway material into Beira during 1902 were valued at £106,443 (of which £101,492 was of British and £3,460 of German origin), against £102,943 in 1902.

Southport.—The charge for current for motive power has been fixed at 2d. per unit, with a reduction of ½d. where consumption exceeds 36 hours per week per B.H.P. installed.

Southwark (London).—The City of London Electric Lighting Co. have offered to supply electricity in bulk to the Council. The matter has been referred to the Electric Lighting committee.

Spain.—A concession has been granted to the Marques de Santallana to employ a portion of the waters of the River Manzanardes at Quebrantaherraduras for the purpose of generating electric current.

Tenders will be opened on Feb. 12 next at 2 p.m., at the Ministry of Commerce and Public Works, for a 60 years' concession for the construction and working of an electric tramway from Mondariz to Porriño (Pontevedra). An application has already been made for this concession by the Iberia Concessionario Co. The *Madrid Gazette* of Dec. 6 contains further particulars,

Stockton-on-Tees.—Acting on the advice of their electrical engineer (Mr. J. J. Smith), the Council, who are anxious to increase their day load, have approached several firms to ascertain their terms for hire-purchase of electric motors.

Sunderland.—Ald. Bruce, chairman of the Electricity and Lighting committee, states that experiments made with "anti-vibration fittings and mantles" in the public lamps have proved unsatisfactory and costly, but that the experiments with Nernst electric lamps have been satisfactory. In streets where electric mains are laid Nernst lamps are to be used in the ordinary lanterns.

The North-Eastern Marine Engineering Works have been taking current since Nov. 23 at the rate of 800 units per day, and this demand is expected to be increased to 1,500 units daily. Supply is also to be extended to Doxford's yard. During the half-year ended September the income of the electricity department was £12,988 (£178 above estimate), and the expenditure £12,147 (£120 below estimate), the net profit being £841. It is hoped to wipe off the debit balance of £400 by the end of the current year, when the amount set aside for sinking fund will have reached £27,573, or 11 per cent. on the capital expenditure.

Sutton Coldfield.—The Electric Light committee report that there are 235 consumers, representing the equivalent of 10,647 8 c.p. lamps connected. For the year ended March 31, the total receipts were £1,937. 8s. 5d., expenditure £1,465. 0s. 1d., gross profit £472. 8s. 4d. to meet sinking fund instalment and interest.

Telephonic Communication with the Continent.—The Liverpool Chamber of Commerce has received a communication from the Postmaster-General, in reply to resolutions urging the establishment of telephonic communication between Liverpool and the Continent, stating that arrangements have been made for such service, which only awaits legislative sanction in France. When this is given Post Office telephones will be available between Liverpool and Manchester and Calais, Chartres, Dieppe, Orleans, Paris and Rouen. Communication between Liverpool and other Continental towns will not, however, be available, on the ground that "it has been found by experiment that communication is limited by electrical conditions to the towns above mentioned."

Theft of Copper Wire.—At the Mansion House on Friday last the Lord Mayor (Ald. Sir J. Ritchie) sentenced two men named Richard Jenkins, an assistant storekeeper, and William Clark, a barman, to one and two months' imprisonment respectively for stealing and receiving 42lb. of copper wire the property of the General Electric Co.

Transfer of an Electricity Supply Undertaking.—The South London municipal authorities, in whose area the Crystal Palace District Electric Lighting Co. is supplying current, have been notified by the Board of Trade that the Crystal Palace Company proposes to sell the undertaking authorised by its orders of 1890 and 1894 to the Blackheath and Greenwich Electric Lighting Co., and that the purchasing company proposes to supply electric energy on the system adopted in the Blackheath and Greenwich areas. The Board is prepared to approve the proposed transfer, subject to a condition that consumers are paid the reasonable cost of, or expenses incidental to, this change of system, including compensation for any loss or damage incurred in consequence of the change. Beckenham Council, which is interested to a small extent in the transaction, is considering the question of purchasing so much of the company's undertaking as lies within their area.

Wallasey.—The first annual report and accounts of the District Council's electric tramways were recently submitted to, and confirmed by, the Council. The total expenditure is £120,503. 2s., the traffic receipts for the year ended March 31 were £30,907. 3s. 8d., or, with advertising rents and miscellaneous receipts £31,474. 15s. 11d. After paying annual charges, including maintenance of cars, building and lands, depot and traffic expenses, general charges, &c., and providing £4,500 for depreciation and renewal, amounting, together, to £23,694. 12s. 11d., there was a gross profit of £7,780. 3s., from which had to be deducted interest and sinking fund and proportion of loan charges and promotion expenses of the Act of 1899, amounting to £5,281. 8s. 9d., leaving a balance profit of £2,806. 18s. 6d. Twenty-three cars were in use on the three routes, and a total of 6,574,239 car-miles were run. The average receipts per car-mile were 11·29d. and average receipts per passenger 1·30d.

Wandsworth (London).—The Traction Company of the United Kingdom have fitted up a section of track on the Kingsland surface-contact system in the basement of the Council House, in order to explain the working to the Highways Committee

Wanstead.—The District Council have decided to oppose the applications of the Leyton District Council and the Empire Electric Light and Power Co. for provisional electric lighting orders. It is

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probable, however, that an arrangement will be made with the Leyton Council for supplying electricity.

Watford.—After a long debate, the District Council last week decided, by a majority of two, to invite the North Metropolitan Electrical Power Distribution Co. to submit an offer for the purchase of the Council's electricity undertaking. The capital expended on the undertaking has been about £55,000, and there has been a heavy annual loss.

Westminster.—The City Council are proceeding with a scheme for the re-organisation of the lighting arrangements in Parliament-street and Whitehall as far as the Horse Guards, where electric lighting commences. The old gas standards, which were erected 80 years ago, are being removed to give place to the Scott-Snell system. The new lamp standards, about 20 in number, will have an elevation of 21ft., and will be fitted with electric lighting apparatus, so that that system of lighting can be adopted at any time.

Willesden (London).—The District Council on Tuesday discussed an agreement for the sale of their electricity works to the North Metropolitan Electric Power Distribution Co. The Electric Light committee recommended that the agreement be approved, "subject to such alterations as the solicitor and the electrical engineer (Mr. E. T. Ruthven-Murray) have already made or may consider necessary for protecting the interests of the Council, and subject to the insertion of a clause enabling the Council to require payment at any time in cash of any balance which may be due from the company on giving six months' notice to that effect."

In proposing the adoption of the committee's recommendation, Mr. PINKHAM, J.P., chairman of the committee, said they were selling certain bricks and mortar, constituting a generating station, to a company who could supply electric current at a lower price than the Council could produce it. The North Metropolitan Company was a large concern, supplying three or four large districts, and could therefore generate cheaper than the Council, which had only one undertaking. The Council were safeguarded in every way.

Several amendments to the committee's proposals were submitted and rejected, and finally the recommendation of the committee was adopted by 10 votes to five.

Workhouse Lighting.—Leicester Guardians have rescinded a recent resolution to put down independent electric generating plant, and it has now been decided to obtain supply from the Corporation mains.

Electro-Harmonic Society.—Mr. W. E. Lane, the hon. secretary, announces that 78 new members have already been elected this season and persons eligible for membership are cordially invited to join the Society. The next smoking concert will be held on the evening of Friday, Dec. 18, in the King's Hall, Holborn Restaurant, London, W.C., commencing at 8 p.m. Mr. A. P. Trotter, electrical adviser to the Board of Trade, will preside.

Cricket.—The annual dinner of the Drake and Gorham Cricket Club was held at the Falstaff Restaurant, London, last week, under the presidency of Mr. Bernard Drake. Mr. Gorham and Mr. G. Drake were of the company. It was announced by the hon. sec. and treasurer (Mr. H. Be enham), that 22 matches had been played during the season—eight won, two drawn, five lost and seven abandoned, not a bad showing. The club, financially, has a stalwart carry forward to next season. In the course of the dinner toasts to the success of Drake and Gorham (Ltd.) and to the health of the chairman were warmly received.

Smoking Concert.—The Electrical Trades' Union hold a smoking concert in the Holborn Town Hall, London, to-morrow (Saturday) at 8 p.m.

TRADE NOTES AND NOTICES.

[Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.]

TENDERS INVITED.

Walthamstow District Council invite tenders for (*a*) permanent way, (*b*) feeders, (*c*) switchboard and plant, (*d*) overhead equipment bonding and pillars. Specifications, &c., as regards (*a*) from Mr. G. W. Holmes, A.M.I.C E., Town Hall, Walthamstow; and for (*b*) (*c*) and (*d*) from Mr. James Enright, A.M.I.C.E., 47, Victoria-street, Westminster. Tenders to Mr. Sydney Watson, clerk and solicitor, Town Hall, Walthamstow, by Jan. 1 See also advertisement.

Tenders are invited for wiring the *Kent and Canterbury* Hospital for electric lighting and other works in connection therewith. Specifications from the architect (Mr. W. J. Jennings), 4, St. Margaret-street, Canterbury. Further information from the secretary (Mr. A. J. Lancaster), 36, St. George's-street, Canterbury. See also advertisement.

Oldham Corporation Electricity committee invite offers from firms who will appoint the Corporation as their agents in a hiring or hire-purchase system for motors, radiators, cooking appliances, &c., to be fixed on the Corporation mains. Particulars from the borough electrical engineer (Mr. S. Wilmott Newington), to whom tenders by 23rd inst. See also advertisement.

Long Eaton Urban District Council invite tenders for engine and dynamo (250kw. set) and accessories, one Lancashire boiler, overhead hand travelling crane and economiser. Specifications from the engineer and manager (Mr. Frank Worrall, M.Inst.C.E.), Electricity Supply Works, Long Eaton. Tenders by noon Jan. 1. See advertisement.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring various installations of May-Oatway automatic fire alarms for direct connection with the fire brigade headquarters of Glasgow, Aberdeen and Paisley. An advertisement contains further information, and full particulars may be obtained from the managing director, 49, Queen-street, Glasgow. Tenders by Dec. 16.

Hackney (London) Borough Council invite tenders for feeding and distributing mains. Specifications, &c., from the consulting engineer (Mr. Robert Hammond, M.Inst.C E.), 64, Victoria-street, Westminster, S.W. Tenders to the town clerk (Mr. George Grocott), Town Hall, Hackney, by 4 p.m. Jan 4. See also advertisement.

Erith Electric Light and Tramways committee invite tenders for the execution of all installation work required under their assisted wiring scheme for the period ending Dec. 14, 1904. Specifications, &c., from the electrical engineer (Mr. Geo. E. Heath), and tenders (addressed to the chairman) to Mr. Heath, High-street, Erith, by 4 p.m. Dec. 14. See also advertisement.

Irvine Corporation invite offers for providing and erecting the whole of the plant and apparatus necessary for the supply of electricity under their provisional electric lighting order. Particulars from the town clerk (Mr. James Dickie). See also advertisement.

Harrismith (South Africa) Town Council invite tenders for supply and laying in Harrismith of high-tension concentric feeder and low-tension triple concentric distributor cables, low-tension service and street lighting cables, joint boxes, service boxes and other accessories; also the supply (f.o.b. British Port) of five 30kw. transformers, one 7·5 ditto, four transformer pillars, high and low-tension switch gear, &c. Specifications from the consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, Westminster, S.W., and tenders to Messrs. Webster, Steel & Co., 5A, West India-avenue, Leadenhall-street, London, E.C., by noon Jan. 18. See also advertisement.

Messrs. Preece and Cardew are authorised by the Municipal Council of *Sydney* (N.S.W.) to invite tenders for the supply, delivery and erection of one or two 600kw., or one 1,200kw., steam alternators (three phase), with condenser, pipework, motor generators, static transformers, switchboards, &c. Specifications and forms of tender from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W., where tenders must be delivered by noon Jan. 12. An advertisement contains further particulars.

Bermondsey Metropolitan Borough Council invite tenders for supply and erection of two water-tube boilers and accessories, steam flues, overhead coal bunkers and coal handling plant, together with extensions of existing steam, feed and other piping. Tenders to town clerk (Mr. Frederick Ryall), Town Hall, Spa-road, Bermondsey, before noon Dec. 15.

Battersea (London) Borough Council invite tenders for coal-handling plant. Tenders by noon of Dec. 28.

Pontypridd Urban District Council invite tenders for tramcars, and for free wiring of premises. Tenders to chairman of Electric Lighting and Tramways committee, Council offices, Pontypridd, by noon Dec. 24.

Preston Corporation invite tenders for the supply and erection at their tramway power station of a traction switchboard and accessories. Tenders to the consulting and resident electrical engineer (Mr. Walter H. Tittensor) by Dec. 12.

Johannesburg Municipality invite tenders for two 500kw. steam alternators, 2,100 volts, 50 periods, three-phase, or alternatively two-phase or single-phase, new or secondhand. Particulars to the consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, London, S.W.

London County Council invite tenders by Jan. 19 for six electrically-driven three-throw boiler feed pumps for their Greenwich electricity station; also by Dec. 15 for 4,100 tons of steel slot rails and 1,490 tons of steel conductor tee rails. Tenders to clerk in each case.

The committee of management of the *Enniscorthy* District Lunatic Asylum invite tenders for electric lighting plant, wiring, &c. Tenders to Dr. T. Drapes by noon Jan. 20.

The *East Indian Railway Co.* invite tenders for electric lighting plant. Tenders by noon Dec. 23 to the Secretary, Nicholas-lane, London, E.C.

Govan Corporation invite tenders for coal bunkers, conveyor and electric capstan. Tenders by noon of Dec. 28.

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TENDERS RECEIVED AND ACCEPTED.

Hadfield's Steel Foundry Co. have secured a further order from Dick, Kerr & Co. for manganese steel points and crossings for the Wakefield tramways, and from W. Griffiths & Co. for similar points and crossings for the Middlesex County Council tramways. The Preston municipal tramways are being supplied by this company with points of the double-automatic type made of a special grade of Hadfield's toughened cast steel, and fitted with a hardened manganese steel centre-piece at the intersection, where wear is severe. Edmundsons' Electricity Corporation have also placed an order with this firm for additional junction work for Scarborough tramways, including points, crossings and lay-outs.

Salford Corporation have accepted the following tenders for electric lighting and tramway stores, &c :—

Stewarts and Lloyds, wrought-iron tubes and fittings.
Anchor Cable Co., cables.
Callender's Co., jointing compound.
Howard Conduit Co., bitumen and asphalte troughing.
D. Firth & Son, wiring central car shed.
F. W. Smith & Co., wiring Pendleton Hall.

The London United Tramways have given a further order to the British Westinghouse Co. for sub-station plant, including two 250kw. rotary converters, seven 100kw. oil insulated self-cooling transformers, switchboard, &c. A large number of rotary converters are now going through the Westinghouse shops, including 500kw., 800kw., 1,200kw. and 1,500kw. units for the District, Metropolitan and North-Eastern Railways.

The British Westinghouse Co. has supplied to Maidstone Corporation (through Messrs. Davey, Paxman & Co.) two 150kw. shunt-compound generators for coupling to Davey-Paxman engines of corresponding size. These generators, which will be available for either lighting or traction, will deliver 300 amperes at 460/500 volts as shunt machines and 275 amperes at 300/550 volts as compound machines.

The Gilbert Arc Lamp Co. have, as sub-contractors to Callender's Cable and Construction Co , designed and supplied an arc lighting equipment for Batley, Yorks. Special boxes and winches were designed for the raising and lowering gear on the tramway poles, Messrs. Lacey and Sillar are the consulting engineers for this work.

Bedford Town Council have accepted the tender of the Indestructible Paint Co., 31, Cannon-street, London, E.C., for painting the machinery and the interior of the engine room at the electricity works for £132. 15s., and that of A. Haacke & Co. for covering steam pipes at £47. 16s. 8d.

St. George's (Hanover-square, London) Guardians have accepted the tender of Laurence, Scott & Co. for engines and dynamos for lighting Fulham-road workhouse ; that of the General Electric Co. for switchboard, &c.; and that of Babcock and Wilcox for steam-piping.

Great Yarmouth Council have accepted the tender of the British Electric Transformer Mfg. Co. for additional transformers at £240, and that of D. McNaughton for arc light carbons at £3. 18s. 9d. per 1,000 pairs. A Blake and Knowles boiler feed pump has also been ordered.

The following tenders have been accepted by Brighton Town Council :—

Dick, Kerr & Co., 10 further tramcars, £5,100; Bolckow, Vaughan & Co., 800 tons tram rails, £5,962. 10s.; Hadfield's Steel Foundry Co., points and crossings, £2,023. 0s. 3d.; Edgar Allen & Co., sole plates, £637. 2s. 9d.

The Power Gas Corporation has placed an order with the British Westinghouse Co. for two 250 H.P. three-cylinder single-acting producer gas engines, solid coupled to direct-current generators of equivalent power. The engines will be installed at Dudley Port.

Swindon Council have accepted the following tenders :—

J. G. White & Co., steel poles and overhead equipment, £4,164. 8s. 7d.
British Westinghouse Co., traction switchboard, £ 750.
British Insulated and Helsby Cables (Ltd.), tramway feeders, £1,190. 9s.

Wednesbury Corporation have accepted the tender of the National Electric Construction Co. for wiring and fitting the town hall, municipal offices, art gallery, public baths and free library for electric light at £465. 18s.

Brighton Corporation have accepted the tender of the British L. M. Ericsson Co. to extend the switchboard at the municipal telephone exchange to 2,088 subscribers and 40 junction lines for the sum of £2,205, the work to be completed within five months.

For extensions at the electricity works at Middlesbrough the tender of the Brush Company has been accepted for engine-house plant at £3,488, and that of J. and J. Horsfield & Co. for boiler-house plant at £1,729.

The British Westinghouse Co. have also received a further order for a number of complete magnetic brake equipments from Bath Electric Tramways (Ltd.).

Lowestoft Corporation have ordered from the British Westinghouse Co. four more double-deck cars equipped with motors and controllers of the Westinghouse 46 and 90 types respectively (similar to those already supplied).

An order has been placed (through Messrs. R. Waygood & Co.) with the British Westinghouse Co. for two 25 H.P. direct-current motors for one of the stations on the Midland Railway.

Fulham (London) Council have decided to purchase 153 Ferranti 10-ampere meters at £2. 8s. 9d. each and 150 Westinghouse 5-ampere meters at £3. 13s. 6d. each.

The War Office have placed an order with Bruce Peebles & Co. for two 400 H.P. slow-speed continuous-current generators directly coupled to Robey engines.

Todmorden Corporation have accepted the tender of Bruce Peebles & Co. for two steam sets (one 150kw. and one 75kw.) and one balancing set.

Hadfield's Steel Foundry Co., East Hecla Works, Tinsley, Sheffield. have received an order from Dick, Kerr & Co. for points, crossings, &c., for Preston tramways.

An order has been placed with the Pearson Fire Alarm (Ltd.) by Mr. J. W. Welsford, Harrow School, for a complete installation of automatic fire alarms.

Hastings Town Council have accepted the tender of Cowans Limited for a complete set of Andrews' duplicate mains apparatus at £126.

Swansea have accepted the tender of Dick, Kerr & Co. for converting a further section of the tramways to electric traction at £11,345, and that of Callender's Cable Co. for cables at £19,169. 8s.

Durban Corporation have accepted the tender of T. F. Glen for erection of telephone exchange at £12,274.

Southwark (London) Council have placed an order with British Insulated and Helsby Cables for 440 yds. of cable at £67. 10s.

West Ham Corporation have accepted the tender of Reavell & Co. for air compressor for cleaning armature coils, &c., at £74. 7s.

BUSINESS NOTICES.

Messrs. S. Appleyard and T. Stather, electrical engineers, 25 and 26, Hopwood-street, Hull, have dissolved partnership. Debts by Mr. Stather.

Messrs. C. D. Falcke and Percival West (trading as the Birmingham Electrical Fittings Co.), 113, Coleshill-street, Birmingham, have dissolved partnership.

After Monday the telephone number of the Hart Accumulator Co., Marshgate-lane, Stratford, London, E., will be altered from "76 Stratford" to "832 East."

Mr. G. E. Fletcher, A.M.Inst.C.E., M.I.E.E., has commenced business at 77, King-street, Manchester, as a consulting electrical engineer. Mr. Fletcher has for many years held the position of chief assistant to the chief telegraph superintendent and engineer of the L. and N.W. Railway Co., whose service he joined in August, 1882.

The British Electric Calibrated Fuse (Ltd.) announce their removal from 118, Queen Victoria-street, to 137, Fenchurch-street, London, E.C.

The address of the secretary of the Incorporated Municipal Electrical Association, Mr. C. McArthur Butler, has been changed to Staple Inn-buildings (South), Holborn, London, W.C., where all communications for the Association should be addressed.

In connection with the death of Sir Frederick Bramwell, it is announced that the firm of Bramwell and Harris, consulting engineers, will continue to carry on business as heretofore at 5, Great George-street, Westminster, London, and also at Edinburgh and Cardiff. The name of the firm will remain unchanged.

LIQUIDATIONS, BANKRUPTCIES, &c.

At a meeting of the shareholders of the British Schuckert Electric Co. (Ltd.) on the 4th inst., resolutions approving the transfer of the business of the company to Messrs. Siemens Brothers & Co. (Ltd.) and for the voluntary winding-up of the British Schuckert Electric Co. (Ltd.) were confirmed. Mr. Arthur Jacob was appointed liquidator. The liquidator notifies that no doubt is entertained that the assets of the British Schuckert Electric Co. are amply sufficient to pay in full all liabilities of the company.

The Electrophone, Limited, is to be wound up voluntarily for reconstruction purposes, and Mr. Albert Anns, Telephone House Victoria Embankment, London, E.C., and Mr. H. S. J. Booth, 36, Gerrard-street, London, W., have been appointed liquidators. Particulars of the registration of the new company are given in another column.

The first meetings of creditors and contributories of the Automobile Supply Co. (Ltd.) will be held on 17th inst. at 33, Carey-street, London, W.C.

The liquidator of Beaman and Deas (Ltd.), 109, Victoria-street, London, S.W., has been released.

A receiving order has been made against John Storr, electrical engineer, Grange-road, Dudley, trading as Webster, Michelson & Co.

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Sale by Auction.—Messrs. Tomlin & Co. are instructed by the Don Clothing Co. (who now take current from a supply company) to sell by auction upon the premises, 27–30, Holborn Viaduct, London, E.C., on Thursday, Dec. 17, at 3 p.m., two self-starting Crossley gas engines, two direct-current Royce dynamos and one Blackman electric fan, air propeller, &c. The plant can be seen running on day of sale or by appointment with the consulting engineer (Mr. Fred. Satchwell, M.I.E.E.), Jesmond Dene, Princes-road, Wimbledon. Full particulars from the auctioneers, 153, Stanstead-road, Forest Hill, and at Catford and Crofton Park, London, S.E. See also advertisement.

Plant for Sale.—Messrs. Cannington, Shaw & Co. (Ltd.), Sherdley Glass Works, St. Helens, have for sale two Silvertown and one Mather and Platt dynamos. See advertisement.

A 250-light electric lighting plant (steam engine, boiler, pumps, dynamo, battery of accumulators, &c.) is advertised for sale in another column. Applications to Sir Alfred Hickman, Wightwick, Wolverhampton.

Mr. A. Underwood, 3, Queen-street, London, E.C., has for sale two Lancashire boilers, two Cornish boilers, four Willans-Siemens electric generating sets, switchboards, steam piping, Worthington compound pumps, &c.

Factory Premises for Sale.—A freehold manufacturing site, up to 50,000 sq. ft., without restrictions and within 2 miles from City and West-end, is advertised for sale in another column.

Two-cycle Gas Engines.—By a printer's error in our last issue Messrs. Mather and Platt's make of "Körting" gas engine was described as a "pro-cycle" instead of a two-cycle gas engine.

"Limpet" Plugs.—The Patent Plug Co. have sent us samples of their "Limpet" plugs and "Lightning" jumper. These plugs, which have been manufactured for some time by the company under a patent, consist of a cylindrical piece of wood with a taper split in it and a metal ring at the end, as shown in Fig. 1. A

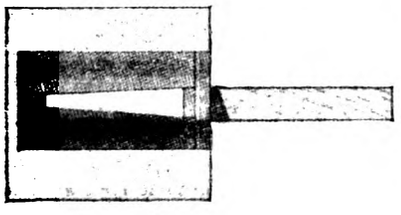


Fig. 1.

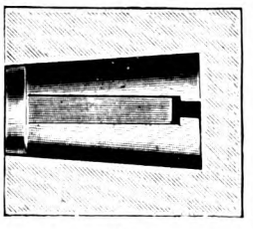


Fig. 2.

small rectangular piece of wood, whose width is the same as the diameter of the plug, is also provided. A hole having been made by hammering the jumper (Fig. 3) into the wall and removing it, the plug is inserted, as in Fig. 1, and the strip of wood hammered

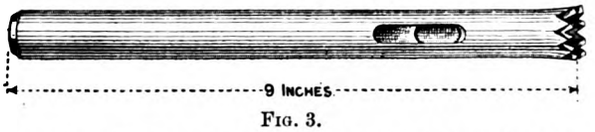


Fig. 3.

home, as shown in Fig. 2. This expands the back end of the plug as seen, and holds it tight in the wall. The plugs are sold in several sizes from 1in. to 2½in. long and $\frac{5}{16}$in. to $\frac{7}{8}$in. diameter. The end of the jumper is hollow, and the hole a few inches up is in order that the dust, &c., may be easily extracted.

"Litholite."—There was recently submitted to the Westminster Electrical Testing Laboratory, for testing for insulation resistance and dielectric strength, a sample of "Litholite," consisting of a disc 8½in. diameter and 0·327in. in thickness :—

Upon the sample was pasted on each side a disc of tinfoil 4in. diameter, and a guard ring of tinfoil was also pasted round the edge of the disc to intercept leakage. The insulation between the two discs measured 67,000 megohms with a test pressure of 1,500 volts taken from a battery. The surface leakage under normal conditions was shown to be negligible. A sample was then immersed in salt water for 24 hours, and, with the surface moisture wiped off, was tested, and an insulation resistance of 60,000 megohms obtained with the guard ring connected and 600 megohms disconnected. The surface leakage was, therefore, about 100 times that through the material. Finally the sample was left standing in a free current of air for three hours to dry, but was not baked. When again tested, 67,000 megohms were obtained with the guard ring and 60,000 without, the surface leakage being thus about 10 per cent. of the leakage through the material, showing that this is practically non-absorptive of water, and has a high specific resistivity, well maintained after immersion. The dielectric strength was measured by applying an alternating pressure of 120 periods between the two tinfoil discs. The sample withstood 35,000 volts for a period of five minutes previous to the application of a pressure of 36,000 volts, at which it broke down.

Messrs. Hunt and Hess, 3, The Grove, Hackney, London, N.E., manufacturers of "Litholite," claim that so satisfactory a test proves all that is claimed for this material as an insulating substance.

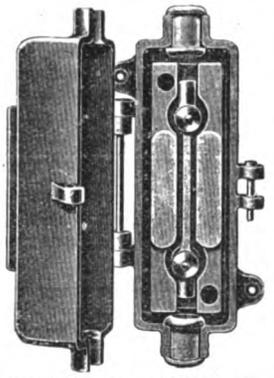
Central Battery Telephone Systems.—With this title the Electric and Ordnance Accessories Co., Stellite Works, Chester-road, Aston, Birmingham, have prepared an exceptionally well-arranged and printed list of telephones and telephone material and accessories, with special reference to the suitability of this company's apparatus for intercommunication purposes in professional establishments, hospitals, asylums, workhouses, large blocks of business premises, &c. The installation of internal telephone systems is becoming of general adoption, and telephone installers and the trade generally will find the book under notice of assistance in dealing with their clients. Copies of the pamphlet may be obtained post free on application to the company. Architects and others engaged in professional work will find the book both useful and interesting.

Catalogues.—A revised catalogue of "Lundell" and "Castle" motors is to hand from Messrs. J. H. Holmes & Co. of Newcastle-upon-Tyne. A new feature of the Lundell two-pole single-field coil-type machine, to which attention is called, is the extension upwards of the commutator end casing to form a protection to the terminal blocks, which are in this way completely enclosed. A new series of multipolar "Castle" machines have just been placed on the market, and are illustrated and described in the list under notice. These machines are made in sizes from 15 H.P. to 110 H.P. at speeds varying from 450 to 800 revs. per min. The motors are of the radial pole type of very open construction. It is claimed that the machines can be depended upon to give the maximum output for their size, and can be run for short periods at a greatly increased output over the normal rating. The motors are wound as standard machines for 115, 230 and 500 volts, but their design and construction enable them to be wound for any special voltage or speed.

Johnson and Phillips Electric Cable Works, Old Charlton, Kent, have ready a new price list of low-tension "Manila" paper-insulated lead-covered, and lead-covered and armoured cables. Tabulated details of these cables in different classes are given.

A useful list of telephones and telephone material, manufactured and supplied by the International Electric Co., 55, Redcross-street, London, E.C., is now ready. Special attention is called to the "Auto-release" inter-communication type of telephone, which the company claim is a great improvement on any known inter-communication switching arrangement and prevents accidental ringing up. This system also allows of speaking from one department to three, four, or five side stations simultaneously. Signalling apparatus for mining work and micro-telephones for tramways, fire brigade and police service are also listed and illustrated.

The accompanying illustration shows a type of supply companies' fuse box for pressures up to 250 volts manufactured by Messrs. Ernest F. Moy (Ltd.), Greenland-place, Camden Town, London. In this type of box the terminals are fitted with sweating sockets to receive the cables, which can be readily removed for connecting up. The boxes are made in three sizes. The bases are of highly vitrified porcelain with stout raised sides well above the fuse strip. The boxes are stove enamelled and are provided with the usual inspection-window in the cover, which is hinged to the boxes and fastened by a sealing bolt. In the double-pole type the two boxes are mounted on a varnished pitch-pine board back to back, porcelain insulators being provided for the fixing screws.



Imports.—The following are the values of imports to this country during November last :—

Electrical machinery, £37,530; telegraph cables and apparatus, £5,782; other electrical goods and apparatus, £82,944. The respective totals for the 11 months ended Nov. 30 were £505,268, £55,981 and £732,088.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Dec. 2 to 8, with the ports of destination :—

Africa—Cape Town, £2,301; Delagoa Bay, £1,003 (telegraph material); Durban, £322; East London, £253; Port Elizabeth, £168 (including £62 telegraph material). *Argentina*—Buenos Ayres, £2,084 (including £1,786 telegraph material). *Australasia*—Adelaide, £16; Brisbane, £745; Fremantle, £1,587; Melbourne, £440 (telegraph cable); Perth, £337; Sydney, £1,660 (including £230 telegraph material); Wellington, £11. *Brazil*—Rio Janeiro, £726 (including £650 telegraph apparatus). *Ceylon*—Colombo, £119. *China*—Shanghai, £95. *Denmark*—Copenhagen, £104. *Holland*—Amsterdam, £67. *Hong Kong*, £189. *India*—Bombay, £125,360 (telegraph material); Calcutta, £452 (including £350 telegraph material). *Japan*—Nagasaki, £1,100 (telegraph cable); Yokohama, £508 (telegraph wire). *Portugal*—Lisbon, £25. *Russia*—Odessa, £241. *Spain*—Vigo, £30 (telegraph cable). *Straits Settlements*—Singapore, £12. Total, £139,956, against £7,483 in the corresponding week last year (Dec. 3 to 9).

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COMPANIES' MEETINGS AND REPORTS.

Aron Electricity Meter Limited.

The sixth ordinary general meeting of this company was held yesterday (Thursday), Mr. H. HIRST, M.I.E.E., presiding.

The SECRETARY (Mr. M. Aron, F.C.I.S.) having read the notice calling the meeting,

The CHAIRMAN observed that, when he addressed the shareholders for the first time a year ago, he gave as his reasons for having then accepted the responsibilities of the chairmanship the fact that he personally believed it to be within the range of possibility and probability that the business might not only be saved, but brought to success once more. He did not wish to imply that he considered this year's balance-sheet a particularly satisfactory document, but whoever knew what it meant to turn a concern that had lost in one year £6,000 into a successful business again, would appreciate that if his hopes had within the period of one year not been realised, there were distinctly strong symptons showing that they were on the road to realisation. They last year had a loss of £6,032, and had to pay £2,500 out of capital towards sinking fund. This year, after a liberal writing off, they had made no loss, and had been able to provide practically the whole of the sinking fund out of profit. Dealing with the balance-sheet, he stated that the figures on the debit side were practically the same as last year with the exception that the amount of debentures had been reduced by £3,100. After referring to the items on the credit side, he said it would clearly be seen that their balance-sheet for the past year must be a healthy one as compared with that for 1902, in so far as they have allowed amply for depreciation, and the decrease in stock and sundry debtors of £9,370 was represented by about £10,000 additional hard cash. These were distinctly encouraging symptoms, considering the position of the company 12 months ago, and the results would have been better had it not been for three particular causes, which showed themselves in the shape of expenses against the year's trading. First, the stagnation prevalent in business last year led the directors to make serious efforts to endeavour to apply some of the unused capital at their disposal for new enterprises. Experiments had been made, negotiations had been carried on, and preliminary expenses had been incurred for the purpose of investigating such things as an automatic prepayment gas meter, an electric ignition apparatus in connection with petrol engines for motor cycles, and a simple and cheap speed indicator for motor cars and other machines. He regretted that none of these investigations and experiments were sufficiently encouraging to warrant their investing any of the company's capital in them, and the several hundred pounds spent had gone towards their general expenses of the last year. One particular reason why the directors decided not to press on with these supplementary manufactures was the resuscitation of the company's own business. The second cause was the continuance of experiments with a new meter and the taking out of patents for it. All expenses connected therewith had been defrayed out of the year's trading, and they amounted to nearly £1,000. He explained last year that the larger quantity of very small meters required, owing to the change of voltage in stations all the world over, had been a reason why the company had been kept out of a great many stations, as their meter could not compete in price satisfactorily for the smallest sizes. Dr. Aron had succeeded in finishing what appeared to be an excellent little meter for alternating currents, and it would very shortly be on the market. He was satisfied with the technical success of this meter, while so far as he (the speaker) could judge as a manufacturer, he believed that the company would be able to produce it sufficiently cheaply to compete with others on the market. The third item which had worked against this year's profit was the expenditure of several thousands of pounds for the purpose of making good the meters in this country which they supplied two or three years ago, and which developed faults in practical use. Reference was made to this unfortunate occurrence last year in connection with the change of management, and the directors had thought it absolutely essential to make this sacrifice if they did not wish to lose the English market. They had succeeded in nearly every instance where they had undertaken this task in proving the worth of the meters, as they were now working reliably. As to their financial position, their assets were rather better than at any time since the formation of the Company. They had cash and other liquid assets amounting to £75,455, and against this there was the debenture issue of £56,900, leaving a net balance of £13,111, and this without any valuation of land, freehold buildings, machinery, tools, fixtures, patents, or goodwill and stock, the latter alone amounting to £37,560. On a recent visit with Mr. Blumlein to Germany he had convinced himself that the company had an excellent property in Schweidnitz, and that it had considerably improved in value. As every inch of their space was at present taken up with manufacturing for orders the directors sanctioned an expenditure of £2,500 for extension of works in which to manufacture the new small meter.

Regarding the commercial outlook, their business had assumed a different aspect in various countries. In Germany they had been eminently successful, especially during the latter half of last year. The pleasant feature of the increase in sales was that they were not only due to one or two customers, for the company supplied 150 stations in Germany, and they had increased their business with nearly all of them. They had much less trouble in Germany than in this country with engineers. The orders during the two months of the present financial year were far ahead of those of the same period last year—by 40 per cent. he had heard by telegram that morning—and the actual number of orders in hand equalled their best records. An additional help had no doubt been that the Physikalisch Technisch Reichsanstalt had, on behalf of the German authorities, passed the company's meter for both alternating and continuous currents. In Austria and France they had held their own. In this country, however, they were in a rather peculiar position. A few stations that used their meters in large quantities, after having once or twice given other meters a chance, had again returned to the company. Their double tariff meter was rising greatly in favour. A great number of engineers, however, were so discouraged about 15 or 18 months ago that they had not yet returned to the company, although the meters were now giving most satisfactory results. He felt that they would have more chance of regaining this custom if they could supply both large and small meters, and the board would make every effort to do this so soon as the small meter was on the market. An effort was now being made to bring more life into the American business, and he hoped to have good news on this point when they met again. Their manager and chief assistants had thrown themselves with admirable devotion into the business during the past year, and in doing so they could not have had a better example than Prof. Aron himself, who never worked harder during the days when the business was his own than he had done during last year. He then moved the adoption of the report and balance-sheet.

Sir JAMES PENDER, Bart., seconded the motion.

The CHAIRMAN, in reply to questions, said this company held all the shares in the German company and the French company, whose balance-sheets could be inspected by any of the shareholders. Not a single branch had worked at a loss except the London branch, and this loss had been owing to the expenses to which he had referred.

The motion was carried unanimously; and the retiring directors and auditors having been re-elected, the proceedings terminated.

INDIARUBBER, GUTTA-PERCHA AND TELEGRAPH WORKS CO. (LTD.)—The directors' report for the year ended Sept. 30 states that, after provision for doubtful debts, a net profit has been made for the 12 months of £54,568. 16s. 3d. Adding £62,361. 11s. 7d. brought forward and deducting £12,500 interim dividend, there is for disposal £104,430. 7s. 10d. The directors recommend the distribution of a dividend of 15s. a share, tax free, amounting to £37,500, making 10 per cent. for the year, and leaving £66,930. 7s. 10d. to be carried forward. The general business shows a falling off compared with the previous year, to a great extent due to the general depression, as a result of which competition has been, if anything, keener than usual.

The cable to connect San Francisco with the Sandwich Islands was laid for the Commercial Pacific Cable Co. by the cs. "Silvertown" on Jan. 1, and the "Dacia" and "Buccaneer" have been employed in cable repairing work during the year. The works at Silvertown and Persan have been maintained in their usual state of efficiency, and extensions continue to be made.

The ground lease for a term of 28¼ years of the Cannon-street premises has been purchased. The company holds a considerable interest in the Palmer Tyre (Ltd.), and has designed a new motor tyre which attracted a good deal of attention at the recent Stanley Show.

The directors record with regret the death of their colleague, Mr. Abraham Scott, which took place on Nov. 19. Mr. T. J. Lloyd, who had been connected with the company since its formation in March, 1864, and occupied the position of secretary and accountant at the time of his death, died on Dec. 24, 1902. Mr. A. P. Crouch and Mr. E. C. Geale have been appointed respectively secretary and accountant. Mr. John Bailey, also connected with the company since its formation, and who was for about 35 years works manager at Silvertown, has retired from active service as from Oct. 1 last. Mr. Bailey was succeeded by Mr. P. M. S. Brodie, who has been with the company since 1872. Col. A. Weston-Jarvis, having returned from military duty in South Africa, was re-appointed a director, and Mr. John Young Buchanan has become an extraordinary director.

ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING CO. (LTD.)—The report for the year ended Sept. 30 shows a balance profit of £12,304. Traffic receipts amounted to £33,465, against £35,088 for the corresponding period of last year (decrease, £1,623). This decrease was entirely due to the inclemency of the weather during the summer and autumn. To pay debenture interest, dividend on preference shares, interest, fees to debenture trustees and income tax an additional £3,403 was required, which has been taken from the unappropriated balance at credit of last year's revenue account. From this balance also a sum of £1,853 has been written off for compensation for accidents and for other charges in the previous year, which were only ascertained after last year's accounts were closed. £500 further has been written off "Improvement of Cars" account. The balance of last year's revenue account (£5,047) has been carried forward. The company has been insured against accidents to third parties since June 16, 1903. The supply of electricity for lighting to private consumers at Margate was commenced on Jan. 2 last. This business is now showing indications of more rapid expansion both at Margate and Broadstairs.

NERNST ELECTRIC LIGHT (LTD.)—The report of the directors for the year ended Sept. 30 states that the return of lamps sold in the company's districts, as well as in England, during the period under review shows an increase, and the working expenses have been further reduced. As the experimental shops and laboratory have been closed, owing to the altered policy of the company, the directors have added the sum which previously appeared on the balance-sheet under these headings to development suspense account, which thus stands at £17,355. As a considerable proportion of the above will have to be met before future profits can be distributed, the directors are of opinion that the balance is not available for dividends. The board consider that the shareholders would be acting wisely in reducing the capital of the company, so that it might represent more accurately the available assets. As already announced,

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the scheme formulated by a section of the shareholders commends itself to the directors as an equitable basis for distribution between the two classes of shares.

POWER GAS CORPORATION (LTD.)—The chairman (Sir Henry Fowler, M.P.), at the meeting last week, said the extension and remodelling of the works at Stockton-on-Tees had been practically completed. The managing director (Mr. Emile Schweich), in his latest report had stated that considerable improvements had been effected in these works, the cost of which had been charged to revenue. Satisfactory progress had been made during the year with the contract for the gas generating and distributing plant for the South Staffordshire Mond Gas Co. Another company had obtained an act of Parliament last session for establishing similar operations in North Staffordshire, and in parts of the counties of Derby, Flint and Denbigh. They had agreed to grant a licence for the sale and distribution throughout that area of power gas manufactured under the patents of the Power Gas Corporation. They had acquired the sole rights in this country for the manufacture and sale of the appliances patented by Mr. Benjamin Talbot for mechanically agitating the fuel in gas producers, and the directors had appointed Mr. Talbot a director. The profit was £13,082. 11s. 8d., something less than the profit twelve months ago, but the previous accounts covered transactions many of them dating back from Jan., 1901. They proposed to pay a dividend of 5 per cent. for the year upon the ordinary shares (absorbing £9,388. 13s. 1d.), and to carry forward £1,700, against £1,400 last year. On the whole, their progress was slow. The engineering world was waiting to see the result of the plants which had been started, and also to see the results of the development of large gas engines. Their managing director reported that many important firms in this country had now entered upon the manufacture of large gas engines, and along with the older-established gas-engine manufacturer, were actively devoting their energies to the manufacture and improvement of large gas engines of various types. A great deal of their prosperity would depend upon the development of these large engines, and from all signs they had come to the conclusion that the prospects were most encouraging. Mr. Alfred Mond said that in all countries the gas engine was recognised as the coming form of power production. Engineers had assured them, on more than one occasion, that they were perfectly ready to put in the company's plant if they could be sure of getting a large gas engine which was reliable.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

DURHAM AND DISTRICT ELECTRIC TRACTION CO. (LTD.)—Reg. Nov. 30, capital £30,000 in £1 shares, to carry on business of carriers of passengers and goods, electrical and general engineers, electricians, contractors, manufacturers of and dealers in railway, tramway, electric and other apparatus, mechanical and chemical engineers, suppliers of electricity, &c. The subscribers are W. J. Greer, G. J. Somerville, electrical engineer, H. S. Day, C. L. Robertson, A. B. Gridley, G. O. Hor, electrical engineer, and C. H. Godward. Reg. office, Donington House, Norfolk-street, London, W.C.

ELECTROPHONE LIMITED.—Reg. Dec. 2, capital £15,000 in 10s. shares, to acquire undertaking known as Electrophone Limited, to adopt an agreement between the old company and A. Anns and H. S. J. Booth (its liquidators) and the National Telephone Co., to manufacture and deal in telephones and all apparatus, appliances, implements, works and things connected with telephonic communication or with the generation and employment of electricity, &c. The National Telephone Co. may nominate one director.

E. C. THEEDAM (LTD.)—Reg. Nov. 30, capital £3,000 in £1 shares, to adopt agreement with E. C. Theedam for acquisition and carrying on of the business of a hardware supply store proprietor, metal and brass goods manufacturer, electrical and mechanical engineer, import and export merchant, &c., at Dudley as E. C. Theedam and the Dudley Electrical Co. E. C. Theedam is first permanent director. Reg. office, 53, High-street, Dudley.

MORTGAGES AND CHARGES.

BROCKIE-PELL ARC LAMP (LTD.)—Debenture created 27th and dated Nov. 30, 1903, to secure not more than £1,000, charged on company's property, present and future, including uncalled capital, has been registered. Holders, Barclay & Co.

BRITISH PROMETHEUS CO. (LTD.)—Memorandum of satisfaction in full of debenture dated Aug. 15, 1903, securing £150, has been filed.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MFG. CO. (LTD.)—(In voluntary liquidation.) Memorandum of satisfaction in full of debenture dated Sept. 3, 1902, securing £9,500, has been filed.

SHANNON ELECTRIC POWER SYNDICATE (LTD.)—Lien reg. Dec. 3, for £180 debentures, part of £8,000; amount previously issued £7,820; charged on undertaking and all property, including uncalled capital.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 25 1/16d. per oz. (Dec. 10). Consols 88½—88⅝ for money, 88 1/16—88 3/16 for account; 2½ per cent. annuities 88½—88⅞ (Dec. 10). Consols Pay Day, Jan. 6; Stocks and Shares Continuation Day, Dec. 28; Ticket Day, Dec. 29; Pay Days, Dec. 11 and 30; Mining Share Carry-over Day, Dec. 24.

BLACKPOOL, ST. ANNES AND LYTHAM TRAMWAYS CO.—The directors' report states that, notwithstanding the doubling of the line and equipping it on the overhead system, the service was opened in June with cars insufficient for the business which offered. The receipts were more than the directors anticipated, and the traffic generally augurs well for the future. It is recommended that the balance of £2,017 be carried forward.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—The directors have declared the following interim dividends:—At rate of 6 per cent. per annum on preference shares for the six months ending 31st inst. (3s. per share), and at rate of 10 per cent. per annum on the capital paid up on the ordinary shares (1s. per share) for the six months ended 30th ult. Both dividends will be paid (less tax) on Jan. 1.

STOCK EXCHANGE NOTICE.—The Stock Exchange Committee have appointed Dec. 16 a special settling day in 15,000 £10 (£8 paid) shares of the *Havana Electricity Co. (Ltd.)*, and have ordered same to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended		Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
			£	£		£	£
*Aberdeen Corporation	Dec.	5	1,066	+ 251	27	33,617	+ 5,756
Ayr Corporation	...		...	...	...	...	...
Barnsley	Nov.	27	165	+ 10	47½	8,549	- 20
Bexley District Council	Dec.	4	105	...	9	1,572	...
Birkenhead	,,	6	926	- 44	...	...	...
*Birmingham Tramways	,,	5	4,890	+ 76	22	113,637	+ 3,141
*Blackburn Corporation	...		...	...	...	...	...
Blackpool Corporation	,,	3	269	+ 2	§35	86,798	- 184
Blackpool and Fleetwood	,,	5	182	+ 12	23	20,216	- 126
Blackp'l,St.Anne's&Lytham	,,	3	176	+ 67	15	732	+ 338
Bolton Corporation	,,	6	1,566	+ 99	36	66,546	+ 7,957
Bournemouth Corporation	,,	2	734	...	36	37,718	...
*Bradford Corporation	,,	6	3,256	+ 248	35	136,168	+ 19,121
Brighton Corporation	,,	6	695	+ 56	40	33,935	+ 2,610
Brisbane Tramways	Oct.	21	2,223	- 18	16	37,492	+ 489
*Bristol Trams & Carriage	Dec.	4	4,273	+ 144	2	8,623	+ 371
*Buenos Ayres & Belgrano	Nov.	8	3,278	+ 303	3	9,532	+ 483
Burnley Corporation	Dec.	5	774	+ 142	36	36,832	+ 6,422
Burton Corporation	,,	6	268	...	18	6,619	...
Calcutta Tramways Co.	,,	5	R35,826	+ R4,155	23	R763,433	+ R138,076
Camborne-Redruth	,,	7	103	...	5	569	...
Cardiff Corporation	,,	5	1,760	+ 292	§6	71,160	+ 19,443
Carlisle Tramways Co.	,,	7	155	+ 32	¶48	9,324	+ 791
Central London Railway	,,	5	7,091	- 50	23	146,101	- 6,910
Chatham and Dist. Lt. Rys.	,,	3	478	+ 155	48	25,985	...
City & South London Rly.	,,	6	3,187	- 161	23	61,187	- 9,390
Cork Electric Trams Co.	,,	3	357	- 23	38	28,025	- 3,405
Darwen Corporation	...		...	...	...	...	...
Devonport & Dist. Trams	Nov.	27	435	+ 69	47½	21,910	+ 1,413
Dover Corporation	Dec.	5	166	+ 7	†36	8,474	+ 79
Dublin & Lucan Railway	,,	6	84	...	23	2,940	+ 174
Dublin Southern District	,,	4	150	- 20	¶22	23,832	+ 7,694
Dublin United	,,	4	3,409	- 62	¶22	89,433	
Dudley—Stourbridge	Nov.	27	762	+ 58	47½	39,701	+ 8,726
Dundee Corporation	Dec.	2	775	- 39	...	...	...
East Ham Council	,,	5	529	+ 122	†26	24,386	+ 7,175
Gateshead & Dist. Trams	Nov.	27	869	+ 61	47½	41,669	+ 5,352
Glasgow Corporation	Dec.	5	13,142	+ 1,033	27	369,462	+ 28,176
Gravesend—Northfleet	Nov.	27	212	+ 45	47½	11,499	+ 1,215
Greenock & Port Glasgow	,,	27	503	+ 59	47½	26,008	+ 2,138
Halifax Corporation	,,	25	1,077	+ 90	} 35	49,183	+ 5,531
	Dec.	2	1,081	+ 105			
Hartlepool Tramways	Nov.	27	242	+ 36	47½	12,869	+ 824
Huddersfield	Dec.	5	1,141	+ 233	§5	45,026	+ 6,986
Hull Corporation	,,	5	1,801	+ 147	†36	67,472	+ 8,856
Ilkeston Corporation	,,	2	122	...	3	372	...
Ipswich Corporation	...		...	...	...	...	...
Isle of Thanet Co.	,,	5	221	+ 40	23	21,627	- 1,061
Kidderminster & District	Nov.	27	96	...	47½	6,076	+ 109
Kirkcaldy Corporation	,,	25	148	} ...	40	6,993	...
	Dec.	2	184				
Lanarkshire Trams Co.	,,	3	524	...	§16	12,258	...
*Leeds Corporation	,,	5	4,855	...	26	199,918	...
Liverpool Corporation	Nov.	28	9,582	+ 418	44	483,457	+ 15,970
*Liverpool Overhead Rly.	Dec.	6	1,514	+ 34	23	38,559	+ 2,464
London County Council	...		...	...	...	...	...
Lowestoft	,,	5	119	...	†20	5,039	...
Manchester Corporation	,,	5	10,565	+ 3,131	§5	295,001	+ 156,330
Mersey Railway	,,	5	1,401	+ 292	23	30,585	+ 6,025
Merthyr	Nov.	27	190	+ 34	47½	9,452	- 26
Middleton	,,	27	233	+ 14	47½	15,097	+ 1,841
Newcastle-on-Tyne Corp.	Dec.	5	3,337	+ 325	23	80,151	- 2,465
*Newport (Mon.)	,,	5	397	+ 243	9	3,936	+ 1,887
Oldham, Ashton & Hyde	Nov.	27	502	+ 10	47½	27,008	+ 1,589
Perth (W. A.) Elec. Trams.	Dec.	4	1,252	+ 179	§18	26,357	+ 6,447
Peterborough	Nov.	27	112	...	44	6,998	...
Poole and District	,,	27	226	+ 23	47½	14,421	+ 2,076
Portsmouth Corporation	Dec.	5	1,201	+ 35	†35	65,989	+ 4,265
*Potteries	Nov.	27	1,544	- 75	47½	75,219	+ 3,487
Reading Corporation	Dec.	3	492	...	...	...	...
Rothesay	Nov.	27	37	- 2	47½	6,846	+ 1,601
Salford Corporation	Dec.	7	3,464	+ 767	36	133,040	+ 40,788
*Sheerness	Nov.	25	47	...	33	2,856	...
Sheffield Corporation	Dec.	6	4,057	+ 310	23	105,788	+ 8,422
*Southampton Corporat'n	,,	3	808	- 87	...	...	...
Southend Corporation	,,	2	182	+ 21	§5	12,240	+ 1,900
Southport Tramways	Nov.	27	247	+ 44	47½	14,928	+ 2,618
S. Staffordshire Trams.	,,	27	1,017	+ 406	47½	43,551	+ 7,456
*Sunderland Corporation	Dec.	6	1,046	+ 70	36	44,791	+ 2,137
*Swansea Trams	Nov.	27	450	+ 23	47½	24,615	+ 2,050
Taunton Trams	,,	27	47	- 4	47½	2,879	- 200
Tynemouth and District	,,	27	200	- 3	47½	14,870	+ 781
Tyneside Trams Co.	Dec.	2	246	+ 47	48	15,563	...
Wallasey District Council	,,	5	570	+ 56	†36	25,041	+ 3,226
Weston-super-Mare	Nov.	25	28	...	47	5,644	- 514
Wigan Corporation	...		...	...	...	...	...
Wolverhampton District	,,	27	346	+ 37	47½	18,522	+ 7,646
Wrexham	,,	27	111	...	34	4,805	...
Yorkshire Woollen District	,,	27	487	...	40½	15,721	...

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ¶ Plus 3 days. § Plus 2 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed. Dec. 9.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS WEEK TO DEC. 9	
				£ s. d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine 8h(1to260,007)5%Cm.Pf.	4¼—4⅝	5 5 3	April, Oct	4⅛	4¼
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	129½	..
10	10 0	Barcelona Tramways Ord.	7⅛—8⅛	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	3⅛—4⅛	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	99 —104	4 8 5	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼—10⅜	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 1	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 —82	3 12 9	..	80½	..
St.	5%	Do. Pref. Ord. Stock	91 —94	5 6 2	..	92	..
10	4/2½	Do. 5% Cum. Perp. Pref.	10 —10¼	4 15 3	..	..	..
4	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	..	..
10	10/0	British Electric Traction Ord.	11⅜—12⅜	6 10 8	..	12	11⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	11⅛—11⅜	5 2 2	Feb, Aug	11⅛	11⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	122½	121
5	..	Buenos Ayres and Belgrano Ord.	2⅞—3⅛	..	..	3⅛	2⅞
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5⅛—5⅜	5 4 0	..	5⅛	..
5	3/0	Do. "B"	4⅜—5⅛	5 14 3	..	5	..
St.	5%	Do. 5 per Cent. Debs.	106 —109	4 12 10	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	5 0 9	..	100⅛	..
5	2 6	Calcutta Tramways	6⅞—7⅛	3 2 1	..	7	6⅞
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 11	..	..	..
1	1/2½	Cape Electric Tramways Shares	1⅛—2⅛	7 1 2	..	1⅛	..
St.	4%	Central London Ordinary Stock	93 — 96	4 4 9	June, Dec	94½	92½
St.	4%	Do. 4 per Cent. Pref. Stock	99 —102	3 18 10	..	..	..
St.	4%	Do. Deferred Stock	96 —99	4 1 8	..	98	..
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 11	..	47½	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 —5⅛	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	47 —50	6 5 0	Feb, Aug	49	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 —129	3 18 7	Feb, Aug	126	..
St.	5%	Do. (1896)	123 —126	4 0 4	..	125	..
St.	5%	Do. (1901)	120 —125	4 1 1	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 0	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 —13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3½—4½	6 13 4	..	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 —98	5 2 0	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7⅛—8½	3 10 7	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	109 —111	4 3 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3⅞—4⅛	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 3	..	..	..
10	1¼%	Liverpool Overhead Railway Ord.	4⅜—5	2 10 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼—10⅜	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	3 19 6	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11⅛—11⅜	4 5 1	..	11⅛	11⅜
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 8	..	105⅛	105
St.	..	Mersey Con. Ord. Stock	8 —11	..	..	8	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅝—⅞	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 4 1	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	100 —103	4 19 0	..	102	101½
10	10/0	Potteries Electric Traction Ord.	8⅛ — 9⅛	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	8¼—9½	5 5 3	Feb, Aug	9⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 —94	3 9 8	June, Dec	93	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	49 —52	6 1 6	F,My,Ag,N	49½	..
St.	30/0	Do. Preferred	92 —94	6 8 3	F,My,Ag,N	93⅜	92¾
St.	1/0	Do. Deferred	7⅛—8	0 12 9	F,My,Ag,N	7⅛	7⅛
100	£2	Commercial Cable Capital Stock	145 —155	5 9 8	Ju,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	Jn Ap,Jy,O	92½	91½
10	7 0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	97⅞—101⅝	4 10 10	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 3 10	Ja,Ap,Jy,O	10½	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 —102	4 8 10	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	122 —127	5 10 8	Ja,Ap,Jy,O	124	122
St.	17/6	Do. 3½ per Cent. Pref. Stock	85 —88	4 0 4	Ja Ap,Jy,O	87½	86
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	106½	..
10	2,6	Eastern Extension	11 —11½	6 1 9	Ja,Ap,Jy,O	11¼	11
St.	4%	Do. 4 per Cent. Deb. Stock	106 —109	3 14 4	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 18 10	Feb, Aug	99½	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 11	May, Nov	100	..
10	5.0	Great Northern of Copenhagen	25 —26	4 16 2	Jan, July	25¼	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	99 —102	4 8 4	June, Dec	..	..
25	12 6	Indo-European	37 —40	6 5 0	May, Nov	38½	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..
2½	..	West Coast of America	⅛—⅜	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	97	96½
10	..	West India and Panama	⅞—1⅛	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	6⅝	..
10	..	Do. 6 per Cent. 2nd Pref.	4 —5	..	May, Nov	5	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 17 7	Jan, July	..	..
10	5.0	Western Telegraph	11⅞—12⅛	5 14 3	Mr,Jn,O,D	12⅛	11⅞
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 8	..	100	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅜—5½	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	8¼—8⅝	4 11 5	Ja Ap Jy O	8⅝	8⅞
10	8/0	Do. 6 per Cent. Pref.	12⅛—13	4 12 4	Ja Ap,Jy,O	12⅞	12½
8	4/0	Reuter's	6½—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	116 —121	4 19 7	April, Oct	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed. Dec. 9	RATE PER CENT. YIELDED.	DIVIDEND DUE	BUSINESS WEEK TO DEC. 9.	
				£ s. d.		Highest.	Lowest.
		TELEPHONES.					
5	6/0	Chili Telephone (fully paid)	4⅞—5⅛	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	101 —103	5 18 9	..	103	101⅛
St.	5%	Do. Def. Stock	78 —81	6 0 6	..	79⅝	77
10	6 0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	14	13½
10	6.0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛—5⅜	4 13 0	Feb, Aug	5⅛	5⅛
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96 —98	3 12 9	June, Dec	..	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	102 —104	3 17 5	..	103⅜	..
1	0/7½	Oriental	⅞—1	7 2 0	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
5	4/0	United River Plate	5⅛—6	5 16 8	July	5⅛	5⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝—5⅛	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 - 107	4 13 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝—¾	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv.Cts.(rd.&con.)	116 —119	3 15 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12⅛—13⅛	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 —11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 —106	4 5 3	..	..	..
St.	4½%	Bromley (Kent) El. Lt. &Power 1stDebs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—10⅜	4 3 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10 —10½	3 6 8	Mar, Sept	10⅛	..
5	3 0	Calcutta Electric Supply Ord.	6⅞—7½	4 6 8	..	..	..
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	105 — 108	3 13 11	..	106½	102½
5	4/0	Charing Cross & Strand Electric Sup.	8⅜ - 9½	5 8 1	Feb, Aug	9⅛	9⅛
5	2/3	Do. 4½ per Cent. Pref.	5⅛—5⅜	3 18 3	Feb, Aug	5⅛	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜—5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	105 —107	3 16 0	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5⅛—6	4 3 4	March ..	5⅜	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —110	4 3 0	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10⅜—11	6 16 4	Feb, Aug	10⅛	10⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 —127	3 18 11	Jn, Dec ..	125	125⅛
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 9 5	..	104	103⅛
10	4/0	County of London & Brush Prov. Ord	7⅛ - 8⅛	4 14 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11⅛—12⅛	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	108 —111	4 2 8	..	110⅛	110
St.	27.6%	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	100⅛	..
5	2 0	Folkestone Electricity Supply Co. Ord	5⅛—6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
5	3 6	Hove Electric Lighting Ord.	7⅛ - 8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10⅛—11⅛	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6⅛—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg.Co.&NottingHill Co. (Joint Station) 4% Deb. Stck.(red.)	101 —104	3 16 11	..	..	..
3	..	London Electric Supply Ord.	1⅞—2⅛	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	5 —5⅜	5 9 1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	4 0 6	Mr,Jn,S,D	..	..
10	8 0	Metropolitan Electric Sup. Ord.	17⅛—18⅛	4 3 9	April, Oct	18	17⅛
5	..	Do. 4½ per Cent. Cum. Pref.	4⅛—4⅜	..	..	4⅛	4⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	110 —114	3 19 8	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 - 99	3 11 7	..	..	..
10	6 0	Notting Hill Electric Ord.	12⅛—13⅛	4 8 11	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —101	3 19 3	..	..	..
5	2 6	Oxford Electric Ord.	5⅛—5⅜	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 6	..	..	..
1	..	Rand Electric	⅜—½	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	99 —102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14⅛—15⅛	4 13 9	Feb, Aug	14⅛	—
5	3 6	Do. 7 per Cent. Pref.	7⅛ - 8⅛	4 2 4	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —101	3 10 4	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3 —3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
†	1/9	South London Electric Supply Ord.	3½ - 3⅝	4 13 4	..	3⅝	..
5	2,6	Urban Electric Supply Ord.	4⅜ 5⅜	4 17 7	..	..	..
5	2,6	Do. 5% Cum. Pref.	4⅛—5⅛	4 17 7	..	4⅛	..
5	6/6	Westminster Electric Supply Ord.	11⅛—12⅛	5 8 4	Mar, Sept	12⅛	12⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6⅜	3 16 11	..	6⅜	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—⅝	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅝—1⅛	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 —6⅛	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5⅛—5⅜	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	103 —108	4 4 10	..	100⅛	..
St.	4½%	British Thoms'n-Houst'n4½%1stMt.Db.	103 —105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	4⅜—5⅛	5 14 3	..	5⅛	4⅞
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	100 —102	3 18 5	..	..	..
½	..	Brush Electrical Engineering	¾—1⅛	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1⅛—1⅜	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 - 89	5 8 6	Jan, July	..	..
5	5,0	Callender's Cable Construction Ord.	11 —12	6 5 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	106 —110	4 1 10	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅜—⅞	6 17 2	..	⅝	⅜
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	91 —96	4 15 3	..	..	..
1	0 7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜—2⅛	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	99⅝—103⅞	4 19 4	Jan, July	100	99
5	..	Edison & Swan United("A"Sh.)(£8 pd.)	½	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	1 —2	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock (rd.)	72 —77	5 5 3	June, Dec	72⅜	71⅛
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6⅛—6⅞	5 3 8	H'lf-yearly	6⅞	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6⅛	4 12 4	..	6⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 4	..	105⅛	..
2	1/2½	Electric Construction Co.	1⅛—1⅜	6 17 2	Jan, July	..	..
2	2 9½	Do. 7 per Cent. Cum. Pref.	2⅛—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 —101	4 0 9	Jan, July	99⅛	98½
1	..	Electrolytic Alkali Ord.	⅝—¾	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅛—10⅛	4 17 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 —99	4 0 10	..	14	..
5	6/0	Henley's Telegraph Works Ord.	14 —15	6 13 4	Feb, Aug	..	..
5	2 3	Do. 4½ per Cent. 1 ref.	5 —5⅛	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort Deb.Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	5,0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 7	Feb, Aug	18½	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10⅜—11⅛	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 8	Mar, July	34½	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 6	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	5 —6	5 8 4	Apr, Oct	5⅜	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6⅛	4 12 4	Apr, Oct	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 5	May, Nov	..	..

In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend ‡ The London Stock Exchange Committee have refused to quote these.

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THE ELECTRICIAN:

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NOTES.

IN connection with the recent fire at Sandringham House and HER MAJESTY THE QUEEN'S timely escape, a statement was circulated broadcast to the effect that the fire was due to the fusion of certain wires which had been installed for the electric lighting of the house. If the outbreak had not been overcome with such rapidity, it is conceivable that all traces of the origin might have been destroyed and irreparable injury done to the electrical industry. Inquiries with regard to the matter have led to the publication of an official statement that the fire was not caused by electricity at all, and users of the electric light may still rest assured that this method of artificial illumination is undoubtedly the safest of any.

SINCE the publication of M. HOSPITALIER'S interesting Paper in *The Electrician* last week, our attention has been called to the fact that an instrument based upon precisely the same principle as his "ondograph" was described as long ago as 1895 at the Ipswich meeting of the British Association (*The Electrician*, Vol. XXXV., p. 719). In this earlier instrument, developed by Messrs. BARR, BURNIE and RODGERS in Prof. AYRTON'S laboratory, a commutator and condenser were employed in the same manner as M. HOSPITALIER uses them, but the curve was traced with the aid of an ordinary reflecting galvanometer instead of a recording instrument. M. HOSPITALIER is to be congratulated on applying the principle in such a way as to give us a commercial form of instrument.

WE believe that, since the reading of the Ipswich Paper referred to above, no instruments of this class have been fully developed in this country until the appearance of Mr. DUDDELL'S ingenious oscillograph. This has one important advantage over the ondograph in the fact that it can record non-periodic and even discontinuous phenomena as well as the periodic curves for the registration of which it has been more frequently employed. For instance, the remarkable momentary rises in pressure which occur sometimes when switching feeders and transformers on and off can be observed by its means, as well as other phenomena which are of interest in laboratory investigations even if the recording of them may have no immediate practical utility. But it is in just this direction of general practical utility that the ondograph has much in its favour. Apparently, it is a less delicate instrument to handle than the oscillograph, and probably, also, it is cheaper—two qualities which go far to compensate a limited range of applicability. If Mr. DUDDELL can develop one or two somewhat cheaper and hardier forms of his instrument that can be operated successfully by those who have not the opportunity to acquire an intimate knowledge of "their tricks and their manners," he will still further advance the study of alternating-current phenomena to which the oscillograph in this country and the ondograph and rheograph in France have already so greatly assisted.

DR. GARRARD'S letter in our correspondence columns this week, commenting upon the recent breakdown at Westminster and our remarks upon it, is extremely interesting, the more so as he offers a piece of apparatus to remove the objections he himself raises to the ordinary equipment of the generator panel on a central station switchboard. We hardly think, however, that engineers who are responsible for the running of electricity works will share his views as to the superiority of reverse-current cut-outs over all other protective devices for continuous-current dynamos. A visit to a number of continuous-current stations in this country will, it is true, reveal the fact that either return-current or minimum cut-outs

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have been placed on the switchboards of most of them; but, on a closer examination of these pieces of apparatus, additional catches or pins (or in some cases improvised devices, such as wedges or pieces of string) will be discovered which effectually prevent their coming into action automatically. The reason of the antipathy to minimum and return-current cut-outs on the part of men who are responsible for the continuity of supply, is that in practice it is found that they occasionally cut off the undamaged generators, just as Dr. GARRARD says the maximum cut-outs do. Usually this is traceable to a back current from the cells, but sometimes, when there are no cells, it is attributable to other causes, as in the case of the famous Brighton breakdown a few years ago.

IN the case of a generating station of fairly large size there is little danger in employing maximum cut-outs between the dynamos and the 'bus bars. Take, for instance, five sets intended for a maximum output of 1,000 amperes each, working on a full load of 5,000 amperes, and assume their cut-outs adjusted to act at 2,000 amperes. If one of these sets is disabled, current will return to it from the 'bus bars, and as soon as 2,000 amperes flows back its cut-out will act. At that moment the other four machines will be supplying 7,000 amperes, or less than 2,000 amperes each, and, in consequence, only the cut-out of the disabled machine will drop out. Of course, with fewer machines in parallel, these figures will not apply, but it is essentially against failures at full load that the supply station engineer must be guarded. At the Eccleston-place station eight machines were running in parallel when the accident occurred.

MR. SODDY, in his serial on "Radio-activity" this week, enters into a new section of his subject. Much is already known as to the properties of radio-active bodies, and methods have been devised by means of which quantitative measurements can be made of the activity of the three classes of rays which they emit, but no definite agreement has yet been arrived at among physicists as to how the phenomenon of radio-activity itself can be explained. Among the hypotheses that have been put forward, the disintegration theory of Prof. RUTHERFORD and Mr. SODDY, which has also found an active supporter in Sir WILLIAM RAMSAY, has been adopted by Mr. SODDY as a working hypothesis, and the part of his serial which commences in this issue clearly and systematically explains this theory and the experiments and investigations that have led up to it.

Electro-Pneumatic Signalling.—The North-Eastern Railway Co. have inaugurated electro-pneumatic signalling on their Sunderland and North Shields line at Harton Colliery, this being the first time it has been adopted for passenger traffic on the North-Eastern Railway.

"Technical Literature."—The Hanover firm of publishers, Gebrüder Jänecke, inform us that they propose to commence the publication on January 1st next of a new periodical in German, English and French, bearing the above title, and that it will contain reviews of books, and detailed tables of the contents of the leading technical journals in both hemispheres.

Crystal Palace Company's School of Practical Engineering.—A party of visitors yesterday inspected the several departments of the Crystal Palace Company's School of Practical Engineering. Afterwards the certificates awarded to the students were distributed by Sir Edward Carbutt, Bart.

Electric Power in Steel Works.—Messrs. Baldwin & Co. have installed in their Panteg Steel Works, Pontypool, an electrically-operated machine which enables the furnaces to be charged with 30 tons of ore in 40 minutes, the operation being performed by two men; thus a saving of three hours at each charging is effected, and the services of a third man are dispensed with.

Personal.—The Paris correspondent of the *Daily Chronicle* telegraphs that the Minister of Public Instruction has been authorised to prepare a bill providing for the creation of a Chair of General Physics at the Faculty of Sciences of the University of Paris as a special honour for M. Curie in recognition of his work in the discovery of radium.

The Berlin correspondent of the *Standard* states that Herr William von Siemens, eldest son of the late Werner von Siemens, has been raised to the Prussian peerage.

Electric Light in the Faroe Islands.—The *Electrical World* of New York states that it is suggested that Thorshavn, in the Faroe Islands, should be provided with electric light. The water power is abundant for nine months of the year, and during that period it is so dark that artificial light is necessary. Petroleum lamps are generally used in the shops and houses and for street lighting; this could all be advantageously replaced by electric lighting during the season that lights are most needed. During the months of May, June and July, when the streams are lowest, no lights would be needed, as it is daylight constantly.

The Nobel Prizes.—These prizes were formally distributed on Thursday evening, December 10th, by the King of Sweden, several members of the Swedish royal family and other distinguished persons being present. The recipients were:—For Physics, Prof. Henri Becquerel and M. and Mme. Curie; for Chemistry, Prof. Arrhenius; for Medicine, Prof. Finsen; and for Literature, M. Björnstjerne Björnsen. Mr. William Randall Cremer, M.P., was awarded the Peace prize. Prof. Finsen and M. and Mme. Curie being absent at the official distribution, they were represented by the Danish and French Ministers respectively.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Anjer—Kalianda	Aug. 2, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Paramaribo—Cayenne	Feb. 27, 1903
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Cape St. Jacques—Haiphong	Dec. 15, 1903
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903

Fire on German Elevated Railway.—The *Electrotechnische Zeitschrift* gives the following account of the causes of the recent fire on the elevated railway in Elberfeld:—"Having run beyond the station platform, the driver, in endeavouring to regain it, either reversed the controller too suddenly or without first loosening the brakes; in any case the current quickly exceeded the normal, and, although the maximum cut-out operated promptly, an arc was formed between the terminals of the latter. A second arc was formed at the ordinary switch, which was only partially opened by the driver. In consequence, the aluminium casing of the switch was melted, and the dropping particles of the molten metal charred the wooden seats below, without, however, setting them on fire. A panic ensued, but all the passengers alighted safely on the platform, at which the train had then arrived.

Siemens and Halske's Rapid Type-printing Telegraph.—At a recent meeting of the Berlin Elektrotechnischer Verein, Mr. W. von Siemens described a rapid type-printing telegraph on the following principle:—A disc, near the periphery of which the letters of the alphabet, figures, &c., are cut out, rotates at a speed of 2,000 revs. per min. between a moving strip of sensitive paper and a spark-gap. Every time a spark

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jumps the gap, that letter on the disc which happens to be at the time opposite the gap is photographed. Two thousand letters per minute may thus be recorded on the moving tape, which passes through a developing and fixing bath, out of which it emerges after about 9 seconds. To obtain good results, the spark, it is said, must occur with a punctuality of $\frac{1}{10000}$th of a second, and this has been attained by a suitable arrangement of condensers. The messages to be sent are first punched on tape, which is then rapidly run through a rotating sender by means of which corresponding current impulses in rapid succession are sent to the line.

The Proposed Yorkshire University.—At the recent annual meeting of the governors of Yorkshire College, Mr. A. G. Lupton, alluding to the charter for the new university, said that they had not decided upon a title owing to opposition from Sheffield to the adoption of the county designation. Donations amounting to £36,000 had been promised provided that £100,000 was raised. It was essential that their annual income should be largely increased if the new university was to take the position to which its central position among the industries of the county entitled it. Lord Allerton said in that part of Yorkshire the feeling was unanimously in favour of the new university being called "The Victoria University of Yorkshire." A resolution was passed authorising the Council to make any alterations in the draft charter which might appear to them desirable, and to promote a bill for the incorporation of Yorkshire College in the university when founded; and to take such steps as would tend to secure the foundation of a university for Yorkshire.

Royal Meteorological Society.—At the monthly meeting of this society on Wednesday evening, Mr. W. Marriott lectured on the meteorological work of the late Mr. James Glaisher, F.R.S., who founded the society in 1850, and who died on February 7th last at the age of 93 years. Mr. Glaisher was appointed superintendent of the magnetic and meteorological department of the Royal Observatory, Greenwich, on its foundation in 1840, and through his instrumentality numerous meteorological stations were equipped in various parts of the country. He furnished quarterly the results from these stations to the Registrar-General from 1847 up to March, 1902. He was a juror of the great exhibition of 1851, and as such he caused a great stimulus to the manufacture of reliable meteorological instruments. To the general public he was best known by reason of the 28 balloon ascents which he made for scientific purposes between 1862 and 1869 on behalf of the British Association Committee.

Society of Engineers.—The Forty-ninth Annual General Meeting of the Society of Engineers was held on Monday, Mr. J. Patten Barber, President, in the chair. The following gentlemen were duly elected by ballot as the Council and officers for 1904:—

As President, Mr. D. B. Butler; as Vice-Presidents, Messrs. N. J. West, M. Wilson, and R. St. G. Moore; as Ordinary Members of Council, Messrs. J. Bernays, G. A. P. Cuxson, G. A. Goodwin, W. H. Holttum, H. Sherley-Price, E. J. Silcock, J. W. Wilson, and G. Green; as Honorary Secretary and Treasurer, Mr. G. Burt; as Honorary Auditor, Mr. S. Wood, F.C.A.

The President announced that the following premiums had been awarded by the Council for Papers read during the past session—viz., the President's gold medal to Mr. Douglas Mackenzie for his Paper on "Motor Transport for Goods"; the Bessemer premium of books to Mr. Robert J. Thomas for his Paper on "Road Maintenance and Administration"; and a Society's premium of books to Mr. Albert Gay for his Paper on "Mechanical Stokers for Electricity Generating Stations."

"The Central."—"The Central" is the title of a magazine which has been started by the Central Technical College Old Students Association. The first number, which has just reached us, is a very creditable production, and the editors, Messrs. E. Frankland Armstrong and Maurice Solomon, are to be congratulated on the results of their labours. As a frontispiece there is an excellent photogravure of Prof. W. C. Unwin, in his fur coat, and among the articles in the magazine is one on the new electrical laboratories at the Central Technical College, by Mr. Joseph Griffin, and one on oscillographs, by Mr. Solomon, which gives a clear and concise description of Mr. Duddell's instrument, and also includes some excellent illustrations of wave forms. The Old Students Notes, with which the magazine concludes, will be valued by old students who still take an interest in their old college, especially by those who have more recently left it. We notice that, at the outset, it is not proposed to publish the magazine at regular intervals, but we think that this is a mistake. A magazine with no definite date for its publication starts its life severely handicapped, and we should recommend the Old Students Association to promise it to their members regularly once a quarter.

Obituary.—It is with much regret that we announce the death of Mr. John W. Curra, who has been a prominent member of the engineer-in-chief's department of the General Post Office. Mr. Curra was born in 1863, and entered the service as a lower division clerk in 1881. Two years later he was transferred from the Savings Bank to the engineer in-chief's office as a clerk. Owing to a display of more than ordinary ability he was promoted to the position of second-class technical officer in 1892, and in the same year he was appointed personal assistant to Sir William Preece, and continued in this capacity until Sir William's retirement in 1899. His last promotion was in the following year, when he was made first-class technical officer. Mr. Curra's chief duties were in connection with the electric lighting and power used in the Post Office buildings. Many of the large provincial offices have their own generating plants and the installation of these was superintended by him on behalf of the engineer-in-chief. Mr. Curra was a universal favourite with his fellow-workers, and, in fact, with all who came in contact with him. We ourselves have had frequent occasion to appreciate his unfailing courtesy and good-nature. The disease to which he succumbed was a heart affection, and, strangely enough, its real nature was not recognised until the end was near. He leaves a widow and four children.

Wireless Telegraph Notes.—In his annual report Gen. Greely, chief signal officer of the United States army, says that the system of wireless telegraphy devised by the Signal Corps in 1899 has been improved in details, but its range of operation is limited, and experimental work has stopped pending the development of this science by experts in civil life. Commercial concerns having failed to instal a wireless system in Alaska, he says, the Signal Corps is engaged in an effort to instal a system that shall work from St. Michael to Safety Harbour, near Nome, a distance of 105 miles. The connection by submarine cable of the detached system in south-eastern Alaska, of 1,400 miles, with that of the Yukon district, 1,619 miles, is strongly recommended as in the public interests, not only as of strategic value, but also in connection with the development of Alaska.

Prof Allessandro Artom, Professor of Telegraphy and Telephony at the Galileo Ferraris Electrotechnical School in Turin, is endeavouring to perfect a uni-directional and syntonised system of wireless telegraphy based on the use of circularly and elliptically polarised waves. Experiments were carried out during February in the Gulf of Spezia, and further trials are now being made at the Monte Mario station, near Rome, communication with stations at a distance of 100km. being maintained. The Italian Navy have placed at Prof. Artom's disposal various ships in order that he may continue his experiments over greater distances.

A Reuter telegram from Berlin states that the experiments to communicate with the Swedish seaport of Kariskrona by the Slaby-Arco system of wireless telegraphy were successfully inaugurated on Wednesday. The distance was 280 miles.

The Junior Institution of Engineers.—At a meeting of the Junior Institution of Engineers, held on December 4th, Prof. D. S. Capper read a Paper on "Recent Developments in the Construction and Working of Gas Engines." After giving a brief résumé of the history of the gas engine, the author described the principles of the Otto gas engine. Turning, then, to more recent developments, he considered the merits of producer gas and blast-furnace gas as fuel. Regarding the capacity of modern machines, the author mentioned that the largest engines on the Otto cycle hitherto constructed were probably those made by the Société Cockerill of Seraing,

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developing, in two tandem cylinders of 31in. diameter, 2,500 I.H.P. Among earlier attempts to replace the Otto engine was that made by Mr. Dugald Clerk, who employed a separate cylinder to compress the charge. This idea had been re-introduced with modifications by Messrs. Körting, who built double-acting engines on this principle in sizes up to 1,000 H.P. Another departure from the Otto principle was the Diesel engine, which followed closely the Carnot cycle. Prof. Capper then mentioned an engine which had recently been invented by Messrs. Vogt and Recklinghausen, designed to overcome the difficulty of cooling with the thicker castings employed nowadays for high pressures. Compound engines had been tried by Messrs. Crossley and others, but the gain achieved thereby had not been commensurate with the additional cost. Finally the speaker expressed his belief that gas turbines would be, in the near future, an accomplished fact. The meeting closed with the announcement of a visit on December 19th to the electricity works of the Walthamstow District Council, which are operated by gas engines.

Submarine Boat Equipment.—In an article on the American submarine boat "Protector," the *Engineer* states that the storage batteries are of the Gould type with solid plates, having an output of about 100 H.P. for three hours. It is suggested that, by using a cell with a shorter life, this amount might be at least doubled. The battery is provided with covers to prevent slopping, and things are so arranged as to permit of an inclination of 45deg. without any of the electrolyte being spilt. Motive power for the "Protector" is supplied both by gasoline and by electricity, either together or separately. The boat has twin screws, and to each shaft is coupled one gasoline engine and one motor, the combined indicated horse-power of motors and engines being 350. The gas engines are of the four-cycle type, with four cylinders, so arranged as to give an impulse to every stroke, and develop 120 H.P. each, making a total of 240 H.P. for the engines. They are provided with three means for firing the charge—namely, a primary battery, magneto machines and current from the storage batteries. The engines can be run under water, drawing their air through the omniscope and exhausting under the surface. This practically increases the radius of action of the vessel in a submerged condition from about 40 miles at a comparatively slow speed to 200 miles. The screws are of the reversing type, and have been especially designed by Mr. Lake. By means of these the boat can be run astern by means of the gas engines. By reducing the pitch of the screws and coupling the motors up as dynamos the batteries may be charged while the boat is making a surface speed of 7 knots. Under gasoline engines alone the boat makes 8 knots, and with the motors as well she makes 10. Submerged, under electrical propulsion alone, she makes 7 knots. With the usual gasoline supply a radius of 500 miles is claimed, and with a reserve supply of gasoline some 1,000 miles.

An Experimental Study of Stationary Electric Waves.—An interesting Paper on this subject was read by the Very Rev. Monsignor Molloy before the Dublin Local Section of the Institution of Electrical Engineers on December 10th. The experimental apparatus used by the author consisted of an induction coil giving from 20,000 to 30,000 volts, two Leyden jars, arranged so that the capacity of the circuit might be varied by placing them in series or parallel, and two coils, the self-induction of which might be varied within wide limits by means of sliding contact-pieces. The frequency of the oscillations was of the order of 10^5 to $10^6 \sim$ per second, and the number of oscillations in each single spark was 8 to 10. An analogy was drawn between an organ pipe and an electric radiator, in both of which the minimum changes of pressure occur at the open end and the maximum at the closed end. Monsignor Molloy then expressed the opinion that though the principle of resonance would protect the secrecy of messages over a very large area near the receiving station, there would always be an area near the transmitting station over which resonance only could not afford complete protection. This point was exemplified very clearly by bringing an untuned receiver into the neighbourhood of a transmitter. As it approached the radiator, the receiver responded fully to waves emitted, and successfully tapped the message. The second part of the Paper dealt with overtones, and for the exhibition of these a long vertical coil was used. A vacuum tube was placed in the field of this coil, and the oscillator circuit was first tuned to the fundamental of the coil, the bottom of which was connected to earth, and a very vivid and beautiful effect as of a web of light, intense at the upper part, and gradually fading towards the bottom, took place when stationary electric waves were set up in the coil. Subsequently, the oscillating circuit was tuned successively to the first, second, and third overtones of the fundamental proper to the coil; and the maxima and minima of the luminous discharge (minima being in this case absolute darkness) corresponding to the maxima and minima of the change of pressure, were clearly evident. A vacuum tube was also gradually lowered from the top to the bottom of the coil, and by its aid the higher overtones were even more evident. In the experiments just described, the upper end of the coil was insulated, and the lecturer explained that, in that condition, it followed the laws of a closed organ pipe, producing only what he called the odd partials; that is, n vibrations a second, $3n$ vibrations, $5n$ vibrations, and so forth. He now connected the upper end to earth, and showed, by a similar series of experiments, that it was capable of producing all the partials, n vibrations per second, $2n$ vibrations, $3n$ vibrations, and so forth; following, in fact, the laws of an open organ pipe. A short discussion followed. Prof. Thrift agreed with the author regarding tuning as a means of ensuring secrecy, and thought that if the receiver were near enough one impulse was sufficient to start the response. He suggested that the radiators used might be likened to the stopped organ pipe exhibited, if it were turned inside out, and dwelt on the need of a continuous oscillator. Mr. Brew said that Mr. Hammond had directed him to ascertain under what conditions resonance was likely to occur upon the Dublin three-phase system, and he found the three trunk feeders between the power house and the city would resonate on open circuit with one of the small 500kw. sets with the seventh harmonic of the fundamental frequency ($50\sim$); again, a fifth harmonic on the same machine would produce resonance if a large section of the sub-feeders were added. The feeders had, however, withstood three times their working pressure of 5,000 volts for an hour, so that there was a comfortable margin for resonance effect. Mr. Tatlow asked if the effective length of the wire in the radiator was the same when coiled as it would be as a straight vertical wire, and Monsignor Molloy said that he thought the effective length of the wire was the same whether coiled or straight.

Electrical Progress in the Midlands.—Mr. J. C. Vaudrey, in his inaugural address to the Birmingham local section of the Institution of Electrical Engineers, advocated a common home for all Midland engineering societies. Engineering training in the future would demand a far higher standard than had been attained in the past, and, although the tendency of the day was to specialise, the successful man would generally be the good all-round worker, and not the specialist only. For some reason or other, dynamo makers did not seem always able to manufacture their machinery with the same certainty of working condition as the machinist turning out an engine or pump. There were certain difficulties: calculable results were probably not as absolutely ascertainable in the dynamo as in the steam engine. Large commutators presented certain difficulties in relation to temperature and expansion that did not exist in the engine bearing. The carbon brush and its holder might also be troublesome, and it was important that the maker of such machinery should assure himself that these details were thoroughly well worked out by test before the machinery was put on the market. The introduction of electrical machinery had undoubtedly had a most marked effect in calling attention to the utter want of economy in the use of power under the older system. He was not sure that the public were obtaining all the advantages they ought from electric traction. Town tramway systems in this country were being absorbed by corporations, ostensibly because the local authorities desired "to be in possession of its own roads," and also, in many instances, to form a "day load" for the electric supply station. As the tram system usually covered the lines within the town area, the traffic, naturally, was heavy. But

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sooner or later our towns would not be altogether gainers by a limited system of tramways within the town area. It was absolutely essential that, instead of concentration, our cities should spread outwards. The large profits derived from lines in the centre of the town ought to help towards the working of the outlying lines.

3,000 H.P. Vertical Engine.—A 3,000 H.P. triple expansion three-cylinder steam engine of the vertical inverted type has just been constructed by Messrs. Victor Coates & Co. of Belfast for driving a Westinghouse generator at the tramways station of the Newcastle Corporation. This engine, which is designed to develop 4,000 I.H.P. at a steam pressure of 180lb per square inch, 100deg. superheat and 75 revs. per min., is claimed to be one of the largest stationary steam engines in existence in the British Isles. From a description of the engine in *Engineering*, it appears that all three cylinders which possess steam jackets, are solidly bolted together to form one continuous beam, and the space between the cylinders is utilised for a receiver. The diameters of the three cylinders are 34in. 52in. and 80in. respectively, the stroke being 54in. Steam inlet and exhaust pipes have a diameter of 11in. and 24in. respectively. Corliss valves, arranged in chambers cast in the top and bottom covers of the cylinders, are used throughout. All the steam valves are actuated by Messrs. Coates' trip-gear motion, the cut-off in the high and medium-pressure cylinders being controlled by the governor, and that of the low-pressure cylinder by hand gear. By means of this gear the cut-off may be varied from 0 to 80 per cent. of the stroke. The piston of the high-pressure cylinder is of cast iron, but those of the other cylinders are of cast steel. The crank shaft is of steel, 18in. in diameter, and has a 3in. hole running throughout its length. It is built up of three divisions, which are connected together by means of solid flanged couplings. The cranks are set 120deg. apart, the one corresponding to the high-pressure cylinder leading. Six bearings, 18in. in diameter by 16in. long, support the crank shaft, the lower halves of the bushes being of gunmetal and lined with white metal, the upper halves being of cast iron and lined with the same metal. Both halves have cored water jackets. An air pump of the Edwards type is driven from the high-pressure crosshead by plate levers. The condenser is circular in form, being 6ft. 6in. in diameter by 13ft. long, and possessing a cooling surface of 5,500 sq. ft. Before entering the condenser, the exhaust steam passes through a Baker oil separator. By means of an automatic valve, the exhaust steam is conducted to the free atmosphere in case the condenser should fail. Two governors control the speed of the engine—one, a centre-weight cross-armed governor, directly geared to the crank shaft, and the other, an auxiliary governor of the Aspinall emergency marine type, is placed on the air-pump levers, and connected by a trip motion to a double-beat throttle valve. It comes into action and shuts off steam when the speed of the engine exceeds 80 revs. per min. The flywheel weighs 100 tons, and consists of nine pieces, eight rim segments with an arm to each and a hub. It is held together by bolts and hoops shrunk on, and has an outside diameter of 22ft.

The Economy of Superheated Steam.—In a Paper on this subject read by Mr. E. A. Reynolds before the Rugby Engineering Society last night, the author said that the principal object of superheating steam is to prevent, or, at any rate, reduce, transfer of heat, and to prevent initial condensation; for although the steam gives up some of its heat to the metal on admission, there is no condensation, the only effect being a reduction of volume and a fall in temperature. The relation between pressure, temperature and volume is given by the equation $PV = 93{\cdot}5T - 91P^{\frac{1}{2}}$, where P is measured in pounds per square foot absolute, V is the volume in cubic feet of 1lb. of steam, T is the absolute temperature in degrees Fahrenheit. On putting T equal to the temperature of saturated steam, this formula gives very closely the volume corresponding to different pressures. On calculating V for various temperatures of superheat, it will be seen that at 300°F. of superheat the volume of the steam is increased by about 50 per cent. Owing to this increase of volume superheated steam requires a less quantity of heat to produce a certain volume than saturated steam at the same pressure, so that by using superheated steam less heat enters the cylinder at each stroke than when saturated steam is used; and as the same amount of heat is converted into work in each case, this shows where the economy of superheat lies. It has been found that to obtain a certain velocity of steam in a pipe, superheated steam requires a smaller drop in pressure than saturated steam; for this reason the steam pipes may be made smaller, thus giving a higher velocity, and yet keeping the pressure drop the same. With superheated steam, the amount required for a given power is less than with saturated steam, and the pipes may be made still smaller. Another advantage is that separators are unnecessary; the absence of water in the steam mains also does away with all risk of getting water into the cylinders through priming. A test the author made a short time ago on a small simple engine running non-condensing at 65lb. pressure in the steam chest and a cut-off of 0·3, showed a gain of 35 per cent. in weight of steam used by using steam superheated 220°F. The water consumption came out at 20lb per I.H.P., which compares favourably with compound engines working at a high steam pressure. In tests of various engines that the author has made, he has found very little difference in the percentage gain with triple or compound expansion, the compound showing a little more than the triple. The gain obtained is about 15 per cent. at 100°F. superheat, 20 to 21 per cent. at 150°F., and 23 to 25 per cent. at 200°F., measured in weight of water used. The gain, of course, varies with the point of cut-off, and the ratio of expansion. In each case the temperature was measured outside the throttle valve. In a trial on a triple engine, when the temperature was measured inside the steam chest, the percentage gain curve came out exactly a straight line up to 180°F. superheat. There is little gain due to superheating in any cylinder after the stage is reached in which the steam is kept dry throughout the whole expansion, and the only object of taking the superheat higher is to obtain dry steam as far as possible during the whole expansion in the engine. The same effect, however, would be obtained by reheating the steam in the receivers between the different cylinders, so that it enters each cylinder superheated sufficiently to ensure it being dry at the end of the expansion in that cylinder. This is most easily effected by passing the superheated steam through coils in the receivers on its way to the steam chest of the engine, so that it may give up some of its superheat to the steam that has already expanded in the previous cylinder, and then pass to the steam chest at a lower degree of superheat. The utility of this method is that although we get the advantage of a high degree of superheat we do not get the disadvantage of a high temperature in the engine. With the use of high superheat temperatures there are, of course, large internal stresses due to the unequal expansion of different parts of the body of the engine. For this reason it would seem best to have the cylinders separate and perfectly cylindrical externally, and valve boxes and other parts to be firmly bolted on with heavy flanges when these are necessarily outside the cylinder. The high temperature also has some effect on some of the metals used. Gunmetal is inadmissible as it becomes almost spongy and gets eaten away in time, and copper pipes are altogether out of the question for steam ranges.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

To-day (FRIDAY), December 18th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. Meeting at the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Among other business will be the resumption of the discussion on Mr. Max Wurl's Paper, "Technical Education in Germany."

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "An Enquiry into the Working of Various Water Softeners," by C. E. Stromeyer and W. B. Baron.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert in the King's Hall, Holborn Restaurant. Mr. A. P. Trotter in the chair.

SATURDAY, December 19th.

JUNIOR INSTITUTION OF ENGINEERS.

3 p.m. Visit to the Walthamstow Municipal Electricity Works. Train from Liverpool Street, 2:23 p.m.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 298.)

It has been shown in the preceding articles that the phenomenon of radio-activity consists essentially in the incessant and spontaneous expulsion of positively and negatively-charged particles from the three heaviest chemical elements that are recognised—viz., radium, thorium and uranium. The positively-charged particles, which constitute the α-rays, are atomic in dimensions and are comparable in mass to the hydrogen atom and to the positive rays, or *canalstrahlen*, of the vacuum-tube. The negatively-charged particles, which constitute the β rays, are corpuscles of mass about one-thousandth of the hydrogen atom, and are similar to those which constitute the cathode-rays and the negative ions shot out by metals in vacuo under the influence of ultra-violet light. The velocity of both the positively and negatively-charged particles shot out spontaneously from the radio-elements is, however, greater than is ever impressed by external agencies upon the positive and negative ions of the electric discharge, even when the latter are caused to move in electric fields of very great intensity. In consequence, the kinetic energy associated with the α and β particles is greater than in the case of the ions artificially produced, and is, in fact, considered with reference to their mass, of a far higher order of magnitude than is associated with matter in any other form.

We have now to consider the radio-active matter from which these particles are projected, and from which their energy must in some way be derived. It must be first pointed out that matter of this kind, from which energy is being continuously dissipated in a new and easily detected form, is naturally far more easy to investigate and trace than non-radio-active matter. New experimental methods of great delicacy are available which are capable of detecting the presence of such matter in quantity so minute that no other indication of its presence exists. The first fruits of the researches in this direction were, of course, Mme. Curie's discoveries of radium and polonium, which have already been discussed. It will be recalled that these discoveries resulted from the view that radio-activity is an atomic property of the element, in that it is exhibited by each radio-element in amount sensibly proportional to the quantity present, and independent of its state of chemical combination, of physical conditions and of previous history. On this view, a substance like pitch-blende, more radio-active than any known element, owes its radio-activity to the presence of new elements of proportionally great radio-activity, and not to any cause increasing the activity of the known radio-elements contained therein beyond the normal value. In spite of the successful separation of these predicted new elements, a series of researches, which have now to be considered, have shown that the view that radio-activity is an atomic property of the element in question is in apparent disagreement with the nature of the phenomena. For it will be seen that the normal radio-activity of a single element, like thorium, is due to several different types of matter radiating simultaneously, and the thorium contributes but a small part of the total radio-activity.

The discrepancy has been reconciled by the Disintegration Theory of Radio-activity, and as this view accounts in a simple manner for all the new facts at present known with regard to the radio-elements, and greatly assists the presentation of the subject as a connected whole, it is used as the basis of arrangement in the remaining articles. The historical development of the ideas which led up to the new views will be considered after the theory itself has been developed. It must be borne in mind that the order in which the researches are here considered is frequently the inverse of the historical order.

Uranium, of the three radio-elements, furnishes the simplest example and will be considered first. Sir William Crookes (*Proc.* Roy. Soc., 1900, 66, p. 409), showed that it was possible by various processes to free uranium completely from rays which affect a photographic plate, and to concentrate the whole of the photographic activity in a minute fraction of the total matter which contained no uranium. He gave several methods, of which we shall consider two. If crystallised uranium nitrate is dissolved in ether, the solution separates into two layers: (1) an ethereal solution containing the bulk of the dissolved uranium salt; (2) an aqueous solution consisting of the water of crystallisation of the original salt, in which a relatively small amount of uranium is dissolved. He found that the uranium salt obtained from (1) was completely inactive to the photographic plate, while that obtained from (2) possessed all the activity of the original uranium salt in concentrated form. Again, if a solution of a uranium salt be precipitated by ammonium carbonate solution and a sufficiency of the latter is added in excess of that necessary to cause precipitation, the precipitated uranium carbonate again dissolves, and on filtering the solution a very minute precipitate of insoluble matter is obtained. This consists mainly of iron and aluminium present in the uranium as impurities, and by the manner of its preparation is chemically free from uranium. Yet this minute precipitate possessed all the photographic activity of the original uranium, and the latter obtained from the solution was completely inactive. In this way Crookes obtained preparations many hundred times more active to the photographic plate than the uranium salt itself. Thinking that possibly he had separated a new radio-element of intense activity which caused the radio activity of uranium, Sir William Crookes proposed the name "Uranium X" for the new substance.

It must be noticed that the actual amount of uranium X obtained is probably quite incapable of detection except by its radio-activity. The bulk of the substance is iron, aluminium, &c, present in the uranium as minute impurities which afford the necessary solid nuclei for the separation of the uranium X by the relatively gross process of filtration.* No new lines were detected by Crookes in the spectrum, and everything points to the conclusion that the actual amount of matter causing the radio-activity of uranium X is infinitesimal.

Becquerel (*Comptes Rendus*, 1900, 131, p. 137), independently of Crookes, obtained evidence of the enfeeblement of the radio-activity of uranium by chemical treatment. Acting on a suggestion of Debierne, he dissolved barium salts in solutions of uranium, and precipitated the barium with sulphuric acid. He found that the precipitated barium sulphate tended to "drag down" the activity of the uranium, leaving it more or less inactive. He so obtained specimens of barium sulphate more radio-active, weight for weight, than the salts of uranium used in their preparation.

The constancy of the radio-activity of uranium, independent of its source, and previous history, which had been shown by Mme. Curie, caused Becquerel to consider as improbable Crookes' hypothesis that the radio-activity of uranium was due to a small intensely active impurity (uranium X). He concluded (*Comptes Rendus*, 1901, 133, p. 977) that if uranium, like radium, possessed the power of making admixed inactive bodies temporarily radio-active by association with them, the discrepancy could be explained. This supposed communication of radio-activity to an inactive molecule had been termed "radio-active induction." Thus M. and Mme. Curie found that objects in the neighbourhood of radium became temporarily radio-active, and called this phenomenon "the induced activity." The theory of Rutherford, which we shall deal with more fully in the sequel, that this radio-activity was caused by a deposit of a film of active matter from the radio-active emanations of a gaseous nature diffusing from the radium or thorium, had not then been accepted by the Continental investigators. This effect of radio-active induction, Becquerel argued, would be produced equally on the active and inactive matter present, so that by induction on itself the activity of the mixture should increase spontaneously at first. In a similar way the activity of solid radium salts was known to increase from the moment of their preparation. If

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co

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* The author has noticed that this separation may fail if the uranium preparation is too pure, until a drop of ferric salt or similar impurity is added to act as nuclei in the filtration.

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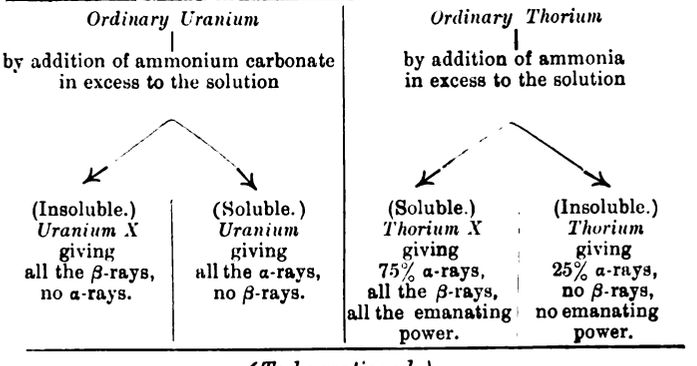
barium were rendered active by induction when it was mixed with uranium, by precipitating the barium it would be possible to remove some of the activity, and, then, after removal the induced activity of the barium would gradually decay, while that of the uranium would gradually increase. Becquerel, therefore, examined his preparations 18 months afterwards and found that the activity of the barium sulphate had completely disappeared, while the uranium had fully recovered its normal activity. Subsequently it was shown (Soddy, *Journal* Chem. Soc., 1902, 81, p. 860) that the processes of Crookes and Becquerel resulted only in the separation of the β-radiation of uranium, and that the relatively far more intense α-radiation of uranium was completely unaffected. Thus, while the bare salt, after the chemical treatment, was sensibly as radio-active as it was before when examined by the electrical method, it was completely inactive to a photographic plate. The uranium X obtained from it by Crookes' ammonium carbonate process was but feebly active by the electrical, but intensely active by the photographic method. On the other hand, a very thin sheet of aluminium (0·005cm. thick) placed over the uranium completely absorbed the radiation, whereas the rays from uranium X pass through this thickness with but little loss. The view that the β-radiation of ordinary uranium is caused by uranium X, a non-uranium type of matter, which can be chemically separated, whereas the α-radiation is a specific property of the uranium and is not affected by this separation, was confirmed by Rutherford and Grier (*Phil. Mag.*, 1902., VI., 4, p. 315), who examined the radiations from the two preparations in a magnetic field. They found the radiation from the uranium X to consist entirely of rays easily deviated, while that from the uranium wholly consisted of non-deviable rays. The chemical separation had analysed the radiation into its two components (α and β) without affecting the nature or intensity of the rays in any way. Uranium is the simplest example of the three radio-elements, for its two main types of radiation result from two different kinds of matter, the one constituting practically the entire mass of the substance, the other present in proportion so minute that its radio-activity is at present the sole evidence we have of its existence. The recovery of the β-radiation of uranium with time and the decay of the β-radiation from the uranium X with time, however, still calls for explanation.

Simultaneously with the above researches Rutherford and Soddy (*Trans.* Chem. Soc., 1902, 81, pp. 321 and 837) had obtained results for the case of thorium similar in character to those obtained by Becquerel for uranium. If thorium nitrate in aqueous solution is precipitated by ammonia, it is found that a large part of the radio-activity of the thorium remains in the solution, so that by evaporating the filtrate to dryness and igniting to remove ammonium salts minute residues are left possessing radio-activity relatively intense compared to that of the original thorium. The thorium hydroxide, which is precipitated completely by this process, on the other hand, is found to have lost the greater part of its radio-activity, and by suitable repetitions may be obtained only one-quarter as active, weight for weight, as the original salt. Now this behaviour is by no means common to the precipitation of thorium from its solution if reagents other than ammonia are employed. For example, sodium or ammonium carbonate, ammonium oxalate and alkaline sodium phosphate, all completely precipitate the thorium in the normally active condition, and the residues obtained from the several filtrates by evaporation and ignition are in each case quite inactive.

Rutherford and Soddy, therefore, concluded that the major part of the radio-activity of thorium is due to the presence of a non-thorium type of matter, not precipitated by ammonia, and they gave the name "Thorium X" to this body in accordance with the nomenclature adopted by Sir W. Crookes in the case of uranium. Ammonia is the only reagent at present known which will separate thorium X from thorium. Besides being responsible for the greater part of the radio-activity of thorium, the power of thorium preparations of giving a radio-active emanation and of imparting radio-activity to surrounding objects is wholly due to the presence of thorium X. For the power of a thorium solution to give the emanation is retained unaltered by the solution after the thorium has been precipitated as hydroxide, and the latter when re-dissolved possesses at first no emanating power at all. As in the case of uranium X, the actual quantity of matter causing these radio-active manifestations is, probably, infinitesimal. Thorium X has no definite analytical reactions which would lead to its separation from the impurities always present, but is dragged down by any precipitate formed in its solution to a greater or less extent by "adsorption." Barium sulphate, pre-eminently, appears to possess the general power of removing in this way the infinitesimal traces of radio-active matter (ThX, UrX, &c.) present in solutions of the radio-elements.

If the preparations of thorium and thorium X so obtained are allowed to remain untouched, it is found that the thorium gradually regains the activity that it has lost until it is just as active as at first, while the thorium X loses its activity gradually, until it becomes at length completely inactive. These processes occur rapidly compared with the similar case of uranium and uranium X. In three weeks or a month the thorium X preparation has lost practically all its radio-activity, while the thorium in the same interval has completely regained its lost radio-activity. The same holds true equally of the emanating power of the preparations. The thorium X at first possesses all the emanating power of the original thorium solution and loses it completely in one month, whereas the precipitated thorium hydroxide if re-dissolved in nitric acid and kept in solution at first possesses no emanating power at all, but gradually recovers it, until, at the end of a month, it again possesses its original power.

When a thorium preparation is precipitated in the above manner several times successively at short intervals, its radio-activity is reduced to about one-fourth of that to which it will recover on standing, and this *non-separable radio-activity* which is, as far as we know, a specific property of the element itself, consists only of α-rays. The β-radiation is wholly retained by the thorium X. These results may be conveniently represented in tabular form.



(To be continued.)

WORKING RESULTS ON THE CITY AND SOUTH LONDON RAILWAY.

At the Institution of Electrical Engineers last night a Paper was presented by Mr. P. V. McMahon with the title "The City and South London Railway: Working Results of the Three-wire System applied to Traction, &c." The Paper describes the new generating station and the sub-stations, giving also particulars with regard to the lifts and the system generally, and concludes with the results of tests during actual working. As the new generating station, sub-stations and lifts were very fully dealt with in a long serial article we published two years ago (*The Electrician*, Vol. XLVIII., pp. 167, 256, 337, 529, 564, 684, 774 and 850), we are omitting these parts of the Paper in the following abstract. We give below, therefore, a brief general description of the system, adding from the Paper a few details with regard to the equipment of the line and other matters which were not entered into fully on the previous occasion, and concluding with the results of the actual working of the line, which form the most valuable part of Mr. McMahon's Paper.

The old line from Stockwell to King William-street, a distance of 3 miles 12 chains, was successfully worked on the plain two-wire system for nine years, but with the extension to the Angel (Islington), coupled with a quicker service and heavier trains, it was necessary to abandon this method of distribution with all its simplicity.

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Before coming to a decision in the matter, all possible systems were carefully considered, and it seemed to the author that the three-wire system with accumulator sub-stations would satisfactorily meet the case. After a couple of years' experience with this system, Mr. McMahon continues, it can fairly be said that the City and South London Railway is a successful example of continuous-current distribution at high voltage. The diagram Fig. 1 shows the system in its simplest form—that is, all the independent cables for supplying the lifts and lighting circuits are omitted for the sake of clearness. The up and down working conductors, with the running rails as the middle wire form the three-wire system pure and simple, the 500-volt generators being on either side of the system. To supply the sub-station, another generator, either steam or motor driven, adds an additional 500 volts to an additional set of high-tension 'bus bars, from which the two sub-stations are fed at 1,000 volts above the rail potential, or 2,000 volts across the outers. The pressure is reduced at the sub-station by special E.C.C. reducing transformers, in which only half the energy is transformed and the cable drop compensated for.

In the engine house at Stockwell, seven direct-connected sets are installed, varying in output from 125kw. to 800kw. It will no doubt occur to many that, with large Corliss engines, the sets might

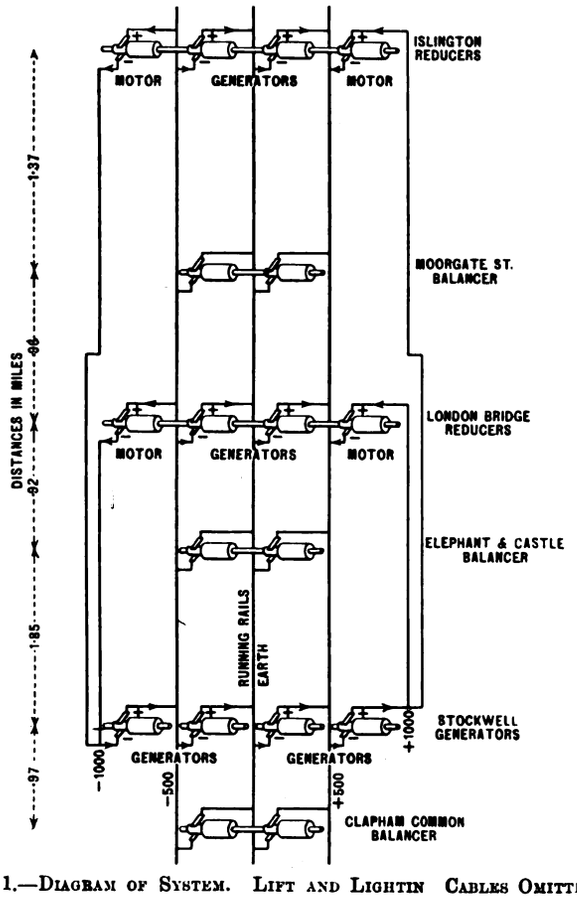

FIG. 1.—DIAGRAM OF SYSTEM. LIFT AND LIGHTIN CABLES OMITTED.

have been larger, and therefore a smaller number of engines and generators would have been required for the same output—say, three 800kw. sets, working at 1,000 volts across the outer, with a couple of small sets at 500 volts for balancing. A moment's reflection will show that, with a generator running at 1,000 volts across the outers, a permanent short-circuit on one side of the system could raise the pressure on the other side to 1,000 volts, and this, even if momentary, would not improve train lamps and lift and locomotive armatures, not to speak of the danger to men operating switches, &c., on that side of the system. For this reason, primarily, it was decided to adopt the method of two 500-volt generators with the middle point connected to the running rails (or middle wire of the system). Further, this method and the sub-station reducers allow all the advantages of a 2,000-volt continuous-current distribution, in which no commutator has more than 500 volts maximum across its brushes.

The first feeding point chosen was Stockwell, where the voltage drop between the working conductor and the switchboard was practically nil. The next point is Kennington, 1·31 miles from Stockwell. In connection with this feeder a double booster is installed to compensate for the feeder drop; but, as already mentioned, this is a refinement which is only used in case of extra heavy traffic, or if it is desirable to reduce the load on the London Bridge sub-station for any reason. The above sub-station, 2·77 miles from Stockwell, forms the third feeding point, and the Angel sub-station, 5·12 miles from Stockwell, is the fourth. The selection of a feeding point at the extreme end of the line may be criticised, but this point was chosen as a farther extension to Euston is under contemplation.

Either generator can be connected to the "up" or "down" side of the system, but the switches on the generator panels of the switchboard are interlocked so that it is impossible to connect any one machine with both "up" and "down" sides at one time. The "circuit-breakers" do not entirely break the circuit, but, when a short-circuit occurs, they throw in a resistance which limits the current to the maximum load for which the feeder is designed. This method of throwing in a resistance instead of breaking the circuit has many advantages. It saves the switch contacts, allows the switchboard attendant to see whether the "short" is removed before replacing the automatic circuit breaker, and also leaves the

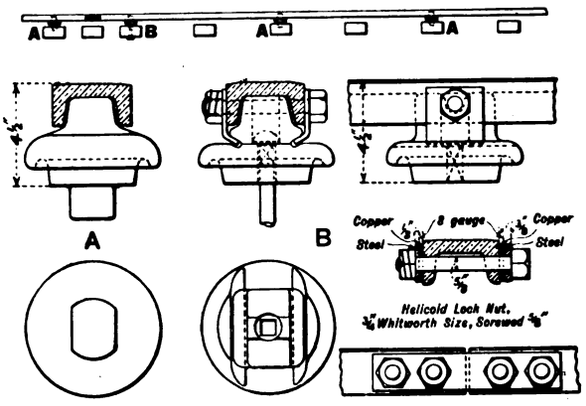

FIG. 2.—DETAILS OF WORKING CONDUCTOR AND INSULATORS.

current on the working conductor, so that in most cases the locomotive is able to reach the next station at low voltage. The train lights are prevented from going out completely, which, from the passengers' point of view, is very important. All the circuit-breakers, both generator and feeder, with the exception of the high-tension feeders, are similarly arranged. Switches are arranged so that the motor side of either motor-generator can be fed from both sides of the system as required. In the ordinary way it is usual for the generator supplying the "up" high-tension 'bus bars to take current for its motor from the "down" low-tension 'bus bars. This arrangement is adopted to assist in balancing, but is sometimes convenient to feed both motors from the same side, should there be a large

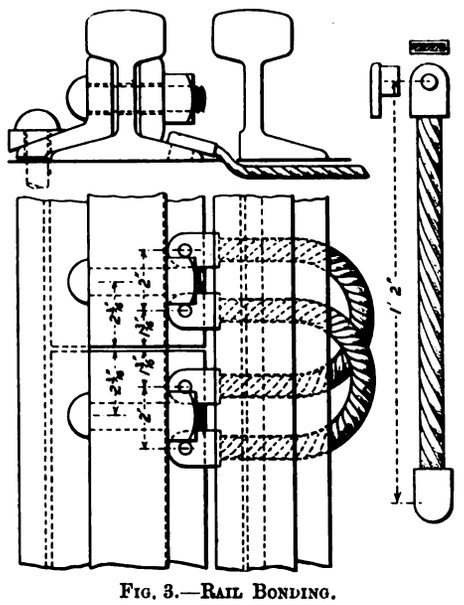

FIG. 3.—RAIL BONDING.

generator working on one side and a smaller one on the other. In addition to using motor-generators for the high-tension service it is possible to use either of the 125kw. or 800kw. sets, and these can be used singly or in parallel. So that if the load is too heavy for the motor-generators, the 125kw. steam set can be used in parallel with it. The working conductor is of channel steel of high conductivity. It has a cross-section of 4 sq. in., and weighs 40lb. per yard. It is laid in 30ft. lengths, and is joined up with copper fishplates, which also form the means of holdiug it down to the insulators. On the Islington extension the copper fishplates were strengthened by steel plates on one side, as experience showed that the copper plates in

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some cases allowed the channel steel to get slightly out of truth. Under each joint or fishplate there is a special holding-down insulator into which the copper fishplates grip and hold the working conductor in position; the remaining insulators are simply let into the sleepers and serve as supports only for the working conductor. Fig. 2 shows the details of conductor and insulators.

Each running rail is bonded with two flexible bonds of 0·165 sq. in. section in bottom flange of the rail—see Fig. 3. In addition, the rails are cross-bonded and joined to the tunnel at regular intervals. The up and down tracks are also cross-bonded at the cross-over roads.

In order to get from one side of the system to the other, or to change from the positive to the negative side, a wooden break 30ft. long is left in the working conductor. This length was chosen so that two locomotives coupled together could not make a 1,000-volt "short." The locomotives run over these breaks by their own momentum, and as the collecting shoes are 13ft. 9in. apart, a break of 16ft. 3in. is left. This break was found to cause an appreciable flicker in the train lights, and the difficulty was overcome by screwing metal plates on each side of the wooden strip and joining them up to the conductor by a fuse, leaving the actual break only 16ft. long. The drivers switch off the current on approaching the break, but if this precaution is neglected sometimes an arc is drawn out by the locomotive shoe, and the fuse blows before any harm is done (Fig. 4).

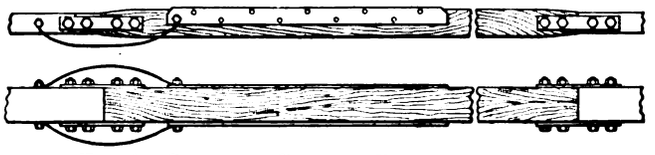

Fig. 4.—Cross-over Break in Working Conductor.

Working Results and Tests.

Before going into the results of working obtained on the present line, it may be interesting to give the result of an all-day test made in January, 1894. The coal was weighed and the water measured from starting in the morning at 6 a.m until the generating station shut down at 11:30 p.m. During the test six Lancashire boilers and two of the Fowler engines were at work. The hydraulic engines operating the lifts were fed with steam from the same boilers, and the amount of coal used for these pumping engines was determined by a previous test which gave 6 tons per day.

The electrical output of the station was 4,005 units. The following table gives the whole of the results of the day's working. It will no doubt be noticed that the coal and water per unit generated are very high, especially the water, but this is accounted for by the fact that the engines were only running with anything like full load for about five hours out of the 17·5 hours of the test. The difference between the units per ton-mile at the switchboard and on the locomotive will probably also appear striking, but in this difference is included the current used in shunting the trains into and out of sidings and also the transmission losses. The units per ton-mile on board the locomotive were observed when driven under the best conditions, and it is probable that in ordinary working the driver did not take such care in driving. The transmission losses as measured between the switchboard and locomotive were 10·5 per cent.

The voltage observations showed that there was a maximum variation of 80 volts at the generating station, and a comparison with the present switchboard voltage curve is interesting and needs no further comment.

All Day Test, January 18, 1894.

Total coal, 24 tons = 53,800lb., North Country small.
Total coal used for generating station, 18 tons = 40,400lb.
Total water, 371,400lb.
Pounds of water per pound of coal = 69 (water at about 60°F.).

Units generated	4,005	
Pounds of coal per unit	9·95	
Pounds of water per unit	69·2	
Train-miles	1,354	
Ton-miles	46,800	
Train locomotive and station lighting	778 units.	
Units per ton-mile at switchboard	0·069	Including shunting operations at termini and siding, distribution losses, &c.
Units per ton-mile on locomotive	0·0515	Average speed 13·62 m.p.h.
Coal per ton-mile at switchboard	0·686lb.	
Coal per ton-mile on locomotive	0·512lb.	

Slow-speed v. High-speed Engines.

Having two widely different types of engines which at certain times do practically the same amount of work, it will no doubt be interesting to give the results as to their working. The Willans engines came well up to their guaranteed steam consumption on the test held at Rugby, and the comparison of working results refers to the 300kw. Willans and the 800kw. Corliss sets. The results of the guarantee tests are first given.

On tests, the 300kw. Willans set when giving 559·31 I.H.P.—that is, the normal load—the steam consumption was 17·73lb. of steam per B.H.P., the efficiency of the generator being 93 per cent., the steam per kilowatt hour comes out at 25·5lb. In a similar manner the steam consumption on overload, or when the engine was indicating 676, was 23·1lb. per kilowatt-hour. The pressures in the steam chest during the tests were 145lb. and 143lb. per sq. in., and the vacuum 23·2in. and 23·3in. of mercury respectively.

The 600kw. to 800kw. Corliss set was tested after erection at Stockwell on an artificial load, the water from the condenser being measured in two tanks which were previously filled with water to the marks used in the test and weighed The first test on this set was for 10 hours at normal load, or 977·25 I.H.P., followed by an overload test for one hour when the mean indicated horse-power was 1,173. The dryness of the steam was tested by a Carpenter's calorimeter placed between the engine stop valve and the high-pressure cylinder, the mean of six readings showing 4·5 per cent. of moisture. The vacuum was fairly steady at 25·75in. of mercury. The result of the normal load test was a steam consumption 21·57lb. of steam per kilowatt-hour, and the overload test 22·5lb. of steam per kilowatt-hour. The makers, however, point out that if allowances were made for the moisture in the steam the result would be 20·41b. of steam per kilowatt-hour for normal load. During the overload test the steam pressure dropped to 132lb. per square inch, which was claimed as equivalent to 0·35lb. of steam per I.H.P. against the engine. If this allowance, together with moisture in the steam, is made, the steam consumption per kilowatt-hour comes out at 20·93lb.

Before, and shortly after, the opening of the Clapham extension, the load was such that the two 300kw. sets were able to deal with it, and in order not to have the Corliss set standing and to give the Willans sets a rest, the Corliss sets were frequently run on alternate days, the maximum load never exceeding that which could be easily taken up by the 300kw. sets. After a short period of running under these conditions, the stokers said it was easier to keep up steam when the Corliss sets were running. The author at first looked upon these remarks as a fad on the part of the stokers, but the latter adhered to their statement, and so the condensed water was measured and the units generated taken during certain periods of the day, with the result that the steam per kilowatt-hour for the 300kw. sets was 32lb. and 26lb. for the 800kw. sets. In October, 1902, tests were again made, under ordinary everyday working conditions, during the periods of light load—that is, from 12 noon to 3 p.m.

The conditions of the later tests were not, however, exactly similar to those of the earlier tests, as it was necessary to run two 125kw. sets in addition to the two 300kw. sets, the load during the test being too heavy for the latter alone. The measured condensed water in each case included that used in driving the air and circulating pumps for the condensing plant, and may therefore be taken as constant. The condensed water was measured by two Kent's Positive water meters, the results were taken every half-hour during the test, and the units generated were taken at the same time as a check on the meters measuring the output; five-second readings were taken of the amperes registered by the Weston ammeters on the board during the whole test and the necessary corrections made. In this connection it may be stated that the output between 12 noon and 3 p.m. on the first day was 2,731 units, and on the second day 2,716 units; in each case the load was 16 trains and 17 electric lifts running. During the test of the Willans sets the average load on the 125kw. sets was about full normal load, while the 300kw. sets were also up to full normal load—*i.e.*, 600 amperes per machine. The average load on the Corliss sets during the test was 900 amperes each, or about 56 per cent. normal full load. The 125kw. load was fairly steady, as these machines were feeding the sub-stations, and the variations were taken up to a large extent by the batteries. Under the above conditions the steam per kilowatt-hour for the Willans sets was 30·2lb., and for the Corliss sets 23·8lb.

From the author's experience there is no doubt in his mind that the Corliss type of engine is more economical than the Willans type as far as steam consumption is concerned; but there are other considerations, as the following will show. The first cost and floor space is very much in favour of the Willans type, but against this must be put the additional cost of condensers, &c., boilers, and buildings for boilers, coal, coal storage, and coal handling plant, and additional labour in boiler-house, which latter may, however, be equalised by the Corliss type of engine requiring rather more attention than the Willans type in the matter of lubrication.

As to the question of upkeep and oil consumption, careful records show the oil bill is much lower for the Willans engine, being 0·012d. per unit generated, as against 0·028d. for the Corliss. The repairs to the Willans, however, come out at 0·018 pence per unit, as against 0·008d. for the Corliss engines. These repairs refer to a period of 2½ years, and in estimating, the total units during that period have been taken. In order to give an idea of the working hours and output of the various sets the following figures may be useful:

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Description of set.	Hours which engine worked.	Units generated.	Max. possible units if engine worked at normal full load.	Percentage of full load during period.
No. 1, 125kw. Willans	2,683	313,637	335,000	93·5
No. 2, 125kw. ,,	4,703	500,567	588,000	85·0
No. 3, 300kw. ,,	9,524	2,599,758	2,860,000	91·0
No. 4, 300kw. ,,	9,555	2,266,433	2,865,000	79·2
No. 5, 800kw. Corliss..	9,012	3,855,595	7,200,000	53·8
No. 6, 800kw. ,,	8,606	4,073,635	6,880,000	59·2

It will thus be seen that if the Corliss engines were loaded in a similar manner to the Willans, the repairs per unit would be about half that given above. Again, in arriving at the cost of the Corliss engine repairs, new high and low-pressure pistons for each engine is included, which in ordinary conditions would not come under the item of repairs. These pistons were changed, as they were considered too light for their work, and amount to 75 per cent. of the total cost.

It is not so much a question of "low versus high-speed engines" as some suitable form of Corliss valve gear to run at high speeds versus high-speed central or piston valve engines. If one could only obtain the Corliss engine economy with the low first cost and floor space per unit of the Willans, a happy solution of the problem would be attained. This end is to a very great extent secured in the Ferranti engine, in which the steam consumption is only a trifle higher than in the Corliss, and speeds very nearly as high as the Willans obtain. The author is unfortunately unable to state definitely the steam consumption per kilowatt-hour of the 400kw. Ferranti-E.C.C. set installed at present. But, if one can depend on the makers' guarantee, it closely follows the Corliss in steam consumption.

All-day Test, April 8, 1903.

On April 8, 1903, an all-day test of the generating station output was made, starting at 6 a.m. and ending 12 midnight. The coal used was weighed and also measured in the ordinary way by the

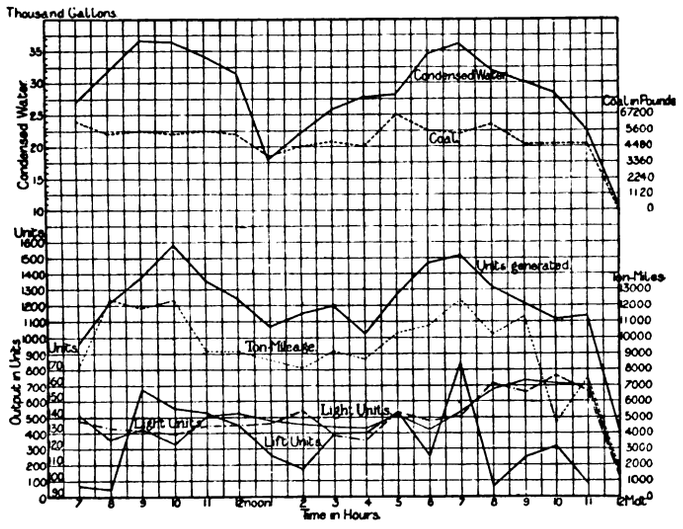

FIG. 5.—RECORD OF ALL-DAY TEST, APRIL 8, 1903.

measuring shoots, the coal weighed was 39·6 tons, and the weight as ascertained by the measuring shoots was 39·97 tons, showing that the latter method was accurate to within less than 1 per cent. The feed-water was measured by using three tanks, one from which the feed pumps drew the water, and the others with gauge glasses were filled alternately to a mark and emptied into the first tank. The condensed water from the main generating engines as well as the air and circulating water pumps was passed through two Kent's Positive water meters, and readings taken every hour. The coal fed into the hopper over the mechanical stokers and the units generated as well as the train-miles were also taken hourly. Owing to the turnstile system, which was in operation during the all-day test given for January, 1894, having been discontinued, and the ticket system put in operation, it was not possible to ascertain the number of passengers per hour, but in other respects the tests were similar, and show very clearly the results obtained in the two stations. The curves (Fig. 5) show the results of the test plotted. It may be mentioned that the weight of coal used by the hydraulic pumping engines was determined by a previous test extending over a week, with a separately-fired boiler. The coal used during the test is known as Broomhill, and careful samples were taken during the test from each 2 cwt. weighed for analysis, the result of which showed a calorific value of 13,200 B.Th.U. for dry sample; the moisture in the coal was 8·16 per cent., and the ash 5·6 per cent.

Careful tests were also made of the flue gases, and the average of 10 samples taken during the day showed 10·3 per cent. of CO_2.

Total coal used, 39·6 tons	88,704lb.
,, ,, ,, by hydraulic engines	13,440lb.
,, ,, ,, ,, generating ,,	75,264lb.
,, water fed into boilers	697,515lb.
Water evaporated per lb. of coal at 150°F.	7·86lb.
,, ,, ,, ,, from & at 212°F.	8·60lb.
Units (Board of Trade)	21,470 units.
Condensed water measured, including steam used on condensing plant	512,780lb.
Steam per unit (including condenser)	23·88lb.
Coal ,, ,, ,,	3·5lb.
Calorific value of dry coal	13,300 B.T.U.

ELECTRIC *v.* HYDRAULIC LIFTS.

In the matter of easy control and steady working the electric lift cannot be said to be as perfect as the hydraulic, but from the point of view of first cost and total working expenses it is so far in advance of the hydranlic lift that it can safely be said more than to hold its own. The figures given are based upon the total number of complete journeys made by the lifts, and, for convenience of comparison with the cost of transportation in a horizontal direction, the total distance travelled vertically is given in "lift-miles." It would, perhaps, be better to use an expression like "ton-miles," which is more satisfactory than "train-miles," when dealing with railways or tramways. However, in the case of lifts, whether electric or hydraulic, the tonnage is complicated by the value of the balance-weight, and the author does not see how the ton-mile basis can be applied in the same manner as in a train or tram.

For the half-year ending June, 1902, the electric lifts made an average of 4,254 complete trips per day, while the hydraulic lifts for the same period made an average of 2,209 complete trips per day. The total mileage for six months was 27,800 lift-miles, made up of 20,500 electric lift-miles and 7,300 hydraulic lift-miles.

	Cost per lift-mile in pence.	
	Hydraulic.	Electric.
Labour, including mechanics, greasers, &c., but exclusive of cage attendant	6·02	7·15
Oil, waste and other stores, including switch or valve gear and motor spares	1·41	1·79
Rope renewals	2·12	4·02
Power costs	32·50	15·85
Total	42·05	28·81

The above table shows the difference in the cost of working, and, perhaps, requires a little explanation. In the first line the cost of foreman, mechanics, greasers and labourers is included; in fact, every item of labour, with the exception of the attendant who actually pulls the rope or works the switch in the cage, as this item is equal in both systems. With oil, waste and other stores are included motor brushes, switch contacts, hydraulic packing and starting valve parts. Rope renewals includes the cost of putting the ropes on. In the case of electric lifts, the power costs means the total number of units at the generated cost, including sub-station charges. The power costs for hydraulics is the cost of pumping the water used, and in this connection it may be interesting to state that the total coal consumed for each system is practically the same.

Analysing the above figures, it will be noticed that only in the item for power is the electric lift more economical than the hydraulic, but the author feels that there is every reason to believe that, with the exception of "oil and other stores," the other can be brought down to the level of the hydraulic lifts, although to attain this end may mean a radical change in the design of the winding and switch gear. The increased cost of labour is largely due to the fact that there is always a man in charge of the motors, either at the bottom or top of the lift shaft, and this item is absent in the hydraulic system. The switch or controlling gear is also more complicated than necessary, and requires an amount of attention that will undoubtedly be reduced in future designs. In the matter of rope renewals, again, the hydraulic lift scores; but there is room for improvement. With the motor at the bottom of the shaft the ropes are longer and go over a number of guide pulleys, which not only affects the life of the rope, but adds to the cost of replacement. In many places, on account of the headroom available, it was necessary to make these guide pulleys smaller than they otherwise would have been; with the motors at the top of the shaft, a number of the pulleys are done away with, and the ropes are about the same length as in the case of the hydraulic lifts. Again, the S form of drive is capable of improvement from the point of view of rope renewals. All rope makers' and users' experience goes to prove that bending a rope in one direction and then reversing the bend has a very bad effect on the life of the rope. Even under existing conditions, the electric lift shows itself to be far more

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economical than the hydraulic, and, given the improvement outlined above, there is no doubt that the electric lifts will supersede the hydraulic. Indeed, where the power has to be transmitted any distance, the hydraulic lift is out of the question. Looked at from the central station point of view, although the peaks due to a lift

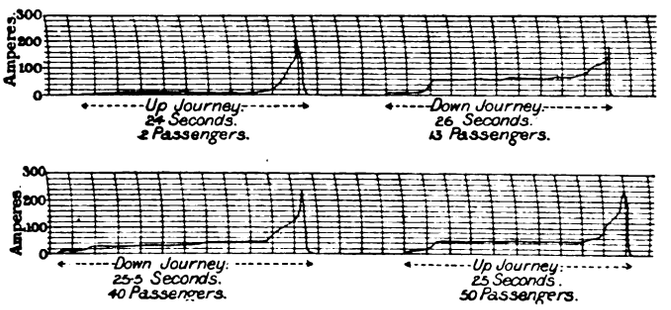

FIG. 6.—RECORDING AMMETER CURVES (LIFT DIAGRAM).

load are infinitely worse than those of a train or tram load, if there are enough lifts on the station, the maximum variation of load is not very great, and, if combined with that of a traction load, the peaks are reduced instead of increased. Fig. 6 shows diagrams taken by

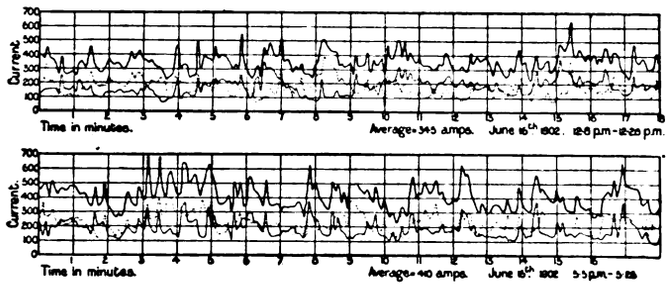

FIG. 7.—OUTPUT CURVE FOR A NUMBER OF LIFTS.

a recording ammeter for single lifts, and Fig. 7 shows the output curve for a number of lifts. A small number of lifts, as on the Clapham extension, however, give a very unsatisfactory load curve, but the peaks are taken up by the battery.

(To be concluded.)

ELECTRIC TRACTION WITH ALTERNATING CURRENTS.*

BY A. C. EBORALL.

Although the subject of the present Paper is somewhat hackneyed, it is hoped that the present brief and general consideration of certain matters in connection with it may be of some interest, and at least give rise to a profitable discussion. It is proposed to deal, firstly, with some features incidental to the employment of three-phase currents for railway purposes, and then to refer to the subject of single-phase railway motors. Two years ago, the latter were not in existence, but to-day the position is very different. The large amount of attention that has been given to single-phase motors by different engineers since that time has already produced results which seem to indicate that single-phase working may eventually take a certain position as far as electric railway work is concerned.

Before proceeding to discuss specific questions in connection with the subject, it may be as well to say a few words with regard to the sphere of utility of alternating-current working as far as electric traction is concerned. The latter has to be considered with regard to various classes of work, the requirements and conditions of which vary very greatly. Apart from those cases in which the lines can be properly supplied directly from continuous-current supply stations, and putting on one side the question of main line electric traction as being at the moment of academic interest only (at any rate, as far as this country is concerned), the following distinct classes of work have to be dealt with as everyday problems at th present time :—

(*a*) Urban and interurban tramways.
(*b*) Overhead, underground and suburban electric railways.
(*c*) Branch line and light railways.
(*d*) High-speed point-to-point railways.

* Paper read before the Manchester Local Section of the Institution of Electrical Engineers on Tuesday, December 15th.

As far as those lines of the first-mentioned class are concerned, it is obvious that three-phase working is out of the question; the mere fact of two conductors being necessary, and the requirements of uniformity in the equipment of the line and rolling stock are more than sufficient, apart from all other considerations, to bring about this result. Again, even if the single-phase railway motor ultimately becomes an important factor in electric railway work, it would be hardly possible to contemplate a change from present practice; even if special circumstances allowed of the requirements of uniformity being waived, such questions as the inductive drop in the rails,* relatively inferior all-round electrical performance, relatively greater cost and weight of the electrical equipment of the rolling stock, &c., would, it is thought, constitute disadvantages for this class of work which would not be made up for by the advantages of replacing the running machinery in the sub-stations by stationary transformers.

With regard to working costs, a certain economy naturally results owing to the substitution of transformers for rotating converting machinery in the sub-stations, but it is thought that this saving will not appreciably influence the total costs of operation, on account of the increased energy consumption in the secondary network. It is hardly likely that the all-round performance of any type of alternating-current equipment will ever equal that of the corresponding direct-current equipment—at any rate, under the conditions usually prevalent in urban and interurban tramway work. However perfect the phase compensation of such motors may become, the losses in them and in the distributing system must be greater, other conditions being equal, while, on the other hand, the maintenance charges are not likely to be less.

With regard to (*b*), which implies, as a rule, the handling of a large number of trains running at short intervals for the greater part of the day, there is more to be said in favour of alternating-current working throughout; but, here again, in the present state of our knowledge, there can be little doubt which method is the better. The commercial success of such lines, which alone is the criterion by which the quality of the engineering portion of the work can be judged in the long run, turns very largely upon the question of rapid acceleration attained at minimum cost with the help of simple and flexible arrangements, and in this respect the direct-current equipment is superior to the alternating-current equipment, no matter what arrangements are made with regard to the starting and speed control of the motors. The better performance of the direct-current motors in this respect outweighs the disadvantages inherent to extended systems supplied with energy from a considerable number of rotary converter sub-stations, and, consequently, recent decisions to employ direct-current working on certain important suburban lines now in course of electrification, are not to be wondered at.

But with regard to the classes of work enumerated under (*c*) and (*d*) above, where the distances are usually considerable, and the acceleration periods are relatively insignificant, the case is quite different. For such work, the disadvantages of three-phase working, for instance, are by no means serious, while the advantages gained with regard to lower first cost and much smaller operating charges, are such that it is difficult to imagine lines such as those projected between Manchester and Liverpool, London and Brighton, &c., being laid out for direct-current working. There can be little doubt but that electric traction on lines of this character, as well as on light railway lines generally, will be carried out with alternating currents in the future, and it is in connection with this class of work that the following observations are more particularly applicable.

THREE-PHASE WORKING.

Motors.—In Table I. a comparison is given between typical standard high-speed 500-volt railway motors of the three-phase and direct-current types, the former arranged for 25 cycles. The rating of each motor is 80 B.H.P. at 720 revolutions, the temperature rise of each motor not exceeding 75°C. after a run of one hour at this load in either case. A section of the three-phase motor is given in Fig. 1, and the circle diagram for it in Fig. 2.

The table shows at a glance the relative performance of the two classes of motor, although the direct-current motor would certainly appear to somewhat greater advantage at a lower and more usual speed; but the three-phase motor, it will be noticed, has an excellent efficiency curve, this having been specially aimed at in the design, and, from this point of view, the three-phase motor is quite as good at all loads as the best direct-current motors of corresponding output. It will be noticed, however, that the power-factor at different loads has a lower value than the corresponding value for three-phase motors used for ordinary work, but this is wholly due to the relatively large air-gap. The motor in question has a rotor having an external diameter of 17¼in., and for stationary work an air-gap length of 0·04in. would be a usual and permissible value for this size of rotor. It is, however, too small for railway

* For information bearing on this matter, see Mordey and Jenkin, *Proc.* Inst. Civil Engineers, 1902, p. 58; Huber, *Street Railway Journal*, June, 1902, p. 470; Herzog and Feldmann, *Elektrotechnische Zeitschrift*, 1900, Nos. 41 and 42.

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Table I.

Leading particulars.	Type of motor.	
	Three-phase.	Direct-current.
Normal rating at 500 volts	80 B.H.P.	80 B.H.P.
*Momentary safe over-load	200 ,,	160 ,,
Speed at 1¼ full load	717 r.p.m.	650 r.p.m.
,, 1/1 ,,	725 ,,	710 ,,
,, ¾ ,,	732 ,,	790 ,,
,, ½ ,,	739 ,,	940 ,,
,, ¼ ,,	745 ,,	1,250 ,,
Efficiency at 1¼ full load	89·0 p.c.	86·0 p.c.
,, 1/1 ,,	90·0 ,,	88·5 ,,
,, ¾ ,,	90·2 ,,	87·0 ,,
,, ½ ,,	90·0 ,,	83·0 ,,
,, ¼ ,,	86·5 ,,	74·0 ,,
Power-factor at 1¼ full load	85·5 ,,	..
,, 1/1 ,,	83·5 ,,	..
,, ¾ ,,	78·5 ,,	..
,, ½ ,,	66·0 ,,	..
,, ¼ ,,	45·5 ,,	..
Current at 1¼ full load	113 amps.	174 amps.
,, 1/1 ,,	92 ,,	134 ,,
,, ¾ ,,	73 ,,	103 ,,
,, ½ ,,	58 ,,	72 ,,
,, ¼ ,,	44 ,,	41 ,,
†Current at no load	38 ,,	..
Net weight, including gear	1·7 tons	1·53 tons
Overall length	47·0in.	38·5in.
,, breadth	48·0in.	44·0in.
,, height	40·0in.	28·0in.
Length of air-gap	0·069in.	0·25in.
Relative cost of motor	1·25	1·0
‡Relative cost of two controllers and the resistance	1·2	1·0

* For three minutes. † Power-factor = 8·4 per cent. ‡ Series-parallel control for the direct-current equipment and control with rotor resistances only for the three-phase equipment.

work, and increasing it by nearly 75 per cent. has naturally a large influence on the power-factor. From the figures given above it will be seen that at full load 83⅓ per cent. and at half-load 66 per cent. of the current actually taken by the rotor is an energy current.

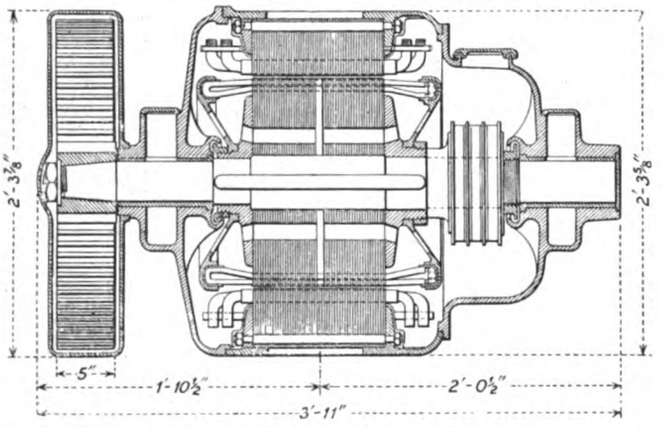

FIG. 1.—SECTION THROUGH STANDARD GEARED THREE-PHASE RAILWAY MOTOR, RATED AT 80 B.H.P.

720 revs. per min. 500 volts. 25 cycles. Pinion, 16 teeth, 5¾" diameter. Gear wheel, 72 teeth, 26" diameter; 160 revs. per min.

It will be seen from the table that there is no great difference between the weight and dimensions of the two types of motor, what difference there is being in favour of the direct-current motor. But the cost of the three-phase equipment is considerably in excess of that of the direct-current equipment, this being due, to a certain extent, to the expensive character of the controlling gear for the three-phase motors. As a matter of fact, the difference is even greater when the cost of the entire car equipment is compared, principally on account of the expensive character of the wiring (especially in the rotor circuits), but also on account of the additional apparatus (current collectors, switches, protective devices, &c.) required in the three-phase case.

As to which is the better motor, considered from the engineering, and cost of upkeep, points of view, the three-phase motor has the advantage. With air-gaps of the order referred to above, no trouble is experienced in practice, provided that the bearings are properly proportioned in the first place and well looked after in the second. As far as the entire equipment is concerned, it must be remembered, moreover, that as a partial set-off to the very considerable disadvantages possessed by such a three-phase equipment with regard to economical speed regulation, and the collection of the currents from two or more trolley wires, it is possible to work with high pressures on the motors, and hence realise a considerable saving for the case of lines of considerable length. The limit in this direction really turns upon the question of the maintenance of effective insulation of the stators of the motors, for no matter what system of control is employed, no handling of high-pressure gear is necessary. For such cases as those included under (*c*) and (*d*) the stators of the motors can invariably be left on,* and the entire control (except reversing) effected on the rotors; with infrequent stops and long runs this is entirely practicable, and for the rest there is no difficulty with regard to the cutting off or reversal of the stator current at the termini, with the help of the excellent types of oil switches (requiring but little space) which are nowadays available. But although pressures of 3,000 and 6,000 volts are used for railways actually at work (and 10,000-volt railway motors have even been made), it is thought that the use of really high pressures for such work is open to serious criticism. It is by no means difficult to construct railway motors of large size to work at such pressures, but the effective maintenance of the insulation under the conditions prevalent in railway work is another matter. What with the effect of vibration on the durability of the insulation (which, it must be remembered, is always at a high temperature on account of the considerable and constant losses in the iron of the stator), and the difficulty of keeping out dirt, moisture and oil, it is thought that the employment of pressures greater than about 2,000 volts is, in general, a mistake. At this pressure, and even at lower pressures, the energy necessary for the heaviest trains can be collected without difficulty by modified forms of the current collectors at present in use, and although the cost of the line and distributors is more, yet it is surely better to spend money once and for all on this part of the work than to spend it in repairs on the motors. Again, the indirect consequences of breakdowns in railway work are far more serious than in any other, absolute reliability being the first consideration. Owing to its nature, electric traction cannot be so reliable as steam traction when it comes to really heavy work, and, knowing this, electricians should surely go out of their way to reduce risks of breakdown to an absolute minimum, even if it does cost more in the first place.

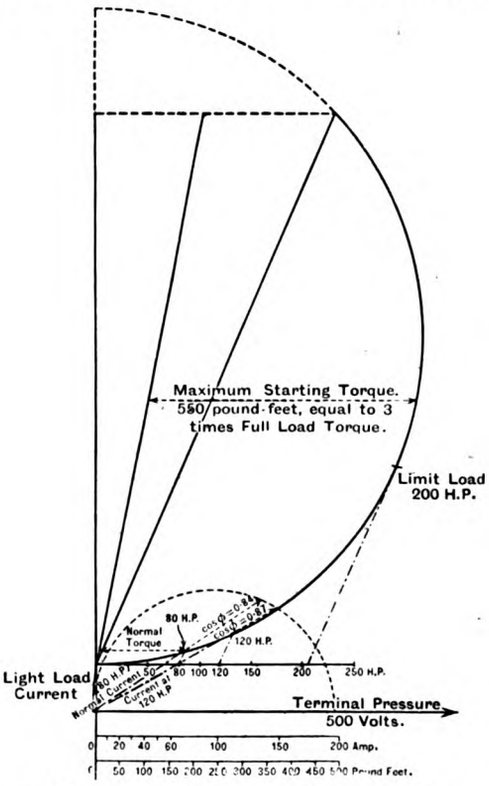

FIG. 2.—CIRCLE DIAGRAM FOR THE 80 B.H.P. THREE-PHASE RAILWAY MOTOR SHOWN IN FIG. 1.

Speed Control.—It is a trite saying that the speed control of the three-phase motor is its weak feature. Unfortunately, as far as

* This, the author believes, is what is done at Valtellina. Of course, for the class of work included under (*b*) this method of working would no longer be possible, on account of the continual waste of energy in the stators of the motors; for instance, the iron loss in the stator of the 80 B.H.P. motor, shown in Fig. 2 and referred to in Table I., amounts to 2kw. The continual switching on and off of the stators of high-pressure motors could not be seriously contemplated, and hence the employment of such motors for this class of work is practically out of the question.

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railway work is concerned, this is indeed the case. There is, of course, no difficulty in regulating the speed of three-phase railway motors, or in properly controlling or handling the trains and fulfilling service requirements, but the control of the motors is either accompanied by great waste or by considerable complication. These difficulties increase when rapid acceleration is an essential requirement, and it is for this reason that three-phase working for the class of work included under (*b*) is outside serious consideration.

Of the various methods that have been proposed for controlling the speed of three-phase motors, two alone are applicable to railway work—namely, rheostatic (rotor) control, and tandem parallel control. The former method is in use on all the three-phase lines at present in operation (including the Zossen experimental line) with the exception of the Valtellina Railway, where tandem parallel control has been adopted by Messrs. Ganz & Co. This latter method of working was also proposed by the same firm in connection with the electrification of the Metropolitan District Railway in London, and the essential features of each method will now be briefly dealt with.

Unlike the direct-current series motor, the speed of which adjusts itself automatically, in accordance with the torque which the motor is called upon to exert, the three-phase motor (or any induction motor) possesses the undesirable property, as far as railway work is concerned, of carrying all loads within its capacity at nearly the same speed; thus the 80 B.H.P. motor already referred to has a slip of only 13½ per cent. at a load of 200 B.H.P. The absence of inherent speed regulation for varying torque means that, if left to themselves, the three-phase motors on the cars will draw them up the steepest gradients on the lines at nearly the same rate as on the level, and as this relatively large amount of power has to be provided for, the practical effect of this is that the capacity of the power station and sub-stations has to be in general about 30 per cent. greater than that of the corresponding direct-current lay-out, for a given running schedule on a given line.*

A reduction of the speed of the motors on the inclines by means of rheostatic control evidently does not help matters in this respect; the power that would otherwise be taken up by the train is now wasted in the rotor resistances, the net result being that, while a slower speed has been attained, the efficiency of the operation has decreased proportionately. The introduction of resistances into the rotor circuits is then analogous to the regulation of the speed of a shunt motor (working with constant field excitation) by means of resistances in the armature circuit. In both cases the energy input into the motor remains nearly constant, as for a given torque the current is nearly independent of the speed; in both cases the method of speed control in question is wasteful in the highest degree, and requires large and expensive resistances, which must be properly ventilated, and for which it may be a difficult matter to find the necessary room on the car. It follows, therefore, that rheostatic control of the speed of three-phase motors on the gradients of the line is useless from the point of view of power economy, and this is why it is never attempted in practice. In addition to the disadvantage relative to the capacity of the power plant already noted, it will be seen that the absence of inherent speed regulation on the part of the three-phase motor has the further disadvantage that the amount of the load on the motors cannot, in general, exceed a certain definite amount. Thus, for instance, on a line having severe gradients, it would, in general, be advisable to take advantage of the excellent overload capacity of the three-phase equipment to work the motors, at an output well above full load on the steepest gradient, and this would mean (after making proper allowances for the varying state of the track and for possible variations in the motor pressure) that an emergency traffic could only be handled properly with the help of additional trains—the addition of a few more coaches to the standard trains might stall the motors on the worst gradient of the line. It is for this reason that the motors on the goods locomotives on the Burgdorf–Thun line are provided with two speed gears, which is one way out of the difficulty. Another way is to work normally with such a margin of power on the motors that, notwithstanding possible variations in the condition of the track and in the supply pressure, considerable emergency loads can be handled on the worst gradients should the necessity arise. This means that the best property of the three-phase equipment—its great overload capacity—is not fully utilised in normal work, and that difficulties will probably arise in connection with getting the motors into the available space.

In all these matters, the great influence of variations in the supply pressure on the performance of the motors must not be overlooked. Whereas the torque of the direct-current equipment is unaffected by variations in the line pressure, the torque of the three-phase motors varies with the square of the pressure at their terminals. Thus, for instance, referring to the 80 B.H.P. three-phase railway motor shown in Fig. 1, the maximum load it can safely exert for a few minutes is 200 B.H.P. at 500 volts; at a pressure 7½ per cent. below this it falls to

$$\text{Maximum B.H.P.} = 200 \times \frac{(462)^2}{(500)^2} = 172.$$

It follows that the transformers supplying current should be so located along the track that on the gradients the full pressure is maintained on the lines under the service conditions; on the worst gradients it is desirable that this pressure should be even higher, which can be readily arranged for by arranging the transformers at such points with smaller transformation ratios. Another point is that an amperemeter and a voltmeter should form part of the equipment of the motorman's cab, and that their indications should be properly taken into account by the motorman at starting. Otherwise it might quite well happen, for instance, that careless handling of a train at starting on a gradient might stall the motors. The pressure at starting would fall, and with it the torque—giving the motor more current might not improve matters, as this might bring about such a further reduction in the pressure that the torque would decrease still more, and so on. Naturally, starting on gradients is to be avoided as much as possible, but the occasional pulling up of a train on a bad gradient has to be reckoned with.

The maintenance of a fairly constant pressure on the motor terminals has hitherto been one of the difficulties of three-phase railway work. For the class of work comprised under (*c*) and (*d*), implying a comparatively small number of heavy trains, the variations in the station output are of necessity very great—it may well happen, for instance, that the whole load suddenly comes on, and

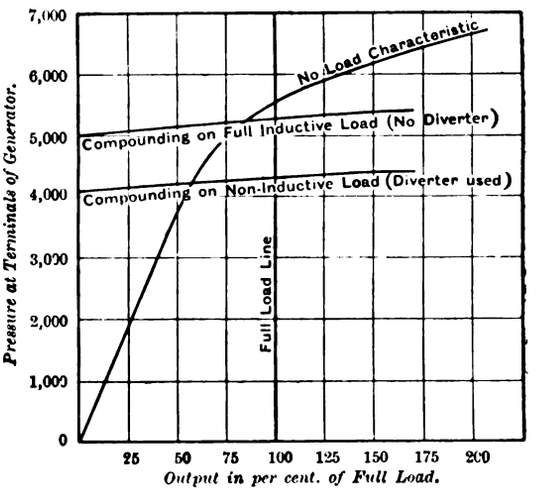

FIG. 3.—COMPOUNDING CURVES FOR AN OVER-COMPOUNDED THREE-PHASE GENERATOR OF THE REVOLVING FIELD TYPE, WITH HEYLAND FIELD WINDING.

then falls to an insignificant amount very soon after. The load is, moreover, of an inductive nature (average power-factor about 0·8), and a little reflection will show that under such circumstances the pressure fluctuations on the line must be very great. When the trains are on the gradients of the line, or starting from the termini, the motors must be worked at their proper pressure, as already indicated, and the generators in the power station must, consequently, be excited to maintain this pressure on the lines during the periods of maximum load. Now, at constant speed and excitation the best three-phase generators of standard design have pressure rises of 14 to 16 per cent. from full load to no-load at a power-factor of 0·8, depending upon the speed conditions, &c., while the step-down transformers will not regulate better than 4 per cent. under the same conditions. If a drop of 5 per cent. is allowed in the trolley lines and feeders respectively, and an allowance of 3 to 5 per cent. made for variation in the speed of the engines from full load to no-load, depending upon the type, it follows that the line pressure might vary in places by some 30 per cent., there being a corresponding pressure variation of the 'bus bar pressure in the power station. This assumes, of course, that the generator excitation remains unaltered, which, in general, would be the case; as an example of the amount of the pressure variations met with in practice (in this case due to a single train little more than half the weight of the standard train), the observed pressure curve shown in Fig. 4 (to be referred to later) should be noted.

Such pressure variations are very objectionable not only from the point of view of the motors and of the lighting of the trains, but also on account of the additional stresses to which the insulation of the whole system is subjected. Fortunately, they need no longer occur, as the problem of compounding three-phase generators, not only with regard to the amount of the load current, but with regard to

* This is only correct, however, when generating plant of the standard pattern is employed, the maximum output of which is determined by the pressure drop on inductive loads. With the over-compounded generators referrred to later on, it is not the case, and the difference between the capacity of the direct-current and three-phase generating stations is nothing like so great.

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its power-factor also, has been completely solved. The new pattern of synchronous self-exciting revolving field generators* (standard machines with Heyland field winding) are a technical and commercial success, and the problem of keeping the pressure fluctuations due to varying load and power-factor within reasonable limits has been solved. In Fig. 3 are given the compounding curves for a typical three-phase railway generator under the conditions of (*a*) a power-factor of 100 per cent., and (*b*) a power-factor of 10 per cent., at constant speed and excitation; the heavy over-compounding on the inductive loads naturally constitutes a great advantage for work of the character under discussion. The amount of the over-compounding for a given power-factor can be adjusted once and for all as readily as for the case of standard direct-current railway generators.

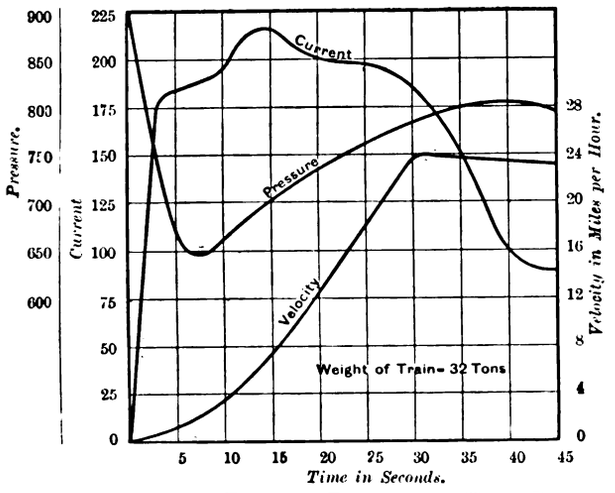

FIG. 4.—ACCELERATION TEST WITH EXPERIMENTAL TRAIN, BURGDORF-THUN RAILWAY.

As the torque of the induction motor increases with the square of the pressure at its terminals, it follows that another way of getting over the above-mentioned difficulty, which arises in connection with the hauling of extra or emergency loads over the steepest gradients of the lines, is evidently to increase the temporary rating of the motors by increasing the motor pressure on the gradients (and at starting) either by means of a booster carried on the train or by changing the connections of the motor windings from star to mesh. In this way the overload capacity of the motors would certainly be considerably increased by an amount depending upon the saturation, increase in leakage, &c., of the motors. But for high-pressure motors such additional arrangements could not well be arranged

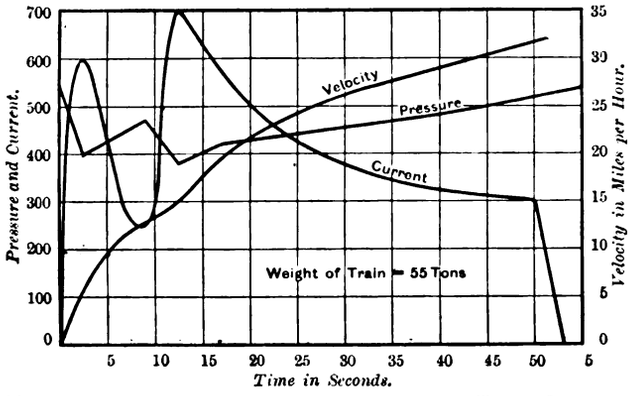

FIG. 5.—ACCELERATION TEST WITH EXPERIMENTAL TRAIN, LIVERPOOL OVERHEAD RAILWAY.

for, while even for low-pressure motors they are not desirable, on account of the extra complication thereby brought about, and also because of the great increase in the iron losses of the motor and the smaller power-factor.

From what has now been said, the quality of the starting performance of three-phase motors controlled by rotor resistances will be readily realised. A starting torque per motor equal to nearly three times the normal full-load torque is available for acceleration if necessary, provided the normal pressure is maintained at the motors, but it is accompanied by large losses in the rotor resistances. Still larger torques can be obtained for quicker acceleration, if desired, by increasing the pressure on the motors, but the result is even greater total losses. Generally speaking, the power consumption of well-designed three-phase motors during the starting period, when employing rotor resistance control, is of the order of 20 per cent. more than that required by the corresponding direct-current motors, starting under the same conditions, with the help of series-parallel control. This is for moderate accelerations—of about 6in. per second per second; for very rapid acceleration, such as that often found with the latest lines of the (*b*) class, the difference in favour of the direct-current equipment is still more marked. The necessary acceleration can be obtained, but at great cost.

It must be pointed out, however, that the characteristic fluctuations of energy during the acceleration period incidental to direct-current equipments using series-parallel control are not nearly so marked in the case of the three-phase equipment using rheostatic control on account of the uniform acceleration, and this is of real value, because it has its effect on the capacity of the sub-stations and on the comfort of the passengers. Figs. 4 and 5, relating to tests carried out on the level on the Burgdorf–Thun and Liverpool Overhead Railways respectively will serve to illustrate this point.

On the other hand, these tests serve to illustrate very well the difference between the performance of the two types of equipment as far as acceleration is concerned; whereas the direct-current equipment has a high initial acceleration, which falls off as the speed increases, the acceleration with the three-phase equipment is nearly uniform throughout. Consequently, for the same average acceleration, the distance travelled over in the same time is considerably greater with the former than with the latter equipment. For certain classes of work, such high initial accelerations are a necessity, and if this is required with three-phase equipments, rheostatic control of the motors is undoubtedly inferior to the method of tandem control referred to below. Large fluctuations in the power supplied to the train are a necessary accompaniment of very rapid initial accelerations.

(*To be concluded.*)

* See the author's article on the subject in *The Electrician* for July 3 and 10, 1903.

METHODS OF CHARGING FOR ELECTRICAL ENERGY.*

BY ELLIS H. CRAPPER.

The Uniform Meter Rate—often termed a flat-rate system—is no doubt a great improvement upon the old flat-rate system, and is in use to a great extent at the present time. At a fixed price the quarterly account is proportional to the consumption, and the undertaker is paid for what he supplies. The large short-hour consumer, however, does not pay his proper proportion of the readiness-to-serve costs, whilst the long-hour consumer pays more than his just portion of the same. The latter, although he may take less kilowatt-hours, is more profitable than the former. The system is readily understood by, and acceptable to, the public, and although a fixed rate has the recommendation of simplicity, it is difficult to offer inducements to the most desirable customer. The price per unit varies from 4d. to 6d. From the nature of the demand, the engineer could well afford to supply the long-hour consumer with some rebate, but, unfortunately, it is the large short-hour consumer—of which the early-closing drapery establishment of considerable dimensions is an example—who expects and demand a reduction on his account, because the kilowatt-hours consumed is large. Discounts, however, are favoured by some undertakers, and discount granted may be based upon the number of units consumed. If the duration of service be ignored, then the wrong individual—*i.e.*, the large short-hour consumer reaps the benefit, since it is the rate at which the supply is given, more than the quantity supplied, which augments the costs' curve. The principle in such cases is, therefore, irrational, and the long-hour consumer would be unfairly treated. It would, in fact, be extremely difficult to exactly apportion the proper amount to be deducted between the individual consumers, when the magnitude and duration of the demand vary so considerably with different classes of consumers. The principle of granting discounts is so prevalent in every-day commercial practice that, not only have they been offered to the more profitable customer, but some engineers maintain that discounts should also take into consideration the period of the year. M. de Fodor, for instance, proposed in his Paper, read at the Paris Congress in 1900, to offer three scales of discounts according to the time of the year, one applying from October to February inclusive, another during March, April, May and September, and a third one from June to August inclusive. It has been found at Budapest that the bills for current in the months of December and July respectively were in the ratio of 7 to 1, and as the generating station has a minimum load during the summer months, Fodor considers that greater discounts can be given during these months than during the winter months. As an example

* Abstract of Paper read before the Leeds Local Section of the Institution of Electrical Engineers last night.

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of his scale of discounts, it may be mentioned that a consumer having 20 lamps installed and using 440 lamp-hours on the average is supposed to use 1,200 and 1,000 lamp-hours in January and February respectively, and would be allowed a discount of 20 per cent. for consumption in excess of these amounts. For the other months the scale is given in the following table:—

Month.	Consumption in lamp-hours before discount allowed.	Percentage of discount for excess.
March	720	
April	580	40 per cent.
May	380	
June	240	
July	200	60 per cent.
August	280	
September	580	40 per cent.
October	1,000	
November	1,280	20 per cent.
December	1,340	

The main idea is that this system will educate the public to understand the advantages of electric lighting during the period of low tariff; on the other hand, there must, of necessity, be some extra trouble in preparing the accounts. A similar system has been introduced at Les Halles, Paris, but in this case the customer pays a fixed amount, with an addition proportional to the consumption. The correct method of giving a rebate would necessitate the division of the consumers into groups of equal value to the station, with regard to profitableness rather than the magnitude of the consumption. And this idea introduces the principle of a sliding scale of charges, which is justifiable from the point of view that the service demanded of the station may be more cheaply rendered to long-hour consumers than to large short-hour consumers. Sliding scales, however, have not been introduced to any great extent on account of the difficulty experienced in getting out the accounts. The best-known example of a sliding scale charge is the one which was in use at Ayr for some time, and consisted in giving discounts to the consumer according to the duration of their demands, which in the case of shopkeepers were fixed by the hour of closing. Shops closing at seven o'clock received no discount; public houses, restaurants, &c., closing at 10 p.m., received 22½ per cent., and private houses 35 per cent.

Two-rate Meters.—On the assumption that the production costs are less between certain hours of the day than at periods in the neighbourhood of the time of the peak, a system has been proposed by some engineers (and has been introduced to some slight extent) in the shape of a differential rate, depending upon the period of the day at which the demand is made, and electricity is offered at a low rate at periods of light load and at a higher rate at periods of heavy loads. Although by some this is considered a satisfactory principle, it appears to be unsound, and nothing more than a special inducement in the nature of bargain hunting to use lamps when the natural light is available with the exaggerated idea that the hollows of the load curve will be filled up, and the curve be flattened. Now, whilst it is desirable to encourage the full use of all the lamps for as long as possible and at times other than at the peak load, it ought to be remembered that, in a general way, the consumer only requires light when the natural light fails, and, except (1) in the case of basement property where artificial light is more or less necessary and (2) at special times, as at the dawn of day, there appears to be no reason (omitting, of course, considerations of motor day loads) why a day supply should be fostered by selling electricity, say, at half-price, and introducing a more prohibitive rate when the natural demand should take place, whilst to the majority of consumers the inducement is offered when electricity is not a necessity. Surely, this is equivalent to offering a bounty to the low-load consumer, inasmuch as a two-rate system, as ordinarily used, tends to flatten the load curve by reducing the peak, instead of building up the low-load curve. The only *raison d'être* of the differential time-rate system is that an early morning consumer making a reasonable demand should meet with some encouragement in the shape of a diminished charge, since he then contributes less to the peak, and his charge may with advantage be based upon, and correspond to, the actual output of the station as a whole, provided such charge contributes something to the standing-by charges. It thus differs from the ordinary demand system, since the charge depends only on an individual demand. Considerations of Hopkinson's fundamental principles as regards the total cost of production impress one with the fact that the ideal tariff should be based on a principle which apportions to each consumer an amount for his service which is commensurate with the total cost of the same, and with this end in view certain systems, described in this Paper, have been introduced. Hopkinson's system is a rate which is composed of a fixed charge on the *demand installed*, plus a charge per unit actually consumed, whilst Andrews' system is a rate which is composed of a fixed charge on the *demand taken*, plus a charge per unit actually consumed, and the last, or Wright's maximum demand, system is a *differential* meter rate *varied by the time the maximum demand is used*. Hopkinson's, or the Manchester, system has not been adopted to any extent, as it is obvious that any scale which includes a fixed charge per lamp capacity seriously tends to restrict the number of lamps installed. It has also the defect that the number of lamps may be increased without notice being given of the change. At Burnley the fixed charge is £8 per annum per kilowatt of maximum demand, plus the charge of 2d. per unit consumed, with the option of a uniform tariff of 6d. per unit, with discount for prompt payment. The system introduced at Hastings by Mr. Leonard Andrews is a modification of the Hopkinson system, and embodies a fixed charge for the maximum number of lamps simultaneously lighted during the quarter, plus a fixed price per unit consumed. The actual rate is 10s. per annum per 8 c.p. lamp, paid quarterly, plus 1½d. per unit consumed, with the option of a uniform tariff of 6d. per unit. The maximum number of lamps in use simultaneously is ascertained by a demand indicator calibrated in lamps, a "lamp" being assumed to take 0·35 amperes at 100 volts. Mr. Arthur Wright's system is an improvement of Hopkinson's method, and takes into account the actual maximum demand instead of the maximum possible demand, and in addition gives a rebate according to the customer's load-factor. It probably more nearly approaches the ideal system than the others, in that the charge made to the consumer more nearly approaches the cost he occasions than they do. It is questionable whether a charge based on the maximum demand irrespective of the time which it occurs tends to improve the conditions of the load, and whether it does not discourage a liberal installation and consumption of current by keeping down the maximum demand. As evidence that the system is not quite perfect, it may be mentioned that when an abnormal and exceptional demand, made for special occasions or purposes, exceeds the normal maximum demand, permission is usually granted for cutting out of action the indicator, provided due notice be given to the officials beforehand and request be made for them to short-circuit the indicator for the occasion. Then, again, the large short-hour consumer is unjustly penalised, whilst the small shopkeeper who lives over his shop receives more than his just share of the benefits attending long-hour consumption. It is also somewhat difficult to get the layman to understand the principle upon which the charge is made, and considerable objection has been raised to the system on this score alone. And, as Mr. Andrews has pointed out, there may, in some extreme cases, be considerable irregularity in the magnitude of the quarterly accounts.

With respect to the special charges made for power, cooking and heating, it is generally recognised that these items form the waste products of the electric light business, and in most cases a fairly low flat meter rate is adopted for electrical energy supplied for these purposes. Probably this is due to the fact that motor loads have to compete with gas, steam and hydraulic power, consequently the price to be charged for electricity for power purposes has to be fixed more by the charge made for gas, steam, &c., than by its relation to the total costs of production. The author gives the following as an example of the relative cost of gas and electricity for power purposes:—A 9 H.P. gas engine, with gas at 1s. 6d., cost from 22s. to to 26s. per week, including gas, interest, renewals, &c., whilst a 9 H.P. single-phase motor which replaced the gas engine, with electricity at 1½d. per unit, cost 14s. to 16s. per week.

If a central station could operate at an approximately constant load for 24 hours per day, the service would be an ideal one, and the commercial age of the electric light business would be realised. Then a uniform rate would be the ideal rate; but at present, a uniform rate for all purposes and at all times is not only impracticable, but unjust. A differential rate in some form, in the author's opinion, has certainly many points in its favour, and is the most workable system, provided the initial rate is not too high. A leading article in *The Electrician* some time ago, referred to the Wright maximum demand system as a "tonic," and suggested that as soon as developments and profits permit, the initial rate should be reduced, but that the period during which the maximum demand must be paid for should be increased.

APPENDIX I.

Since the total cost of production of electrical energy is made up of two factors—*i.e.*, the preparation costs and production costs—we may, in searching for a method of fixing the selling price of electrical energy, consider each component separately, as if the other were absent. If the operating costs of a central station were wholly production costs, then on a diagram, with cost per unit used as ordinates, and hours of daily use as abscissæ, the resulting curve would be a horizontal straight line, and indicate a uniform tariff, whilst if the operating costs were wholly preparation costs, and constant in magnitude, the resulting curve would be a rectangular hyperbola. The former would naturally correspond to the load curve of a station, with an ideal service of full load for 24 hours per day, but as this ideal condition is not realised, the actual costs' curve will be intermediate between the rectangular hyperbola and a horziontal straight line, and will indicate a differential tariff. Such a curve, for a station of 5,000kw. capacity, is represented by the curve ABC in Fig. 1, which has been obtained from actual data of a certain central station. The ordinate OD represents the preparation cost for this station per month, and includes interest, depreciation charges, &c., and the straight line DEF has been obtained by adding to the preparation cost a quantity directly proportional to the production cost (fuel, &c.) for different outputs in kilowatt-hours.

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The equation to the curve DEF is $y=a+mx$, in which y is the total cost for x kilowatt-hours per month, a is the preparation cost per month, or the constant OD, and m (0·82d. in this case) is the production cost per kilowatt-hour. By dividing the values of the ordinates of the curve DEF by the values of the corresponding abscissæ—by dividing the total cost by the corresponding output—the curve ABC is obtained, which represents the cost per kilowatt-hour, and the equation for this curve is

$$y_1=(a+mx)/x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (A)$$
$$=(a/x)+m \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (B)$$

Equation (A) indicates that the cost per kilowatt-hour is a function which varies inversely as the use of the current, whilst equation (B) shows that if there were no production costs, and $m=o$, then $y_1x=a$ (a constant), which is the equation of a rectangular hyperbola, and which, for the case under consideration, is represented by the curve AGH. Again, if a uniform meter rate be charged for electrical energy, the equation of the curve representing the cost of a number of units consumed will be $y=px$, since the curve passes through the origin O. In

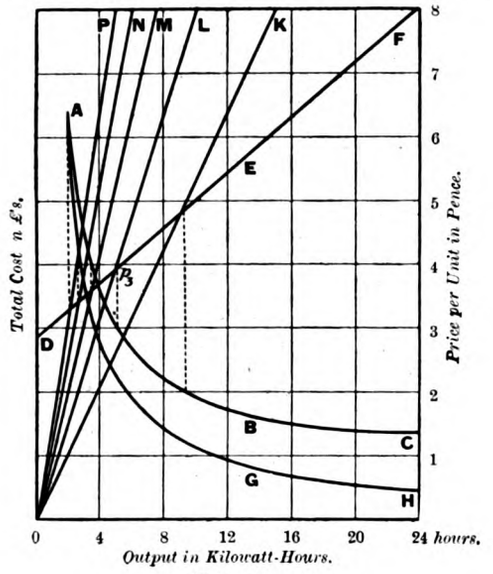

FIG. 1.

the figure the five straight lines OK, OL, OM, ON and OP have been plotted by taking as values of p, 2d., 3d., 4d., 5d. and 6d. per unit, they are, therefore, the cost of output rates at 2d., 3d., &c., and it will be noticed that these lines intersect the line DEF at the points k, l, m, n, and p. Taking the case of the point of intersection of the curves OL and DEF, the co-ordinates of which are x and y, the equation for the curve DEF is $y=a+mx$, and for the curve OL is $y=p_3x$, from which $x=a/(p_3-m)$. Now let y_1 = the cost per kilowatt-hour for the particular output of x kilowatt-hours—*i.e.*, the value of the ordinate of the curve ABC for x—and $y_1=(a/x)+m$. Substituting $a/(p_3-m)$ for x we obtain

$$y_1=\frac{a(p_3-m)}{a}+m=p_3.$$

As the result implies, and the diagram shows, the curves OK, OL, &c., intersect the total costs' curve DEF at the same output that the curve ABC intersects the horizontal line giving the corresponding rate or price per unit.

These curves give several other interesting relationships; thus, for the central station considered, the maximum output for a month of 30 days when running at full load continuously, is: Maximum output possible = (5,000kw. × 24 hours × 30 days) kilowatt-hours = 720K, where K = capacity

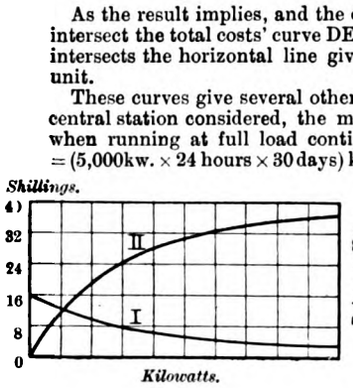

FIG. 2.

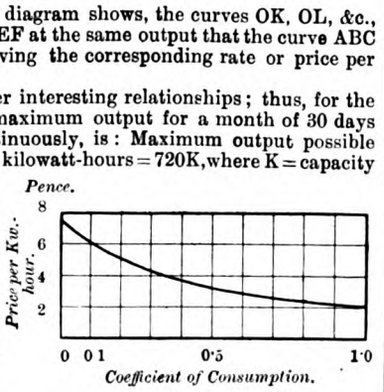

FIG. 3.

of station in kilowatts, and the curve DEF shows that, for continuous work, the cost will be 1d. per kilowatt-hour. Then, again, if the maximum output be divided into 24 equal parts, each portion would represent one hour's average daily use per month; and the rates for different lengths of service per kilowatt, as given by the curve ABC, are as follows:—5·4d. for one hour; 3·13d. for two; 2·36d. for three; 1·97d. for four; 1·75d. for five; 1·60d. for six.

M. G. Claude has pointed out another principle for the determination of the rate to be charged according to the class of consumer. Even if the maximum demand system be adopted, it may be advisable to differentiate between different classes of consumers. In the first place a consumer may take a large quantity, and upon the principle that the cost charged ought to increase less quickly as the demand increases instead of directly proportionately, the initial price should be of the form

$$p=k/(x+q) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (c)$$

so that the total cost should be

$$y=kx/(x+q), \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (d)$$

in which k and q are suitable coefficients. Curves I. and II. (Fig. 2) have been plotted to give the tariff per kilowatt per month and the cost per month respectively, taking $k=30$ and $q=3$. Claude also introduces what he terms "a coefficient of consumption," and argues that the magnitude of the amount of energy taken per month, as well as the maximum demand, should be taken into account. Let C be the coefficient of consumption, which is defined as the ratio of the effective consumption to the maximum possible consumption according to the maximum demand indicated. Then the price of a unit as a fraction of C would be of the form $p_1=k_1/(C+r)$, and the total amount of energy consumed during the month (H hours) would be of the form $W=HCx$ units, and the cost of these units would be $y_1=k_1HCx/(C+r.)$ Taking $k_1=0\,3$ and $r=0·4$, the curve in Fig. 3 has been obtained as the price of a kilowatt-hour as a function of the coefficient of consumption. The total cost to the consumer for his monthly consumption would amount to

$$Y=y+y_1=\underbrace{\frac{kx}{x+q}}_{\text{Preparation component.}}+\underbrace{\frac{k_1HCx}{C+r}}_{\text{Production component.}}.$$

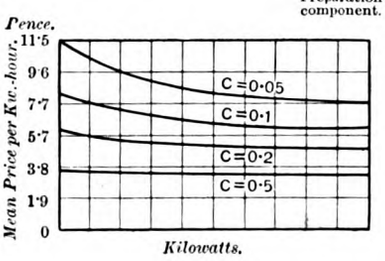

FIG. 4.

The mean price per kilowatt-hour would, therefore, be $P=Y/HCx$,

$$=\frac{k}{HC(x+q)}\times\frac{k_1}{C\times r}.$$

Taking the same values of k, k_1, q and r as mentioned above, H = 720 hours, the mean price per unit has been plotted in Fig. 4 for different values of C, the coefficient of consumption.

APPENDIX II.

Some Continental Flat Meter Rates.—According to the *Electrical World and Engineer* (New York) of November 14, 1903, and on the authority of Mr. F. H. Mason, United States Consul-General at Berlin, the cost of electric current for lighting purposes at Berlin will be reduced from 6·6d. to 4·8d. per kilowatt-hour from January 1, 1904. This change of price is made to meet the competition of gas, which is furnished for lighting as well as for heating and cooking purposes at 3·78s. per 1,000 cubic ft. The rate for lighting purposes per kilowatt-hour in some of the Continental cities is as follows:—Budapest, 11·56d.; Cologne, Leipzig, Nuremberg, 9·1d.; Genoa, 8·856d.; Breslau, Rotterdam, 8·364d.; Dresden, Frankfort, Munich, Hamburg, Vienna, 7·38d.; Christiania, Copenhagen, 6·9d. For power purposes electric current is supplied at Berlin as low as 2·04d. per kilowatt-hour in large quantities during daylight hours; this price is to be still further reduced to 1·68d.

THE STONE WIRELESS TELEGRAPH SYSTEM.*

BY DR. LOUIS DUNCAN.

The commercial future of wireless telegraphy depends largely upon the possibility of selective signalling. To attempt the extended application of wireless telegraphy without such a system would cause confusion and failure. It is not possible that any international agreement should help matters at the present time, for wireless telegraphy is such a new art that we cannot tell at present what its final development will be, and any restrictions that might be imposed would only confine and delay its improvement and application. The futility of any such agreement is evident to any one who has followed the past development of the art and has in view its future possibilities. What has already been done is most encouraging. I think there is no doubt that signals have been sent across the Atlantic and under favourable conditions messages have been sent and received. And the methods and results have been steadily improved. In fact, it has been shown that as far as overcoming distance goes wireless telegraphy is a success. The efforts to make this signalling selective—that is, to make it possible for a station to communicate with a station selected out of a number of others without interfering with the others—has so far proved a failure. Mr. Stone's system aims to do away with this difficulty. His work deals almost entirely with selective signalling. Broadly, he accomplishes his purpose by the use of a sending apparatus that emits simple harmonic waves of a determined period, not a number of waves of different periods, as in other systems; and a receiving apparatus that responds to a single period only. To do this he utilises the properties of resonant circuits.

It is well known that a single circuit, including a capacity and inductance, has a definite period of electrical vibration, the expression for the frequency of this vibration being $n=1/2\pi\sqrt{CL}$, or if $p=2\pi$, $np=1/\sqrt{CL}$. If E.M.F.s of different periods, including the period of the circuit, be impressed on this circuit, the current due to the E.M.F. of period $p=1/\sqrt{CL}$ will be exaggerated, while those due to the other periods will be to a large extent suppressed. If, however, this circuit be placed in inductive relation with a second circuit, the natural periods of both circuits will be modified; but

* From the *Electrical World* of New York.

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this modification will be unimportant provided L′L″ is great compared with M^2, L′ and L″ being the respective self-inductions of the two circuits, and M their mutual induction. So, by filtering an electric vibration of mixed period through a number of such circuits having the same period and placed in inductive relation, we can finally arrive at a vibration of a single period—that is, at a simple harmonic wave. So far we have considered the natural vibrations of the system, but if an E.M.F. of a period different from the natural period of the system be impressed on it, it will excute "forced" electrical vibrations of a period equal to that of the impressed E.M.F. The mechanical analogy is exact and evident. If there are no frictional losses in the system—magnetic and dielectric hysteresis—and a simple harmonic E.M.F. of a given period be impressed on it, the result will be a simple harmonic current of the same period. This is the principle of Stone's transmission device, which I have shown in Fig. 1. An induction coil has a secondary, B, and a spark-gap, S. On a discharge taking place across the spark-gap, an oscillating discharge from the condenser passes through the circuit SA′L′C′, this circuit being so tuned that it responds to the period desired. In inductive relation to it is a second circuit, $A^2C''A^3L'$, tuned to the same period and in turn placed in inductive relation with the vertical wire *v* through the coils

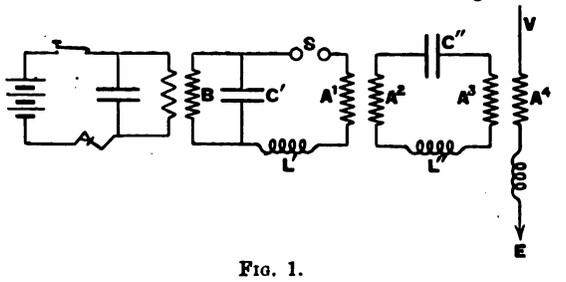

Fig. 1.

A^3, A^4. The coils A^1, A^2, A^3 and A^4 consist of a few turns of wire (20 is the greatest number in the apparatus used) wound on a wooden frame about 8in. square and placed about $\frac{1}{3}$in. apart. The inductances, L′L″ are placed in the circuit to make the condition hold that L′L″ must be much greater than M^2; actually, they are immeasurably small, but their values may be calculated from the dimensions. Any number of intermediate circuits similar to $A^2L''A^3C''$ might be used to still further purify the wave, but it is not necessary to multiply them. The use of this apparatus gives this result: We have impressed on a continuous vertical conductor simple harmonic alternating waves of a definite and determined period. By changing the values of L′C′L″ and C^2 we may alter this period as we wish.

Now to turn to the receiving end of the system. If we have a resonant circuit such as we have been considering—that is, a circuit with concentrated capacity and inductance, as distinguished from distributed capacity and inductance—and place it in inductive relation with a circuit on which is impressed an alternating E.M.F., then as the period of this E.M.F. approaches the natural period of the circuit the current in the latter increases rapidly, reaching a sharp maximum when the two periods are equal. Fig. 3 shows such a state of affairs. If the impressed wave is not simply harmonic, but contains a number of waves of higher periods, then the maximum

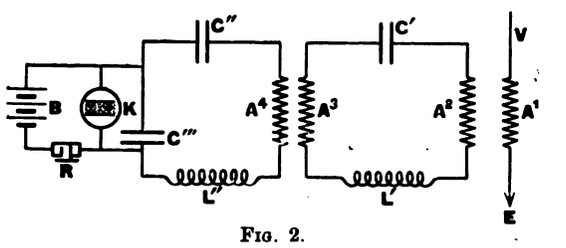

Fig. 2.

is not so sharp, and some part of the higher impulses appear in the resonant circuit. It is true, too, that even simple waves of different periods would cause the circuit to execute forced vibrations. To obviate this, and prevent impulses of a different period affecting the receiving devices, the same means may be employed as at the transmitting end—*i.e.*, a second circuit tuned to the same period may be placed in inductive relation to the first and the receiving device placed in it. In this way a receiving station may be constructed that will respond, within narrow limits, to one period, and to only one period. This is the plan Mr. Stone has used. It is shown in Fig. 2. Here V is the vertical wire containing the coil A′ in inductive relation with the coil A^2 of the resonant circuit $A^2C'L^1A^3$, which is in turn through the coils A^3 and A^4 in inductive relation with the circuit of equal period, $A^4C''C'''L''$. Across the condenser C‴, in the latter circuit, is the circuit of the receiving device. In such an apparatus for receiving signals there is one matter that should be carefully considered. The magnitude of the effect on the receiving apparatus due to a slight change of period of the impressed E.M.F. depends on the sharpness of rise of the resonant curve. In 1892, with Messrs. Carichoff and R. H. and G. E. Hutton, I made a number of experiments on resonant circuits and published a brief description of the work, giving a few quantitative results. We found that hysteresis losses in the circuits greatly decreased the effect of resonance, the introduction of a solid iron core into the inductance core used reducing the results to a small fraction of what was obtained by calculation from the resistance, inductance and capacity of the circuit. We found that dielectric hysteresis had the same effect. With the high frequencies used in wireless telegraphy these results are greatly exaggerated, and the presence of even slight amounts of hysteresis will mask all of the effects and render the method inoperative. In the apparatus being used by Mr. Stone hysteresis is practicallv eliminated. The coils that I have described have no hysteresis loss, and dielectric hysteresis is eliminated by using air condensers. Such, very briefly and without detail, is Mr. Stone's system for selective wireless telegraphy. There are, however, three or four points in connection with it I wish to discuss a little further.

It may be objected that the train of waves due to a spark of the induction coil does not persist long enough to take advantage of the resonance effects. That this is not true may be proved by measuring the spark across C″ in Fig. 1 when the circuit $A^2L''A^3C''$ is tuned, and when its period is changed by, say, 20 per cent.; in this case the spark length around the condenser varied from $1\frac{3}{4}$in. to something less than $\frac{1}{32}$in. We should consider, too, that while the waves in the condenser circuit, starting when the discharge takes place, commence at a maximum, gradually die out, the induced waves starting at a low value increase for a while, probably persist for a time and then die out slowly. It is impossible to say exactly how long the trains of waves do last, but the experiment cited above shows that they last long enough to have their full or almost their full resonant value. I have already stated that in the Stone system the vertical sending wire is continuous, the condition of affairs being shown in Fig. 4. The typical sending wire of other systems is shown in Fig. 5, where there is a spark-gap in the circuit. This spark-gap to a certain extent limits the voltages used on account of the high ohmic resistance of a long gap—or perhaps I should say it would limit it but for the employment of large shunting condensers, which throw so much energy into the discharge that the resistance is diminished. In the Stone apparatus any desired P.D. between *a* and *b* may be obtained by changing the ratio of transformation

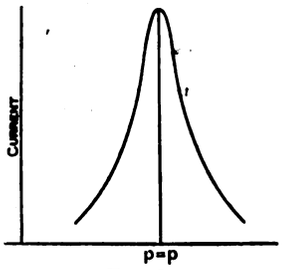

Fig. 3.

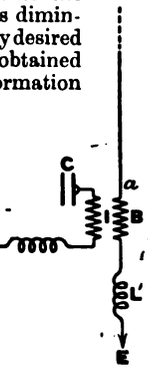

Fig. 4.

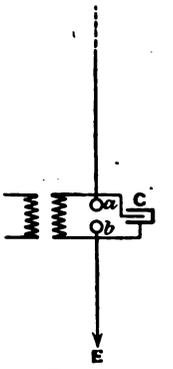

Fig. 5.

at I without changing the length of the spark-gap in the induction coil secondary. Again, to change the period of the waves in systems represented by Fig. 5, the geometrical constants of the system must be changed—the length of the vertical wires, for instance. In the Stone system the period may be changed without regard to the length of wire by changing the electrical constants L and L′, Fig. 4, for instance. But the most important thing is that the system with the spark-gap in the vertical wire cannot send out simple harmonic waves of one definite selected period, while the Stone system can.

I have had the opportunity of witnessing tests on the selectivity of the Stone system. There are two stations about 1,600ft. apart in Cambridge and one in Lynn, about 12 miles from the others. The selectivity shown was about 10 per cent.—that is, a variation of 10 per cent. in the period changed the results from a maximum receptive strength to absolute zero. Trolley lines run very close—at Lynn to within 100ft.—to the stations, but they have no effect on the receiving apparatus. In the work that has been done on the system, coherers are used as the receptive device. A coherer is peculiarly unfitted for selective work, because of its great variations in sensibility. In changing the resonant period of the receiving device from a maximum effect a stage is soon reached where the results are uncertain—sometimes the coherer works and sometimes it does not—and this is the condition of affairs over a considerable part of the interval between maximum effect and silence. With such a system the limits of sensibility are as important as the actual sensibility. As I have said, Mr. Stone's apparatus enables him to do two things, one of which at least must belong to any successful selective system of wireless telegraphy. First, to send out simple harmonic waves of a definite period; second, to receive these waves by an apparatus that does not respond to any other electrical disturbances.

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SPECIAL NOTICE.

CHRISTMAS WEEK.—"THE ELECTRICIAN" will be published on **THURSDAY MORNING,** December 24th instead of on Friday.

Correspondents and Advertisers will please note this alteration, and favour us with their communications by not later than Wednesday morning's post in Christmas week.

"A COMPLETE SATIRE ON MUNICIPAL TRADING."

The Marylebone imbroglio continues "to drag its slow length along." The Metropolitan Electric Supply Co. is still without its purchase money and the Marylebone Borough Council is not yet in possession of the once much-coveted electricity supply undertaking. Eminent K.C.s continue to be refreshed and briefed and fee-ed and to put posers of extreme insolubility to learned judges; the Marylebone ratepayer has been at last aroused from his slumbers; and the columns of *The Times* bear eloquent testimony to the great interest which the general public is taking in this "Complete satire on municipal trading," as Mr. Justice BUCKLEY has advisedly termed it. It must, indeed, be a proud day for the local authority of St. Marylebone, which conducts its business through the medium of handy committees of twenty, at which all the members speak at once and resolutions are passed unlistened to amid the din.

Let us summarise with all possible brevity the recent history of this curious phenomenon. The first motions of the Borough Council after the Award were a series of wriggles. Mr. ASQUITH'S aid was invoked, but, alas! he could find no flaw in Mr. RUSSELL'S pronouncement. Then the County Council's assistance was secured, and it declined to grant the requisite loan, upon legal grounds of the comic-opera type. The deadlock looked as complete as it was perhaps intended to be. But the company gave the legal screw a sharp turn, and on July 2nd Mr. Justice BUCKLEY ordered "specific performance" of the contract and fixed December 31, 1903, as the date for completion. Then came the Marylebone municipal elections, and the excitement caused by this battle of Borough *v.* Company brought exceeding great grist to the sandwich man, cabman and bill-poster. Amongst other impassioned appeals, the electors were adjured not to allow Marylebone to come under the sinister influence of that bloated monopoly, the British Electric Traction Co. What the B. E. T. was doing in that *galère* we failed to discover at the time, but learned afterwards that the sinister influence of "the octopus" stood personified in Mr. CORNWALLIS-WEST, chairman of one of the B. E. T. Associated Companies, who was standing as one of the candidates for the Portman ward. Since the elections, the number of cross-currents can scarcely be said to have diminished. The Council has, indeed, been waited upon by deputations and urged to come to terms with the Company, and on Wednesday, we believe, there was a preliminary conference between a special committee, appointed by the Council, and the Board of the Company, the idea of the conference being to ascertain on what terms and conditions the Company might be prepared to agree to, if the Award were set aside. Meanwhile notice has been given of a motion to be made at

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the next general meeting of the Council for the termination of the engagement of Mr. ARTHUR WRIGHT as the Council's electrical engineer, Mr. Justice BUCKLEY has granted an extension of time for completion of the purchase until February 29th next, and a Bill is to be promoted in the next Session of Parliament empowering the Council to raise a sum of £1,866,444 wherewith to buy out the Marylebone portion of the "Met.," lock, stock and barrel—or, rather, plant, power house and mains—and to erect a local generating station of adequate capacity. Another factor which adds to the confusion prevailing is the fact that the Bill aforesaid has to be specifically approved by the ratepayers, and the ratepayers of St. Marylebone happen, at the time of writing, to be in a rather disapproving mood.

If the Company should fail to come to terms with its old enemy, and if the ratepayers should refuse to approve the Bill, events by no means unlikely of occurrence, the situation will become "even more acute," as the Judge remarked. Parliament may and can in its wisdom do whatsoever it pleaseth, and it may decide to make a *tabula rasa* of the whole business and say to each party "As you were." It must not be forgotten, however, that the time for depositing Private Bills for the next Parliamentary Session is now past, and this result could therefore only be obtained by means of a "Late Bill," or by the ratepayers allowing the present Bill to proceed and then inducing Parliament to pass an Amendment to this effect when the Bill comes up for consideration. Either procedure would be unusual in a contentious matter involving such large issues—but we are prepared for the unusual in connection with the Marylebone Arbitration Award. Unless, moreover, substantial compensation be at the same time given to the Company, and also substantial guarantees that never again shall it be exposed to another raid upon its property, an edict of such a character would be distinctly inequitable. An inequity of this description would have been perfectly possible a few short years ago, but to-day, thanks to the enlightenment of public and Parliamentary opinion on the subject of municipal trading, a limited company has every reason to expect fair treatment.

The chairman of the Metropolitan Company, therefore, has the ball at his feet: What will he do with it? Both Bar and Bench are, we believe, not a little exercised in their minds as to what steps should be taken to enforce specific performance, in the event of the situation being rendered "even more acute" by the refusal of the ratepayers to countenance the proposed Bill. *Mandamus* has an impressive sound, but it is no more than sound until the Court has decided *what* it shall order to be done. The most likely legal course would appear to be an order empowering the Company to levy a rate sufficient to raise the £1,212,000 plus £100,000 owing to it. The rateable value of St. Marylebone being £1,679,240, a rate of 15s. 7½d. in the £ would achieve this object. Such a levy, coming on top of the normal six and tenpenny rate, would give rise to a tremendous storm and no small amount of "passive resistance." Apart from the purely financial strain, however, there would be an ethical strain. A ratepayer may be reasonably called upon to pay his annual share of the interest and sinking fund on municipal capital outlays which have been duly authorised, but to exact an unauthorised capital sum of over one and a quarter million sterling in one lump from the fortuitous concourse of ratepaying units who may happen to be gathered together in Marylebone at one particular date "would be practically preposterous," to quote once more the Judge's words. As it is, there will be lamentations over the 9d. rate which the Judge has already ordered. The logic of facts, it seems to us, will compel the Company to come to terms with the Council, but naturally any proposition for a settlement other than in strict accordance with the Arbitrator's Award must emanate from the Council and not from the company. The Company can rightfully claim payment, to the uttermost farthing, of the whole of the vast expense, direct and indirect, to which it has been put, and it should certainly not ground arms until the local authority has given an undertaking, in precise and legal form, to leave the Metropolitan Company in peaceful possession of its property until the expiration of its Provisional Order 28 years hence. No doubt if the Company were a mere individual, instead of merely a group of individuals, it could also easily secure heavy compensation for "moral and intellectual damage," and probably some such extra payment will be obtained under another name. Another possible alternative might be some arrangement by which the Council nominally acquired the undertaking and the Company continued to run it under a lease or contract; or, again, instead of the Borough Council borrowing the money from the London County Council, the Company itself might, as it were, become the lenders, accepting payment in the form of interest and sinking fund. These are mere surmises, however, for the company has so far not disclosed its intention to do otherwise than insist on payment of the 1¼ millions awarded it, together with the other items to which it is entitled. In any case, before retreating a step from their present strong position, the directors of the company will doubtless feel bound to take a vote of their shareholders on the question, and it may be as troublesome to convince them to accept anything less than cash payment in full as it is to convince the Marylebone ratepayers that they must authorise their Council to obtain powers to borrow money for the purchase.

The moral of Marylebone is too obvious to need exposition. It is, to quote Mr. Justice BUCKLEY for the last time, simply: "They ought to have thought of all this before they came under statutory liability to purchase." If such a muddle can be made in the light of day by intelligent and honest folk in the West-end of London, we can realise what municipal trading must inevitably lead to in more obscure parts of the United Kingdom.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Magnetic Change of Resistance.—W. E. Williams has studied the influence of stress and temperature on the magnetic change of resistance in iron, nickel, and nickel steel. In nickel wire, the effect of stretching is to diminish the magnetic change of resistance at low fields and to increase it at high fields. In the finer wires the change of resistance is smaller at low fields and greater at high fields than in the thicker wire. The effect of stress is much smaller in iron than in nickel, and there is hardly any effect in the highest fields. In platinite, the highest value in the change of resistance is rather greater than in the case of iron, the curve, being, however, of a very different shape. As regards temperature, it has the greatest effect upon the change of resistance in platinite, and the least in iron. In every case, there is a diminution of the change on annealing.

[W. E. WILLIAMS, *Phil. Mag.*, December, 1903.]

A Standard of Inductance.—The condenser is not suitable as a standard in alternate-current work owing to its great variation in the course of time. The inductance coil is comparatively free from such variation, and is therefore as valuable for alternate-current work as the resistance is for direct currents. F. Dolezalek has examined the standard inductances made by Siedentopf on the plan devised by M. Wien. He found them to be exceedingly constant for all frequencies below 300, but found increasing discrepancies on

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progressively raising the frequency beyond that amount. He could only get rid of these discrepancies by substituting a rope made of thin insulated wires for the solid conductor, thereby eliminating the eddy currents and the unequal distribution of the lines of flow. On studying the influence of the various elements he found that the resistance increases as the square of the frequency and rather more quickly than the square of the thickness of the wire. The frequency also influences the inductance directly, but this influence is small, amounting to a diminution of about 0·6 per cent. on increasing the frequency from 825 to 650 periods.

[F. Dolezalek, *Ann. der Physik*, No. 13, 1903.]

The Mercury Arc.—M. de Valbreuze describes some curious phenomena observed when the pressure in a cold mercury-arc tube is between 2mm. and 4mm. At first, the anode shows a bright spot uniformly illuminated. Then it becomes covered with small brilliant stars, forming regular geometrical figures. Often these stars are six or seven in number, forming the corners and the centre of a regular pentagon or hexagon. Again, they are very small and numerous, disposed along the circumference of concentric circles. Generally, the various aspects appear, change and disappear with great rapidity. As the temperature of the electrode rises, the stars become thicker and take the shape of spherical luminous pearls swimming on the mercury. Then the pearls unite and form a central patch surrounded by luminous rings. The dark rings between them finally disappear, and the electrode assumes its normal aspect of a uniformly illuminated surface. The author ascribes these phenomena to the existence of a surface membrane on the mercury, whose vibrations produce regular figures. He has also observed a phenomenon of spontaneous lighting-up. As a rule, the mercury arc requires several thousand volts to ignite. But if, with an iron anode and mercury cathode, and a pressure of about 0·1mm. of mercury, the tube is exposed for some minutes to a difference of potential of 550 volts, the arc ignites spontaneously. At much smaller pressures the spontaneous ignition must be assisted by a slight concussion. When the electrodes are reversed spontaneous ignition only takes place at the pressure of maximum conductivity, and then only if the tube is heated by previous discharges. The author connects these phenomena also with the existence of a surface film which resists the passage of the current in the cold.

[De Valbreuze, *Comptes Rendus*, November 30, 1903.]

Suppression of Hysteresis.—The recent experiments of Marconi and Tissot with the magnetic detector have drawn attention to the action of a rapidly varying magnetic field on magnetisation. Marconi attributes the effect to the suppression of the time-lag, while Tissot thinks that the hysteresis is modified. Now C. Maurain has found that, under certain conditions, the magnetic hysteresis may be entirely suppressed. If a core of iron or steel is exposed to a magnetic cycle and to the continuous action of an oscillating field in the same direction, one obtains, in place of the well-known magnetisation curve, a single curve containing all the points observed with either an increasing or a decreasing field. For this, it suffices that the core be so thin that the oscillating field can penetrate with some intensity to its centre. The author used steel chronometer springs about 0·1mm. thick enclosed in a long magnetising coil containing a smaller co-axial coil fed with electric oscillations. The latter were produced by connecting the coatings of a Leyden jar with the terminals of an induction coil and with those of the internal coil, and introducing a spark micrometer into the latter circuit. The measurements were made by means of the magnetometer method. It was found that in the untempered specimens the ascending and descending magnetisation curves coincided exactly. But if the specimens were thicker, they did not coincide, though they were closer together than ordinarly. The separation between the two branches was the greater the thicker the specimens. In the case of tempered specimens, the suppression of hysteresis could only be attained by using stronger oscillations—*i.e.*, by opening the gap of the spark micrometer. Iron dust embedded in paraffin showed a complete suppression of hysteresis.

[C. Maurain, *Comptes Rendus*, November 30, 1903.]

Motions of the Carbon Arc.—W. B. von Czudnochowski describes some new rotations and oscillations of the ordinary free arc. He fed a normal oscillating 10-ampere lamp with current at 35 volts, and noticed that the arc had a tendency to draw away to one side and to travel along the rim of the carbons in the direction of the hands of a clock. The time of revolution was very constant, and kept at 15 to 17 seconds. At 40 volts the revolutions were no longer so marked owing to the disturbed character of the arc, but on lowering the potential again the phenomenon set in as before. The explanation offered by the author is the existence of a continuous-current in the arc, superimposed upon it by a kind of valve action, as already supposed by Marchant and Duddell. Another phenomenon described by the author is observed in the horizontal hand-regulated continuous-current arc when it begins to burn. It changes about between the ordinary pear-shaped form and a spherical or, rather, ellipsoidal form, the transition being sudden and recurring at intervals of seven seconds. At the same time, the current and luminosity show corresponding variations, and the crater widens and narrows alternately. The theory suggested is that the arc oscillates between the arc discharge proper and the glow discharge, the variation being due to special cooling conditions such as obtain with horizontal arcs. These oscillations probably occur in all horizontal arcs, but are ordinarily masked by the automatic regulation.

[W. B. von Czudnochowski, *Phys. Zeitschr.*, December 1, 1903.]

Radium Radiation and Contact Electricity.—When the air between two insulated plates, of different metals, is subjected to the influence of a radio-active substance, similar wires connected with the plates acquire a difference of potential. This difference may be measured by joining the plates to the quadrants of a sensitive electrometer. It is of the same order of magnitude as that which could be obtained by connecting the metal plates with a drop of water. Lord Blythswood and H. S. Allen have measured this P.D. for various metallic couples, employing a radium salt as the source of radiation. The apparatus consisted wholly of lead, in order to avoid complications arising from the presence of various foreign metals. The results were thus all referred to lead, and the deflections obtained show a close correspondence with the voltaic series. As regards the effect of gaseous pressure, it was found that the P.D. under the influence of radium radiation showed no variation as great as 5 per cent., when air at atmospheric pressure was admitted to a vessel previously exhausted to $\frac{1}{1000}$mm. of mercury.

[Lord Blythswood and H. S. Allen, *Phil. Mag.*, December, 1903.]

PROTECTION IN SPECIAL RELATION TO TRAMWAY AND LIGHT RAILWAY ENTERPRISE.

At the Society of Arts on Friday evening, December 11th, a meeting was held under the auspices of the Tramways and Light Railways Association, when a Paper with the above title was read by Mr. Atherley-Jones, K.C., M.P., president. Sir Charles Rivers Wilson, K.C.M.G., was in the chair.

Mr. Atherley-Jones, who at the commencement pointed out that the president of the Tramways and Light Railways Association enjoys freedom of speech, and that the opinions which he expressed had no official sanction from the Association, dealt largely with general matters in putting the case for Free Trade, of which he is an ardent supporter. Referring to the imports of electrical goods and apparatus, however, he said he had taken figures from *The Electrician* of November (a series of articles by Mr. W. Pollard Digby), and the figures there given fully bore out the statement that our only disadvantage in this industry was our backwardness in the development of electric traction, lighting and power, and was not at all due to any want of enterprise on the part of Englishmen. This was due, in the main, to the repressive and restrictive operations of the laws which were passed in the early days. As evidence of this the source of information already mentioned told him that our exports of electric lighting apparatus increased from a value of £99,000 in 1887 to £617,000 in 1902, and our imports of electrical goods decreased from £1,265,000 in 1887 to £687,000 in 1902 or by about one-half. The value of capital invested in electricity supply works was £44,993,000 in 1902, as against only £7,000,000 in 1896. A point, however, to which he wished to draw

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particular attention was that whereas in 1899 the ratio of the value of imported electrical goods to every £100 invested was 39·97 per cent. in 1902 it was only 22·42 per cent. In other words, the value of foreign imports fell from 39·97 per cent. in 1899 to only 22·42 per cent. in 1902. As further evidence of the growing vitality of the electrical manufacturing business in this country, it was worthy of note that in 95 per cent. of the electrical supply works in this country dynamos or alternators of foreign origin were unknown. At the conclusion of his speech Mr. Jones moved a resolution to the effect that no change was needed in the present fiscal policy of the country.

Mr. MORETON FREWEN, in a speech which vigorously supported Mr. Chamberlain's propaganda moved the following amendment to the resolution:—"That in the opinion of this meeting the time has come when a change in the fiscal policy of this country is required, and that change, if it makes likely the federation of the British Empire, is in the interests, not only of the working classes, but of all classes in this country."

Mr. WADHAM, of *The Machinery Market and Exporter*, supported Mr. Jones' resolution.

Mr. G. BYNG, of the General Electric Co., opposed the views expressed by Mr. Jones. He believed the question to be primarily a manufacturers' question, and he maintained that the statements made by Mr. Jones as to the electrical industry were absolutely incorrect. First of all, the electric supply industry had been confounded with the electrical manufacturing industry. But there was a great difference between making dynamos, motors, telephones, switches, &c., and the supply of electricity. In referring to some proof that electricity was progressing, Mr. Jones had said that £44,000,000 was employed in the electrical industry. But that referred to electricity supply, which could not be "dumped" here. We could not get our electricity from Berlin—at any rate, not yet. If they took the electrical industry as a manufacturing industry, he was sorry to say it was not in a flourishing condition. The importation of £5,000,000 of electrical goods into this country during the last five years was a serious matter. He could make this public statement, that out of that £5,000,000 worth of goods there was not a single sixpennyworth which could not have been made in this country as well and better than by the foreigner who had supplied them. In fact, with the exception of 10 per cent. of that amount, which had been especially dumped into this country for ulterior motives, we could make them 10 per cent. cheaper. [A Voice: Why did you not, then?] Because of Free Trade. He would give some facts. In connection with telephones he had had experience. The Government bought telephone instruments in Sweden for 54s. He sent to the Government and offered to take an order for 500 instruments at 52s. He got it, and put down extra plant costing, alone, £2,000. The instruments cost him 45s. each to manufacture. Six months afterwards he went for a second order, but the gentleman in Copenhagen offered them at 40s. He followed, but again the price was lowered to 35s. He was obliged to stop there, and he lost the order as well as his £2,000 for the initial plant. He employed 5,000 workmen, and if this sort of thing went on these workmen would be in the workhouse. Therefore, he maintained that Mr. Jones was not correct in his statements with regard to the electrical industry; it was in exactly the same position as any other industry. The principles of Free Trade, as generally understood, were quite wrong, because he could make an article, under Protection, cheaper than under Free Trade, even if he paid double the wages and more for his material. The main question was, "How many do you make?" The quantity ruled the price, and by having free access to this country the foreigner was able to work his factories full all the time and get rid of his surplus here. In reply to two questions by a member of the audience, the speaker continued that he had reduced his price for the telephones, and was selling really at a loss in the hope that with a continuance of the orders the cost of manufacture would be reduced a shilling or two, and that he would keep this trade. The reason why he had come from a Protectionist country and erected works in a Free Trade country was because he felt convinced that with time England would have to adopt Protection.

Mr. WARD HUMPHREYS (Secretary of the Free Food League) spoke in opposition to Mr. Byng.

Mr. EMILE GARCKE (British Electric Traction Co.) said he was entirely disappointed and disheartened with the conclusions which Mr. Jones had come to. The electrical industry was a new industry, and one in which every country started level. Twenty-five years ago there was very little electrical work in any country, but England was practically foremost as a commercial nation developing this industry. He remembered 19 years ago that he was concerned in establishing the first electric light station in Berlin with British machinery. About 18 years ago also he was concerned in establishing the first electric lighting station in Austria with English apparatus. But how was it that we were now unable to export a single electrical apparatus to Germany or Austria or America? We were told that it was because of their superior scientific education. It was because of the fact that they had not the same trade union regulations. It was an entire evasion of the question that we should seek for all kinds of reasons which did not apply, and ignore the only difference between this country and all others—viz., that we were the only Free Trade country manufacturing electrical apparatus. All others manufacturing electrical apparatus on a big scale were Protectionists. Mr. Jones had mentioned certain figures appertaining to the electrical industry, but what did these figures mean? A very great point had been made of the fact that the imports of electrical apparatus into this country had been less during the past year than they were in the year 1900, and Mr. Jones stated that he obtained these figures from *The Electrician* for November. But unfortunately for his (Mr. Garcke's) opponents he happened to have *The Electrician* for November in his pocket, and what did he find? For the purpose of making these comparisons, Mr. Jones took the year 1900, when the imports were as he stated, and compared them with the imports in 1902, from which he inferred, quite correctly, that they were now less than a few years ago. But the year 1900 was a most exceptionally prosperous year, and we were importing a very considerable amount of American apparatus. If the previous year had been taken it would have been seen that instead of diminishing, the imports had increased by about £70,000. Taking the years 1900 and 1902 again, it would be found that the imports from all countries, with the exception of America, were greater in 1902 than in 1900. Last year was a most depressed period in the electrical industry, resulting partly from the expenditure in South Africa. The diminution in the American electrical imports was easily explained. Hitherto the imports from that country in electrical goods were mainly from two firms who had now, however, established works in this country. Further, and he did not wish to give information which was not of a public nature, it was not at all clear why a large amount of electrical apparatus was being imported into this country under different schedules and not as manufactured articles. Another matter was that whereas, in rough figures, our trade with foreign countries had increased in the ratio of 87 to 194 in the years given by Mr. Jones, our trade with our colonies had increased in the ratio of 87 to 442. Mr. Jones had made all sorts of statements which he (Mr. Garcke) could not stop to argue, but he himself could prove that with regard to the electrical industry in protective countries the areas were absolutely and entirely closed to England. In conclusion, he emphasised all that Mr. Byng had said.

After a few remarks from the chairman,

Mr. JONES replied briefly, claiming to have taken a perfectly disinterested view of the situation.

A show of hands was then taken, only 17 voting in favour of Mr. Moreton Frewen's amendment to the resolution, and the chairman announced that the motion had been carried.

CORRESPONDENCE.

CUT-OUTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your editorial notes this week (December 11th) you make reference to the entire failure of supply which took place recently at the Eccleston-place generating station, and suggest that a remedy against the future occurrence of such breakdowns will be found in the insertion of a maximum current cut-out in each generator circuit. With your permission, I would point out that such an alteration of the present switch gear will not have the desired effect, and, in fact, would make the existing arrangements not less dangerous than they are at present. As you yourself say, "the brushes and commutators . . . of the other machines were fused, thus indicating the enormous current which must have been generated." Such a large current would have caused one or more of the maximum current cut-outs, if they had been in existence, to open, thus piling up the current in the other machines, whose maximum cut-outs would therefore have opened one after the other and the entire station would have been shut down.

The only automatic cut-out required in a generator circuit is a *reverse current cut-out*. This should, however, not be set to operate at too low a reverse current. A safe value would be about 30 per cent. of the full load current. In the event of a short developing on the armature of a machine the corresponding reverse current cut-out will at once cut the faulty machine out of circuit. A *minimum* current cut-out on a generator is worse than useless. Care must be taken in the selection of the reverse current cut-out that it is a *true* reverse current device. Many devices which are on the market depend for their working on the mutual action of a shunt and a series coil. In the event of a short-circuited armature the volts across the shunt coil fall and the chances are the cut-out fails to act at the right time. The only form a proper reverse (continuous) current cut-out can take is that of a polarised relay. This can be adjusted to operate at any exact value of reverse current, and will not operate under any other conditions. The actuating apparatus for knocking out the switch is a tripping coil, the circuit of which is made by the relay. The current for energising the tripping coil can be taken from an external source, which is the better way, or it may be taken from the same 'bus bars as the generators are feeding. It is easy to construct the trip coil with such a large factor of safety that it has sufficient power to open the switch, even if the 'bus bar voltage is only one-fifth of the normal value.

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Such an apparatus, as described above, depending on the same principle as the d'Arsonval galvanometer, has lately been put upon the market, and it would seem that its extended use would go far towards preventing the re-occurrence of such disastrous accidents as you have described.—Yours, &c.,

Manchester, Dec. 12. CHARLES C. GARRARD.

THE DE FOREST WIRELESS TELEGRAPH SYSTEM.

[*Translation.*]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the article on the de Forest wireless telegraph system which appeared in *The Electrician* of December 4th, p. 240, we venture to make the following corrections:—

Mr. de Forest employs a transmitter identical with the one which has been protected by us under numerous German and foreign patents taken out since 1900. This is the transmitter used, for instance, in the German navy. Its peculiar feature is only the manner of connecting the system of air-wires to the exciting circuit of the transmitter. We have, however, employed a connection of this nature—by means of a spark-gap—since 1900, although this part of our arrangement is not patented.

As regards the receiver, according to the drawing the wave detector itself is a conducting point in a vessel, and according to the description an electrolyte is employed. An electrolytic detector, the positive pole of which takes the form of a point of the smallest dimensions, has also been patented by us in all civilised countries, including England. It is the detector of Schloemilch, which was described in the same issue of *The Electrician* (p. 250). The only novelty with regard to the receiver lies in the peculiar connection of the air-wire, which acts as an open loop. This method of connection has been repeatedly employed by us since 1901. No patent has been acquired for this mode of connection. In connecting up the receiver use is made of two branched circuits tuned to one another. One of these contains the wave detector and a condenser, and represents, therefore, a method of connection which was patented by us in Germany and in most of the civilised countries in 1900, in connection with the filings coherer. This method is, however, according to our patent specification, also applicable for the new electrolytic coherer.

We draw attention to the fact, therefore, that the method of connection given by de Forest for the transmitter as well as for the receiver, *are identical* with those patented by us in nearly all civilised countries. Moreover, the wave detector itself, which is said to be an electrolytic one whose resistance decreases under the action of the radiation, and which is drawn as a point in a conducting receptacle, *appears* to be *identical* with the electrolytical cell also patented by us in most civilised countries.

Even the arrangement used by De Forest, consisting of blocking the primary current of the transmitter by means of a receiving switch (Empfangsschalter) is very old, and has been used by us since the year 1899.

We take the present opportunity of drawing Mr. de Forest's attention to the repeated infringement of our rights, and we shall possibly take legal steps to uphold them.—Yours, &c.,

GESELLSCHAFT FÜR DRAHTLOSE TELEGRAPHIE,

Berlin, Dec. 7. Graf Arco.

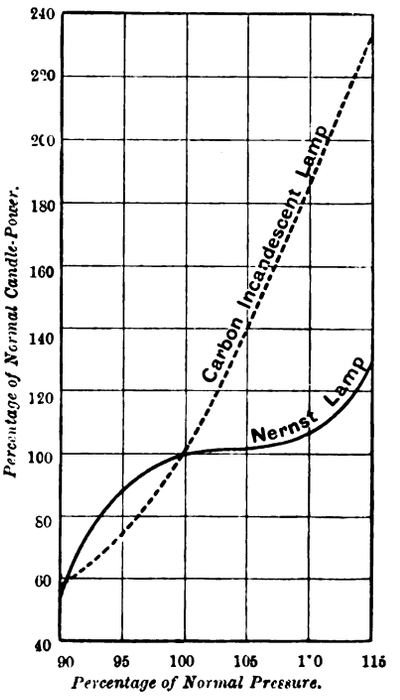
PHOTOMETRIC TESTS ON "NERNST LAMPS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of November 13, 1903, I notice in the report published of the N.E.L.A. Committee of America for investigating the photometry of arc lamps, &c., that it is found that the candle-power of a Nernst lamp varies very considerably with a small difference in voltage; thus it appears that a 1 per cent. variation will make a change of 14 per cent. in the candle power of the lamp. That these figures may not be misconstrued, I would like to point out that they are taken from tests upon the Nernst lamp as manufactured by the Nernst Lamp Co. of America, and do not apply in any way to the lamp as placed on the market in this country. It would seem that there is some marked difference between the behaviour of the American lamp and that manufactured by the Allgemeine Elektricitäts Gesellschaft.

In the discussion which followed Mr. Stottner's Paper, read before the Institution of Electrical Engineers in February last, and published in *The Electrician*, Vol. L., p. 808, Mr. B. M. Drake and Mr. Solomon referred to a curve, which is given below, showing the change in candle-power resulting from a change in pressure at the lamp terminals. From this curve, which was taken by the Nernst Electric Light Limited, it is seen that a rise in pressure of 5 per cent. on a Nernst lamp only increases the candle-power of the lamp by 1·5 per cent., as against 40 per cent. increase found when treating a carbon lamp in the same way. On the other hand, a drop of 5 per cent. on the pressure at the terminals of the lamp reduces the candle-power of the Nernst lamp by 13 per cent., as against 26 per cent. in the case of a carbon lamp. These figurges show at once the difference which apparently exists between the American and the German Nernst lamps.

It is the practice in this country to use Nernst lamps not merely for the nominal pressure of the supply, but designed for the maximum pressure likely to be met with. The curve illustrated shows this to be sound economy, as the effect of underrunning the lamp produces so little difference in its



COMPARISON OF OVER-RUNNING CARBON AND NERNST LAMPS.

candle-power. On the other hand the series resistance acts in such a way that if a Nernst lamp is consistently overrun, its life is reduced without any appreciable gain in efficiency. By underrunning the lamp, however, the candle-power is only slightly reduced, but the life, which commercially is of the utmost importance, is much increased. I take this opportunity of pointing out this difference which exists between these two types of Nernst lamp, as, if your readers take the figures obtained by Prof. C. D. Mathews, as referring to Nernst lamps in general and not solely to that type which is manufactured in America, they would at once consider that all the instructions issued by the manufacturers of the lamp as used in this country, were not in accordance with the actual effects produced. Users of Nernst lamps in this country need, therefore, have no fear, in the face of the figures I have given, in slightly underrunning their lamps, as by so doing they scarcely alter the efficiency of the lamp but experience great benefit owing to the fact that they obtain thereby a much more satisfactory life than would otherwise be the case.—Yours, &c.,

London, S.W., Dec. 8. E. GRAHAM SHEPPARD.

[We are informed by the National Electric Light Association's Committee on Photometric Values of Arc Lamps that a clerical error appeared in their report on "Photometric Tests of the Nernst Lamp," and as a consequence of this, in the sentence on p. 128 of *The Electrician* for November 13th, where

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it is stated that "a change of 1 per cent. in the voltage makes in this particular case a change of more than 14 per cent. in candle-power," the figure 14 per cent. should be 6·38 per cent.—ED. *E.*]

STEAM TURBINES v. RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: For some time past I have been an interested onlooker of the wordy warfare taking place between the champions of steam turbines and reciprocating engines respectively. In your last issue, however, there is a letter which relates to some occurrence at West Bromwich. The effect of that letter is to induce me to enter the lists.

In the first place, why, in the name of all that is scientific, has the person who signs himself "Reciprocating Engine" not the courage to put his name to his letter? Is it that he prefers the modern system of attack by taking cover? I am the more surprised at this, seeing that, so far as his statement relates to West Bromwich, it is substantially true. But does this refute Mr. Wilkinson's statement? Does it condemn steam turbines *per se*?

Those turbines were specified for a steam temperature of 450°F.; later turbines have been put in for a higher superheat. The engines and boilers are arranged on the unit system, and the capacity of the superheaters is proportioned to the temperature standards of the engines in the first and second parts of the station. Now, under circumstances which the resident engineer could not control, the original turbines were supplied with steam at, if anything, rather above 600°F. The result has been that the blades, composed in this instance of a yellow brass, lost their ductility, and, under the flow of steam, broke.

Two other instances of broken blades have occurred in my experience, but these latter are both trivial. In the first case, a pellet of red lead wedged itself in the second row of rotor blades, and knocked out two of the first row of blades. The other case was a mechanical one, the fitter damaging the blades. In no other instance since I commenced using modern steam turbines (June, 1897) have I had any trouble with turbine blades, and little, if any, trouble with other portions of the turbines.

Mr. Wilkinson stated that turbines gave no trouble when working with superheated steam. The only proviso which I would add to his statement is "when the particular turbine under discussion is built to withstand the applied temperature." I only regret that, so far, Messrs. Parsons have not adopted the plan of fitting every turbine with blades composed of metal which would not be adversely affected by temperatures up to 700°F. The increased cost would be slight, and the advantages far-reaching.

Now, the general tone of the discussion taking place has not been to my liking. Rather do I subscribe to the remarks of your correspondent Mr. Henry Lea in your issue of the 11th inst. The question before us is not steam turbine *stations* versus reciprocating engine *stations*, but steam turbines versus reciprocating engines. It has nothing whatever to do with cost of coal per unit, or with the cost per unit sold. It has only to do with the thermal efficiency of the steam turbine versus that of the reciprocating engine under specified conditions. All other matters are outside the question. And this question, Sir, is not one between Mr. Morcom and Mr. Wilkinson, or between any other of the partisans who have as yet entered the field; it is a question for the engineering profession at large, and it would be a thousand pities if the opportunity for trial suggested by Mr. Wilkinson, and partly accepted by Mr. Morcom, were lost.—Yours, &c., ROBERT C. QUIN.

Westminster, S.W., Dec. 15.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest the correspondence following on Mr. Wilkinson's Paper. As I hope to shortly have an opportunity of dealing with this question at greater length than is possible in a letter, I will not discuss in detail the accuracy of the figures quoted by your correspondents; but, as more than one reference has been made to the Wallsend plant of our clients, the Newcastle-upon-Tyne Electric Supply Co., I think it well to point out that the results quoted depend upon such a variety of factors that, in the absence of fuller information, any deductions therefrom are liable to be quite misleading. As Mr. Lea points out, an attempt is being made, based upon entirely inadequate information, to compare plant working under conditions which differ almost as widely as the machines themselves.

The first of the two 2,000kw. turbines now working at Wallsend was ordered more than three years ago, and it is sufficient indication of our opinion to say that, as a result of our experience, we have recently placed orders for six Parsons turbines, with an aggregate output of over 11,000kw., for our clients, the Newcastle-upon-Tyne Electric Supply Co. and the Priestman Power Co. We have also on order for another client a 500kw. Curtis turbine, which will, we believe, be the first turbine of this type to operate in a central supply station in this country.—Yours, &c., CHARLES H. MERZ.

London, S.W., Dec. 15.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Morcom, in his latest letter on the above subject, quotes the fact that for the year 1902 the cost of coal at Scarborough was 0·85d. per unit, while at Cambridge, with a less output and a lower load-factor, it was only 0·66d. as a proof that load-factor and, presumably, output also have "no very close bearing on the relative economies." He adduces this in support of the utility of his comparative tables in which, as I have shown, his selected reciprocating engine stations have on the average a 50 per cent. better load-factor and a 100 per cent. greater output than the turbine stations. Now, for the year 1902 the Scarborough load-factor was only about 2½ per cent. and the output only about 5 per cent. better than the corresponding Cambridge figures, and while 2½ and 5 per cent. differences may very well be masked by other conditions, this is not so likely to be the case where it is a matter of differences amounting to 50 and 100 per cent.

Mr. Morcom's whole argument on this point is illustrative of the extreme danger that attends his method of making comparisons between stations as to the precise circumstances of which he is necessarily very ignorant. He could not very well be aware of it; but the reason for the superior fuel economy attained at Cambridge over Scarborough in 1902 is perfectly well known to me, and was simply due to the fact that during a considerable portion of the year in question Cambridge was working with much larger and, therefore, more economical units of plant than were in use at Scarborough. The effect of this was to more than counterbalance the slightly superior load-factor and output of Scarborough, which by themselves would, of course, have a contrary tendency. Further, in objecting to my criticism of his comparisons on the score of load-factor, Mr. Morcom is not consistent when it suits his own purpose, as in the case of the comparison he makes between Leeds and Newcastle he himself calls in the matter of load-factor to support his argument.

What is, however, altogether amazing is that Mr. Morcom appears to be ignorant as to what is really meant by the term "load-factor" in connection with ordinary electric supply stations. He surmises that the inequality in the load-factors that I have pointed out "might be due to anxiety on the part of the turbine stations to hold a big margin of spare plant." What in the world has spare plant to do with load-factor? As everyone knows, it is a matter not of plant capacity nor of special load, but of ordinary maximum load actually ascertained in practice. The poor load-factors at Cambridge and at Scarborough are easily understood when one remembers that at Cambridge a large part of the output goes to colleges which are practically shut up for about half the year, while Scarborough is a watering-place with a very short season in the summer months, where the maximum load in kilowatts actually occurs in the beginning of September instead of in December, with its much shorter days, as is the case in most places.

No doubt both at Cambridge and at Scarborough at the end of the year 1902 the amount of plant installed was considerably in excess of actual requirements. The reason for this was twofold—viz., a considerable provision in each case for extension, and also the fact that in both stations some new and much larger and, consequently, more economical units of plant had just been installed to replace the original smaller

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units which sufficed when the load was less, which smaller units had not then been removed, as has since been done to a considerable extent.

Here, again, we have an illustration of the way in which Mr. Morcom is arguing about places with the special local conditions of which he is evidently entirely unacquainted. This is further evidenced by the fact that among his selected reciprocating engine stations he included Salisbury, where, as I have already mentioned, a large proporation of the generation —to the extent, I am authoritatively told, of one-third of the total units—is carried on by water power. I do not find any allusion to this matter of Salisbury in Mr. Morcom's reply to my criticisms.

With regard to the Leeds and the Newcastle-on-Tyne stations, Mr. Morcom's comparison, as I understand, refers to the figures for the year 1902, when, as I am informed, the Newcastle station was still running largely with reciprocating engines. Consequently, the results are but of small moment in relation to the present controversy.

For the year 1903, whether the figure is Mr. Barker's 0·38, or the still lower figure which, as I understand, is now being attained, even if we accept as necessary Mr. Morcom's allowance of 20 per cent. for the difference between units generated and units sold, we shall still have a result which I am sure it will take Leeds all its time to equal, and this with almost the whole Newcastle output generated by turbines. As to this, however, no doubt it will be best to await in patience the publication of the exact figures, which ought now to be available in a few weeks.

In conclusion, I would point out that cost of fuel, labour and upkeep do not comprise the whole matter. There is also the question of first cost both of the engines and dynamos themselves and also of the foundations and buildings. Interest on capital expenditure being a very large item in the final result, these latter matters must not be overlooked, and there can be little doubt that in respect to these the turbine has the advantage.

Finally, I would say that after a very considerable and somewhat exceptional experience of several thousands of horse-power of steam turbines, both for electrical and also for other purposes, covering in all a continuous period of some 18 years, I am satisfied that though in the earlier days there were admittedly not a few cases of blade stripping (just as there were many broken crank-shafts in the earlier development of high-speed reciprocating engines), this is not now a contingency that need be taken seriously into account, given only proper workmanship in the first instance, and reasonable care in running. In fact, under similar conditions in these respects, I have no hesitation in expressing my opinion that the steam turbine is now quite as reliable as any other form of steam engine.—Yours, &c., A. A. CAMPBELL SWINTON.

Westminster, S.W., Dec. 14.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the above correspondence the original question, in which results of my tests on the Cambridge plant were compared with those of Prof. Ewing in a manner unfavourable to the latter, is gradually being passed over by the champions of reciprocating engines. I think before further items are raised it might be well to settle this.

In your issue of November 6th, your correspondent said I was *wrong* in my figures respecting the value of vacuum; on the 8th inst. he says "*possibly I am wrong*," and when I tell you I have authority for saying that "the results of more recent tests on turbines" than the one on which the table published in the *Proc.* Inst. M.E. Glasgow Congress was based "show that the curve really bends down, and that the earlier test was based on so small a range of vacuum as not to give the curve accurately; it is always difficult for a small range of tests to determine which way a curve bends," he will do me justice to say I am right.

I cannot agree that the original point is a fine one. 13 per cent. deterioration in one year's wear, as alleged, needed correction, but I quite agree 1½ to 2 per cent. increased consumption when a separator is not in use is an extremely fine point. I may, therefore, I think without undue presumption, assume that the statement by Prof. Ewing on which my share in this correspondence began—namely, "I am of opinion that the results of the present trials show that there has been no deterioration due to wear," has been sustained.

In a letter in your issue of November 20th, my attention is drawn to some tests on Belliss engines referred to in the *Proc.* Inst. C.E., and on these figures I made some comments in *The Electrician* of December 4th. It appeared to me that not only were the trials incomparable without correction for vacuum in favour of the original trials, but that a deterioration of 5 per cent. had taken place due to wear. I am anxiously waiting a reply to this. The value of this correspondence is very small to your readers if statements when started are not fully substantiated or withdrawn; may I appeal to Mr. Morcom to continue this portion of the discussion?

Again, Mr. Swinton and I are accused of *attacking* Mr. Morcom's examples of station results. I fear he forgets he is the attacking party; he began by alleging that turbines are *greatly inferior* to reciprocating engines, whilst we are defending only. I have, as yet, only tried to prove in defence that turbines are on at least an equal footing.

Now, to come to the Newcastle-on-Tyne figures, I have not the good fortune to possess a copy of the returns for this station; my figures were obtained from a printed report of the chairman of the company's speech issued by the company, and the figures quoted are for nine months later than two of Mr. Morcom's reciprocating examples, the same year as one, and three months earlier than four. Leeds is included in the last four. I think that disposes of the charge of unfairness. The Newcastle-on-Tyne figures are certainly not published in the technical press, but surely this is not the fault of turbines or a prohibition on their use.

Now, before we go any further, may I be allowed to clear a little ground. I have had some experience in buying and selling engines, and I never remember a case where the guarantees were other than the amount of steam consumed per kilowatt or per horse-power (omitting maintenance for six or 12 months). May we not, therefore, confine ourselves to coal and load-factor, at any rate for the present? I have already pointed out that "stores and oil" and "repairs" include dynamos, mains, batteries, buildings, &c. Even if you placed your valuable space at our disposal, these other figures would require much more time than I have at my disposal to reduce them to the common denominator of turbines and reciprocating engines.

Newcastle-on Tyne figures are for units *sold* not generated, if the chairman is to be believed; page 1 of his speech says:—"The number of units *sold* during the year was 5,537,500," which includes wholesale to Wallsend and retail to Newcastle city. Further, on page 2, the number sold retail in Wallsend is given, and the whole of the sales retail are 5,011,300. Before I accept these figures for the reduction to price per unit in coal, may I ask how many units are sold wholesale in Leeds? for I believe all the public lighting is so metered. Even if we take this lower figure of total units sold, the coal still is 0·2d. per unit against Leeds 0·28d., a superiority of 27½ per cent. Mr. Morcom may have later knowledge of Wallsend power house than I, but during 1902 I was in the station almost every week, and the turbine did by far the larger portion of the work. I note the parenthesis *re* the load factor, which reads as though I had wilfully suppressed essential figures. I stated in my last letter against the table that the figure was not available, and even now I do not know what it is.

However, I am prepared to go further in meeting Mr. Morcom as he objects to Newcastle in my list, and take it out. I must also remove Leeds, and we now have:—

——	Units sold.	Coal.	Average.	Load-factor.	Average.
1901 Newcastle & Dist.	1,619,671	0·69		13·67	
1902 Cambridge	419,005	0·66		9·13	
1902 Scarborough	431,777	0·85	0·687	9·34	10·35
1902-3 West Bromwich	285,848	0·55		9·27	
1902-3 Bootle	1,619,129	0·41		28·44	
1902-3 Taunton	646,273	0·70		12·77	
1901-2 Yarmouth	418,021	1·38	0·77	9·74	16·63
1901-2 Kings Lynn ..	286,679	0·59		15·58	

The result is: Turbines, average coal, 0·687 .... Load-factor, 10·35
Engines „ „ 0·77 .... „ „ 16·63

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Now as to Yarmouth—why may I not "drag" it in? An appeal has been made to the list in the *Electrical Times*, and when I select a town from the same list as nearly comparable to Scarborough as is possible, but to its own disadvantage in load-factor, an objection is raised. How then can your readers prepare a list for themselves for a few pence if they may not take the figures from the list?

However, to pursue this new argument, which I shall presently show is two-edged, surely the engineer at Yarmouth is the best judge which coal gives him the cheapest result, and I presume he is of opinion that Welsh will produce more pounds of steam per pennyworth of coal than any other.

On this coal basis, let us take Leeds and Cambridge. Both are using smudge. The railway and cartage rates to the latter town are from a minimum of 8s. 6d. per ton from Nottingham to 9s. 6d. per ton from South Yorkshire. The price paid for coal is, I believe, from 10s. to 11s. (in my time as low as 9s. 9d.); let us say 10s. 6d. Value of coal is therefore 2s.; shall we say 2s. 6d.? Leeds, presumably, has a siding, and their carriage rate should not be more than 2s., making smudge 4s. 6d. per ton, and on this basis we have Cambridge coal 0·283d. per unit. May I ask now where is the superiority of Leeds?

Mr. Morcom says he can show 38 stations giving an average of 0·41 for fuel, but this is less than a quarter of the reciprocating stations in the list; what about the remainder?

Does Mr. Morcom seriously maintain he took trouble to make a comparable list when all of the reciprocating stations he selected are condensing and two of the turbine stations non-condensing or only partly so; when the turbine load-factor is 10·56 per cent., engine 15·67 per cent.; when one of his stations was partly water-driven? I drew his attention to the load-factor in my last letter, but I am afraid I cannot follow his reasoning. The total amount of plant in a station has no relation to load-factor whatever, and, as far as I know, the maximum reading in all stations is based on the maximum demand made on a station during the year, whether turbine or reciprocating. If the load-factor has no close bearing on economy, why should Mr. Morcom accuse me of suppressing Newcastle-on-Tyne? However, I am sure of the support of all station engineers in my view of the value of this figure.

Lastly, Mr. Morcom makes a series of ex parte statements regarding turbines which consideration for your space prevent my replying to. No doubt he will refer me to the mishap at West Bromwich; in the absence of a reply to this by the builders themselves, I shall be happy to give what I consider a perfectly satisfactory account, as I am conversant with the particulars of this case.—Yours, &c.,

Loughborough, Dec. 14. JOHN H. BARKER.

ROYAL COMMISSION ON LONDON TRAFFIC.

Further evidence for the London borough councils was heard on Friday last week, December 4.

Councillor LEVY, of Hammersmith, pointed out where congestion was greatest in that district and gave his opinion as to its cause. Generally speaking, the main cause was the increased population which had been brought to Hammersmith by the construction of the Central London Railway and the London United Tramways Co.'s system of electric trams. Notable spots which needed relief were King-street, Broadway, Shepherds Bush and Uxbridge-road. In King-street there was only about 10ft. of roadway available on either side of the single line of electric tramway. When the widenings in connection with the tramways which were authorised by the London County Council Act of 1903 were made, some relief would be afforded in Hammersmith Broadway. But this would only apply to the present traffic at that point, and in the event of a tube railway being authorised which would put a station in the Broadway, as had been suggested more than once, further improvements would be necessary. In the opinion of the Hammersmith Borough Council, these further improvements should be done at the expense of the promoters of the railway. A re-arrangement of the tramway terminus in Uxbridge-road was desirable, and it might be placed further east with advantage. The extension of the Central London Railway in a half circle to near Hammersmith Broadway was also suggested. Although in a sense there was no deficiency of railway accommodation in Hammersmith, yet so pressing were the needs of the borough that alternative routes were urgently needed. One such line could be an underground electric railway from Hammersmith via Kensington, Knightsbridge, Piccadilly and Charing Cross to the City. Additional and quicker services were also required westwards and southwards over existing routes. He agreed that an independent tribunal should be established, and expressed the willingness of the Hammersmith Borough Council to surrender its veto to such an authority.

Mr. SCHUSTER: Have you taken into consideration the extra means of communication which you will soon have in Hammersmith. The District Railway Co. is electrifying its lines?—Yes, but this will not serve the population in the way that is necessary.

Sir FRANCIS HOPWOOD: Do you think that the termini of the tramways should be on private property rather than in the centre of the road?—That matter has not been considered by my Council.

When you speak of alternative routes, has the Borough Council in mind an extension of the tramways underground or an independent tube railway?—We have not considered the question of a tramway extension underground, but we have approved tube railway schemes such as I have suggested.

Tramways continuing their journey in a subway would prevent transshipment, would it not?—Yes, we have at the present moment before us a scheme for connecting Hammersmith Broadway with the south side of the river.

Mr. J. PATTEN BARBER, borough engineer of Islington, expressed general views in accordance with those already given by the representatives of other councils. He laid stress upon the want of communication between the north and south of London and between Islington and the west of London.

Mr. W. EVE, an alderman of the Stoke Newington Borough Council, while not advocating that local authorities should give up the tramway veto to the London County Council, thought that London had suffered considerably through the want of one supreme authority to deal with locomotion matters. Many desirable tramway schemes had been abandoned through the multiplicity of control of the streets now existing. The electrification of the tramways in the north should be proceeded with at once, and a tube railway to the north and north east of London was very desirable. He certainly preferred tube railways to shallow-tunnel tramways, chiefly on account of the obstruction and inconvenience which the latter caused to shopkeepers during construction.

Thursday, December 10.

Mr. R. F. WHUR, chairman of the Works committee of the Paddington Borough Council, supported the general views of the London borough councils on the questions of street openings and tramway veto. He advocated the formation of a scheme of underground railways or shallow tramways for the whole of London. This, he thought, would considerably mitigate the existing difficulties of locomotion in London, and an example of this was to be seen in the relief to the traffic in Uxbridge-road since the opening of the Central London Railway. As to street widenings, he was very emphatic that the cost of these should be borne by the promoters of tramways when the street improvements were necessary through the tramways. As to the maintenance of the streets, the Borough Council thought the tramway authority should be responsible for the maintenance of the tramway track, because the presence of the tramlines seriously diminished the value of the road for general traffic purposes. Further, the cost of maintaining tramway track was disproportionately high as compared with the cost of the maintenance of an equivalent area of ordinary roadway. The present means of communication between the outlying districts of west London and the southern, north and north-east of London were very inadequate.

By the CHAIRMAN: He admitted that the cost of underground communication would be greater than surface tramways, but both the City and South London Railway Co. and the Central London Railway Co. had been as successful, financially, as other railways. He rather questioned the advantage of handing over the tramway veto to a special authority, and he was against giving it up to the London County Council. But he agreed that the existence of a Board of Locomotion in London would be advantageous. This body could make suggestions as to possible lines of communication which would, no doubt, be adopted by private promoters. The present difficulty was, that very often promoters had to get over the opposition of the London County Council and the borough council. If the suggestions of the Board of Locomotion were made after consultation with the districts concerned, this objection would disappear, and the possibility of a company getting its act would be greatly increased. At present, the allocation of the cost of street widenings in connection with tramways was a great point of dispute between the Paddington Borough Council and the London County Council, and the consent of the Borough Council had often been withheld to tramway proposals on this account.

Mr. W. N. BLAIR, borough engineer and surveyor at St. Pancras, expressed the opinion that no street having two lines of tramways should be less than 73ft. in width, thus allowing 17ft. 6in. between the tramrail and the kerb. The great discussion which had taken place in regard to the proposed tramway down Tottenham Court-road was on the question of street widening, and although for some years the Borough Council had objected to give its consent, the new Borough Council, just elected, had decided to allow the bill to go forward, and then to argue before the Parliamentary Committee that before passing the bill a proviso should be inserted compelling the London County Council to bear the cost of the street widening. His own opinion was that the tramway was necessary, and that its value would be enhanced if it were continued on to Charing Cross and St. Martin's Church. But to this latter the Westminster City Council was greatly opposed. To carry the tramway to the end of Tottenham Court-road would simply congest the existing traffic, and that the full effect of the line would not be appreciated until it was continued to St. Martin's Church. He agreed as to the utility of a Board of Locomotion for London, but before surrendering any powers to such a body, the St. Pancras Borough Council would require to be convinced as to its complete impartiality. There was a fear that the London County Council

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would acquire too much interest on such a tribunal. On the question of subways for pipes, electric cables, &c., he failed to see any material advantages. There would still be a large number of road openings for branch connections to the mains. He did not see, either, that any adequate return for the expense in building the subways was forthcoming. Apart from this, too, except in the case of new streets, he considered it practically impossible to build such subways without absolutely stopping the traffic.

By Mr. GIBB: He did not think the introduction of electric tramways resulted in a better speed for all the traffic on a road. It might have the effect of reducing the number of omnibuses and cabs, but it could not accelerate the speed of any particular vehicles.

Mr. CHAMBERS LEETE, town clerk to the Borough Council of Kensington, said that if a special tribunal were constituted, as had been suggested, to deal solely with locomotion matters in London, it would be possible then for it to define roughly what new lines of communication were necessary, and that then proposals could be open for inspection by prospective promoters of tramways or tube railways. Following upon this, the promoters would submit their own schemes to the Commission, which would express an opinion as to whether a bill should be allowed to proceed. Surface tramways, he considered, were objectionable, and he hoped that the tribunal would be led to favour schemes for the construction of tube railways or shallow tunnel tramways in preference to surface tramways. In fact, given a comprehensive scheme of tube railways for London, he considered it would be a question whether the necessities of the general traffic would not justify and even demand the abolition of certain of the existing tramways which penetrated towards the centre of the metropolis. He was entirely against the abolition of the tramway veto, and he had known many instances in which the possession of this had been of great value to the district. In one instance the London United Tramways Co. had proposed to build a tramway along Kensington-road and Kensington High-street from the western boundary of the borough, in continuation of the proposed line along Hammersmith-road, to a point opposite Kensington Church. Anyone who knew the district would at once realise the unsuitability of this route for a tramway line. On other occasions the Borough Council had vetoed proposals of the London County Council, which, in its turn, vetoed a scheme by the London United Tramways Co. which the Borough Council had consented to. The London County Council promised to carry out this scheme itself, but had not made any move in this direction, although an interval of two years had elapsed. He failed to see that it was right to allow the County Council to be the sole tramway authority, to the detriment of the powers already held by the borough councils, and to override the opinions of the latter, who were the road authorities. As to street widenings in connection with tramways, he expressed the same opinions as previous borough council witnesses.

By the CHAIRMAN: With the establishment of a Board of Locomotion for London, which was an essentially impartial tribunal, and one upon which the borough councils were represented, no doubt the latter would not object to handing over their veto. He looked upon the omnibuses as the real cause of the appointment of the Royal Commission. The congestion caused by these was enormous, and for this reason he advocated that the borough councils should be the power to prescribe routes.

By Sir G. TROUT BARTLEY: The Kensington Council was so far opposed to tramways as to say that, if tube railways and underground tramways could be constructed which would answer the same purpose, they were far less dangerous to the ordinary street traffic, and caused less damage to property along the route.

Friday, December 11.

Mr. H. C. JONES, town clerk of Holborn, speaking on the point of the facilitation of travelling in London, strongly urged the intercommunication of all the tube railways by means of exchange stations. One was an exchange station between the Charing Cross, Euston and Hampstead Railway with the Central London Railway at the junction of New Oxford-street and Tottenham Court-road. At Kingsway, the Council had supported the proposals of the Great Northern, Piccadilly and Brompton Railway for an interchange with the Central London Railway at that point. The Holborn Borough Council was strongly of the opinion that surface tramways were impossible for busy thoroughfares, but it would cordially support an extension of shallow tunnel tramways such as the London County Council was constructing beneath Kingsway. Surface tramways caused considerable congestion. In Holborn the omnibuses carried 11,000 more passengers than the tramways per year, and, he maintained, with less congestion. If further means of communication were necessary between north, south, east and west than existed at present, they must be put underground or above the surface. Certainly not on the surface of the existing roadways. He objected to the transfer of the veto, and also advocated that the police should prescribe specified stopping places for omnibuses and tramways. If a special traffic commission were established for London, no representatives either of the London County Council or the borough councils should sit upon it. It should be an absolutely impartial and independent body. On the question of street openings, he paid a tribute to the efforts of the London County Council on this matter, but thought that greater powers to regulate these should be given to the borough council.

By the CHAIRMAN: The special tribunal should have judicial functions. If a general scheme was prepared for the whole of London, promoters could then fall into line with it as far as possible and place their proposals before the tribunal.

By Sir JOHN WOLFE BARRY: A surface tramway should never be constructed on a roadway of less than 100ft. in width. The formulation of a general scheme of communication for London by an independent body was very desirable before Parliament sanctioned any further proposals.

Mr. H. C. J. EDWARDS, borough engineer to Lambeth, admitted that the conduit tramways in Lambeth were extremely useful, but the extra speed of electric cars had the effect of making drivers of vehicles keep to the sides of the road and so increasing the congestion there.

Mr. T. W. E. HIGGINS, borough surveyor to Chelsea, said that two years ago tube railway schemes were brought forward, one to run under Fulham-road and join the Piccadilly Circus Railway at South Kensington, and the other under Kings-road. Either of these schemes would have been a great boon to the western portion of Chelsea, but both were dropped.

Thursday, December 17.

Mr. A. J. HOPKINS, late chairman of the Works committee of the Marylebone County Council, said it was the opinion of his Council that a Standing Commitee of Metropolitan members of Parliament should consider all new schemes of tube railways or underground communications affecting the metropolis. He also stated that subways for foot passengers should be constructed at all busy crossings, and that if a tramway passed at those points, the tramway authority should bear the cost of the subways. In other respects, the whole of witness's evidence supported that given by the other borough councils.

Alderman TYLER, of the Bermondsey Borough Council, also gave evidence.

Mr. ARNOLD F. HILLS, of the Thames Ironworks Co., said he had devoted much attention to the problem of providing better communication about London. As long ago as 1894 powers were granted to some local people for making an electric tube railway from the City to Walthamstow and Epping Forest, but these persons had been unable to raise the necessary capital. He took over the powers, but the disturbed state of the money market, owing to the outbreak of the South African war in 1899, prevented them being put into effect, although he had spent £20,000 in the project. In the autumn of 1900 he formed a group of exceptional financial strength, including the well-known firm of Messrs. J. S. Morgan & Co. He then traced the history of the tube railway schemes promoted by Messrs. Morgan and the London United Tramways Co. in 1902, and the final result, all of which has already been related very fully in *The Electrician*. In this venture he had lost £80,000. Continuing, Mr. Hills expressed the opinion that the present Parliamentary procedure with regard to the promotion of schemes of locomotion was too rigid. To avoid the extravagant expenditure and waste involved by the present system, and the delays and difficulties which were put in the way of trade enterprise, he suggested the following remedy:—1. The creation of an administrative authority to deal with the existing state of affairs. 2. The creation of a development authority to deal with all schemes. 3. The creation of a confirming authority to settle finally all promotions, whether of private or public enterprise. The administrative authority, he suggested, should have the control of all streets, roads and locomotion within the county of London, and should also be responsible for the repairing, cleansing and keeping in order of all such means of communication. It would also consider the best methods of improving the existing means of communication. The development authority should be composed as follows:—A chairman, lawyer and engineer (paid), a peer and a member of Parliament (unpaid), a representative of the London County Council and the City Corporation (unpaid). The three paid members should be appointed by the Board of Trade, the peer and the member of the House of Commons to be elected *ad hoc* by their respective houses and to be ex officio members of the confirming authority, and the last two members to be ex officio members of the administration authority. The paid permanent members of this body would devote their whole time to the work. The expenses of appearing before such a tribunal could be reduced to the very lowest possible limit, as it would be unnecessary to employ counsel. This particular authority should be possessed of judicial functions alone, having no power to initiate new schemes or to finance or in any way to undertake the responsibility of new developments. It should be empowered to hear all suggestions and study the general problem, and be authorised to make recommendations to promoters for the purpose of harmonising and co-ordinating means of communication. In the event of this authority approving any scheme it should be empowered to issue to the promoters a provisional order or certificate with such recommendations attached as they may think well to adopt. But before this order or certificate could be made effective, it would have to be submitted in due order and proper form by the promoters to the confirming authority. This latter authority, he suggested, should be composed of five members, and, being a Joint Committee of the Houses of Parliament, consisting of three peers and two members of the House of Commons, the chairman being a peer. This joint committee would consider bills in the ordinary way, thus only having one committee stage instead of two. He considered a most pressing question at the present time was the adjustment of the respective interests of private and public enterprise. In his opinion no more valuable pronouncement could be made by this Commission than a recommendation to Parliament that the municipal purchase clauses of the tramways and electric lighting acts should be abolished. The true remedy for the present civil and commerial warfare going on between municipal and private enterprise was a co-partnership between the two, in which he saw no insuperable difficulty. In conclusion, he said that the standing orders needed revision and the several vetoes dispensed with.

The Commission adjourned until to-day (Friday).

Electric Driving.—At the meeting of the Dundee Floorcloth and Linoleum Co. on Tuesday, the chairman (Bailie William Henderson) said that electric motors were being largely used in their various departments, and were doing well, but further experience was needed before much could be said as to the saving to be effected. Their new factory was lighted throughout by electricity.

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LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) v. St. Marylebone (London) Borough Council.

In the Chancery Division on Friday, Mr. Justice Buckley heard a motion by the St. Marylebone Borough Council that the time be extended which the Court fixed in July last (see *The Electrician*, July 3, p. 469) for the completion of the purchase by the Council of the undertaking of the Metropolitan Electric Supply Co. (Ltd.) in the Marylebone district.

Mr. BUCKMASTER, K.C., for the Council, said his clients, by virtue of their Act of 1901, became, as his lordship had held, bound by statute to buy the undertaking of the company. The award of the arbitrator in certain proceedings had been made on Feb. 4 last, and adjudged that £1,212,000 should be paid to plaintiffs as compensation. On June 23 last the London County Council, who had been asked to grant a loan for the purpose, declined to give their sanction to the raising of the money. One of the grounds upon which this sanction was refused was that, under the terms of the statute, the Council would have no power to work until after the completion of the purchase. An appeal was made to the Local Government Board, but before that appeal came on an action was brought by the company for specific performance of the contract. It was on his lordship's judgment in that case that they now came to ask for an extension of time. The judgment declared that there was a binding contract created by the notice to treat and the award and that the contract ought to be specifically enforced. The Council had submitted that it was quite impossible for them to raise the purchase-money except by loan or by an increase of the rates. The rate necessary to raise this money would amount, apart from the other rates, to something like 20s. in the £. On Sept. 28, 1903, the Council had notice from the Local Government Board that the Board had no alternative but to uphold the decision of the County Council. The only remedy open to the Council was to go to Parliament again, and they had resolved to amend the bill in order to get the proper and necessary relief. Under an act which was passed this year it was essential, before they could do this, to get the opinion of the ratepayers. Jan. 28, 1904, was the earliest date on which they could get this consent, and Feb. 18 was the latest date if a poll were demanded. The position at the moment was this:—On Dec. 31 instant the Council was bound by the order of his lordship to complete the purchase and pay money which they had not got and could by no possibitity get by that time. They, therefore, asked for an extension of time in order to see if they could obtain the necessary relief from Parliament by raising a loan which would enable them to carry out their part of the bargain. Under the circumstances, I ask your Lordship to further extend the date fixed for completion by this order, and the notice of motion asks that the postponement should be to June 30. I should be willing, if your Lordship would grant me that indulgence, to allow this postponement to be made until the end of February in order that we might see what the ratepayers do, reserving to us, again, a further liberty to apply if we find we are able to proceed with the private Act of Parliament after that date. There was nothing which the Council had done which should disentitle them to the assistance of the Court. The bill would be deposited on the 17th of this month, but until the ratepayers had given their consent the Council could do no more. If Parliament did not assist the Corporation the only possible means of satisfying this purchase money would be by levying a rate which would be perfectly intolerable and would dislocate the whole machinery of local government.

Mr. CRIPPS, K.C., for plaintiffs, submitted that the Council had come under a statutory obligation to purchase the undertaking of the plaintiff company, and were given untii Jan. 1, 1904, to carry out the purchase. As regarded the means of obtaining the money, prima facie the vendors had nothing whatever to do with that. Plaintiffs were entitled to the money, and if the Council and ratepayers did not obtain borrowing powers it made not the slightest difference to plaintiffs' rights. Plaintiffs had nothing to do with the way the moneyis raised by the Council. There are two ways. If they have borrowing powers they can do it, if not the obligation is upon them to raise a sufficient rate to meet the liabilities which they have assumed on their own invitation to Parliament under the Parliamentary purchase. He was quite willing that, on certain terms, the Council should have an additional opportunity as regards borrowing the money. It was said the Council were now promoting a bill which might or might not be accepted by the ratepayers. If it were accepted and it became possible to comply with the standing orders and proceed with the bill, he was prepared, on behalf of the company, to give all proper indulgence to the Council on terms. So far as the company could see, and it was perhaps not improbable, the ratepayers might reject this application to obtain borrowing powers. Assuming the ratepayers did so, that had nothing to with the vendors. The only other method of procedure would be for the Council to levy a rate for the purchase-money. He was obliged to guard himself against any risk in regard to the time for the issue of the mandamus. If plaintiffs came within six months of the date, when the liability has arisen, they could legally go for a mandamus and get this rate enforced, because the ratepayers themselves have not adopted the alternative of getting these borrowing powers. He asked that nothing should be done which would be to the detriment of the power which existed in the company at the present time. The company could, immediately after Jan. 1 next, have taken the necessary steps to enforce their rights by mandamus according to the recognised methods.

Mr. Justice BUCKLEY: From what date does the six months run?

Mr. CRIPPS: We have been discussing it this morning, my lord, and I think it runs from Dec. 31.

Mr. Justice BUCKLEY: They were to pay you £1,200,000 on Dec. 31, and then within six months from that date you could get a mandamus to get a rate levied. If the time is now extended by me until Feb. 28, surely you would be in a like case?

Mr. CRIPPS then read an affidavit by the general manager of plaintiff company in which it was set forth that the company objected to the time being extended at all, except on the distinct undertaking of the Council that, in the event of the ratepayers refusing to sanction the proposed bill before Feb. 18 next (the latest date to which the ratepayers' decision can be postponed if the Council proceed in the matter without delay), the Council proceed to levy a sufficient rate to discharge their obligations.

Mr. Justice BUCKLEY: Suppose they do not get their bill, do you want to enforce the sale or reject the contract?

Mr. CRIPPS: To enforce the sale, not to reject the contract. We should set to work to enforce the contract by means of mandamus against the ratepayers, for that is our right.

Mr. Justice BUCKLEY: Suppose there was an application made for a mandamus, has the Court a discretion?

Mr. CRIPPS: No, my lord, there is no discretion. The directors (continued counsel) of the company had reason to believe that considerable opposition to the completion of the purchase existed in the borough, and they were, therefore, of opinion that any extension of time now granted should only be for a period sufficient for the defendants to ascertain the decision of the ratepayers on the bill. Plaintiffs considered an extension of two months to Feb. 28 next to be ample under existing circumstances. He (counsel) did not know whether his lordship would go so far as to ask for an undertaking from defendants, but he wanted it to be clear, and to state it in public, in order that defendants might realise the company's attitude, that, on Feb. 29 (as it will be leap year), if the ratepayers did not assent to what was really the business basis of the matter, and allow these powers to be got in order that this purchase might be dealt with, as it has been by thousands of municipalities, waterworks, gasworks and so on, they would have to take the consequences, and they would do this with their eyes open. It was plaintiffs' only form of remedy. Plaintiffs did not intend to rescind the contract, and they would therefore be forced to take steps which would give them a legal right to get a mandamus.

Mr. Justice BUCKLEY: You ask that I should impose it as a term that the Council should undertake to levy the rate, but they would be in the same position if I did not, because you would have a legal right to do it by mandamus.

Mr. CRIPPS: Yes, but there was a difference between a council co-operating as regards a matter of that kind and a council being in opposition as regards a matter of that kind. They knew that enforcing rates by mandamus created difficulty and friction. If the company agreed to the extension of the time to the end of February, as asked, they ought to have the advantage of the Council's co-operation. He did not believe that any other municipality in the kingdom had taken up this attitude of attempting to get out of legal liabilities, which they had incurred on their own motion, simply because a particular arbitrator had not assented to their views as regarded value. Having gone so far, he wished to say that plaintiffs desired a modification in four very important particulars of the terms upon which they consented in August last to the postponement of the completion of the purchase. The capital of the company consisted of ordinary shares, 4½ per cent. preference shares, 4½ per cent. first mortgage debenture stock and 3½ per cent. mortgage debenture stock, but the capital expended to the present time considerably exceeded the capital raised, and, in consequence of the delay which had already taken place in the completion of the purchase and of the uncertainty as to the date on which it would be completed, the company had been and still were unable to make provision for further expenditure on capital account required for any portion of their undertaking, including Marylebone, except by borrowing from their bankers at the rate of 4½ per cent. per annum or by the issue of additional 4½ per cent. preference shares. At present the company owed large sums to their bankers on loans at that rate contracted solely in consequence of the delay in the completion of purchase which had already taken place. It was extremely inconvenient to the company financially to owe these large sums to their bankers and still more inconvenient to increase these large borrowings to the extent of their further capital expenditure which was absolutely necessary to enable them to meet the normal growth of the St. Marylebone undertaking and to comply with the statutory obligations of the company. On the other hand, there were grave objections to issuing further capital of the company to meet a temporary necessity of the kind, and in view of the fact that all this capital and a sum of over £1,200,000 in addition would be thrown on the company's hands on the completion of the purchase. The capital expenditure incurred from Dec. 31, 1901, to June 30, 1903, was agreed between the parties as being £67,250, and further capital expenditure had been and was being necessarily incurred, and a large portion of this capital expenditure was still unproductive. Under these circumstances the company submitted that as one term of any extension of the time for completion the Council ought to provide a sum of at least £60,000 towards the capital expenditure that had been and was being so made. Such a sum only amounted to a rate of something like 9d. in the £ on the rateable value of the borough. It was obviously unfair that the company should, by the default of the Council, and without any fault of their own, be not only kept out of their purchase money, but actually compelled to raise large additional capital for the purpose of maintaining an undertaking which really belonged to the Council. The company also submitted that it was only fair that if further time for repayment of the whole or any portion of the capital sums expended by them on the Marylebone undertaking since Dec. 1901, until Dec., 1903, was granted, the rate of interest to be paid from the last-mentioned date until the

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completion o the purchase, on such sums or the unpaid portion of them, should be at the rate of 4½ per cent. per annum, that being the rate actually paid by the company. The company found that it was impracticable, in the ordinary course of their business, to submit every item of capital outlay for the approval of defendants before the outlay actually took place. Various minor alterations in and additions to the plant, fittings and instruments in the stations and sub-stations had to be made from time to time, and often at very short notice, the cost of which alterations and additions, although small individually, probably would, by continued delay in completing the purchase, amount in the aggregate to a considerable sum. The company also let on hire to consumers electrical appliances, such as motors, fans, radiators and other heaters, upon which it is necessary from time to time to expend capital, and it was impossible, in the ordinary course of business, to seek the approval of the Council on every occasion on which an appliance is sent out on hire. Plaintiffs found it practically impossible to wait weeks because the Council was not meeting, or they could not get an answer to a letter. Plaintiffs were bound to go on and fulfil their statutory obligation. Yet, under the terms of the judgment, as it at present stands, the company would be absolutely precluded from being repaid any of the above items of expenditure, however reasonable in themselves, that have been or may be made by the company unless the Council choose to give an approval which it appears to be in the absolute power of the Council to withhold. Plaintiffs say, as regards these items, that they have expended some thousands which they do not know they can recover. They ought to be allowed to make this capital outlay, defendants' remedy being to come before the Court and get the items struck out if improperly incurred. Within the six months from June, 1903, certain moneys had been spent (the amount was then ascertained at £67,250), but the Council had not given their approval to this expenditure. They now asked for an extension of time, and his clients urged, as regarded expenditure incurred by them up to now and in the future they should be reimbursed.

His LORDSHIP said the Council had, unfortunately, involved themselves in an enormous liability, and unfortunately did not find themselves in a position to discharge it. They ought to have thought of all this before they came under statutory liability to purchase.

Mr. CRIPPS: We do not consider it is an unfortunate liability in a sense, if they had dealt with this matter on ordinary business grounds. We believe the income they would get would be quite sufficient to meet liability. It must not be said that we look upon it as an unfortunate liability at all. They seem to have been disappointed with the award, and so were we. Proceeding, counsel said the company had dealt with the business on the basis that the Council would fulfil its obligations. The company had wished to be left in possession of the locality, but after five or six years' communication and friction between the Council and themselves, the former always saying it wished to purchase, the company had to give way and a compulsory bill was brought forward. The conditions accordingly were now changed, and the company were now going on another policy to that they followed five or six years ago. The ratepayers or the Council seemed to think that they could play fast and loose with the matter. The company wanted the situation clearly brought home to the minds of the ratepayers.

His LORDSHIP: I think it is coming home to their minds.

Mr. CRIPPS said the ratepayers had only to realise what the true liability was. To end the whole matter the Council ought to get borrowing powers and deal with the thing in a business way. If that were done there would not be the loss of a farthing to any ratepayer. If the ratepayers did not assent to what was really a business basis, and allow the powers to be got in order that the purchase might be dealt with as it was by thousands of municipalities in this country in the case of water and gas works, they would have to take the consequences. The company would be forced, in order to protect their interests, to obtain a mandamus so that the necessary rate could be levied.

His LORDSHIP: I cannot help thinking it was by inadvertence and oversight that the Council obtained the act. It was an act which compelled them to purchase. They did so without thinking of the consequences, and they are now face to face with the consequences. It seems to me that they are in very considerable difficulty. The levying of a rate sufficient to pay this purchase would be an oppression—that is, perhaps, not a correct word to use, but it would at any rate bear very hardly, indeed, on the ratepayers. It would be practically preposterous. It is, of course, for them to find the money, but at the same time it is for me to see that they are given a reasonable opportunity of complying with the obligation which, in my view, they have been very foolish to place themselves under. It is a complete satire on municipal trading.

Mr. ASTBURY, K.C. (with Mr. Cripps for the company), pointed out that until the money could be paid by the Council the company were in the position of having to remain in possession and carry on the works. They were under statutory obligations to do certain work and make certain connections, and were bound by the order of the Court to convert the system from high tension to low tension. It was common knowledge that, if possible, the ratepayers of Marylebone were anxious to get out of the contract. There was a strong agitation in the borough against it. Unless the ratepayers consented to the bill for the borrowing of the money they would have to bear the rate. The Council had actually refused their approval of certain expenditure which the company had been bound to make. If there was any likelihood or possibility of the works coming back to the company the company ought to be allowed in the meantime to carry on the concern as in the past. The company ought to have some part of this agency expenditure paid to them at once. They suggested £60,000, and they should have the right to make reasonble and necessary expenditure in the conduct of the business, even if they did not get the previous approval of the Council to that expenditure.

Mr. Justice BUCKLEY: You want me to substitute in the existing judgment February for December. You will then have your £60,250 on account, and interest at 4 per cent. on moneys already expended.

Mr. ASTBURY: Yes. The judgment would be that they are to pay £67,250 for the expenditure up to June, 1903, £5,000 for capital expenditure which plaintiffs have made, or are committed as from that date, and such further and other expenditure as plaintiffs shall make up to and including Dec. 31, 1903, with the approval of defendants, together with interest on such further and other expenditure as from the respective dates of expenditure at the rate of 4 per cent. per annum. We have got no interest on the £67,250, which was an agreed sum.

Mr. Justice BUCKLEY: Till completion you retain the profits.

Mr. ASTBURY: The £67,000 odd has nothing to do with that. Retaining the profits is in lieu of interest on the purchase price, the £67,000 is additional, and is what we have spent since the purchase.

Mr. Justice BUCKLEY: You want interest then on the £67,000 odd from December?

Mr. ASTBURY: Yes, and we ask for it at the rate we have to pay ourselves—namely, 4½ per cent. We further ask for reimbursement for all such further and other capital expenditure, not falling under any of the foregoing heads, as the plaintiffs shall have made since June 30, 1903, or shall hereafter make in the reasonable and proper management. We want to guard against the undertaking being starved if we have to take it over ourselves in the future.

Mr. BUCKMASTER, in reply, said he wished to make it clear that there never had been any wish or desire on the part of the Council he represented to escape from this bargain. The company got the whole of the profits at present. If they were to retain these it was a little hard to say that the Council should pay now part of the purchase-money to enable the company to make these profits. He further submitted that there had been no withholding of approval as to expenditure by any of the agents of the Council.

JUDGMENT.

His LORDSHIP, in giving judgment, said the Council's difficulties began with the arbitration award. They seemed to have gone to Parliament with a light heart to get an act to compel them to purchase and the company to sell. When the purchase price was fixed, however, they had not the money to pay. Of course, the Council had not got the money, and they failed to get sanction to borrow it. Since the judgment, under which the defendants were ordered to complete on Dec. 31, the Council had, to the best of their ability, sought to obtain leave to raise the money, but they had failed. As the sum was very large the levying of a rate would be a very heavy burden indeed on the ratepayers, and he was not all surprised that the Council were not prepared to face the ratepayers with such a rate. The company said that the Council having entered into the bargain it was no affair of theirs how the money was to be raised. The vendors were quite right, and the Council should have thought of how they were to raise the money before they obtained the powers. It was for them to resolve the difficulty and find the money. The position was complicated by this, that an undertaking of this description is not one and complete at any moment; it is perpetually requiring additions, and the undertakers were under statutory obligations; they were not free agents, they had to keep up the undertaking and make capital expenditure. As things stand they were in the position of custodians of somebody else's undertaking, which that somebody else would not pay for. They had to go on and do that which they are bound to do under the Act of Parliament. The Council had presented a bill in Parliament which would or would not be capable of going forward according to whether the ratepayers did or did not approve of the bill. If they did not do so, the situation would become even more acute. Meanwhile the company proposed to enforce the contract, but at the same time they said it was competent to Parliament to do anything, and if the municipal authority had entered into such a bargain as was oppressive to the ratepayers it was possible for Parliament to relieve them of the contract on proper terms. It was not an impossible event that the sale might never be carried through. That was the situation, and under these circumstances he was asked to extend the time till Feb. 29, and he thought he ought to do so, as before that date they would know what was going to happen. But upon what terms? The first term that the company asked was that the Council should give an undertaking that, if the ratepayers decline to approve the proposed bill, they would forthwith levy a rate to raise the necessary amount. He was not minded to require that undertaking as a term, as, if the final date arrived at which this purchase money must be paid, it would be competent for the company to apply by mandamus that the Council do levy a rate to collect the money. Whether the Court would have any discretion in dealing with that he did not know, and did not say. He thought he ought to leave the matter so that the parties should be entitled to resort to their legal remedy by way of mandamus, and the Council should not be required to give an undertaking to do that which there would be a legal obligation upon them to do under the supposed circumstances. The second point was that capital expenditure was necessarily from time to time made in carrying on this undertaking, and by a clause of the Order it was ordered that the company do, up to and including Dec. 31, 1903, proceed with reasonable diligence, and in accordance with the reasonable instructions of defendants, with the conversion of the system of supply in what was known as district C of the St. Marylebone area from the high-tension system to the low-tension system, so that, both by reason of their statutory obligation and by reason of some part of the terms of this order, the company had to go on spending money, and they urge that, under the circumstances, it is not reasonable for them to raise more capital by the issue of more shares or more debenture stock. What they do, therefore, is to go to their bankers and get it at 4½ per cent. interest. They asked him, therefore, to take this factor into consideration. He thought there was great justification for that argument. He thought it was not an unreasonable term that the Council should, within such a time as was reasonable, levy

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a rate and pay to the company a sum of, say, £60,000. Then, as regarded the balance of £67,250, and as regarded any further capital expenditure which plaintiffs had to make, it was not unreasonable that the Council and not the plaintiffs should bear the 4½ per cent. He decided, therefore, that it was a reasonable term that the Council should pay the £60,000 and interest at 4½ per cent. on the £7,250 and upon the further capital expenditure which had been or would be made by plaintiffs. The order provided also that such further expenditure as plaintiffs should make up to and including Dec. 31, 1903, with the approval of defendants, together with interest on such further expenditure as from the respective dates of expenditure at the rate of 4 per cent., should be added to the money which was to be paid by the Council. Plaintiffs said that that did not work, as they could not, in practice, go to the Council for their approval for all little items of capital expenditure that had to be made from day to day; and they suggested, not unreasonably, and to some extent at their peril, that he should make it a term that future expenditure which should be repaid should be all reasonable and proper expenditure on capital account that has been or may be made by them, subject to their vouching or proving such expenditure as might be reasonable and proper. That made the Council masters of the situation when plaintiffs, through no fault of their own, were compelled to expend their own money upon what was an undertaking of the defendants. He thought, therefore, that that also should be a term of his order. He therefore extended the time till Feb. 29 next upon the three terms: (1) That by Jan. 31 next £60,000 should be paid by the Council to the company, (2) that 4½ per cent. should be payable upon the balance of the £67,250 and upon the further and other expenditure, and (3) that the amount to be added to the purchase money should be such further and other expenditure as plaintiffs should make in respect of reasonable and proper expenditure on capital account, subject to their vouching such expenditure as being necessary and proper. This expenditure would, of course, be in respect of that portion of the company's undertaking which had to be acquired by the Council. Now, to give effect to the finding as to the payment to be made by Jan. 31, the order would have to be carefully looked at to see that it was correctly varied in the material particulars for the extension of date. The company would take the profits down to Feb. 29 instead of Dec. 31.

Mr. BUCKMASTER: Can we have the expenditure made by the company submitted to us week by week?

Mr. Justice BUCKLEY: I agree that periodical statements were better. The company would communicate with the Council in reference to future expenditure much as before, but the Council would not have the right of veto. The general accounts might be submitted monthly as before.

Mr. ASTBURY: Might we have it understood that for anything extraordinary or large we are to ask their approval first and not take the risk of bringing it under the "reasonable" clause until we have?

Mr. Justice BUCKLEY: That is a reasonable way for you to work, but I do not propose to put that in the order. Then, as to the costs of this application, they will have to be borne by the Council.

Ferranti Limited.

In the High Court on Tuesday Mr. Justice Buckley had before him an application on behalf of a creditor of this company asking for the production of certain documents referred to in an affidavit filed on a petition for liquidation.

Mr. BUCKMASTER, K.C., for the petitioner, said he was a creditor for dishonoured bills, and he had presented a petition for the winding up of the company. The answer put in to that petition consisted chiefly of an affidavit by receivers who had been appointed in a debenture holder's action. They had been appointed on Sept. 9, and the main grounds of their objection was the allegation that certain contracts of which the company had the benefit contained clauses which would cause the contracts to be forfeited in the event of a winding up order being made. On that affidavit being served it was suggested that the creditors should call a meeting to consider what should be done. The petition accordingly stood over. At that meeting a committee was appointed, one of the members of that committee being the petitioning creditor. On Dec. 1 his lordship allowed a further adjournment until the first petition day of next sitting, in order to see if this committee would recommend any course. Several applications had been made to the solicitors for the deponents, who had asked for liberty to inspect the documents, but the petitioning creditor had been unable to obtain such inspection.

Mr. VERNON, for the receivers and managers, said they were really no parties to the proceedings at all. He submitted that what they had done was perfectly right in the circumstances. They were willing to give any reasonable information, but they considered it undesirable and detrimental to the interests of the company that such contracts should be produced. They were further instructed that the company could not conduct its business if these contracts were taken from the works at Manchester. If copies were made it would lead to very considerable expense, and would be an oppressive proceeding.

Mr. BUCKMASTER said he wished to see the forfeiture clauses.

Mr. VERNON said he was perfectly willing to give up verified copies of these as well as the dates of the contracts. The reason the receivers and managers were so cautious was because Mr. Ferranti and Mr. Anderson had specially warned them that it would be detrimental to the company to produce any contracts relating to the works. There was danger of these becoming known to competitors in the trade.

Mr. BUCKMASTER said that the petitioner was Mr. Estler, and the petition was in respect of goods supplied. He did not carry on business in competition with the company, nor was he in a position to undertake the work.

His LORDSHIP said it was perfectly reasonable that the contracts should not be produced. The receivers and managers must, however, give copies of the forfeiture clauses, and so far as possible the date fixed for the completion of these contracts. The costs would be costs with the petition.

Geipel v. Manchester Corporation.

Mr. Justice Swinfen Eady, in the Chancery Division, on Saturday delivered judgment in the action brought by Mr. Wm. Geipel against the Manchester Corporation for an injunction for infringement of letters patent relating to inventions and improvements in steam traps.

In delivering judgment his Lordship said the plaintiff claimed an injunction to restrain defendants from infringing his patent of 1894 for improvements in steam traps, and for damages. The action originally extended to another patent of 1893, but that portion of the action had been discontinued. It was not disputed that the defendants were using a steam trap manufactured by Mr. Berry, who was formerly in the employ of plaintiff, or of his firm of Geipel and Lange, as traveller, which steam trap was identical with that forming the subject-matter of plaintiff's 1894 patent as now amended. The only question was whether plaintiff's patent was valid, defendant insisting that the invention was not the proper subject-matter of letters patent. Previous to the date of the patent in question, plaintiff had described and specified a steam trap or apparatus for automatically draining the water arising from condensed steam in cylinders or other receptacles. The trap was of the kind known as expansion traps. It was found in practice that those traps possessed two disadvantages. If the pressure of steam rose beyond that for which the valve was set, the increased pressure, and correspondingly the increased temperature, operated injuriously on the valve and its seat; after the valve had been pushed hard on its seat the strain continued, and the valves got quickly cut, and the cutting of the valve destroyed the seat, or some permanent set or distortion of the trap was caused, so that when the steam pressure fell again to its normal condition the valve was damaged, and allowed live steam to pass, and the trap would not work properly without re-adjustment. The other disadvantage was that there was no hand blow-through. To obviate these disadvantages, plaintiff arranged a combination, which was the subject of his 1894 patent. It was not disputed that plaintiff's arrangement was a great improvement on the trap of 1893. It had proved commercially successful, for while not more than two or three traps of the 1893 pattern had ever been sold, the sales of the 1894 pattern in this country ranged from 102 in 1895 to 2,452 in 1902. Plaintiff's invention was simple, ingenious and effective, and had made the apparatus more reliable and durable than before. The claim was a very restricted one—only a claim for the particular combination of a lever and spring with the valve of a steam trap arranged and operating as described, and illustrated in the amended specification. It was urged by defendants that all that plaintiff had done was to take a well-known mechanical contrivance, and apply it to a subject to which it had not hitherto been applied, and that there was no invention in that. In his lordship's opinion, the arrangement of the new combination required the exercise of considerable ingenuity, and came within the principle laid down in "Hinks *v.* The Safety Lighting Co." Defendants had also pleaded prior publication, but none of those publications were anticipations of plaintiff's invention. In his opinion plaintiff's invention, the new combination which he claimed, was proper subject-matter and his patent a valid one. Berry recognised its value by manufacturing an almost exact copy of it, which was used by defendants. Plaintiff was entitled to an injunction, and the costs of the action, with the usual inquiry as to damages or profits, and to a certificate.

National Company for the Distribution of Electricity by Secondary Generators (Ltd.) v. Gibbs and another.

This matter came before Mr. Justice Farwell in the Chancery Division on Wednesday for consideration on the report of the Master as to the damages recoverable by plaintiffs against defendant, who was personal representative of defendant Gaulard. Judgment was entered on July 11, 1901, when Mr. Justice Cozens-Hardy ordered an inquiry as to damages caused to plaintiffs from the estate of Gaulard by breach of covenant by Gibbs and Gaulard, who sold to plaintiffs a patent which was bad. On an admitted counterclaim judgment was entered against plaintiffs for £2,581. The Master found £11,600 damages for the company, payable from the estate of Gaulard, by reason of breach of covenant, and judgment for this amount was now asked for.

His LORDSHIP said that, as the executrix did not admit assets and did not appear, that could not be done. He sent the case back to the Master on the usual administration decree.

Calwell v. St. Pancras (London) Borough Council.

In the Chancery Division yesterday (Thursday) before Mr. Justice Joyce, Mr. HUGHES, K.C., applied for an injunction in respect of a nuisance alleged to have been caused by defendants' electric lighting plant in Great College-street, London, N.W., the nuisance being by vibration, noise, smell and dust, the dust coming from a refuse destructor. Counsel said the only solution of the difficulty was for the Council to buy plaintiff's house out. They had bought all the private houses in Great College-street between the works and Platt-street. The nearest point of the generator station from the plaintiff's house was only 40ft. or 50ft. away. The works were put in operation in May last. Complaint was at once made, and plaintiff had delayed proceedings from time to time on the representations of the defendants that the nuisance, if it existed, would be put an end to. The evidence was strong as to vibration, and it was stated that ornaments in some of the houses were shaken, and that the vibration interfered with the possibility of sleeping. Defendants had three 750 H.P. engines at work, and they said there was considerable vibration, but if a sufficient time was given them—say nine months—the nuisance would be abated.

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Mr. Justice JOYCE: If I granted an injunction I should have to give defendants some time to remedy the nuisance.

Mr. YOUNGER, K.C., for the defendants, said that if his lordship granted an injunction, 3,000 users would be deprived of light and 22 miles of street would be in darkness. It was the old case of the makers of the engines. They said it took time to adjust engines of that sort, and they were having elaborate experiments made to put the thing right. The defendants had met the plaintiff in the most handsome way possible, and they were trying to perform their statutory duties with the least possible inconvenience to the public. He was prepared to say that if the result of what they were doing was that the vibration could not be put right these three engines would be taken away,

Mr. Justice JOYCE suggested that the case was one for an early hearing, and, after some discussion, the trial was fixed for Jan. 19.

Brooker and others v. Urban Electric Supply Co.

In the Chancery Division yesterday (Thursday) before Mr. Justice Joyce, Mr. HUGHES, K.C., moved for an injunction to restrain the company from so carrying on their works at Weybridge as to cause a nuisance by vibration, smoke and noise. Plaintiffs had gone to Weybridge to live in rural quiet, but they found that defendants were carrying on their works in such a way as to cause a nuisance.

Mr. YOUNGER, K.C., for defendants, said the works were commenced in May, 1902, and it was not a case for an interlocutory injunction. The first named plaintiff himself carried on a steam laundry, and there must be vibration caused by his works.

Mr. Justice JOYCE said he would not grant an injunction on the motion, which must stand over until trial. He would advance the hearing, and the parties could apply to fix a date for the trial.

Knight v. Isle of Wight Electric Light and Power Co. (Ltd.).

The adjourned hearing of this action, brought by plaintiff for an injunction to restrain defendants from causing or permitting a nuisance by the running of their electricity works, and for damages, was resumed by Mr. Joyce on Tuesday.

Mr. Hughes, K.C., proceeded to address the Court on behalf of plaintiff, when

Mr. Justice JOYCE said that the question was whether the nuisance was occasional and temporary, and he would have to consider whether plaintiff was entitled to an injunction at the time the action was instituted. There might have been a nuisance when the works were started, but whether what had been done had cured it he would have to consider.

Mr. HUGHES said his case was that the nuisance had not even yet ceased—that it existed still when the wind was in a certain quarter. He submitted that "occasional and temporary" meant what it was known would be of that nature, and not a nuisance which it was only hoped could be cured by steps that it was in contemplation to take. "Temporary" did not include any case where it was a matter of experiment and trial to see whether the nuisance could be put an end to. It was admitted that defendants' plant was novel, and that the engine was the first of its type. On the evidence he was entitled to an injunction and an inquiry as to damages.

Mr. WAGGETT was given leave to reply on the point of law raised, and contended that "occasional and temporal" meant the construction and getting into working order of any works. He could not find any reported case, but he thought the reason for that was that in other cases people had not begun their actions with such precipitant hurry as the plaintiff in this case had shown.

His lordship said he would consider his judgment.

Workman's Compensation.

A mechanic named Newton sued Messrs. H. A. Willey & Co., engineers, Exeter, at Exeter County Court recently for compensation at the rate of £1 a week for eight weeks and 10s. a week since July 1 for partial incapacity caused by a piece of metal entering one of his eyes while he was at work in defendants' service. The injury was caused by a piece of brass thrown in plaintiff's direction by a blow from a hammer worked by a man three lathes off the plaintiff.

Mr. HARRIS, for defendants, said the metal was thrown intentionally, and that the case, therefore, did not come within the provisions of the Workmen's Compensation Act, as the injuries were not received in the course of plaintiff's employment.

Judge WILSON was not satisfied that the injuries were received by plaintiff in the course of his employment, and dismissed the case for want of sufficient evidence.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Leicester Tramways committee require a resident electrical engineer for their electric tramways to take charge of the working, general repairs and maintenance of the power station plant, car depots, overhead work, cars, feeder cables, &c. Commencing salary £250 per annum, increasing by £25 per year to £350. Applications to chairman by Jan. 1. See also advertisement.

Birmingham Asylums committee require a resident working engineer in connection with the new Hollymoor Asylum, capable of taking charge of the electric lighting and laundry machinery, &c. Wages 40s. per week, with house, coal and gas. The committee also require an electrical assistant to work under the resident working engineer. Applications to Mr. Wm. Hutton, Council House, Birmingham, by Jan. 4. See advertisement.

A junior draughtsman is required for the Hornsey (London) electricity works. Applications by 28th inst. to the borough electrical engineer (Mr. Norman Staniland), electricity works, Tottenham-lane, Hornsey, N. See advertisement.

A head draughtsman, with good knowledge of electrical machinery and appliances connected therewith, is wanted by Messrs. J. H. Holmes & Co., Newcastle-on-Tyne. See advertisement.

An assistant electrical engineer is wanted by the Bengal-Nagpur Railway Co. (Ltd.), with thorough mechanical and electrical training. Further particulars are given in an advertisement. Applications to the Company, 132, Gresham House, Old Broad-street, E.C., by Jan. 15.

An assistant, with factory experience, competent to give instruction in the theory and practice of electric machine design, is wanted in the department of electrical engineering of the City and Guilds of London Institute, Exhibition-road, S.W. Salary £150 per annum. Applications to Prof. Ayrton.

Wellington (N.Z.) Technical Education Board require a director for their technical school. Salary £500. Further particulars from the Agent-General, 13, Victoria-street, London, S.W. See advertisement.

Staffordshire Education committee require a country instructor in experimental science. Salary £200. Applications to director of education, Stafford, by 28th inst.

Mr. Arthur R. Fearnley, general manager of the Corporation tramways, Birkenhead, has been recommended by Sheffield Tramways committee for the appointment of general manager of the Sheffield Corporation tramway undertakings, in succession to Mr. A. L. C. Fell.

Mr. T. Parnell, of St. John's College, Cambridge, has been appomted tutor in physics at Trinity College, University of Melbourne.

Mr. L. C. Gilmore, of Crewe, has been appointed mains superintendent at Bexhill.

Anglo-French Telephone Service.—In the French Senate on Tuesday M. Berard, Under-Secretary of State for Posts and Telegraphs, introduced a bill approving the convention passed on July 29, 1903, between France and Great Britain for the regulation of the telephonic service between the two countries. The bill was referred to the Finance Commission.

Asylum Lighting.—The estimated cost of the electricity generating plant and the wiring and fitting up of Grove and Fountain hospitals for the electric light is £4,300.

Aston.—The Electricity committee recommended the Council on Wednesday to seal the agreement between the Council and the Birmingham Corporation for the supply of electric energy to the latter for the tramways within the city of Birmingham for two years commencing Jan. 1. It was also stated that the demand for electricity was becoming so large that the Council would, at an early date, have to consider an extension of the works. It was resolved to approve the agreement when the work of laying the cable was completed and the Council in a position to supply.

Barnstaple.—The Town Council are to advertise for a loan of £5,400 for extending the electric lighting mains in the outside area. A proposal of the consulting engineer (Mr. W. H. Trentham) to fix the charge for current for motive power for motors of ½ H.P. to 1 H.P. at 3d. per unit, 1 H.P. to 2 H.P. at 2½d. per unit, and for motors over 2 H.P. at 2d. per unit has been approved. It has been decided to proceed with further arc lighting.

Bath.—Official inspection of the electric tramways took place on Saturday.

Beckenham.—The District Council have resolved to exercise their power of purchasing so much of the undertaking of the Crystal Palace District Electric Supply Co. as lies within their district.

The British Electric Traction Co. have intimated to the Council that under no circumstances would they be prepared to adopt the conduit system for the local tramways.

Tenders for "free" wiring have been referred to the engineer with instructions to communicate with three of the tenderers and arrange for a uniform schedule of prices for wiring and fittings with a view to contracts being entered into. A report on the financial position of the "free" wiring scheme and on the proposal to wire houses during construction is also to be prepared.

Belfast.—The Electric committee recommend the City Council to apply to the Board of Trade for the appointment of an electrical inspector under the provisions of the Electric Lighting Acts.

Bethnal Green.—The Borough Council have acquired a freehold site in Marian-square for electricity works.

Bolton.—The question of applying for a provisional electric lighting order for Horwich has been referred to the borough electrical engineer (Mr. A. A. Day) for report.

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Bournemouth.—At the last meeting of the Council, Councillor Youngman stated, in reply to a question, that public electric lighting had been adopted from the County Gates to Boscombe, and from the Hotel Metropole to the Central Station, and along that route they had 132 arc lamps, which cost to run about £11. 6s. each, or a total of £1,500 a year. The lamps were lighted at sunset and kept alight until 11:30 p.m. The amount of gas saved amounted to about £250, so that the extra expenditure for electric lighting in the main roads was £1,250 beyond the price they had been paying for gas. The extra cost to light the lamps on Sundays would be another £250 and the matter was to be considered by the Lighting committee.

For the six months ended September there was a net profit of nearly £7,000 on the municipal electric tramways.

Bradford.—Official inspection of the Church Bank electric tramway route took place on Tuesday.

British Electrical Friendly Society.—The second annual general meeting was held on Monday under the presidency of Mr. W. G. Bond, when the report of the Central Committee was read, showing that there are now 1,989 members and 30 branches, a net increase for the year of 636 members and seven branches. The total income for the year was £3,010, against £1,130 for the previous year. The expenditure for sick pay was £1,844, death claims £598, medical fees £317. The total expenses had been £2,870, compared with £701 the previous year. The chairman moved the adoption of the report, and called attention to the very heavy sickness experienced during the past year. The report was adopted, and Mr. Garcke, who had retired from the chairmanship of the society, was elected a trustee.

Buenos Ayres.—Negotiations are in progress for the transfer of the City of Buenos Ayres Tramways Co.'s undertaking to the Anglo-Argentine Tramways Co.

Canadian Electrical Investment.—United States Consul McMillan says of the district of Port Sarnia, Ontario:—

This country is not traversed by electric tramways to the same extent as is the United States. An excellent opportunity, in my opinion, presents itself for some company to build a tramway or railway from Port Sarnia to Beaches, on Lake Huron; from Beaches to Petrolia, an inland town of some 10,000 inhabitants; and thence back to Port Sarnia, passing through several villages and the best farming country in Canada. No gradients exist, and there are no streams to bridge. Such a line would be a paying investment.

Cheltenham.—The new town hall, opened by Sir Michael Hicks Beach recently, has an elaborate electric lighting installation. The wiring work was carried out by Messrs. Handley and Shanks of Birmingham. Messrs. F. and C. Osler, Birmingham and London, supplied the ornamental fittings for about 800 lights, ranging from 16 c.p. to 50 c.p., throughout the building. The wiring is in six circuits. Steel conduits were used throughout for the wiring, and all draw-in and angle boxes have been so arranged that inspection and repairs can be effected without tampering with ceilings, floors or walls.

Cheshire.—The Cheshire Non-County Boroughs Association have resolved to recommend the Cheshire Borough Councils to oppose the proposed Cheshire Electricity and Power Gas Bill.

City of London.—At the meeting of the Court of Common Council last week Mr. A. C. Morten submitted the report of the Streets committee with reference to a communication from the Board of Trade asking the views of the Corporation on an application by the undertakers, under the St. Martin's Electric Lighting Order (1889), the Strand District Electric Lighting Order (1895), the Holborn and St. Giles' Electric Lighting Order (No. 2) (1898), and the City of London Electric Lighting Order (1899), for consent to the transmission of energy up to 2,000kw. in certain trunk mains in the City.

The committee recommended that the Board of Trade should be informed that the Corporation had no observations to offer in the matter, and was quite content to leave it to the discretion of the Board. This course was approved.

Clydebank.—The Council on Monday approved the agreement for the transfer of the electric lighting order to Clyde Valley Electrical Power Co.

The terms include payment by the company to the Council of the cost of the order (£400) and, in consideration of its transfer, £100 per annum for ten years. At the end of this period the annual payment is subject to a reduction of £2 per annum for each arc lamp, or for every 10 incandescent lamps or their equivalent. The company agree to supply electric energy for public lighting, the Council paying £10 per annum for each arc lamp and £1. 12s. for each 16 c.p. incandescent lamp for street lighting. The Council have the option of resuming possession of the powers under the order at certain periods.

Colchester.—Last Friday a new generating set at the electricity works was started by the mayoress. The engine was built by Messrs. Davey, Paxman & Co., and gives 600 H.P. at 300 revs. per min.

Coventry.—In addition to a proposed expenditure of £5,000 upon the purchase of electric motors, &c., for letting on hire, the Corporation are considering the further extension of the electricity works at an estimated cost of £31,000.

Dublin.—A special meeting of the Corporation will be held to-day (Friday) to consider a communication from the Local Government Board in regard to the recent application of the Corporation for sanction to a loan of £48,000 to complete the city electric lighting scheme and £28,000 to give a supply of electricity in the Clontarf district, and also to consider a report from the consulting engineer (Mr. R. Hammond) on the same matter.

The letter of the Local Government Board stated that the Board had considered the report of their chief engineering inspector (Mr. Cowan) on the recent inquiry held by him into the application of the Corporation for sanction to loans of (*a*) £48,000 to cover extra expenditure on the electric lighting scheme, for which a loan of £254,500 had already been sanctioned; and (*b*) £28,000 to carry out an electric lighting extension scheme for Clontarf. As regards loan (*a*) the evidence showed that on July 28 last, Mr. Hammond reported that, in carrying out the work "its scope had been somewhat enlarged with the authority of the Council from time to time, with the result that liabilities beyond £254,500 had been incurred," leaving £48,000 required in respect of such excess. The inspector, however, reported that he ascertained that the capacity for total output of electricity from the undertaking had not been increased, that no additions had been made to the buildings, boilers, or machinery at the generating station, beyond the provision in the plans and estimates submitted at, or immediately after, the inquiry in 1899, and that the trunk mains had not been increased. The only way in which it appeared that the scope of the system could be considered to have been in any way extended was as regards the provision of extra lengths of distributing mains in certain streets at a cost of about £6,500. It would therefore appear that £41,500 of the £48,000 now applied for represented an under-estimate of the cost of the scheme, notwithstanding the fact that a saving of about £6,000 was effected by the adoption of a cheaper method of generating electricity than that provided for in the original estimate. It also appeared that in addition to the £41,500 now sought in respect of an under-estimate of cost, a further £4,300 would be required for extra works. In his explanatory statements at the recent inquiry, Mr. Hammond proposed to drop the latter amount out of the provision made in the loan of £254,500 for the expense of connections with consumers' premises, but in his evidence he stated that it should be retained, and in this opinion the chairman of the Lighting committee concurred. About 87 per cent. of the additional cost for which the new loan was required, appeared to be due to expenditure which did not increase the earning capacity of the system. That appeared to be a remarkable and unfortunate result, especially when it was considered that at the inquiry in 1899 assurances of a definite kind were given by the engineer, and on behalf of the Lighting committee, that the amount then applied for would be sufficient for the completion of the scheme. In the detailed statement showing how the £48,000 now applied for was arrived at, provision was made for sums of (1) 1,000 guineas as payment to Mr. Hammond for supervision during 12 months of the working of the new system, (2) £330, cost of preliminary running of machinery, and (3) £250 for alteration of arc lamps and motors belonging to customers supplied from the old works rendered necessary by a change in the periodicity of the electric current now generated. The Board did not consider that these could properly form the subject matter of a loan, as (1) and (2) were not expenditure of a capital nature, and (3) appeared to be of doubtful legality. The form of application was returned by the Board, for such correction of the amount applied for as the Corporation might think necessary, having regard to the evidence given at the inquiry by the engineer and the chairman of the Lighting committee as to its insufficiency. The reply to query 2 should be supplemented by some such words as "or other lender as may be found desirable." With respect to the £28,000 for carrying out an electric lighting extension scheme to Clontarf, it appeared that by sec. 64 of the Dublin Corporation Act, 1900, the Corporation were required as soon as reasonably practicable, and within a period of four years after the commencement of the act, to lay down suitable and sufficient distributing mains for the purposes of a general supply of energy throughout every street, or part of a street, specified in that behalf in the second schedule to the Clontarf Electric Lighting Order, 1899, if and so far as such mains should not have been laid down before the commencement of the Act of 1900. The loan sought was made up of £14,000 expenditure in the compulsory area, £1,250 for extension in other prominent streets, £1,550 for house connections and meters, £5,239 for public lighting from Newcomen Bridge to Dollymount, and £5,961 already expended, according to estimate of Mr. Hammond, at generating works and on cables in the direction of Clontarf. The Board, having considered Mr. Cowan's report and the evidence given at the inquiry with regard to this application, would be prepared to consider the question of sanctioning a loan when detailed plans, specifications and estimates for the works have been submitted to them. This form of application was also returned in this case for amendment as regards the reply to query 2. Attention was drawn at the inquiry by the inspector to the much greater cost of street lighting by electric arc lamps than by gas lamps, which, on the lighting of the Clontarf Strand road, would show an increase of at least £750 a year, but he was informed that that question had been considered by the Corporation before deciding as to the scheme in question.

Reporting to the Lighting committee upon the above communication, Mr. Hammond states that he was pleased that, in spite of the criticisms of the Board in certain directions, they were willing to sanction the loan for additional works with three exceptions, and also that for the Clontarf lighting, subject to approval of plans, &c. After the exhaustive inquiry by Mr. Cowan he was surprised to note the observation that out of the £48,000 applied for, £41,500 represented an under-estimate of the cost of

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the scheme, as he (Mr. Hammond) had occasion, in the course of the inquiry, to draw attention to so many items to which that remark could not apply. Mr. Hammond replies in detail to the criticisms of the Board and points out the various items not covered by the original loan of £254,500. As to a suggestion of the chairman that, taking advantage of his evidence with regard to the insufficiency of the £48,000, an application might now be made for a further sum for contingencies, he was not altogether in favour of it, as he felt quite certain that the L. G. Board would not grant a sum for that purpose. Undoubtedly, judging by the present satisfactory demands, many of them from streets not included in the scheme, further extensions of mains would be necessary; but for those a separate application must be sent to the Board, possibly at an early date, setting them forth in detail.

The Lighting committee, on their part, recommended the Council to amend the application to the Board by the addition to the amount of £4,305. 4s. 7d. for various items, particulars of which were given at the recent inquiry; and by the omission of the three items mentioned by the Board, Council, however, reserving the right to make further application for £250 for alterations of consumers' arc lamps, &c., should the revised regulations of the Board of Trade on that head satisfy the L. G. Board of the legality of such expenditure. The committee also recommended that the words referred to in the letter from the Board be added to query 2. of the form of application. Owing to the urgency of the matter the committee advised that the necessary standing orders be suspended to enable the Council to consider and confirm the report immediately after its first reading.

East and West Molesey.—Edmundson's Electricity Corporation, who are applying for a provisional order for this district, have agreed with the District Council to supply electric current for public lighting and power at 2½d. per unit.

Edmonton.—The district auditor has overruled the objections recently raised by ratepayers to certain expenditure incurred by the Council in opposing the bill of the North Metropolitan Electrical Power Distribution Co., in applying for a provisional electric lighting order and in obtaining reports from consulting engineers. The facts were given in our issue of Nov. 20. The auditor holds that the Council were under no obligation to take a poll of the ratepayers before opposing the bill, and as they were entitled to apply for the order he allowed the whole of the charges.

At a meeting of the Council on Friday last several offers for leasing and working the order were considered, and ultimately it was resolved not to entertain any one of them, but that the Council should establish municipal works.

Exhibition.—An electrical exhibition is to be held at Warsaw from May to September, 1904, and will include a special section for new electrical inventions. Foreign exhibitors are specially invited to take part in the undertaking, and it is stated that permission will be granted for the admission of exhibits duty free. A committee has been appointed, which can be communicated with at Philharmonia-building, Monieuszki-street, Warsaw.

Glasgow.—The Electricity committee recommend that the extension of the Port Dundas station be proceeded with, and that a deputation be sent to Sunderland and other English towns to see turbine machinery in connection with the proposed extension of the plant.

The chief engineer (Mr. Chamen) estimates the cost of the extensions at £135,000, which would be distributed over three years.

The committee also recommend that application be made for sanction to borrow £250,000, this being the balance of the half-million authorised by the Provisional Order, 1901.

Greenock.—The Greenock and Glasgow Tramways Co. have informed the Corporation that there is an actual loss on the running of workmen's cars between 4:30 a.m. and 5 a.m., even at the reduced rates for electric energy, and that if the Corporation is unable to supply energy on the terms and conditions hitherto prevailing the running of the early morning cars will have to be discontinued.

Hackney (London).—In order to increase their day load and to stimulate the use of electricity for power, the electricity department have issued a pamphlet pointing out the advantages of electric motors. Already there are connected to the supply mains 146 motors which drive sewing machines, ventilating fans, hair brushes, printing machinery, lifts, &c. Current is supplied at 2d. per unit for power, and in order to accommodate intending consumers who find it inconvenient to pay cash down for motors, the Council have made arrangements for supplying on the hire-purchase system.

At the last meeting of the Borough Council the chairman of the Finance committee (Councillor Hosgood) drew attention to the item for expenses in connection with the opening of the electric lighting station, which the committee considered might be liable to surcharge:—

The expenses were incurred in preparations for opening for which the contractor was directed to proceed with certain works, in order to make the place ready for the reception of those who attended. He considered that the greater part of the work would have had to be done under any circumstances, but he wished for a division for and against the payment. The item recommended for payment was that certified by the electrical engineer (Mr. Robinson) and the architects, and other items in the contractor's claim would have to be dealt with hereafter.

Ald. SHEEHAN considered it unjust to saddle the present Electric Lighting committee with past muddles. He moved that the item be deleted for the present, as he thought it wrong for the chairman of the Finance committee, without consulting the officials or chairman of the present Electric Lighting committee, to take exception to a cheque which was signed by the proper officials of the committee.

Ald. RAWLL seconded, and said he understood that the amount was about was £200. He had not the slightest doubt that the payment was illegal.

After two divisions, the cheque was thrown out.

Hamilton.—We learn that the existing street arc lamp lighting at Hamilton is to be substituted by the Gilbert Arc Lamp Co., who are putting in Gilbert arc lamps, the work to be completed in about four weeks.

Hammermith (London).—It was reported to the Council on Wednesday that there were 1,236 customers of the electricity department, and extensions of the mains, estimated to cost £371, were authorised.

In the fortnightly statement of the electrical engineer (Mr. G. G. Bell) it was announced that Howden's forced draught apparatus was now working most satisfactorily, and the output of No. 1 boiler had been much increased. With the furnace it was possible to use cheap Scotch coal at between 11s. and 12s. per ton without making smoke, and to obtain as much steam from 1 ton of the cheap coal as they did with Welsh coal at 18s. 4d. per ton. The steam given by the boiler was not so suitable for their work as that given by the water-tube boilers on account of the boiler never having been fitted with a superheater. In June, 1896, they decided to fit the two water-tube boilers with superheaters at an extra cost of £270, and all the other boilers had been so fitted. As it was now possible, on account of the increased draught, to have a superheater fitted to the boiler, he recommended that one be supplied at once, so that they might obtain as much benefit as possible from the use of superheated steam generated by cheap coal. The total cost of coal per unit generated on Oct. 25 when No. 1 boiler was working with natural draught and expensive coal was 0·424d. The total cost per unit generated on Nov. 29, when the boiler was working after being fitted with Howden's forced draught, and working with cheap coal, was 0·383d., a saving of nearly £1 per day. If the boiler had been supplying superheated steam the saving would have been more marked, as the steam required to generate one unit working without superheater and low load-factor was 56lb., the steam required to generate one unit when working with superheater and higher load-factor was 33lb.

Hornsey.—The Borough Council are recommended to determine the agreement with the National Electric Construction Co. for "free" wiring of premises.

Hospital and Asylum Lighting.—Chesterfield Guardians have decided to call in an electrical engineer to report on the electric lighting of the new hospital and nurses' home.

Walsall Guardians are urged by their medical officer to adopt electric lighting at the workhouse and infirmary, and a committee has been deputed to obtain estimates.

Islington (London).—In a report issued by the Electricity committee on Wednesday the Council are recommended to make extensions of the low-tension distributing mains in three thoroughfares at an estimated cost of £470, of the feeder and distributing mains and arc lighting circuits in two streets at a cost of £500, and high-tension feeder and low-tension distributing mains in three streets at an estimated cost of £1,633. The committee also recommend that electric energy be supplied to electric motors at the reduced rates authorised by the Council on Oct. 16, and that the present day-light rate for lighting at 2d per unit be not extended unless the consumption of at least 250 units per quarter be guaranteed, and also that all cooking, heating and domestic appliances be supplied at a uniform rate of 2d. per unit through a separate meter; that a uniform rate of 4d. per unit be charged to lecture halls, libraries and church or school rooms, as well as to churches, chapels, places of divine worship, hospitals, infirmaries, theatres, music halls and places of public entertainment and resort.

Leith.—At a special meeting of the Council on Wednesday it was decided to proceed with their application for a tramway provisional order.

Light Railways.—The Board of Trade have, after modification, confirmed the Maidstone Corporation Light Railways and the Avonmouth Light Railway orders, 1903.

Little Hulton.—The Council have received an offer from the Lancashire Electric Power Co. for the supply of electricity in bulk, and the Electricity committee have been instructed to obtain information as to what other districts of the same size are doing in regard to electricity supply.

Liverpool Overhead Railway.—The Liverpool Overhead Railway Co. has entered into a working agreement with the Lancashire and Yorkshire Railway Co. for extending the former company's line from Seaforth Sands station, and effecting a physical connection with the latter railway at Seaforth. The Southport branch of the Lancashire and Yorkshire Railway is being electrified, and the agreement provides that the Lancashire and Yorkshire trains shall run

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over the Overhead Company's system, and the Overhead trains over the Lancashire and Yorkshire. Through bookings will be arranged from all Overhead stations to and from stations on the Southport line of the L. and Y., so that the journey to Southport may be made without a change. Last session the Cheshire Lines committee obtained powers to connect with the Overhead Railway at the south end, and the Seaforth and Sefton Junction Railway Co. also obtained powers to connect with the Overhead Railway at the north end.

London County Council.—At Tuesday's meeting a loan was granted to St. Pancras of £5,764 for street arc lamps and columns.

Electric Lighting.—On Nov. 3 the Council referred several tenders for the supply and erection of electrical machinery and fittings at the Abbey Mills pumping station to the Main Drainage committee. The committee now suggested that the provision of an electric light installation at this station should be postponed, and do not at present propose to report on the tenders.

Tramways and Improvement Bill.—The Parliamentary committee recommended the approval of the above bill, which authorises an expenditure of £2,349,995.

London Southern Tramways Undertaking.—The Highways committee recommended that the Council consider next Tuesday a resolution for the purchase of the above tramways, subject to the Lambeth Council agreeing to contribute one-third of the street widenings required to enable the tramways to be reconstructed for overhead electric traction (with the exception of the lines in South Lambeth-road). The estimated net cost of the street widenings is £121,350.

Mr. HUBBARD moved to omit that part of the recommendation referring to a contribution from Lambeth for street widenings. The borough had refused to contribute, but he believed the new Council would reverse that decision.

Mr. BENN could not agree to the amendment. It would be unfair to place Lambeth in a different position from other London boroughs, and it would be impossible to make these tramway extensions pay unless the localities contributed their share towards street widenings.

Mr. S. LOW protested against the Council holding out these threats to local bodies. The tramways were needed for the convenience of the whole of London.

The amendment was rejected and the recommendation carried.

Tramways.—The Highways committee recommended: "That the estimate of £90,000 be approved, and that expenditure not exceeding that amount be authorised in connection with the reconstruction for the conduit system of electric traction of the cable tramways between Kennington and Streatham."—Adjourned.

Mr. Alfred Baker.—It was recommended that Mr. Alfred Baker be granted an honorarium of £300 in respect of the services rendered by him in connection with the management of the London County Council tramways subsequent to the relinquishment of his office on October 1 last.—Agreed.

Marylebone (London).—A special meeting of the Council was held last evening to consider the judgment recently delivered by Mr. Justice Buckley, fully reported in our issue this week. By the judgment the Council are to pay to the Metropolitan Electric Supply Co. £60,000 by Jan. 31.

The Finance Committee reported that after consulting the Council's bankers they desired to recommend the Council "to comply with the Order of the Court by taking advantage of the existing arrangement of the Council with their bankers, and that the Council do at the usual and proper time consider the desirability of raising any amount required in this connection in the next half-yearly rate."

The CHAIRMAN (Rev. H. Russell Wakefield, J.P.) said the Council's bankers had agreed to help them to avoid the necessity of taking an immediate poll by advancing the money. The first advertisement of the Council's bill would appear about that day week, after which the public meeting must take place after an interval of not less than 14 nor more than 28 days.

Councillor Dr. LEAF in moving the adoption of the recommendation, said £60,000 would be obtained as an overdraft at 3 per cent.

The resolution was carried by 37 votes to 3.

Mr. DEBENHAM then moved, on behalf of the Electric Supply committee, that the full report of the recent proceedings of the court be printed and sent to every ratepayer. This was estimated to cost £100.

This was approved, with only one dissentient.

Mr. WHITE then moved that the Legal and Parliamentary committee prepare and submit to the Council a bill to be introduced next session to relieve the Borough of St. Marylebone from the obligation of purchasing the Marylebone portion of the Metropolitan Electric Supply Co.'s undertaking, upon equitable terms.

Mr. ELGOOD moved the adjournment of the debate to the Council's first meeting night in February (Feb. 4).

This was carried by 19 votes to 18.

Municipal Telephony.—We have in previous issues set out in full the correspondence which has passed between the Mayor of Brighton and Mr. W. E. L. Gaine, general manager of the National Telephone Co., on the subject of certain steps taken by Councillor Carden, as chairman of the Brighton Telephone committee, to obtain subscribers to the new telephone service initiated by Brighton Corporation. A further development of the matter is the following correspondence, which has passed between the Postmaster-General and the Telephone committee of Brighton Corporation:—

General Post Office, London, Dec. 2, 1903.

SIR: I am directed by the Postmaster-General to acknowledge the receipt of your letter of 19th enclosing copy of correspondence between the Mayor of Brighton and the general manager of the National Telephone Co. as to the methods adopted on behalf of the Corporation in their competition with the company at Burgess Hill. The Postmaster-General awaits your observations, as asked for in his letter of the 18th ult., but thinks it desirable to communicate to you the opinion which he has formed on the facts as now before him. As regards the offer of a free service until the number of subscribers to the Corporation system throughout the area reaches 750, which is stated by the mayor to have been made generally throughout the area, I am to say that the Postmaster-General is advised that the Corporation are not entitled under their licence to give an exchange service without charging subscribers at some rates within the specified limits. In the establishment of other Corporation systems it has been recognised that some interval must elapse between the connection of the first subscriber and the opening of the exchange service, for which subscribers pay subscriptions, and during this interval no question has been raised as to the moderate experimental use which has been made of the comparatively small number of lines connected with the exchange. It would appear, however, that the Corporation of Brighton intend to go beyond the limits which have been observed by other Corporations, and to offer to subscribers, and especially to subscribers who at present have lines provided by the National Telephone Co., an effective exchange service without payment. The Postmaster-General regards such an arrangement as a breach of clause 11 of the Corporation licence, and I am to ask that subscriptions at rates within the specified limits may at once be collected from all subscribers who are enjoying an effective exchange service. The Postmaster-General notes the mayor's assurance that the offers of money which have been made to subscribers of the Telephone Company at Burgess Hill have been made without the knowledge of the Corporation, and that there is no possibility of any disbursements in this respect being repaid by the Corporation. Lord Stanley cannot, however, dissociate the Corporation from responsibility for the acts of the chairman of their committee, and as those acts constitute a breach of the conditions contained in clause 21 of the Corporation licence, which forbids the giving of favour or preference, he considers that the offers made to the Telephone Company's subscribers at Burgess Hill should be at once withdrawn.—T. S. LAMB.

The following reply to the above is from Mr. F. J. Tillstone, town clerk of Brighton:—

SIR: I have submitted to the Telephone committee of the Corporation your letter of 2nd inst. with reference to the correspondence which has taken place between the Mayor of Brighton and the general manager of the National Telephone Co. The committee regret to learn the opinion which the Postmaster-General has expressed upon the subject matter of that correspondence and with respect to the course which the Corporation are taking with a view to establishing an effective exchange before charging rents for the services now being connected with the Corporation telephone system, and which opinion appears to the committee to be based in a large measure on inaccurate and incomplete information. In the first place, the committee desire me to assure the Postmaster-General that the representation made to him (as the committtee assume by the National Telephone Co.) that an offer has been made by the Corporation "to subscribers who at present have lines provided by the National Telephone Co." other than that made to all subscribers to the Corporation system is contrary to fact. The promise which has been made to subscribers to the National Telephone Co. is exactly the same as that made to all other subscribers—namely, that no charge will be made until 750 subscribers are attached to the system—in other words, until there is what will, in the opinion of the Corporation, be an effective exchange service. The committee are informed that, in adopting this course, they are following the usual practice in telephone business in all countries in the world, as well as that of the National Telephone Co., and they are of opinion that it is not possible to establish an exchange in any other way, as it is certain no person would pay for a telephone until he had a sufficient number of others to talk to to render the instrument useful.

In forming an opinion as to what will be an effective service in Brighton the committee have had regard to the total number of lines they are providing, and what course, as they are informed, was taken under similar circumstances in other towns. The committee are officially informed that in Glasgow no charge was made to subscribers until after a lapse of five months after the switching on began, and that at the date when rents were first charged the number of subscribers working was 1,450; and that at Portsmouth no charge was made until 700 had been connected. In the case of Swansea, where the Corporation system only provided for 750 lines, the number of subscribers at the date of the formal opening was 366, or nearly half the total. Brighton Corporation are providing for an exchange of 2,000 lines, the first of which was connected on Oct. 5 last, and the committee submit that, having regard to the total number of lines being provided, 750 is not an unreasonable number to constitute an effective exchange for the borough and the other towns and parishes within the Brighton telephone area, and that, in fixing that number, the Corporation are not going beyond the limits observed by other corporations. The present number of subscribers connected with the exchange is 284, nearly all of whom are situate in a very limited area closely approximate to the exchange.

With reference to offers of money by Mr. Carden to subscribers at Burgess Hill, these, as already stated by the mayor, were made by Mr. Carden on his own responsibility and without the previous knowledge of the committee or any official authority whatever. The committee regret that Mr. Carden took the course he did, but they cannot admit any responsibility on the part of the Corporation or themselves or their officers for the acts of an individual under such circumstances. Mr. Carden's authority as councillor and chairman of the Telephone committee ceases as soon as he leaves the council chamber or the committee room, as the case may be, and probably the Postmaster-General is aware that no member of the

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council of a borough, except the mayor, has any authority except when acting with his colleagues in a collective and corporate capacity.

Respecting the last paragraph of your letter, Mr. Carden informs the committee that he will act in accordance with the Postmaster-General's wishes in the matter.

Brighton Telephone committee have resolved "That for the present all terminal fees of Corporation customers be paid by the Corporation."

Municipalities and Endowment Funds.—A Finance sub-committee of Dundee Corporation approved last week the principle involved in the establishment of a fund for the saving of a portion of the wages of each of the employés of the municipality, together with contributions by the Corporation, and the payment of the accumulated savings, with 4 per cent. interest, to the employés on their attaining the age of 65 years. Details of the scheme will come up for discussion later.

Newcastle-on-Tyne.—The receipts of the municipal electric tramways for the year ended 15th inst. were £173,260, compared with £127,250 in the previous year, an increase of £46,010. Nearly 10,000,000 more passengers were carried, the totals being 28,250,000 for the first year and 38,220,000 for the year just closed. There are now 42 miles of tramway track, compared with 14½ miles when the cars were first run and 38 miles on the first anniversary last December. The present number of cars running is 150.

Obituary.—The death took place at Cairo on Dec. 1 of Mr. E. A. Floyer, Inspector-General of Egyptian Telegraphs. Mr. Floyer entered the Indian Telegraph Service in 1869. In 1876 he was appointed Inspector-General of Egyptian Telegraphs, a position in which he rendered useful service to the military authorities during the campaigns of 1882 and subsequent years.

Poplar (London).—The General Purposes committee recommend the Council to approve the plan for the construction of the London County Council electric tramways on the conduit system along East India Dock-road and also the proposed extension to the Iron Bridge.

Post Office Telephone Proposals.—Blairgowrie (N.B.) residents some time ago asked the National Telephone Co. to provide telephonic facilities for the district, but the company stated that the request could not be complied with as the Post Office authorities would not give permission for the use of the trunk line in connection with Blairgowrie. Subsequently, application was made to the Postmaster-General who has signified his willingness to accede to the request on condition that a guarantee be given of a minimum payment for trunk calls of £5 per annum per mile of trunk line between Dundee or Perth and Blairgowrie. Coupar Angus could be taken in the route and could share in the guarantee. It is anticipated that the requisite number of subscribers will be secured.

Railway Merchandise Traffic Classification.—Notice is given in another column that, pursuant to the Railway and Canal Traffic Act, 1888, the various railway companies of Great Britain and Ireland have applied to the Board of Trade to amend the classification of merchandise traffic and the schedule of maximum rates and charges applicable thereto charged by such companies, by including in class 5 of the classification phonograph records and gramaphones. Objections to the proposed amendment must be sent to the Assistant-Secretary, Railway Department, Board of Trade, S.W., within 21 days from 18th inst.

St. Annes-on-the-Sea.—Sanction to a further loan of £4,000 for extensions of the electric lighting mains and house-service extensions has been applied for.

St. Pancras (London).—At the meeting of the Council last week the chairman of the Electricity committee (Councillor Hickling) presented the report of the committee.

The minutes stated that an offer had been received of £200 for one of the original Willans-Kapp generating sets which was dismantled to make room for the larger units now installed at the Regent's Park works. At the sum named the committee were of opinion it would be in the interests of the Council to dispose of the set.

An amendment was moved that the matter be referred back with a view to advertise the disused machinery. It was said that there were 11 of these sets on their hands, which, according to Councillor Dr. Beaton, showed the necessity of a large reserve by the electricity department.

The amendment was withdrawn, and the offer was agreed to.

Sale.—Pursuant to sub-sec. 2, sec. 91, of the Manchester Southern Tramways Act, 1903, Sale Council have formally intimated to the Manchester Southern Tramways Co. that they desire to be substituted in the place of the company for the purposes of the said act so far as they relate to Sale.

South Africa.—Cradock (Cape Colony) Town Council have instructed Mr. Gerrard, hydraulic engineer, to prepare plans for an electric lighting and water supply scheme estimated to cost £50,000. The scheme is to provide for the generation of electrical energy by water-power in addition to supplying water for general consumption in the town.

South Shields.—The Tramways committee recommend the Council to invite alternative tenders for the construction and electrical equipment of tramways, and for constructing and working same on lease.

Spain.—Señor Don Angel Garcia Rendules has been appointed Director-General of Spanish Posts and Telegraphs in the place of Don Rafael Monares, who died on 3rd inst.

Stoke Newington (London).—The London County Council have informed the Council that they intend to adopt the conduit system of traction on the tramways in the borough.

Stroud.—The application of the Gloucestershire Electric Power Syndicate for a provisional electric lighting order will not be opposed by the Rural Council.

Sunderland.—The fourth annual dinner of the Sunderland electric lighting staff took place on Tuesday.

The borough electrical and tramways engineer (Mr. John F. C. Snell) presided over a company numbering about 130, including the mayor (Ald. H. J. Turnbull), Ald. Bruce, the town clerk (Mr. F. M. Bowey) Messrs. H. England (late tramways manager), A. R. Dayson, A. E. Hadley, J. F. Moore, E. White, Donkin, &c.

The toast of "The Mayor and Corporation" was submitted by Mr. E. White, station superintending engineer, who said that while eight years ago the electricity department supplied 96,000 units in 12 months, in one week during the present year they produced 109,000 units, and when they got the power scheme fairly working they would, he had no doubt, turn out twice that amount.

The Mayor, in responding, referred to the increase in the electrical department staff since their last dinner. The Corporation was proud of the electric lighting department, and greatly pleased that the Municipal Electrical Engineers' Association had held their annual meeting in that town, and delighted to see the esteem and respect in which their chief (Mr. Snell) was held. The success of the Corporation undertakings depended a great deal upon the employés, to whatever department they belonged.

Responding to the toast of "The Engineering Contractors and other Visitors," Mr. A. E Hadley (Electrical Company) thanked Mr. Snell for his kindness, fairness and firmness in dealing with them.

Mr. H. D. Wight (Sunderland Forge Company) also responded.

The Chairman of the Electric Lighting committee (Ald. Bruce) submitted "The Borough Electrical Engineer and Staff of the Electrical Department," and said it was a great satisfaction, not only to members of the committee, but to the Corporation to know they had a superintending engineer in Mr. Snell who had not only their confidence, but also the esteem of the whole of his profession, and that he was respected and honoured by every contractor. He heartily approved of the principle on which Mr. Snell ran the department, in that he had no intermediary persons between himself and the heads of the various branches. He was ably assisted by Mr. E. White, whose ability was testified to by the contractors. Mr. Moore was a capable distributing engineer, who had lately had added to his duties the charge of three sub-stations; and Mr. Donkin, the chief clerk and cashier, had the confidence of the department. He advised the young men to attend the Technical College classes, and to study earnestly so that they would know the technical as well as the practical side of their work. He then referred to the launching of the three-phase system, and said already its success was assured. They were now supplying 2,500 units daily to shipyards, and they had so many promises of custom that a third engine would have to be put into the Hylton-road station in the early part of next year. Now they had three sub-stations (Pallion, the Docks and Monkwearmouth), and soon they would have to have one at Hendon. The present capital was a quarter of a million, and they had £27,500 as reserve. During the half-year ended Sept. 30 the net profits were £841. He also briefly referred to the success of the trams.

In response, Mr. Snell referred to the self-sacrifice shown by members of the committee, and by the chairman in particular. He would like to express his gratitude to his colleagues in the Corporation, to the town clerk, whose mature advice was always at his service, to the borough engineer for the help he had given at times, as well as others who had assisted from time to time. He also thanked his own staff, and assured them that he did not take all the praise that was given to him to himself, for he knew much of it was due to his juniors. When the three-phase system developed, he expected they would require not three, but four or five engines.

Swinton and Pendlebury.—The clerk has been instructed to obtain the terms of Salford Corporation and the Lancashire Tramways Co. for the supply of electricity in bulk.

Theft of Cable.—At the Guildhall (London) on Monday, before Ald. Smallman,

Alfred Toms, a marine store dealer, and five cable jointers, all in the employment of the Charing Cross and City Electric Co., were charged on remand with being concerned in stealing and receiving a quantity of copper cable, the property of the company. Mr. Frampton prosecuted, and said that detective-sergeant Collison went to an address in Old-street, St, Luke's, and found Toms in the act of stripping cable. On the place being searched there was found from 8 cwt. to 10 cwt. of copper wire and some plumbers' metal and solder. Mr. A. P. Hudson, electrician to the company, said the "jointers" had to work at the various inspection chambers and they frequently had occasion to cut short lengths, which should be returned to the stores. He had identified between 6 cwt. and 7 cwt. of material found at Toms' shop, valued about £18.—Remanded until yesterday (Thursday) when Toms was sentenced to 6 months' hard labour.

At the same court,

John Brown, Frederick Kerr, David Lang, William McConkie and Ernest Ezra, all jointers in the employment of the same company, were

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charged with stealing cable, plumbers' metal, &c. Brown and Lang came to Toms' premises in Old-street while the police were in possession, bringing the alleged stolen property, and were taken in charge by the police. Kerr was afterwards arrested while at work.—Remanded. Yesterday (Thursday) all prisoners were convicted, each of the first four being sentenced to six weeks' hard labour, and Ezra to a month's hard labour.

Theft of Electricity.—At Bow-street (London) Police Court last week Walter Lawrence, described as an electrical engineer, was fined £5 for stealing electricity from the Charing Cross and Strand Electricity Supply Corporation.

Tiverton.—On Monday the Council approved a recommendation of the Lighting committee to enter into a contract with Frank Suter & Co. for the erection and working of electricity supply works and to apply for sanction to a loan of £12,200 for the undertaking.

Walsall.—On Monday the Council authorised the expenditure of £1,430 for additional plant at the electricity works for tramway supply.

West Ham.—The Education committee have, owing to complaints as to the gas lighting at Clarkson-street and Maryland Point schools, instructed the architect to prepare estimates of the cost of wiring and fitting up for electric lighting.

Westinghouse-Parsons Marine Steam Turbine.—The American Westinghouse Co. have acquired full rights to manufacture the Parsons steam turbine in the United States and Canada. A special department is being organised at Pittsburg for building this type of engine. It is stated that some half-million horse-power of these turbines are in daily operation in different parts of the world, 84,000 H.P. being used for steamship propulsion. In the United States alone some 60,000 H.P. of turbine engines are employed in electricity generation, and 150,000 H.P. more are under construction. Engines as large as 8,000 H.P. are already being built at Pittsburg, and the Westinghouse Company are looking forward to immense developments in this new branch of industry, more especially with regard to ship work.

Widnes.—The Council have memorialised Liverpool Corporation in favour of extending the electric tramway to Widnes.

Wolverhampton.—The Town Council have decided, on the recommendation of the Tramways committee, to discontinue the ordinary service of cars on one section of the tramways.

Ald. CRADDOCK, in moving the adoption of the committee's report on Monday, said there had been a mistake in constructing this section, as it had resulted in a loss of £800 per annum.

Mr. ALLEN deprecated the proposed abandonment, as that portion of the system had, he said, cost £10,000, and involved the payment of £536 in interest.

An amendment that the service be continued was lost.

Electro-Harmonic Society.—Members and their friends are reminded that a smoking concert of the Electro-Harmonic Society will be held in the King's Hall, Holborn Restaurant, London, W.C., this (Friday) evening, at 8 o'clock, under the presidency of Mr. A. P. Trotter.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Erith Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, brickwork settings and steam feed pump; steam, &c., pipes; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam engine of 500kw.; and extensions to main switchboard and cable connections. Specifications from the clerk to the Council (Mr. Charles H. Fry), Council Offices, Erith, Kent. The works are to be carried out in accordance with plans and specifications prepared by the consulting engineers (Messrs. Hawtayne and Zeden), 9, Queen-street-place, London, E.C., from whom further information may be obtained. Tenders to the clerk by noon Jan 18. See also advertisement.

Oldham Corporation Electricity committee invite offers from firms who will appoint the Corporation as their agents in a hiring or hire-purchase system for motors, radiators, cooking appliances, &c., to be fixed on the Corporation mains. Particulars from the borough electrical engineer (Mr. S. Wilmott Newington), to whom tenders by 23rd inst. See also advertisement.

Long Eaton Urban District Council invite tenders for engine and dynamo (250kw. set) and accessories, one Lancashire boiler, overhead hand travelling crane and economiser. Specifications from the engineer and manager (Mr. Frank Worrall, M.Inst.C.E.), Electricity Supply Works, Long Eaton. Tenders by noon Jan. 1. See advertisement.

Kettering Urban District Council invite tenders for supply and delivery of electricity meters. Specifications can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to the clerk (Mr. John Bond), Council offices, Kettering, by Jan. 9. See also advertisement.

Wallasey Urban District Council invite tenders for the supply and delivery only of about 7,100 yds. of concentric armoured cable, together with joint boxes and section boxes. Specifications from the electrical engineer (Mr. J. A. Crowther), Electricity Supply works, Sea View-road, Liscard. Tenders, addressed to Mr. H. W. Cook, clerk and solicitor, Public offices, Egremont, Cheshire, by Jan. 16. See also advertisement.

Walthamstow District Council invite tenders for (*a*) permanent way, (*b*) feeders, (*c*) switchboard and plant, (*d*) overhead equipment, bonding and pillars. Tenders to Mr. Sydney Watson, clerk and solicitor, Town Hall, Walthamstow, by Jan. 1.

Tenders are invited for wiring the *Kent and Canterbury* Hospital for electric lighting and other works in connection therewith. Further information from the secretary (Mr. A. J. Lancaster), 36, St. George's-street, Canterbury.

Irvine Corporation invite offers for providing and erecting the plant and apparatus necessary for the supply of electricity under their provisional electric lighting order. Particulars from the town clerk (Mr. James Dickie).

Hackney (London) Borough Council invite tenders for feeding and distributing mains. Tenders to the town clerk (Mr. George Grocott), Town Hall, Hackney, by 4 p.m. Jan 4.

Pontypridd District Council invite tenders for tramcars, and for free wiring of premises. Tenders to chairman of Electric Lighting and Tramways committee, Pontypridd, by noon Dec. 24.

Blackpool Tramway committee invite tenders by Dec. 29 for laying about 1,650yds. of double-track tramway.

Battersea (London) Borough Council invite tenders for coal-handling plant. Tenders by noon of Dec. 28.

Hackney (London) Electric Lighting committee are also inviting schemes (by noon Jan. 4) for wiring consumers' premises on a rental system.

Messrs. Preece and Cardew are authorised by the Municipal Council of *Sydney* (N.S.W.) to invite tenders for the supply, delivery and erection of one or two 600kw., or one 1,200kw., steam alternators (three phase), with condenser, pipework, motor generators, static transformers, switchboards, &c. Tenders to Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W., by noon Jan. 12.

The *Melbourne Argus* tables of the Australian mails for 1904 will be found a useful pocket companion for those interested in matters Australasian.

Tenders are invited until 28th inst. by the *French Post and Telegraph Authorities* for 1,081 tons copper wire, 80 tons bronze wire, 250 tons galvanised iron wire 4mm. diameter, and a quantity of rubber insulated electric cables. Particulars from, and tenders to, Le Sous Secretariat d'Etat des Posts et des Télégraphes, 103, Rue de Grenelle, Paris.

Tenders are invited until 31st inst. by *Petrinja* (Croatia) Municipal Authorities for an electric lighting concession.

TENDERS RECEIVED AND ACCEPTED.

The Australian Commonwealth Government have accepted (for Victoria) the tender of—

J. Bartram & Son (Melbourne) for 580 Ericsson telephone wall sets, with hand combination, spare receiver and two agglomerate cells complete at £2,599. 11s. 8d.; also for 150 Ericsson table telephone sets complete at £495; 200 ebonite transmitter mouthpieces at £5. 16s. 8d.; 100 transmitter stocks at £7. 1s. 8d.; 200 detached transmitters without mouthpieces at £55; 4 gross nuts for Ericsson "conversers" at £1. 2s.; 10 telephone trunk line stop watches (3 and 5 minutes) with start, stop and flyback action at £7. 11s. 8d.; 45 tons hard-drawn copper wire (100lb. per mile) at £3,420; 20 tons ditto (200lb. per mile) at £1,520; 5 tons stranded steel wire (7-strand, 17 gauge bound to 8 gauge) with breaking strain of 2,000lb. at £74. 1s. 3d.; 1,000yds. flexible cord (35/40) at £8. 5s.; 50 magneto extension bells at £19. 11s. 8d.

The tender of the India Rubber Company's Melbourne house has been accepted for 10 condensers, 2 mfd. capacity, £58. 10s; 10 ampere-meters, £14. 9s. 2d.; 10 voltmeters, £14. 9s. 2d.; 4,000yds. telephone cord, single, central main board, £37. 16s. 8d.; 3,000 zincs, Callaud, to sample, £143. 15s.; 18,000 zincs, Leclanché, No. 2, £121. 17s. 6d.; 100 battery brushes, steel, £11. 5s.; 1,000lb. instrument tape, £20. 16s. 8d.; 224lb. staples, steel, coppered, ½in., £6. 1s. 4d.; 300 telephone back plates, carbon, £5. 6s. 3d.

J. A. Newton & Co., Melbourne, have received an order for two D'Arsonval galvanometers (by Nalder Bros. & Co.), 1,000 ohms, brass case, £11; 2,000lb. wire for transfer boxes, 18 gauge, insulated with vulcanised indiarubber and braided, insulation resistance 500 megohms per mile, £166. 13s. 4d.; 2,240lb. office wire, 18 gauge, tinned, first insulated with pure indiarubber, then covered with rubberised tape, then

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with paraffined-plaited cotton, £177. 6s. 8d.; 5lb. copper wire, No. 24 gauge, 0·022 silk, double-covered, 16s. 3d.; 5lb. copper wire, No. 30 gauge, 0·0124 silk, double-covered, £1. 4s. 2d.; 500 ebonite rings, for Berthons, £2. 12s. 1d.; 300 do. ear-pieces, £10; 200 do. casings, for transmitters, £25. 16s. 8d.; 5lb. do. sheets, ¼in., sheets to be not less than 2ft. by 2ft., 15s. 5d.; 56lb. do. sheets, ⅛in., sheets to be not less than 2ft. by 2ft., £8. 12s. 8d.; 5lb. do. tube, ⅛in. diameter, $\frac{1}{16}$in. thick, £1. 3s. 9d.; 5lb. do. tube, ¼in. diameter, $\frac{1}{16}$in. thick, £1. 3s. 9d.; 50 fibre hooks (Berthon pattern), 12s. 6d.; 500 fibre clips, for transmitters, £9. 7s. 6d.; 1,000 incandescent lamps, 110 volts, 16 c.p., £26. 0s. 10d.; 150 incandescent lamps, 200 volts, 16 c.p., £5. 3s. 1d.; 80 extension telephone indicators, 40 repeater and 40 permanent ringer, fitted with two shutters, £99. 6s. 8d.; 12 extension telephone indicators, permanent ringer, fitted with three shutters, £18. 17s.; six extension telephone indicators, permanent ringer, fitted with four shutters, £12. 6s.; three extension telephone indicators, permanent ringer, fitted with 10 shutters, £14. 3s. 6d.; 10 gross nuts, £1. 17s. 6d.; 100 plugs, for section switches, £4. 3s. 4d.; 50 lever switches, small, £12. 1s. 8d.; 50 handles for Berthons, £2. 18s. 4d.; 50 transmitters for exchange, £12. 10s.; 50 cutouts, £1. 17s. 6d.; 10 mountings for cable boxes, 54 wire, £38. 4s. 2d.; five mountings for cable boxes, 28 wire, £11. 6s. 3d.; 10 terminal strips for underground cables, £6 0s. 10d.

W. H. Wischer (Melbourne) is to supply 5,000 McIntire sleeves, for jointing 100lb. H.D. copper wire, £25. 2s. 1d.; 10 tons galvanised iron wire, 600lb. per mile, £109; 25 tons galvanised iron wire, 400lb. per mile, £372. 10s.: 15 tons galvanised iron wire, 200lb. per mile, £178.10s.; 1 ton galvanised iron tie wire, 60lb. per mile, £14. 18s.

Maidstone Corporation received the undermentioned tenders for the construction and equipment of light electric railways in the district:—

Dick, Kerr & Co. (*accepted*)	£18,871	3	11	Wm. Griffiths & Co.	£21,634	11	11
British Westinghouse Co.	23,052	5	10	British Elec. Equipment Co.	21,532	8	9
Brush Co.	21,759	11	5	R. W. Blackwell & Co.	20,079	3	3
				J. G. White & Co.	19,016	1	4

Wednesbury Corporation received seven tenders for wiring the town hall, municipal offices, art gallery, public baths and public library to the specification of Mr. F. J. Warden-Stevens, C.E. The amounts varied from £465 to £657, and the lowest, that of the National Electric Construction Co., was accepted. Seven tenders, varying in amount from £40 to £60, were also received for wiring the electricity sub-station, and the lowest, that of Mr. W. Preston, jun., was accepted.

The following tenders have been accepted by Kilmarnock Corporation:—

Yates and Thom (boilers)	£1,765
Dick, Kerr & Co. (engines and dynamos)	3,855
Carrick and Ritchie (overhead crane)	268
Tudor Accumulator Co. (storage battery)	1,201
Cox, Walkers (switchboard and boosters)	1,989

Messrs. Edgar Allen & Co. (Ltd.) have secured, through Messrs. J. G. White & Co., the contract for cast-steel points and crossings, with tongues and renewable pieces, in their imperial manganese steel and cast-iron bound crossings, with manganese steel centres, for Northampton. The firm have also secured a contract for the Sunderland District Tramways (through Messrs. A. Krauss & Sons) for the whole of the cast-steel points fitted with manganese steel tongues and crossings required in the construction of these tramways.

The contract for the supply of tramway rails, fishplates and flange rails at Johannesberg has been secured by Bolckow, Vaughan & Co. The total quantity required is about 7,000 tons, and the total value of the order is over £40,000. The order for the points and crossings for the same tramways has been secured by Hadfield's Steel Foundry Co., Sheffield.

East Ham District Council have accepted the following tenders:—

Dick, Kerr & Co. (steam dynamo, with Musgrave steam engine)	£8,687
Babcock and Wilcox (boilers, &c.)	5,080

The tender of Hewett and Kellet for boilers for Middlesbrough electricity works has been accepted, Messrs. J. and J. Horsfield & Co. having been allowed to withdraw, owing to an error in their tender.

Sunderland Corporation have accepted the tender of F. Reid, Ferens & Co., for re-wiring for 220-volt supply the High-street Baths, and for the electric light fittings at Pallion and Whickham-street sub-stations.

Bray Urban District Council received 17 tenders for a jet condenser and steam-driven pump for their electricity works, and the tenders ranged from £129 to £530. The lowest (that of Blake and Knowles Steam Pump Works) was accepted.

Portsmouth Telephone committee received three tenders for switchboard extension at the central exchange, and recommend the acceptance of the International Electric Co. at £645.

Newport (Mon.) Borough Council have accepted the lowest tender (that of Johnson and Phillips), out of 36 tenders received, for the supply of three electric motors with switch gear.

Whitehaven Guardians have accepted the tender of Ramsay Bros. for wiring the workhouse at £432. 10s.

Hammersmith (London) Borough Council have accepted the tender of Gwynnes Limited for two steam-driven centrifugal pumps for the electricity works at £179. 10s.

Messrs. Rowland Carr & Co. have again secured the annual contract for supply of insulating compound for the National Telephone Co.

Gravesend Council have accepted the tender of H. Balbour & Sons for a tank for the electricity works at £178, and that of G. F. Zimmer for conveyors.

Beckenham Council have accepted the tender of the British Westinghouse Company for electricity meters.

Hull works committee have placed an order for 15 Kennington collapsible tramcar covers at £80 each.

Bolton Corporation have accepted the tender of Messrs. Pullin and Shaw for high-tension switches.

Whitehaven Council have accepted the terms of the Brush Company for electric motors for letting out on hire.

Hammersmith Borough Council have placed an order with Easton & Co. for a superheater at £79.

BUSINESS NOTICES

Messrs. W. Court and H. Taylor, electrical engineers, &c., 53, Broadway, Wimbledon, London, S.W., have dissolved partnership. Debts by Mr. Court, who continues.

The new telephone number of the Hart Accumulator Co. (Ltd.), Marshgate-lane, Stratford, London, E., is 823 East, and *not 832* East as stated in our last issue.

LIQUIDATIONS, BANKRUPTCIES, &c.

A meeting of creditors of Max Margowski, financial agent, &c., 13 and 14, Abchurch-lane, E.C., took place at the London Bankruptcy Court on Thursday last.

Debtor said he was born in Russia, but was a naturalised American. For some years prior to coming to England in 1893 he carried on business in New York as a financial agent. In 1895 he subscribed £3,500 for working capital of the Apostoloff Automatic Telephone (Parent) Syndicate (Ltd.) of which he acted as managing director. The concern was reconstructed in 1897 and again in 1903, as the Automatic Telephone Co. (1903) (Ltd.). He had also been interested in other companies. He attributed his failure to losses in connection with various companies and enterprises that he had financed, and to the present stagnation of finance business. The meeting was adjourned to Monday to enable debtor to submit an offer.

A meeting of the creditors of Cecil Wray, electrical and mechanical engineer, 16, Chevin-view, Eccleshill, and 24, Simes-street, Bradford, was held last week. Liabilites £1,508, assets £143. Mr. W. A. Turner, Bridge-street, Bradford, is trustee, with committee of inspection.

T. Hyom, electrical installation contractor, 139, Fawcett-road, Southsea, has been adjudicated bankrupt. First meeting of creditors 23rd inst. at Cambridge Junction, public examination 30th inst. at Court House, Portsmouth.

J. W. M. Storr, electrical engineer, 29, Grange-road, Dudley, has been adjudicated bankrupt.

The discharge in bankruptcy of Frederick King, electrical engineer, Stone Bridge, Bristol, is suspended for two years.

The trustee has been released in the bankruptcy of L. Bayliss (trading as F. Terrill & Co., Cardwell & Co. and the Thames Electrical Mfg. Co.), Wednesbury and London.

It is announced that Bland Bros. (Ltd.), Newcastle and Darlington, is being wound up voluntarily in consequence of the resignation of the managing director, Mr. W. E. Bland. Mr. W. A. Rycroft, 70, Pilgrim-street, Newcastle-on-Tyne, is liquidator.

The British Electric Car Co. (Ltd.) is to be wound up voluntarily. Mr. T. F. Wild, 23, Broad-street-avenue, London, E.C., is liquidator.

Meetings of the Imperial Electric Supplies (Ltd.) and the P Bloc Battery Co. (Ltd.), will be held on Jan. 15 at 5, Gray's Inn-square, London, W.C., to receive an account of the winding up.

Factory Premises for Sale—A freehold manufacturing site, up to 50,000 sq. ft., without restrictions and within 2 miles from City and West-end, is advertised for sale in another column.

Plant for Sale.—Messrs. Bottone & Son, Wallington, Surrey, have for sale a 1 H.P. Tangye dynamo gas engine, a ½ H.P. gas engine and accumulator-charging dynamo, a ¾ H.P. high-speed vertical steam engine, X-ray coil, 4in. spark, 1 H.P. direct-current series motor, and ¼ H.P. 200-volt direct-current motor, a 3 H.P. petrol engine, &c. Further particulars in advertisement.

Three 20 N.H.P. Marshall horizontal compound engines and three 20 H.P. Marshall multitubular high-pressure boilers, with feed-water heater, two Worthington pumps, &c., are for sale. Applications to inspect the plant (in working order) to the clerk to the Governors, People's Palace, Mile End-road, E. See advertisement.

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Car Works for Sale.—Some modern well-equipped car-building works, occupying a covered area of 8¾ acres, with 25 acres available for future extensions, are advertised for sale in another column. Applications to Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C.

Catalogue.—The British Thomson-Houston Co. have ready lists Nos. 79, 155 and 162. These deal respectively with electric measuring instruments, induction motors and automatic circuit-breakers.

Calendars, &c.—With the advent of Christmas comes the usual and always welcome batch of calendars, date pads, desk and table requisites, &c., which are so effective a means of advertising. The first to come to hand is the artistic and useful framed calendar issued by Messrs. G. Street & Co., the well-known British and Colonial advertising contractors, 30, Cornhill, 8, Serle-street, and 164, Piccadilly, London.

The Direct United States Cable Co. issue a neat hanging tear-off pad calendar for the New Year, in which the addresses of the company's numerous offices in Great Britain, the United States and Halifax (Nova Scotia) are prominent.

Accompanied by a useful book price list for rough calculations of E.P.S. storage cells, we have received a copy of the ever-welcome E.P.S. blotting pad, calendar and diary, one of the most serviceable of the desk companions which reach us at this season of the year.

From the Simplex Steel Conduit Co. we have to acknowledge an advance copy of a diary for 1904, which, in addition to being a useful waistcoat-pocket diary, is an accident insurance policy for £1,000. The company's special class of manufactures are servicably illustrated and described in brief, without in any way interfering with the usefulness of the volume as a pocket book.

Messrs. Dorman and Smith have prepared for their clients a useful pocket book with foredge index for notes and memoranda. In this useful pocket book an infinite variety of electrical apparatus and accessories manufactured by Messrs. Dorman and Smith at Ordsal Station Electrical Works, Salford, is illustrated and described. There is a quantity of useful information also given, and some squared paper for engineers' use.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Dec. 9 to 15, with the ports of destination:—

Africa—Alexandria, £310; Cape Town, £329; Delagoa Bay, £31; Durban, £2,317; East London, £251; Port Elizabeth, £142. *Argentina*—Rosario, £172. *Australasia*—Adelaide, £78; Hobart, £685; Melbourne, £169; Perth, £52; Sydney, £473; Wellington, £1,303. *Belgium*—Antwerp, £285. *Brazil*—Rio Janeiro, £103. *Canada*—Montreal, £40. *Channel Islands*, £70. *China*—Shanghai, £180; Tientsin, £157. *Corea*—Chemulpo, £59. *Germany*—Hamburg, £120. *Gibraltar*, £1,345. *Holland*—Amsterdam, £60. *India*—Bombay, £259; Calcutta, £671. *Malta*, £55. *Mauritius*, £120 (telegraph apparatus). *Siam*—Bangkok, £50. *Spain*—Grenada, £16 (telegraph material). *Straits Settlements*—Singapore, £183. *Uruguay*—Monte Video, £105. Total, £10,190, against £22,444 in the corresponding week last year (Dec. 10 to 16).

COMPANIES' MEETINGS AND REPORTS.

Arc Lamps Limited.

The third ordinary general meeting was held yesterday. Mr. C. Williamson Milne (chairman) presided.

Mr. SYLVESTER D. STIRLING (the secretary) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: It is a pleasure to meet the shareholders with a report such as that which we have circulated. The accounts are very clear and concise and scarcely call for any explanations or special comment from me. You will have noticed there is a profit from the trading account of £5,835, and that the balance available for dividend is £4,350. Out of that we have already paid a dividend at the rate of 5 per cent. for the first six months of the year, and we now propose, with your consent, to pay a further dividend at the rate of 7 per cent. for the second half. I think you will agree that that is a very satisfactory result for a company that has only just finished the second year of its existence. The report refers to the continued increase in the popularity of the W. J. Davy lamps, and I think the measure of our success may be guessed when I tell you that not only have our lamps been selected by the London County Council for lighting their new tramways in South London, after the most severe tests against all the best known makers of enclosed arc lamps, but, besides that—and we regard that as one of our greatest triumphs—we have again and again scored in competitive tests under ordinary working conditions which have been undertaken by corporation engineers all over the United Kingdom. During the past year no fewer than 36 new corporation accounts have been opened by the Company, and that is without taking any account of borough councils and other large consumers. A fact which should not be lost sight of is that, once we have secured a customer, I think I am safe in saying we have never lost him. We have had repeat orders from all the firms, practically, on our books who have once taken up the lamps and who have had occasion to order additional lamps, and when I mention such firms as the Fairfield Shipbuilding Co., the British Westinghouse Co., the British Insulated and Helsby Cables Co., the London and North Western Railway Co., and the Great Central Railway Co., I think I indicate that our customers are people who really understand what arc lamps should be, and who appreciate the Davy lamp at its proper standard. Well, with facts like these, I think we may fairly claim to have lived up to the statement which we made in our prospectus, that: "The W. J. Davy lamp contained features of marked superiority over every other type of lamp; its repeated selection by consumers, after severe competitive trials against other enclosed lamps, would fully demonstrate its efficiency." Now we may attribute our success, I think, to the following:—The efficiency and reliability of the lamp even under varied conditions; its thorough standardisation; its extreme simplicity of construction; the interchangeability of every part; the use only of the very best materials obtainable, and the highest class of workmanship. Our patents during the year have been increasing to such a degree that it has become imperative that we must again extend our works and acquire additional premises. Negotiations are in progress for the requisite accommodation, and I hope before many weeks have gone we shall have the extended factory in full operation. There is a modest reference in the report to what we call our 1904 lamp. This is really an important discovery, and it is difficult for us to over-estimate the value of our new patents. They are the result of extensive and continuous experiments by Mr. Davy. Those of you who know anything of electric lighting will appreciate the value of the lamp when I tell you that it has really only one working part. There are no dash-pots, bobbins, springs or complicated levers in the lamp; it burns equally well on both direct and alternating currents, and either in series or parallel without alteration. As to the consumption of electrical energy, the watts per candle-power are lower than any previous record we have had with our present type of lamp; and our present lamp has always had the reputation of being one of the best, if, indeed, it is not the very best, in the market in this respect. Apart from the enormous business to be done in the home market with such a lamp as this, you can easily guess the scope for such a lamp in the colonial and foreign markets, because the advantage of having an extremely simple lamp such as this is one which appeals to the practical mind and to those who have had experience of the intricate mechanism of other enclosed arc lamps. It gives our lamp, I think, a peculiar value to exporters and engineers who have occasion to fit up distant installations. I consider our 1904 lamp ought to quadruple the value of our shares before very long. There is only one other matter I need particularly refer to. Away back in November, 1899, the Jandus Arc Lamp and Electric Co. issued a writ against Mr. Davy. That was before the existence of this Company. They delivered their statement of claim on Jan. 16, 1900, and after a long period of delay, and when Mr. Davy, as defendant, had been pressing to either have the trial proceeded with or the summons dismissed, the plaintiffs, on June 22, 1900, served notice of their discontinuance of the action, and on June 28 an order dismissing the action was drawn up, and the plaintiffs, the Jandus Company, paid Mr. Davy's costs in the action. In March last the Jandus Company issued a writ against this company, the grounds of action being identical with those which they advanced when they commenced their action against Mr. Davy personally in November, 1899. Notwithstanding all our efforts there has been very considerable delay in getting this matter brought to trial, and you will notice from the report that the Jandus Company have applied for leave to still further postpone the action for the purpose of amending their patents. The judge on Nov. 18 granted permission, but he imposed the following terms:—(1) That the Jandus Company should issue no further advertisements or threats in the meantime; (2) that no claim should be made for damages for any infringement up to the date of the order; (3) the costs of the application and all costs occasioned by the plaintiffs having sued on an invalid specification to be paid by them to the defendants; (4) all amendments to the specifications (which can only be made by way of disclaimer) to be made within four months from Nov. 18. This matter is *sub judice* and so my lips are sealed, and I move the adoption of the report.

Capt. EDMUND IRONSIDE BAX seconded the motion and expressed his thanks to Mr. Davy, whose hard work, he said, had brought the Company to a successful issue.

The motion was adopted, as were resolutions approving the dividend and re-electing the retiring director, Mr. C. Williamson Milne.

The CHAIRMAN then referred to the future capital requirements of the company, and the retiring auditors having been re-appointed, a vote of thanks to the Chairman concluded the proceedings.

Nernst Electric Light (Ltd.).

At the meeting on Tuesday, the chairman (Mr. B. M. Drake) moved the adoption of the report given in our last issue. He was pleased to be able to report that during the past year, for the first time, they had made a net profit. He regretted that Mr. H. Hirst was compelled to resign his seat on the board owing to pressure of other work, but Mr. Wallis-Jones and Mr. Oppenheimer, who had been elected directors, would prove of considerable assistance to the company. The net profit for the year was £3,926. 1s. 11d., against a deficit of £3,157. 9s. 7d. in the previous year. Mr. Drake proceeded to explain the various items in the accounts. The value of patents had been left as before, the charges in connection with the maintenance of the patents having been paid out of revenue, as they only amounted to about £70. It has not been necessary to augment the suspense account as a result of the year's working, but an item which previously appeared under another heading was considered by the auditors to fall under the suspense account owing to alterations

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introduced under the new working agreement with the Allgemeine Elektricitäts Gesellschaft. The royalty on lamps sold in Great Britain was considerably in excess of last year's figure, but it was thought inadvisable to publish that as a separate item in future. He was pleased to say that the working arrangement with the Allgemeine had resulted in the continuance of friendly relations, and he was satisfied that they were doing their best to improve the quality of the lamps sent out. With regard to the progress of the lamp itself in the last report of the Allgemeine Company it was stated that the Nernst lamp, as regards durability and life of burners, had been further improved, and was showing good results, particularly on the higher voltage circuits. New types of lamp had also been placed on the market. Up to date approximately 2,000,000 lamps and burners had been sent out, and the demand was increasing. Mr. Drake said that they had received some excellent reports from their own districts, and others were of a varying nature, dependent largely upon the local skill available and the regularity of the supply upon which lamps were used. The lamp consumed about half the current required by carbon lamps for the production of an equivalent amount of light, but, like the Welsbach mantle, with which the Nernst lamp was so much associated by the earlier investors, it was a more delicate piece of apparatus than the ordinary lamp; hence it was more difficult to get to its destination, and required a skill in handling which was not always available. For those reasons they ought to appreciate the fact that the original hopes formed of the invention—namely, that it would create a complete revolution in the industry—would not be realised by the lamp in its present form. It, however, fulfilled a useful purpose, and he had little doubt that sales would increase, especially in quarters where the generating stations had been well designed and the staff possessed good electrical knowledge. With regard to their finances there was no doubt that the directors would not, under existing circumstances, be justified in dividing any profits made until the losses of the past had been made good. The report and accounts were adopted, and a resolution was passed in favour of reducing the capital to £100,000, in ordinary shares of £1 each, all one class, the preference shareholders receiving £75,000, and the ordinary shareholders £25,000.

India Rubber, Gutta Percha, and Telegraph Works Co. (Ltd.)

The fortieth ordinary general meeting of this company was held on Tuesday, Major Leonard Darwin in the chair.

The SECRETARY (Mr. A. P. Crouch) having read the notice convening the meeting,

The CHAIRMAN (having feelingly referred to the lamented death of Mr. Scott, a director of the company) moved the adoption of the report and accounts, and said they were not at the present moment engaged in any work of great importance. The directors thought the shareholders were to be congratulated on the result of the year's working, as it would be noticed that, while paying the usual dividend of 10 per cent. for the year, there had been written off buildings, machinery and ships £46,150, or some £26,000 in excess of the usual annual depreciation. The general business had fallen off in bulk when compared with last year, and competition had been keen. In one line, a not inconsiderable one, they had been beaten by German manufacturers, who, under the cartel system in vogue amongst them, were selling, he believed, about 18 per cent. cheaper to English consumers than they sold to the German trade. The directors hoped to recover this line by new methods of manufacture while maintaining the good quality of production. The laying of the San Francisco-Honolulu cable was successfully accomplished shortly after the directors met the shareholders a year ago. Since the laying this cable had continued to give every satisfaction to the Commercial Pacific Cable Co. The company's works at Silvertown and Persan were in an efficient state, but it would be necessary to make some further additions to the plant if, as the directors anticipated, the new motor tyre referred to in the report met with the approval of the motoring public. Their chairman (Mr. Marsham) was absent on a tour in Japan, and would, doubtless, make the company's name and the nature of their manufactures known to many in the districts he would visit. Mr. Moore, who was also absent, was expected to leave Cape Town on the 16th inst. on his return journey. He then moved the adoption of the report and accounts, and the payment of the dividend therein recommended.

Mr. GEORGE HENDERSON seconded the motion, which was carried unanimously,

Major Darwin and Mr. C. H. Moore, the retiring directors, were re-elected, and the retiring auditors were re-appointed.

Mr. COCKBURN proposed a vote of thanks to the chairman and directors, and, on the part of the shareholders, congratulated the managing director (Mr. Robert Kaye Gray) upon the distinguished position to which he had been nominated.

Mr. ROBERTSON seconded the motion, which was carried unanimously.

The CHAIRMAN, in reply, said the directors had adopted a cautious attitude, and had spoken of trade as not being very flourishing for the time being, but he thought that the general outlook of the company was, on the whole, very promising.

The proceedings then terminated.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The interim report of the directors to December states that, having regard to the very unfavourable weather which has prevailed throughout the past year, the traffic receipts of the various associated undertakings show on the whole satisfactory increases. During the present year over 50 route miles of new or reconstructed tramways or light railways have been opened for traffic by electric traction on the overhead system. The policy of the directors for some time past has been to restrict as much as possible further capital commitments on new schemes or extensions, and the attention of the management is now mainly concentrated upon increasing the revenue from the company's present investments. No portion of the authorised additional debenture capital has yet been issued. The Auckland Electric Tramways Co. (Ltd.) (New Zealand), in which the company has an interest of nearly £300,000, has been successfully established, and some of the lines opened for traffic. Traffic receipts are in excess of the estimates, and it is expected a dividend will be paid on the ordinary shares of the Auckland Company for this the first year of working by electric traction. The business of the Metropolitan Electric Tramways (Ltd.), in which the company holds shares to the amount of about £219,000 and has guaranteed to raise further capital to the extent of about £300,000, is also developing satisfactorily. Arrangements are in progress for the consolidation of the company's interests in the various associated companies in Birmingham and adjacent districts, now operating about 90 route miles of tramways and light railways. During the past session the company obtained acts of Parliament authorising the construction of and reconstruction for working by electric traction of existing tramways at Brighton, Shoreham and Croydon, and generally the company's business is developing satisfactorily. The usual interim dividend on the ordinary shares is declared.

JOHNSON-LUSDELL ELECTRIC TRACTION CO. (LTD.)—The directors' report for year ended June 30 states that a series of trials of the company's motors and controllers had been made under skilled supervision over the tramways of the Newcastle-on-Tyne Corporation, and had been reported upon favourably. A gain of 25 per cent. in efficiency had been certified by the electrical experts appointed for the purpose over the standard method of traction. It was pointed out that if further improvements could be effected the gain might be increased to 40 per cent. At the same time certain defects in the smoothness of operation called for a remedy before the apparatus could be accepted generally by tramway managers. To enable those improvements to be carried out, Messrs. J. H. Holmes & Co., who were interested in the promotion of the company, agreed to lend £10.000 at a low rate of interest, this sum not to be repaid unless the company became an assured success. During the past year continuous attention has been given by the technical staff towards accomplishing the objects in view. Twenty motors and controllers were built in Berlin, fresh patents have been taken out, incorporating new and valuable features, while a braking system has been devised, which, it is anticipated, will be adopted generally for tramway work. It was now reported to the board that the objects aimed at had been accomplished. A car fitted with the new apparatus has been run on trial at Newcastle. This trial was attended by the directors, the committee appointed at the last meeting and other leading shareholders. Arrangements have been made to have independent efficiency tests applied by leading authorities, and to have the operations watched by tramway and electrical engineers. If the apparatus should prove as efficient as is claimed, its value cannot fail to be established as an important and striking advance upon present standard methods of electric traction, and lead to early development on commercial lines. The long delay in reaching those results has (says the report) been a matter of grave anxiety to the board, but the directors were powerless to expedite a process of improvement which depended upon highly-skilled experts working upon a problem which has taxed the brains of electrical engineers for many years. The meeting of shareholders is to be held on Dec. 22, but will probably be adjourned to a date in February.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

ASHFORD AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Reg. Dec. 12, capital £1,000 in £1 shares, to construct or acquire any tramway or tramways in Tavistock or elsewhere in Devon, and to carry on the business of suppliers of electricity for light, heat, sound and power, electrical engineers, electricians, mechanical, electrical and chemical engineers, &c. The subscribers are A. T. Pressland, electrical engineer, C. L. Cooper, electrical engineer, G. D. Handley, A. West, electrical engineer, E. W. Oakley, C. S. Ashdown and A. J. Fippard, electrical engineer.

BRITISH CABLE SYNDICATE (LTD.)—Reg. Dec. 11, capital £3,000 in £1 shares, to carry on business of electricians, electrical and mechanical engineers, ironmongers, makers of electric tramcars, motor cars, &c, manufacturers of and dealers in electric light cables, telegraph and other wires and accessories, dynamos, motors, telephones, arc and other lamps, electric light fittings, &c. Reg. office, 70, Bishopsgate-street Within, London, E.C.

KROEGER LIGHT-CURE AND ELECTRO-THERAPEUTIC INSTITUTES (LTD.)—Reg. Dec. 7, capital £15,000 in £1 shares, to acquire goodwill of certain businesses carried on under the style of Kroeger's Light-Cure Institutes, and to carry on the business of proprietors of sanatoria, hydropathic and other establishments, medicated, light, electric and other baths, &c. Mr. Kroeger is permanent managing director.

PENZANCE AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Reg. Dec. 12, capital £1,000 in £1 shares, to construct or acquire any tramway or tramways in Penzance. The subscribers and other particulars are the same as in Ashford and District Electric Supply Co., Ltd. (*q.v.*).

SYNCHRONISED ELECTRIC CLOCK CO. (LTD.)—Reg. Dec. 8, capital £2,500 in £5 shares, to acquire certain provisional specifications for patents, improvements in electrically-synchronised clocks, &c., and to

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manufacture and deal in electrical and patent clocks, &c. First directors are B. Bonnisken, J. H. F. A. Chandler, W. Davis, C.C., R. S. Gold, W. G. Leigh, G. Norris, C.C., and H. E. Thornley.

TAVISTOCK AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Reg. Dec. 12, capital £1,000 in £1 shares, to acquire any tramway or tramways in Ashford, Kent. The subscribers and other particulars are the same as in Ashford and District Electric Supply Co., Ltd. (*q.v.*).

MORTGAGES AND CHARGES.

GENEVA TRAMWAYS CO. (LTD.)—Debentures for £39,692. 7s. 9d. (39 of £1,000 each and one for £692. 7s. 9d.), created by resolution of Nov. 5 and dated Dec. 7, 1903, have been registered. Property charged: Company's undertaking and assets, present and future, subject to agreement of June 30, 1903, with London Trust Co. and Messrs. L. Hirsch & Co. No trustees. Holder, A. Ries.

HOVE ELECTRIC LIGHTING CO. (LTD.)—Debenture dated Nov. 23, 1903, to secure £7,500, supplemental to trust deed dated June 30, 1896, to secure an unspecified amount of debenture stock, but stamped to cover £50,000, has been registered. Property charged: Company's undertaking and property, present and future. Trustees, Col. A. J. Filgate, R.E., and C. F. Tufnell.

KEYNSHAM ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Nov. 30 of £1,200 debentures, part of series created same date, to secure £1,500, charged specifically on company's freehold land and buildings at Keynsham and as floating security on company's undertaking and property, present and future, including uncalled capital. No trustees.

PROVINCIAL ELECTRIC CONSTRUCTION CO. (LTD.)—Issue on Nov. 24 of £800 debentures, part of series created Nov. 20, 1903, to secure £1,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 25⅞d. per oz. (Dec. 17). Consols 88½—88⅝ for money, 88½—88¾ for account; 2½ per cent. annuities 88½—88¾ (Dec. 17). Consols Pay Day, Jan. 6; Stocks and Shares Continuation Days, Dec. 28 and Jan. 12; Ticket Days, Dec. 29 and Jan. 13; Pay Days, Dec. 30 and Jan. 14; Mining Share Carry-over Day, Dec. 24.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The coupons of the company's 4 per cent. mortgage debentures to bearer, due Jan. 1, will be paid on and after that day at Parr's Bank, Bartholomew-lane, London, E.C. The debenture register will be closed from 24th to 31st inst. inclusive.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD).—The transfer books and register of holders of the debenture stock will be closed from 18th to 31st inst. inclusive, preparatory to the payment of interest due Jan. 1.

CAPE ELECTRIC TRAMWAYS (LTD.)—An interim dividend of 5 per cent. (tax free) has been declared.

CITY OF LONDON ELECTRIC LIGHTING CO.—The transfer books and register of holders of the £400,000 5 per cent. first debenture stock and £300,000 4½ per cent. second debenture stock are closed from 17th to 31st inst. inclusive.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of the first debenture stock will be closed from 18th to 31st inst. inclusive, preparatory to payment of interest due Jan. 1.

EASTERN TELEGRAPH CO. (LTD.)—Payment will be made on Jan. 15 of a dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock of the company for the quarter ending Dec. 31, and an interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the quarter ended Sept. 30. The transfer books will be closed from Jan. 7 to 14 inclusive.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended Sept. 30 of 2s. 6d. per share (tax free), payable 15th prox. The share register will be closed from 7th to 14th prox. inclusive.

GENERAL ELECTRIC CO. (LTD.)—The transfer books of the preference shares of this company will be closed from 18th to 31st inst. inclusive, preparatory to the payment of half-yearly dividend.

GENERAL TRUST AND FINANCE (LTD.)—The first report, to Sept. 30, states that the company has taken an interest in the Compañia General d'Electricite de Lourenço Marques to the extent of $\frac{3}{16}$ths of the share capital.

MICA.—A prospectus is in circulation of the Brazilian Mineral Syndicate (Ltd.), formed with a capital of £10,000 in £1 shares, to acquire provisional leases and options of purchase of two properties named repectively Boa Vista and Fonseca, in the State of Minas Geraes, Brazil, "reported and believed to contain very valuable deposits of mica," and to take on lease or otherwise acquire similar properties in Brazil or elsewhere; and to otherwise deal with such property. Subscriptions are invited to an issue at par of 4,700 of these shares, to provide working capital, to pay the cash portion of the purchase price, and to defray expenses of promotion, &c. Reports accompany the prospectus concerning the probable output of the mines, including an extract from a Paper read before the Institution of Mining and Metallurgy in April last on "The Occurrence of Mica in Brazil and on its Preparation for Market," by Mr. H. Kilburn Scott. The bankers of the syndicate are Messrs. P. Macfayden & Co., Winchester House, London, E.C.; the secretary and offices are Mr. Charles A. Sack, 29, Great St. Helens, London, E.C.

PROVINCIAL TRAMWAYS CO.—The directors' report states that the net revenue received from the local companies for the year ended Sept. 30 amounted to £23,353, compared with £18,551 in the preceding year. £6,000 has been set aside for depreciation, and, including balance brought forward, the available total is £18,794. Dividends upon the ordinary shares of 6s. per share for the year are declared, leaving £2,742 to be carried forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Dec. 29 a special settling day in and have granted a quotation to 52,000 fully-paid £5 ordinary shares, 61,000 fully-paid £5 6 per cent. cumulative preference shares and £300,000 4½ per cent. debenture stock of *Dick, Kerr & Co, (Ltd.)*. The committee have also ordered a further issue of 1,500 fully-paid £10 5 per cent. cumulative preference shares of the *British Columbia Electric Railway Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended		Amount.	Inc. or Dec. (*a*)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (*a*)
			£	£		£	£
*Aberdeen Corporation	Dec.	12	1,679	+ 270	28	84,696	+ 6,926
Ayr Corporation	,,	5	168	+ 4	29	9,627	+ 49
Barnsley	,,	4	152	+ 19	48½	8,701	- 2
Bexley District Council	,,	11	102	...	10	1,674	...
Birkenhead	...		...	...	...	...	...
*Birmingham Tramways	,,	12	4,894	+ 342	23	118,531	+ 3,483
*Blackburn Corporation	...		...	...	...	...	...
Blackpool Corporation	,,	10	254	+ 26	§36	87,053	- 158
Blackpool and Fleetwood	,,	12	159	+ 17	24	20,375	- 108
Blackp'l, St. Anne's & Lytham	,,	10	128	+ 93	16	860	+ 430
Bolton Corporation	,,	13	1,660	+ 201	37	68,207	+ 8,159
Bournemouth Corporation	,,	9	770	...	37	38,483	...
*Bradford Corporation	,,	13	3,324	+ 389	35	140,193	+ 19,510
Brighton Corporation	,,	13	721	+ 93	37	24,657	+ 2,703
Brisbane Tramways	Oct.	28	2,197	- 73	17	39,689	+ 416
*Bristol Trams & Carriage	Dec.	11	4,309	+ 477	3	12,932	+ 848
*Buenos Ayres & Belgrano	Nov.	15	3,238	- 116	4	12,770	+ 317
Burnley Corporation	Dec.	12	746	+ 113	37	37,578	+ 6,535
Burton Corporation	,,	13	291	...	19	6,910	...
Calcutta Tramways Co.	,,	12	R35,637	+ R3,918	24	R799,070	+ R141,994
Camborne-Redruth	,,	14	187	...	6	6,814	...
Cardiff Corporation	,,	12	1,813	+ 467	37	72,973	+ 19,911
Carlisle Tramways Co.	,,	13	169	+ 51	¶49	9,493	+ 842
Central London Railway	,,	12	7,054	- 275	24	153,154	- 7,185
Chatham and Dist. Lt. Rys.	,,	10	466	+ 197	49	26,471	...
City & South London Rly.	,,	13	3,458	- 419	24	64,045	- 9,609
Cork Electric Trams Co.	,,	10	385	+ 37	39	25,409	- 3,168
Darwen Corporation	...		...	...	...	...	...
Devonport & Dist. Trams	,,	4	420	+ 51	48½	22,330	+ 1,463
Dover Corporation	,,	12	176	+ 27	†37	8,651	+ 107
Dublin & Lucan Railway	,,	13	82	+ 7	24	3,022	+ 180
Dublin Southern District	,,	11	759	+ 247	¶23	24,591	+ 8,131
Dublin United	,,	11	3,575	+ 347	¶23	93,008	
Dudley—Stourbridge	,,	4	732	+ 33	48½	40,424	+ 3,759
Dundee Corporation	,,	9	768	+ 24	...	...	...
East Ham Council	,,	12	564	+ 152	†37	24,950	+ 7,328
Gateshead & Dist. Trams	,,	4	884	+ 15	48½	42,503	+ 5,367
Glasgow Corporation	,,	12	18,582	+ 2,066	28	383,044	+ 40,183
Gravesend—Northfleet	,,	4	188	+ 29	48½	11,687	+ 1,245
Greenock & Port Glasgow	,,	4	428	+ 14	48½	26,446	+ 2,152
Halifax Corporation	...		...	...	...	...	...
Hartlepool Tramways	,,	4	235	+ 31	48½	13,104	+ 855
Hudderfield	,,	12	1,087	+ 207	36	46,113	+ 7,193
Hull Corporation	,,	12	1,822	+ 209	†37	69,295	+ 4,065
Ilkeston Corporation	,,	9	111	...	4	483	...
Ipswich Corporation	...		...	...	...	...	...
Isle of Thanet Co.	,,	12	213	+ 10	21	21,840	- 991
Kidderminster & District	,,	4	99	+ 8	48½	6,175	+ 176
Kirkcaldy Corporation	,,	9	190	...	41	7,183	...
Lanarkshire Trams Co.	,,	10	533	...	§17	12,786	...
*Leeds Corporation	,,	12	4,939	+ 430	33	204,877	+ 12,604
Liverpool Corporation	,,	5	9,317	+ 285	49	492,774	+ 16,355
*Liverpool Overhead Rly.	,,	13	1,512	+ 143	24	39,762	+ 2,605
London County Council	,,	5	8,272	+ 1,384	†37	365,961	+ 68,342
	,,	12	8,908	+ 1,895			
Lowestoft	,,	12	134	...	†21	5,137	...
Manchester Corporation	,,	12	10,737	+ 3,237	26	305,738	+ 159,617
Mersey Railway	,,	12	1,304	+ 284	24	31,889	+ 6,267
Merthyr	,,	4	182	+ 19	48½	9,633	- 7
Middleton	,,	4	285	+ 27	4·½	15,333	+ 1,868
Newcastle-on-Tyne Corp.	,,	12	3,483	+ 507	24	83,784	- 1,898
*Newport (Mon.)	,,	12	423	+ 272	10	4,859	+ 2,159
Oldham, Ashton & Hyde	,,	4	494	+ 12	48½	27,502	+ 1,101
Perth (W. A.) Elec. Trams.	,,	11	1,867	+ 249	§49	57,724	+ 6,696
Peterborough	,,	4	105	...	45	7,103	...
Poole and District	,,	4	199	+ 8	48½	14,623	+ 2,084
Portsmouth Corporation	,,	12	1,287	+ 227	†37	67,276	+ 4,493
*Potteries	,,	4	1,648	+ 67	48½	76,867	+ 3,554
Reading Corporation	...		..	...	...	...	...
Rothesay	,,	4	83	- 6	4·½	6,879	+ 1,595
Salford Corporation	,,	14	3,741	+ 959	37	100,056	+ 41,726
*Sheerness	,,	2	46	...	34	2,301	...
Sheffield Corporation	,,	13	4,193	+ 439	24	109,981	+ 8,861
*Southampton Corporat'n	,,	10	861	+ 126	...	...	...
Southend Corporation	,,	9	181	+ 39	36	12,421	+ 1,999
Southport Tramways	,,	4	245	+ 30	48½	15,174	+ 2,648
S. Staffordshire Trams.	,,	4	951	+ 303	48½	44,501	+ 8,019
*Sunderland Corporation	,,	13	988	+ 26	37	45,780	+ 2,103
*Swansea Trams	,,	4	482	+ 63	48½	25,127	+ 2,113
Taunton Trams	,,	4	43	- 3	48½	2,322	- 202
Tynemouth and District	,,	4	175	- 17	48½	15,045	+ 764
Tyneside Trams Co.	,,	9	254	+ 58	49	15,816	...
Wallasey District Council	,,	12	573	+ 110	†37	36,214	+ 8,386
Weston-super-Mare	,,	2	26	- 1	48	5,670	- 515
Wigan Corporation	...		...	...	...	...	...
Wolverhampton District	,,	4	526	+ 28	48½	18,849	+ 7,674
Wrexham	,,	4	109	...	35	4,914	...
Yorkshire Woollen District	,,	4	485	...	41½	16,157	...

(*a*) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed. Dec. 16.	Rate per cent. Yielded. £ s. d.	Dividend Due	Business Week to Dec. 16 Highest.	Business Week to Dec. 16 Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4½—4¾	5 5 3	April, Oct	5	4⅞
St.	6%	Do. Permanent 6% Deb. Stock	127 —132	4 13 0	..	130	129½
10	10 0	Barcelona Tramways Ord.	7½—8½	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	99 —101	4 8 5	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼—10½	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 1	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 —82	3 12 9	..	80½	79
St.	5%	Do. Pref. Ord. Stock	91 —94	5 6 2	..	9.3	92½
10	4/2½	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
4'	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102%—104%	4 6 7	..	..	..
10	6,0	†British Electric Traction Ord.	11½—12	6 13 4	..	12	11½
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—11¾	5 2 2	Feb, Aug	11¾	11⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	..	..
5	..	Buenos Ayres and Belgrano Ord.	2⅞—3⅛	.. ..	..	3⅜	3
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5⅝	5 4 0	..	5½	5⅜
5	3/0	Do. "B"	4⅜—5¼	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	106 —109	4 12 10	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	5 0 9	..	..	..
5	2 6	Calcutta Tramways	6¾—7¼	3 2 1	..	7	6¾
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 11	..	106	..
1	1/2⅜	Cape Electric Tramways Shares	1⅜—2	7 10 0	..	..	..
St.	4%	Central London Ordinary Stock	93 — 96	4 4 9	June, Dec	94½	93⅜
St.	4%	Do. 4 per Cent. Pref. Stock	99 —102	3 18 10	..	..	..
St.	4%	Do. Deferred Stock	96 — 99	4 1 8	..	..	..
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 11	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 —5½	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	47 —50	6 5 0	Feb, Aug	50	47
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 —129	3 18 7	Feb, Aug	..	..
St.	5%	Do. (1896)	123 —126	4 0 4	..	..	..
St.	5%	Do. (1901)	120 —125	4 1 1	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 —103	4 17 0	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 —13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3½—4½	6 13 4	..	..	..
.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 —98	5 2 0	..	..	..
0	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7½—8½	3 10 7	..	7⅜	..
0	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	.. ..	..	9	..
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110 —111	4 3 1	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¼—4½	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —95	4 4 3	..	..	..
10	11%	Liverpool Overhead Railway Ord.	5⅞—5⅞	2 7 1	Feb, Aug	..	..
1'	5%	Do. 5 per Cent. Pref.	10¼—10⅜	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —101	4 1 0	Jan, July	..	..
1(	5,0	London United Trams. 5% Cum. Pref..	11¼—11¾	4 5 1	..	11⅛	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 —106	3 16 8	..	105¾	104½
St.	..	Mersey Con. Ord. Stock	8 —11	.. ..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	.. ..	..	13	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	.. ..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1⅛	.. ..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 4 1	..	..	..
5	..	New General Traction Ord.	⅛	.. ..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	.. ..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	100 —103	4 19 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½—9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	8½—9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	102	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	.. ..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	.. ..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	.. ..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 — 94	3 9 8	June, Dec	92½	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —103	3 18 0	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	.. ..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	.. ..	..	..	..
St.	15/0	Anglo-American	49 —52	6 1 6	F,My,Ag,N	49	..
St.	30/0	Do. Preferred	92 —94	6 8 3	F,My,Ag,N	93⅜	92⅜
St.	1/0	Do. Deferred	7⅜—8½	0 12 5	F,My Ag,N	8	7⅛
100	$2	Commercial Cable Capital Stock	145 —155	5 9 8	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	Jn Ap,Jy,O	92	..
10	7,0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	7⅛	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	97%—101%	4 10 10	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10½	6 3 10	Ja,Ap,Jy,O	10⅛	10⅛
100	4½%	Direct West India Cable 4½% Rg.Db.(rd.)	99 —102	4 8 10	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	122 —127	5 10 8	Ja,Ap,Jy,O	125	122
St.	17/6	Do. 3½ per Cent. Pref. Stock	85 —88	4 0 4	Ja Ap,Jy,O	87⅜	87½
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	..	..
10	2,6	Eastern Extension	11 —11½	6 1 9	Ja,Ap,Jy,O	11¼	..
St.	4%	Do. 4 per Cent. Deb. Stock	106 —109	3 14 4	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb.1909	99 —102	3 18 10	Feb, Aug	99⅛	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 11	May, Nov	100	..
10	5,0	Great Northern of Copenhagen	25 —26	4 16 2	Jan, July	..	..
100	4½%	Halifax & Bermuda4½%1stMt.Db.(red.)	90 —102	4 8 4	June, Dec	..	..
25	12 6	Indo-European	37 —40	6 5 0	May, Nov	..	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..
2½	..	West Coast of America	⅛—⅜	.. ..	..	⅜	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	½—¾	.. ..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	6⅞	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	.. ..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 17 7	Jan, July	..	..
10	5,0	Western Telegraph	11⅞—12½	5 14 3	Mr,Jn,O,D	12⅛	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	4 0 0	..	101	100½
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5½	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	8½—8¾	4 11 5	Ja Ap Jy O	8⅝	8⅞
10	3/0	Do. 6 per Cent. Pref.	12½—13	4 12 4	Ja Ap,Jy,O	12⅝	12½
5	4/0	Reuter's	6¾—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	116 —121	4 19 7	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed. Dec. 16.	Rate per cent. Yielded. £ s. d.	Dividend Due	Business Week to Dec. 16 Highest.	Business Week to Dec. 16 Lowest.
		TELEPHONES.					
£	6'0	Chili Telephone (fully paid)	4¾—5¼	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	101 —103	5 18 9	..	102¾	101¾
St.	5%	Do. Def. Stock	78 —81	6 0 6	..	80¼	78½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	..	..
10	6.0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref...	5⅜—5⅝	4 13 0	Feb, Aug	5⅝	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.) ...	96 —98	3 12 9	June, Dec	96½	..
St.	4%	Do 4 per Cent. Deb. Stock (red.).....	102 —104	3 17 5	..	..	..
1	0/7½	Oriental	⅞—1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	.. ..	..	..	..
5	4/0	United River Plate	5¼—6	5 16 8	July.....	5⅛	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	104 - 107	4 13 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
)	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝—¾	.. ..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	116 —119	3 15 7	..	..	..
10	16,0	Bournemouth & Poole Elec. Sup. Ord.	12½ - 13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 —11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
3	4½%	Do. 4½ per Cent. Deb. Stock (red.) ...	103 —106	4 5 3	..	105½	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—10¾	4 3 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10 —10½	3 6 8	Mar, Sept	10⅜	..
5	3 0	Calcutta Electric Supply Ord.	6½—7½	4 6 8	..	..	..
St.	4%	Central Elec. Sup.Co.4% Guar.Db.Stock	105 —108	3 13 11	..	..	..
5	4,0	Charing Cross & Strand Electric Sup...	8¾—9½	5 8 1	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	3 18 3	Feb, Aug	5¾	5½
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	4¾	4½
St.	4%	† Do. 4% Deb. Stock (red.)	103 —105	3 16 3	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5½—6	4 3 4	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	107 —110	4 3 0	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¾—11	6 16 4	Feb, Aug	10¾	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	122 —127	3 18 11	Jn, Dec .	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 —105	4 9 5	..	..	..
10	4,0	County of London & Brush Prov. Ord.	7½—8½	4 14 2	..	..	..
10	6.0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	11⅜	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	108 — 111	4 2 8	..	..	..
St.	27 6½	Do. Second Deb. Stock Prov. Certs..	99 —102	.. ..	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5½—6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10½—11½	4 6 11	..	..	..
£	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
3	..	London Electric Supply Ord.	1⅞—2⅛	.. ..	..	..	..
£	8,0	Do. 6 per Cent Pref.	5 —5⅜	5 9 1	..	5⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 —100	4 0 6	Mr,Jn,S,D	..	..
10	8 0	†Metropolitan Electric Sup. Ord.	17—18	4 6 1	April, Oct	18⅛	17⅝
5	..	Do. 4½ per Cent. Cum. Pref.	4¼—4⅜	.. ..	..	4⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	110 —114	3 19 8	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	96 —99	3 11 7	..	..	..
1	6 0	Notting Hill Electric Ord.	12½—13½	4 8 11	March....	13⅜	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5½—5¾	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 6	..	..	..
1	..	Rand Electric	⅛—¼	.. ..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	99 —102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½—15½	4 13 9	Feb, Aug	15	14½
£	3 6	Do. 7 per Cent. Pref	7½—8½	4 2 4	Feb, Aug	8⅜	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	98 —101	3 10 4	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord...	3 —3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
£	1,9	South London Electric Supply Ord.....	3½ - 3⅜	4 13 4	..	3⅜	..
5	2.6	Urban Electric Supply Ord.	4⅜ 5⅛	4 17 7	..	..	..
5	2 6	Do. 5% Cum. Pref.	4⅜—5⅛	4 17 7	..	..	..
5	6/6	Westminster Electric Supply Ord.	12 —13	5 0 0	Mar, Sept	12⅝	12½
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref...	⅜—½	6 18 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅜—½	.. ..	Mar, Sept	..	..
5	4 0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5¼—5½	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	103 —108	4 4 10	..	105½	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	103 —105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	4½—5	5 0 0	..	5⅛	4½
St.	4%	Do. 4 per Cent. Mort. Deb. Stock ...	97 —100	4 1 8	..	..	..
£	..	Brush Electrical Engineering	¾—1¼	.. ..	March ..	..	..
½	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1⅛—1¼	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	78 —85	5 8 9	Jan, July	80	65
5	5/0	Callender's Cable Construction Ord. ...	11 —12	6 5 0	Jan, July	11⅜	11⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	106 —110	4 1 10	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	90 —95	4 15 3	..	..	..
1	0.7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000) ..	1⅞—2⅛	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	99%—103%	4 19 4	Jan, July	101¼	101
5	..	Edison & Swan United("A"sh.)(£3 pd.)	½	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1½	.. ..	Feb, Aug	1	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 5 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
£	4/6	Edmundson's Elec. Corp. Ord.	6 —6½	5 7 8	H'lf-yearly	6⅛	6⅛
5	3.0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	..	6½	6⅜
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 4	..	105½	..
2	1/2½	Electric Construction Co.	1⅜—1⅝	6 8 0	Jan, July	..	..
2	2 9½	Do. 7 per Cent. Cum. Pref.	2¼—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 —101	4 0 9	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	¾—⅞	.. ..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾—1	.. ..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	9½—10¼	4 17 7	..	9¾	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 — 99	4 0 10	..	..	..
£	6/0	Henley's Telegraph Works Ord.	14 —15	6 13 4	Feb, Aug	..	..
£	2.3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
£	2.3	Do. 4½ per Cent. Mort Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
St.	4½%	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 7	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11½	4 8 11	Mar, Sept	..	..
15	12/0	Telegraph Construction & Mainten'ce.	34 —37	6 9 8	Mar, July	36	35
100	4%	Do. 4 per Cent. Deb. Bonds, 1909.....	101 —104	3 17 6	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	5 —6	5 8 4	Apr, Oct	..	..
5	3.0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	Apr, Oct	6	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	98 —102	3 18 5	May, Nov	99	..

In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

LAST week we commented in these columns on the action of the London County Council with regard to the matter of the Belgian tramrail contract. The Council directed that an inquiry should be made into the conditions of labour and pay of the Belgian and German workmen employed by firms supplying rails,—not only so far as contractors to the London County Council were concerned but also with regard to the firms supplying other municipal departments and the Government. In order to obtain the desired information, the clerk has now been instructed to make arrangements for an expert adviser to visit Belgium and Germany to make the necessary inquiries. The expert is to take with him an assistant and to have the services of an interpreter at his disposal. All this work is to be executed for the sum of £150, the Council being apparently under the impression that this will be sufficient. If an expert of high standing can be found to undertake the work for such an amount the Council are to be congratulated. but we venture to think they will experience difficulty in this respect.

IT is gratifying to observe, however, that in connection with the purchase of 12,500 tons of new rails, the tenders of English firms have been accepted. Fourteen tenders for the track rails were submitted, the lowest coming from Brussels, while for the slot rails 16 tenders were received, the lowest in this case emanating from an American firm. English firms were, however, lowest for acid steel, and their tenders were consequently accepted.

IT appears from a Paper read by M. P. JANET before the Société Internationale des Electriciens, that considerable changes are being made in the construction of the Edison accumulator. The active material of the positive electrode consists of pulverised peroxide of nickel. The mixture of iron and protoxide of iron which constitutes the active material of the negative electrode is obtained by passing a current of hydrogen over pulverised sesquioxide of iron (Fe_2O_3) at a certain temperature, which EDISON himself has said ought to be 480°C. The reduced iron is then very slowly cooled in a current of hydrogen and washed in water; it thus loses its property of igniting, or at least of oxidising, when exposed to air. The mixture of iron and protoxide of iron, rich in protoxide, is a bad conductor, but conductivity was formerly imparted to it by the addition of small pieces of graphite to the extent of one part to four, and from this mixture rectangular briquettes were formed under a pressure of 4,300lb. per square inch. The positive active material consists of Ni_2O_3, $3H_2O$, which changes during the charge to NiO_2. This material is an even worse conductor than the oxide of iron, and in forming the briquettes recourse again is had to graphite, used in even larger proportions than before. Now, however, graphite has been abandoned in connection with the active material for the negative electrode, and a different process of manufacture is employed. The iron is not raised to quite so high a temperature, and, therefore, probably contains less protoxide; it is then mixed with ammoniated copper and oxide of mercury, and, the iron reducing the compounds, there is finally obtained a mixture containing 64 per cent. of iron, 30 per cent. of copper and 6 per cent. of mercury. Each particle of this mixture is, according to EDISON, made up of a grain of iron covered by a porous envelope of copper amalgam, in a very finely-divided state, together with a small quantity of oxide of iron.

ANOTHER alteration is in the number of plates contained by an individual cell. The standard cell which was tested in the Laboratoire Central D'Électricité in Paris contained 14 positive and 14 negative plates; but Mr. EDISON has experimented with a cell containing 20 positives and 10 negatives. Mr. HIBBERT obtained discharges of 173 ampere-hours from the standard cell when discharging at 30 and 60-

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ampere rates; but, with the new type, Mr. EDISON claims to obtain 250 ampere-hours at the 30-ampere rate, and 240 ampere-hours at the 60-ampere rate. In this cell, the capacity of the positives is made slightly less than that of the negatives in order to avoid the oxidation of the copper and mercury, previously mentioned, at the end of the discharge.

AT first sight it would seem that the active material itself would be more or less shielded, as it were, by the metallic pockets containing it, especially as it is not too good a conductor, and it is in this connection that a curious though fortunate phenomenon occurs. The pockets themselves, it must be remembered, are really better conductors than the active material, they are in direct contact with the electrolyte, and the adjacent faces of the positive and negative pockets are only 1mm. distant. In these circumstances it is somewhat difficult to imagine why current enters the active material at all, and to obtain a solution to the mystery, two cells were connected in series, both being identical, with the exception that one contained no active material. A current of 150 milliamperes was passed through the cells, and it was found that the voltage between the terminals of the cell containing no active material was 1·8, but between the terminals of the other cell it was only 1·62. The back E.M.F., therefore, set up by the pockets is higher than that of the active material, and consequently the latter is the conductor so long as the charging voltage is kept below 1·8 volts per cell. If, however, the applied E.M.F. per cell be increased beyond this point, the pockets become conductors, and the potash solution is electrolysed in the ordinary way, hydrogen and oxygen being liberated.

WE give particulars in this issue of a remarkable accident which occurred in East London, South Africa, similar in some respects to the fatal accident at the Fulham Baths a year ago. Owing to a trolley wire coming into connection with the iron pole supporting it, contact was made through two other pipes to a bath on the first floor of a house, and a man was killed by establishing contact between the bath and a water pipe making good earth through the water main. A contributory cause of the accident was the fact that the iron pipe leading electric light services to the house from the same pole was in contact with the pole. Although precisely the same conditions are not likely to occur in this country, the question still arises whether it would not be advisable to bond every iron trolley pole to the rails whether the pole carries guard wires or not.

THE Marylebone Borough Council's electric lighting bill is now available for inspection, and we publish in this issue a summary of its contents. Before being proceeded with, consent of the ratepayers will have to be obtained at a public meeting, and if a poll is demanded this will have to be taken. The bill, it will be remembered, is for the specific purpose of authorising the Borough Council to raise a loan for electric lighting purposes and so to overcome the technical legal difficulties raised by the London County Council. It contains clauses relating to other matters, however, one of which provides for a bulk supply being given by the Company to the Council, should this be desired, without its being necessary for the Company to obtain additional powers itself. Even if the Marylebone Borough Council does build its own electricity works, these would not be completed for a year or two, and it would be necessary for it to take supply in bulk in the meantime. It may also be noticed that provision is made in the estimates in the preamble for increasing the declared pressure of the supply.

OTHER clauses are inserted in the bill which are familiar to those acquainted with the usual form of supplementary electric lighting clauses in municipal bills. There is the provision for a reasonable minimum charge being made for "stand-by" supply, a clause exempting the Council from supplying a consumer who has not paid his bill, and a wiring- fittings- and motor-hiring clause. The last-mentioned will doubtless be opposed by the wiring contractors; for, if passed as it stands, it would authorise the Council to do wiring itself, and it is followed by a clause authorising the enforcement of bye-laws with regard to house wiring. This, therefore, would enable the Council to compete with wiring contractors and at the same time to frame rules and conditions as to the manner in which contractors with whom it was competing should carry out their work.

PHYSICISTS throughout the world will learn with satisfaction of the gift of 60,000fr. to Mme. CURIE in order that she may continue her researches in radium, and 40,000fr. to M. BRANLY for wireless telegraphy. Both these amounts have been awarded by a committee of the Parisian Press Association, through the generosity of M. OSIRIS. In addition to this, moreover, we learn that a sum of 30,000fr. has been placed at the disposal of Prof. D'ARSONVAL to aid him in the continuation of his researches in radium phenomena. Large sums of money are always needed to carry on scientific research of any kind, but where radium is concerned the amounts required are enormously increased. It would, indeed, be rash to venture any prophecy of what may be done with radium in the attempt to find a cure or preventative of that horrible scourge cancer; but if there is the faintest ray of hope that it may prove even partially effective, then no effort should be spared to prosecute investigations until some successful method of application can be evolved. But in the interests of electrical science and applications other than therapeutic, there are even greater reasons why researches into radio-active phenomena should be carried out thoroughly and without delay, and this is impossible unless funds of considerable magnitude are at the disposal of those entrusted with the work. Would it be indiscreet to suggest a Government grant in our own country?

THE political horizon in Ireland being clearer than it has been for some time past, Dublin's citizens are now devoting their attention to matters that concern their more immediate welfare. We recently described the fine new electricity works which have been built in order to keep pace with the extension of electric lighting and the probable extension of the demand for electric power in the Irish capital. These works were costly, partly on account of the unsuitability of their site,

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and partly owing to the fact that it was deemed advisable to make ample provision for a large increase in output, the undertaking having previously been starved by the adoption of too unprogressive a policy. When the extension was finally decided upon, Mr. HAMMOND, who was appointed consulting engineer, impressed the Corporation with the view that it should be on a liberal scale, and the Corporation, wishing to atone for past errors, adopted this point of view also, and made it clear to Mr. HAMMOND that his estimates must be based upon the principle that, after money had been borrowed for the purpose, no further electric lighting loan should be necessary for some time to come. The sum finally borrowed on Mr. HAMMOND'S estimate was £254,000. It appears, however, that £48,000 more than this was expended, and an application to the Local Government Board was made this autumn for sanction to borrow this sum to pay for "extras." We published last week the communication made by the Local Government Board to the Corporation after the usual inquiry had been held, and this week we report the debate which followed in the council chamber. As will be seen, the Board has decided that £41,500 of the £48,000 was not expended on "extras," but was simply represented by over-expenditure on the original scheme of extensions.

AN under-estimate of 16 per cent. in a scheme of this magnitude has naturally given rise to much adverse comment, the more so as an endeavour had been made to show that the surplus had been spent in "extras," and that the original estimate had not been exceeded. Mr. HAMMOND'S ability as an expert witness in inquiries of this nature is such that, if he failed to impress the Local Government Board inspector that the items in question were for additional work, it may safely be concluded that they were not.

Manufacture of Lead Accumulators.—The draft regulations made by the Home Office for the manufacture of lead storage batteries have now been issued without amendment as regulations, and they will come into force on January 1, 1904. They were published in *The Electrician*, Vol. LI., p. 748.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Anjer—Kalianda	Aug. 2, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Paramaribo—Cayenne	Feb. 27, 1903
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Cape St. Jacques—Haiphong	Dec. 15, 1903
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903
St. Kitts—San Thomé	Dec. 22, 1903

Third International Congress of Mathematicians.—An international congress of mathematicians will be held in Heidelberg (Germany) from August 8 to 13, 1904. Since the hundredth anniversary of the birth of the eminent German mathematician C. G. J. Jacobi will fall in the same year, it is intended to commemorate this event by an address to his memory at the first general meeting of the conference. In connection with the congress an exhibition of mathematical models and of the more recent mathematical literature is to be held. Full particulars can be obtained from Prof. Dr. A. Krazer, Westendstrasse 57, Karlsruhe.

Electric Railways in Sweden.—The Stockholm correspondent of the *Daily Mail* states that the Administrative Board have decided, after an exhaustive inquiry on the Continent and in the United States, to recommend the Government to adopt electric traction on the Swedish State Railways. Owing to the vast natural water resources at present unemployed electrical power is likely to prove much more economical than steam. The present intention is to convert the suburban lines running into Stockholm early next year, when a substantial vote on account of cost will be passed. The transformation of the remainder of the system would then proceed gradually.

Telegraphic Breakdown in Russia.—Yesterday's *Times* contained a message from their Odessa correspondent to the effect that in consequence of the recent severe storm in South Russia and the formation of a thick coating of ice on the wires, telegraph communication between North and South Russia was again interrupted. Only a portion of the telegrams for the north were being got through by a circuitous route, and many telegrams for abroad had been refused at Odessa telegraph offices. Between Odessa and Kieff a considerable number of telegraph posts, only recently fixed, had been broken, while the weight of ice on the wires had brought down some scores of versts of cable. As such interruptions are of almost annual occurrence, it is proposed to carry the main cables north of Odessa underground.

Electricity on Warships.—The recently-launched German man-of-war "Preussen" possesses a very complete electric installation, electric power being used, for instance, in connection with the numerous ventilators, the ammunition hoists, the coal lifts, the cranes for putting the lifeboats to sea, the machine tools in the workshop, the freezing machine and the medical apparatus. The lighting throughout is of course done electrically, and there are four search lights of 61,000,000 c.p. each. Orders are transmitted by electrical means to all parts of the ship, and a system of wireless telegraphy has been installed. Electrical energy for all these purposes is produced in two small stations, each comprising two steam generators of about 105 H.P. and 67 H.P. respectively. Each station, too, is equipped with a storage battery.

The Paris Disaster.—The Paris correspondent of the *Daily Chronicle* states that the committee of experts appointed by the Prefecture of Police to inquire into the Metropolitan Railway disaster, and the improvements to be adopted, has now presented its report. One of the principal reforms suggested is that the driver should be able to lift the contact shoe running on the third rail without leaving his post. At present the cars are so constructed as to oblige the driver to leave his cabin, go to the side of the carriage and lift the shoe with his hands. Another important modification insisted upon by the committee is the division of the third rail into insulated sections, so that only a limited number of trains may move within the section. Each section should also be supplied by special cables, provided with overload cut outs. Between the stations, and at short distances apart, switches should be established all along the line, so that the current may be shut off from all or several sections without the necessity of telephoning. This would prevent danger from the third rail in case the passengers had to leave a train between stations. The lighting throughout the tunnel ought to be assured by a current entirely separate from that used for traction purposes. The carriages should be made of incombustible material wherever possible, and the rest should be made fireproof. The committee finally suggests that special provision should be made for cooling the motors before starting and during the service.

King's College Engineering Society.—Prof. E. Wilson delivered a lecture before this Society on December 10th, the subject being "Aluminium." After a few introductory remarks in which the price of aluminium was traced from the year 1854 up to the present time, during which it has varied from £122,000 to £120 per ton, the lecturer proceeded to describe the electrolytic method for the dissociation of alumina into aluminium. The works of the British Aluminium Co. at Foyers were illustrated by excellent lantern slides. He next dealt with aluminium as an electric conductor, and it was pointed out that to carry a given current the ratio of the weights of aluminium and copper would be 1 to 2 in favour of aluminium. As the price of aluminium per ton was about twice that of copper, it followed, therefore, that the first cost of the metal conductor would be about the same in the two

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cases, but the aluminium conductor only weighed one-half of the copper. For insulated cables at high voltages, under certain circumstances the aluminium cable came out cheaper. By alloying aluminium with small quantities of other metals, such as nickel, copper and iron, the breaking strength could be greatly improved, in one case a value of 46,000lb. per square inch being obtained. The beneficial use of aluminium in connection with iron and steel founding was then dealt with, and the results of experiments quoted to show that the magnetic permeability and the specific resistance of iron could each be increased by the presence of a small quantity of aluminium. The enormous affinity of aluminium for oxygen was being made use of in connection with welding. The great quantity of heat locally produced when, say, iron oxide combined with aluminium was sufficient for welding purposes. But perhaps the latest development was the use of aluminium mixed with ammonium nitrate for the purpose of forming an explosive. The lecturer pointed out that great safety and cheapness were combined with a strength, if necessary, equal to that of the most powerful of known explosives. The reaction which took place was as follows:—The aluminium combined with oxygen to form alumina, and in the process nitrogen and steam were produced in the presence of intense heat, thereby causing enormous expansive forces. The gases formed were harmless, and this was a further point of importance.

Swiss Three-phase Railway.—A short three-phase railway has, according to the *Zeitschrift für Elektrotechnik*, recently been built connecting the town of Schwyz with Seewen, a station of the St. Gothard Railway. These places are 1·17 miles apart, the difference in their altitude being 190ft. Water power to the amount of 3,000 H.P. is obtainable from the Musta River, the available quantity of water being 126 cubic ft. per sec., and the head 230ft. So far, the installation of the power house comprises four 600 H.P. Girard turbines coupled to 550 H.P. Brown-Boveri three-phase alternators, which generate each a current of 40 amperes at 8,000 volts and a frequency of 40 $\sim$ per sec. Half-way between the termini is situated the transformer station, where the high-tension current is transformed down by means of oil-cooled transformers to 550 volts. Current is conducted to the trains by two overhead wires and the rails, which act as third conductor. The overhead wires have a diameter of 8mm. (0·315in.), and are placed, our contemporary says, only 10in. part. Trolleys conduct the electrical energy from the line wires to the car, which is equipped with 12-polar motors of an output of from 20 H.P. to 25 H.P. A motor car weighs approximately 9·5 tons. Lighting and heating is done electrically, the current for these purposes being transformed down from 500 to 100 volts. The up journey is made at a speed of 10 miles per hour, the descent being accomplished at the rate of 10·8 miles per hour.

Agreement between Electric Contractors and Manufacturers.—We have received the following digest of the agreement recently entered into between the National Electrical Contractors' Association and the National Electrical Manufacturers' Association:—

1. The contractors and manufacturers will not allow trade discounts to architects, consulting engineers and other persons or firms who cannot fairly be considered entitled to be electrical contractors, wholesale factors or a trade house.

2. It is also provided that members of the Contractors' Association will confine their dealings to members of the Manufacturers' Association, and the latter association agree to give members of the Contractors' Association an exclusive bonus therefor.

3. The manufacturers agree not to give trade discount or terms to any but a trade buyer. Businesses having their own electrical engineering or electrical trading department under the supervison of a qualified electrical engineer are to be considered as a trade house, also all goods for shipment delivered direct to the docks shall likewise come under the heading of trade buying.

Exceptions are made in the case of railway companies, Government departments and others requiring goods by public tender, who will be entitled to trade privileges.

The agreement becomes operative from January 1, 1904, and an arbitration committee, consisting of four members from each Association, has been elected to deal with questions arising out of the agreement and with matters of general interest. The committee consists of the following members:—

For Contractors' Association: E. L. Berry (President London Electrical Contractorss' Association), J. McDermott (Ashton-under-Lyne), A. Rashleigh Phipps (London) and W. R. Rawlings (President National Electrical Contractors' Association).

For Manufacturers' Association: H. Bevis (General Electric Co., London), C. S. Northcote (Veritys Limited, London), H. Oppenheimer (International Electric Co., London) and S. Patersen (Johnson and Phillips, London).

In addition, Mr. Tweedy Smith, solicitor, has been appointed umpire to act in case of any dispute arising under the agreement.

A Relic of the Past.—Our Calcutta correspondent writes us to the effect that some time in 1880 or 1881 an installation of Jablochkoff candles was put up to light the lawns of the Eden Gardens in Calcutta, and after doing admirable service for over 22 years it is now being dismantled, the lamps having been lighted for the last time on November 14th. The original installation consisted of some 30 lamps, the wiring being carried in iron pipes to the engine house close by. After about a year the cables developed faults and had to be abandoned, and new cables were laid in teakwood troughs run in solid with pitch. To this day they are still good, and reflect great credit on the engineer who supervised the job, and who is still here. There is no telling how long the old arrangements might have been adhered to had not one of the boilers been finally condemned by the inspector. The new installation will consist of Crompton enclosed arc lamps run off the 450-volt circuit of the Calcutta Electric Supply Corporation, together with incandescent lamps in the bandstand replacing the present gas pendants. Mains are again laid on the solid system from lamp to lamp, all circuits being taken to a switchboard fixed under the bandstand. The supply comes up overhead to a special pole a little way off and is brought across the more frequented lawns underground. Overhead lines are protected in every span by a safety device which will disconnect the service at the pole fuses if any line should break. It is no secret that the renewal of the candles under the old system cost a very great deal, since they had to be specially manufactured, and the old generating sets were not of the highest efficiency. A similar set was called by its friends a "feed water *eater*" owing to its insatiable appetite for steam, but that is another story. In future a flat rate of 4 annas a unit is to be paid for the garden lighting, and the saving will soon pay for the installation. There are a few more lamps of the same era still working in Bengal, and this fact, as well as so early an example of the "solid system" of mains, may be of some interest to our readers.

Walthamstow Palace of Varieties.—The electric lighting of this building has been carried out on the most modern and approved methods. Current is obtained at 460 volts from the Walthamstow Urban District Council, and there are two entirely separate three-wire services, consisting of 37/14 cables. The stage switchboard is divided into two sections situated about 6ft. apart and facing each other. One controls the positive and the other the negative side of the system. All fuses are covered with glass, the panels are of marble and the backs of the boards carry no inflammable material. A noticeable feature is the amount of room available for the attendant and the ease with which he is enabled to see the effect produced by switching lights on or off. On the stage itself there is a number of lamps equivalent to 1,550 8 c.p., those in the auditorium being equivalent to 700 8 c.p. There are also four 10-ampere arcs on the stage, and provision is made for a 60-ampere cinematograph arc. Although the stage projectors only take 10 amperes normally, each one is tested up to 55 amperes, and owing to the new and special construction of the carbon holders, it is found that no undue heating occurs. A very good effect is obtained outside the building by eight 10-ampere "Flame" arc lamps, manufactured by the Union Electric Co. These lamps give an exceptionally brilliant steady light largely composed of yellow rays. The iron fireproof curtain is raised and lowered by an electric motor, and by means of gearing it may be operated either by hand or electrically. For working the Lyon resistances, special gearing is employed which enables the attendant to dim or brighten different sets of lamps individually or collectively. All wiring is contained by seamless steel tube, efficiently earthed. The General Electric Co. supplied the fittings, some of which are very handsome, and Messrs. Leo Sunderland & Co. were responsible for the actual work.

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Institution of Electrical Engineers.—The date of the visit of the Institution of Electrical Engineers to America, on the invitation of the American Institute of Electrical Engineers and the McGill University, Montreal, has now been so fixed as to enable the members to take part in the International Electrical Congress, which will be held in September in connection with the Exhibition at St. Louis. As at present arranged, the party will leave England on or about August 26 or 27, 1904, and, arriving in New York early in September, will spend three weeks in visiting (probably) Albany, Chicago, Montreal, New York, Niagara, Philadelphia, Pittsburg, St. Louis, Schenectady, Washington, &c. The order in which these places will be visited has not yet been fixed. Members will thus be free to leave for England about the last week in September. Allowing a week for the voyage in each direction, the time required from the date of leaving England to the date of landing again will be between five and six weeks. Those wishing to prolong their stay in America would be able to do so. Ladies will be heartily welcomed, and, wherever possible, special arrangements will be made for their entertainment whilst the members are engaged in visiting works. Negotiations are proceeding with the shipping companies as to the conveyance of the party as a whole. Although nothing of a definite character can at present be published as to cost, &c., it is anticipated that, including first-class fares on steamers and railways and ordinary hotel expenses, together with a contribution towards the expenses of the Institution, the cost of the tour will be about £80 per head. But as this sum does not include incidental expenses, such as gratuities, &c., a further sum of £10, it is recommended, should be allowed for. Unless the Council feel assured that the party will number, at least, 40, inclusive of ladies, it is not proposed to proceed with the arrangements for the visit. All intending to take part in this trip should communicate with Mr. McMillan. With the exception of ladies travelling with members, the party will be restricted to the various classes of members of the Institution.

The Testing of Electric Generators by Air Calorimetry.—The following is an abstract of the discussion which took place at the Birmingham Local Section of the Institution of Electrical Engineers on December 16th in connection with Prof. R. Threlfall's Paper on the above subject. The Paper itself, as read at the parent Institution, was published in *The Electrician* of November 27th, and the report of the discussion in London in our issue of December 4th :—

Mr. Henry Lea asked at what distance the Pitot tube was to be placed from the entrance of the main air duct.

Prof. Threlfall replied that, if he remembered rightly, the distance required was about 20ft. with a pipe 22in. in diameter.

Mr. Lea, continuing, said that, in the case of water in the pipe, a revolving vortex might be produced. He should like to know if Prof. Threlfall in his experiments had tried a vertical division or two divisions crossing each other at right angles, in order to destroy any rotating effect in the main air duct due to the rotation of either the fan or the alternator.

Prof. Burstall was afraid that in the hands of the majority of works engineers the tests would not give results anywhere near the 3 per cent. mentioned by Prof. Threlfall. The thermometry could be done differentially by resistance thermometers with great accuracy. He had recently had occasion to devise an arrangement for measuring the air drawn into a gas engine of about 110 B.H.P. That meant approximately 30,000 cubic ft. of air per hour. A large meter was employed to calibrate three anemometers placed in series with it. The calibration could be carried out at different rates of flow up to 8,000 cubic ft. per hour with an accuracy approaching 1 per cent. In order then to measure a current of 28,000 cubic ft. per hour, the three anemometers were put in parallel, and suitable arrangements were made to ensure that the stress lines took exactly the same directions when parallel as when in series. One had then only to take three readings of the anemometers to get the flow. It came to him as a great surprise to be told that the distribution of velocity was not affected by the value of the velocity. He regarded the Paper as so important that he thought it was highly probable that he would use a modification of Prof. Threlfall's method to determine the efficiencies of the whole of the plants at the new University buildings at Bournbrook.

Mr. A. H. Bate said there would naturally be some vibration in a building when testing a large alternator, and he would like to ask the author if means were taken to prevent the communication of that vibration to the water in the gauge tubes.

Dr. W. E. Sumpner thought that the long investigation necessarily undertaken with the Pitot tube formed a much more important investigation than that on the dynamo. Prof. Threlfall had said that he assumed no energy to be radiated electrically from the dynamo. Long before Hertz's experiments, Prof. FitzGerald showed that radiation would not take place under ordinary conditions unless the frequency of the currents was over ten millions a second.

Prof. Threlfall, in reply, said they did not use diaphragms as suggested by Mr. Lea, but they had put in mosquito netting, and in that way a standard form of distribution could be obtained with regular results. In reply to Prof. Burstall, he pointed out that in place of the more delicate instrument, a stream gauge could be employed if extreme accuracy was not aimed at. As to the velocity of the air, his tests had been carried out at between 500ft. and 3,000ft. per second.

Technical Education.—In a report of the Educational committee of the North-East Coast Institution of Engineers and Shipbuilders the following regulations for apprentices and pupils are recommended :—

In the first place the committee is of opinion that youths intending to qualify as artisans should receive while at school the best training possible, including, when practicable, some instruction in elementary science, that more attention than at present should be given in schools to the inculcation of habits of order, perseverance and good conduct, and that the development of these studies and habits should be encouraged in the workshop by a system of rewards offered by employers.

The term "apprentice" is to be understood to refer to those who enter the works to learn one or other of the trades or handicrafts therein practised, who serve the usual five years' apprenticeship in the works, who may or may not attend evening science classes, but who do not attend a systematic university college day course of instruction during their apprenticeship, and whose object is to qualify as tradesmen, mechanics or artisans.

The term "pupil" is, on the other hand, understood to refer exclusively to those who enter works, not with the sole view of becoming expert in any handicraft, but with the view of ultimately rising into the higher branches of the profession of engineering or shipbuilding—*e.g.*, draughtsmen, managers, superintendents, inspectors, consulting experts, employers, &c., who may or may not attend evening science classes, but who either have already attended, or will attend, a systematic course of instruction at university college day classes.

Regulations for Apprentices.—In starting apprentices, preference will be given to those who bring the best certificates of conduct and character and the highest school-leaving certificates. The age of starting should be from 15 to 16 years. At the end of September in each year each apprentice will be awarded marks as follows :—For each approved examination passed during the year, 20 marks; for time-keeping, a maximum of 40 marks; for good conduct, perseverance and progress in the workshops, a maximum of 40 marks.

Marks for time-keeping will be deducted at the rate of 1 mark for every three hours lost. Conduct marks will be awarded quarterly by the chief-foremen of departments on the following scale :—Very good, 40 marks; good, 30 marks; fair, 20 marks; moderate, 10 marks.

An apprentice obtaining 60 marks will have the sum of 6d. added to his weekly rate of pay for the ensuing year, and for marks in excess of 60 his rate will be proportionately increased. No payment under this scheme will be made to apprentices obtaining less than 60 marks, and apprentices who fail to obtain any marks for time keeping, good conduct, perseverance and progress will be subject to dismissal. Promotion in the workshops will depend upon marks obtained. Should an apprentice during the first three years of his time have shown marked ability at the evening classes, and obtained maximum marks for time-keeping, perseverance and progress in the workshops, he may, at the discretion of his employer, be allowed to spend his fourth or fifth year at college day classes, the fees for which will be paid by his employer.

At least one vacancy per annum in the drawing office will be filled by an apprentice obtaining the highest marks under the above scheme.

Regulations for Pupils.—Scheme A.—Youths who have passed through a three or four years' engineering day course at a university college, and who have obtained therefrom either an approved certificate, or a pass degree in engineering science, or in naval architecture, may be admitted into the works as pupils. They will serve a three years' pupilage, and for the first year the scale of pay will be that of an ordinary apprentice of the *third* year. The scale of pay for their last two years will be that of ordinary apprentices of the fourth and fifth years, plus 3s. and 5s. per week respectively.

Those who hold a degree with honours may be admitted on the same conditions as the above, but the scale of pay for the last two years will be increased by 4s. and 7s. per week, instead of 3s. and 5s.

Scheme B.—Youths who desire to combine workshop experience with college study, and who hold no certificate or degree from a university college, may be admitted to the works as pupils on the production of evidence that they have received a sufficient preparatory education. A certificate showing that they have passed the matriculation examination required for graduation in engineering at a science college of university rank, or an equivalent certificate, will be accepted as evidence of this. They must give an undertaking that they will attend for at least three academical years the degree course of study at a university college during the currency of their pupilage, which will extend over a period of six years, including the time spent at college. Their pay will be that of ordinary apprentices in the corresponding years, plus 4s. per week in years subsequent to their first year's college training.

Scheme C.—Youths who, having entered the works as apprentices, succeed during their apprenticeship in passing the matriculation or equivalent examination prescribed under Scheme B, will for the remainder of their time be treated as pupils under Scheme B, in respect of leave to attend college day classes, promotion and rates of pay. The time served, including that spent at college, will be a minimum of six years.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Re-combination of Ions.—R. K. MacClung showed on a previous occasion, that over a considerable range of pressures, both above and below atmospheric pressure, the rate of re-combination of ions is governed by Rutherford's law, according to which the rate varies as the square of the density of the ions. He has now completed a series of experiments undertaken with the object of ascertaining, in the first place, whether this same law of re-combination holds at various temperatures of the air, and, secondly, what effect a change of temperature of the gas has upon the value of the coefficient of re-combination. The Röntgen ray bulb and the induction coil which runs it were, as usual, enclosed in a lead-covered box as a shield, and the rays were allowed to emerge through a circular opening in the lead. The apparatus was enclosed in an iron cylinder heated by a long Bunsen burner. The results show that Rutherford's law applies to all temperatures covered by the experiments, which ranged from 15 to 300°C. The coefficient of re-combination, however, increases rapidly at the higher temperatures, being 35 at 15deg., 65 at 135deg., and 270 at 270deg. The relation between the coefficient of re-combination and the temperature does not seem a very simple one, for the curve showing the connection between them does not seem capable of being represented by any simple mathematical formula. Whatever the changes are which take place among the ions, either in the individual ions or in their relations to one another when the gas is heated, they would appear from this to be somewhat complicated.

[R. K. MACCLUNG, *Phil. Mag.*, December, 1903.]

Magnetisation in Volcanic Rocks.—B. Brunhes and P. David have made some interesting magnetic observations in connection with the magnetism of volcanic rocks which recall the work of Folgheraiter on the magnetism of the Tuscan vases and his conclusions as to the dip in Italy about 1,000 years before the Christian era. The authors go back much further than this by means of measurements carried out on the burnt clays and lavas of the Puy de Dome. In several places, flows of lava have covered beds of pliocene or quaternary clay, baking them to a depth of several metres, and producing what is known as "natural brick." This natural brick has a magnetisation different from that which would be produced by the earth's field as it exists at present, and may, as has already been shown, be considered to have retained the magnetisation imparted to it at the time it was baked. The magnetic dip indicated by the brick ranges from 70deg. to 72deg. The covering lava shows a dip which is a few degrees less than that, but its composition is less uniform, and it may be supposed that it preserved the original dip less perfectly. The declination can also be determined in this case, whereas it could not be fixed in the case of the vases. It is some 50deg. or 60deg. in excess of the present declination. A convincing counter-proof is brought by the fact that a basalt found underneath the clay, and evidently due to a previous flow, shows a dip of only 59deg. 40min., and a declination only 1deg. west of its present value.

[BRUNHES and DAVID, *Comptes Rendus*, December 7, 1903.]

Comparison of Coloured Lights.—We know already that the curves connecting the brightness of light with its objective intensity differ for different colours. According to Purkinje, if a red patch and a blue patch have apparently the same intensity, and the intensity of both is diminished in the same ratio, the blue patch appears much brighter than the red patch. A. Broca and D. Sulzer have found that there is another element which also complicates the work of colour photometry. It is the element of time. It is very much more pronounced in its action than the effect observed by Purkinje, and increases markedly with the brightness. If a blue light and a light of another colour have the same brightness while steady, they have a very different brightness when they act upon the retina during a fraction of a thousandth of a second. Since the blue impresses itself much more quickly upon the eye than any other light, it appears much brighter in comparison. There must, of course, be a maximum of divergence, and this maximum occurs at a time interval of about 0·00007 second. Red appears brighter than green, but the difference is very much less marked. The comparative brightness of the blue may be four or five times its normal brightness. But this large preponderance rapidly dies away, owing to the fatigue of the eye. This can only be avoided by allowing the flashes to occur at intervals of more than two seconds, which allows the products of retinal fatigue time to get absorbed.

[BROCA and SULZER, *Comptes Rendus*, December 7, 1903.]

Spectra and Atomic Weights.—C. Runge calls attention to the importance of taking "homologous" lines in calculating the atomic weights of new elements from those of known elements, by means of their spectra. According to Ramage, a diagram may be drawn with oscillation frequencies as abscissæ and the squares of the atomic weights as ordinates. In this way each spectrum is represented by certain points on a parallel to the axis of abscissæ, the distance from this axis being proportional to the square of the atomic weight. In many cases the points representing homologous spectrum lines lie approximately in a straight line. The atomic weight of an element may thus be determined from the atomic weights of two other elements as soon as three homologous lines are known in their spectra. Homologous lines are marked by similar behaviour in the Bunsen flame, in the arc and in the magnetic field. But if care is not taken to ensure that the lines chosen for calculation are really homologous, the atomic weight of a substance may be made almost anything we please. This fault the author attributes to Watts in his calculation of the atomic weight of radium, which, according to him, may be anything from 177 to 233. The law found by Precht and Runge, that the differences of the oscillation frequencies of homologous doublets are proportional to some power of the atomic weight—in other words, that the logarithm of the difference is a linear function of the logarithm of the atomic weight—seems to furnish a better means to calculate the atomic weight from its spectrum. It makes the atomic weight of radium 258. Whether this value or the value found by Mme. Curie, 225, be the right one is as yet open to discussion.

[C. RUNGE, *Phil. Mag.*, December, 1903.]

Intensity of Sunlight.—The values hitherto obtained for the intensity of sunlight show great discrepancies due to the uncertainty of the photometric units employed, the variation of atmospheric absorption and systematic errors attached to the instruments employed. C. Fabry has endeavoured to get consistent and accurate results by a new method, in which the solar intensity is reduced in a known proportion in a way suggested by Bouguer. After traversing a short-focus lens, the beam of sunlight falls upon one of the faces of a Lummer-Brodhun screen. The other face receives a constant illumination of the same colour as sunlight. A small incandescent lamp is placed in the focus of a lens, and illuminates the screen through a trough filled with a solution of ammoniacal copper sulphate, thus imparting the necessary whiteness to the light. The ratio of transmission is measured once for all, and the brightness of the lamp is kept rigidly constant. Readings are taken after displacing the lens in the path of the sunlight till equality of illumination is obtained. The measurements were made at Marseille. The figure for the brightness of the sun in the zenith at its mean distance from the earth, observed from sea level, is 100,000 times the brightness of a decimal candle (1·13 hefner) at 1 metre. One square millimetre of the solar disc emits normally a brightness of 1,800 decimal candles. This figure compares favourably with the 200 candles per square millimetre of the arc. The total energy per candle-power is probably between 0·15 and 0·20 watts. Seeing that the error of the measurements is now reduced to 1 per cent., the author suggests systematic measurements at elevated stations in order to observe variations in the brightness of the sun.

[C. FABRY, *Comptes Rendus*, December 7, 1903.]

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WORKING RESULTS ON THE CITY AND SOUTH LONDON RAILWAY.

(Concluded from page 327.)

Sub-station Efficiency.

At the Angel sub-station the following tests were made to ascertain the efficiency. Five second readings were taken, over periods of a quarter of an hour, of the high-tension volts at the generating station, the high-tension volts at the sub-station, the amperes in the

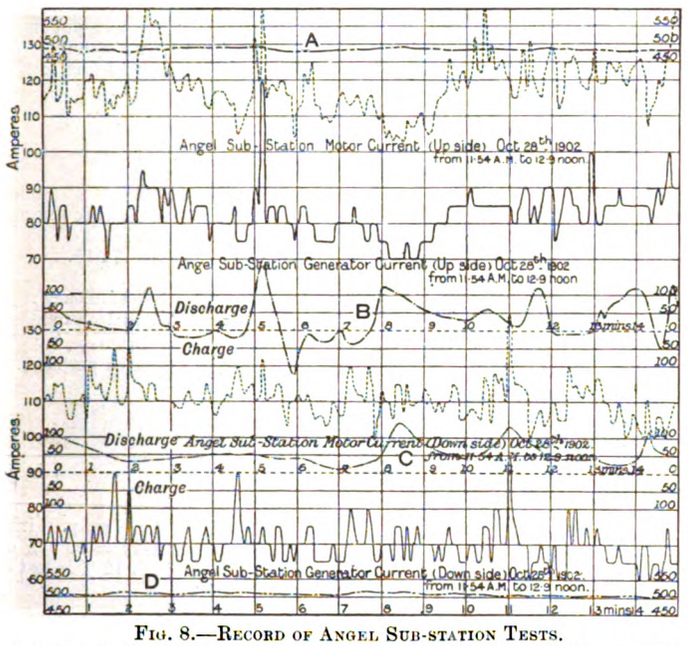

FIG. 8.—RECORD OF ANGEL SUB-STATION TESTS.

A, Up Line Volts; B, Up Battery Current, Oct. 28, 1902. C, Down Battery Current, Oct. 28, 1902. D, Down Line Volts.

high tension feeders which correspond with the current in the motor armature of the reducer, the generator, armature current, and the 'bus bar voltage. The efficiency of transmission and transformation is, therefore,

$$\frac{(\text{Motor amperes} + \text{generator amperes}) \times \text{'bus bar volts}}{\text{Motor amperes} \times \text{generating station volts}}.$$

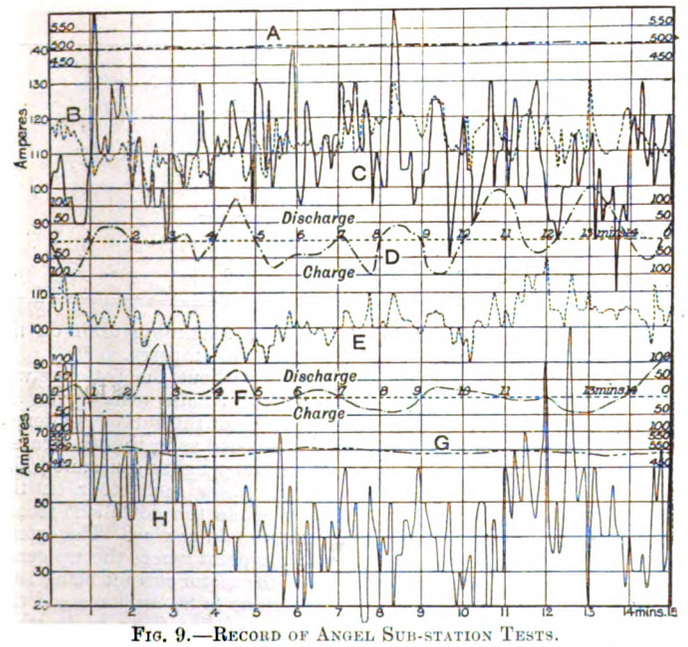

FIG. 9.—RECORD OF ANGEL SUB-STATION TESTS.

A, Up Line Volts; B, Up Side Motor Current, from 12:20 p.m. to 12:35 p.m. C, Up Side Generator Current, from 12:20 p.m. to 12:35 p.m. D, Up Battery Current, from 12:20 p.m. to 12:35 p.m. E, Down Side Motor Current, from 12:20 p.m. to 12:35 p.m. F, Down Battery Current, from 12:20 p.m. to 12.35 p.m. G, Down Line Volts; H, Down Side Generator Current, Oct. 28, 1902, from 12:20 p.m. to 12:35 p.m.

The sub-station efficiency is, of course, lower, as the power to drive the Highfield booster and the battery losses must be taken into account. The battery efficiency was obtained by putting two Vulcan meters in series, one reading the charge and the other the discharge. The result of some months' daily readings were taken, and the meters reversed so as to eliminate any error due to the meters. The average efficiency over this period comes out at 88 per cent. This high figure is reached as the battery is always working on the flat part of the voltage curve. On deducting these losses from the energy given to the 'bus bars, the useful output of the sub-station is obtained.

Two sets of tests were made, one for four periods of 15 minutes during the mid-day and the other for three periods in the afternoon, so as to get the efficiency under all conditions. The results of these tests are given in Tables S I., II., III., and the curves shown in Figs. 8–11.

It will be noticed from the curves that while the currents in the reducer motor-armatures are fairly steady, the generator-armatures'

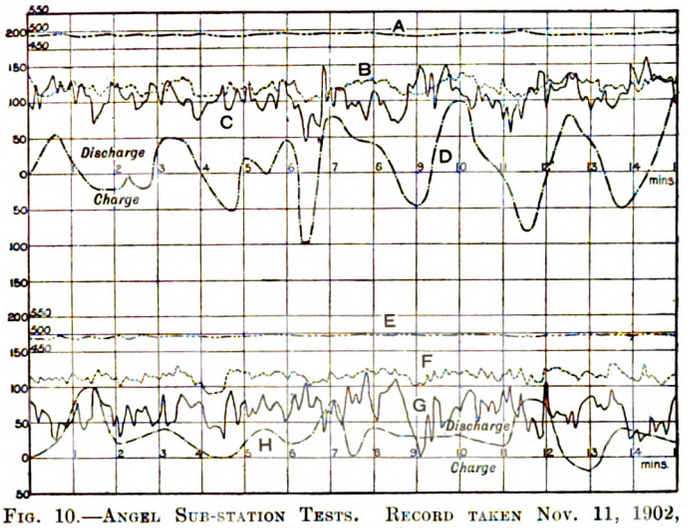

FIG. 10.—ANGEL SUB-STATION TESTS. RECORD TAKEN NOV. 11, 1902, FROM 5:30 P.M. TO 5:45 P.M.

A, Up Line Volts. B, Up Motor Current. C, Up Generator Current. D, Up Battery Current. E. Down Line Volts. F, Down Motor Current. G, Down Generator Current. H, Down Battery Current.

currents vary considerably, showing that the reducers do a considerable amount of balancing. The effect of running the machines uncoupled is clearly shown in the curve Fig. 8 from 11:54 a.m. to 12:9 p.m.

From the curve it will be noticed that the motor current is always higher than the generator armature current, and that the variations in the former exactly follow those in the latter. The balancing in this case is taken up by the batteries. The efficiency of transformation during this test is higher than in the other tests taken at this period of the day, and is no doubt due to the reducers not acting as balancers. Compared with the curve, Fig. 9, taken during the following quarter of an hour, it will be seen that the load on the up

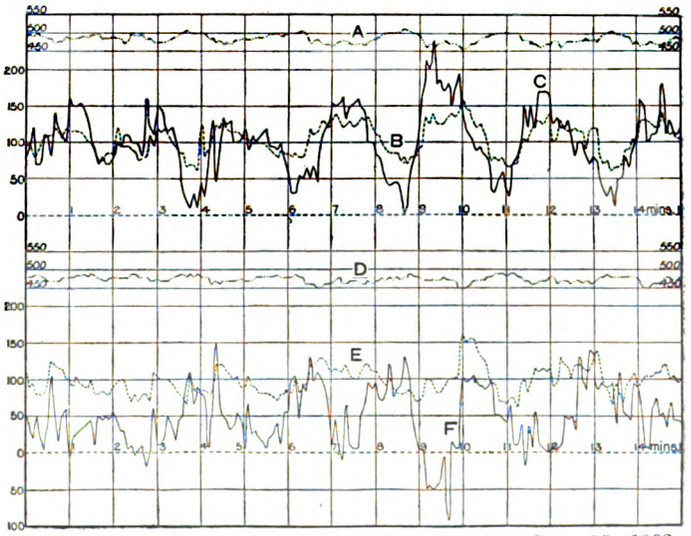

FIG. 11.—ANGEL SUB-STATION TESTS. RECORD TAKEN DEC. 15, 1902, FROM 4:41 P.M. TO 4:56 P.M.

A, Up 'Bus-bar Volts. B, Up Motor Current. C, Up Generator Current. D, Down 'Bus-bar Volts. E, Down Motor Current. F, Down Generator Current.

side of the system is heavier than on the down side, and that a portion of the up-side load is taken by the down-side motor, the average amperes delivered to the up 'bus bars being 225, while the amperes delivered to those of the down side were 149·5. At the same time

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Table S I. (*October 28, 1902.*)

Time.	—	Generating Station.		Angel sub-station.				Kilowatts.			Efficiency.			Remarks.
				Amperes.		Volts.								
		Amperes.	Volts.	Motor armature.	Generator armature.	High tension.	'Bus bar.	To feeders at generating station.	To reducers at sub-station.	To sub-station 'bus bars.	Transmission.	Transformation.	Transmission & transformation.	
11:15 a.m. to 11:30 a.m.	Up ..	99·2	1,000	99·2	108 8	403	495	99 20	89·20	102·00	Per cent.	Per cent.	Per cent.	Av. kw. put into battery = 6·96, of which 12% is lost = 0·835kw.
	Down	106·7	995	106·7	28·1	410	495	106·25	96 60	63·75				
	Total.	..	..	..	..	..	..	205·45	185·80	165·75	90·6	89·4	80·7	
11:54 a.m. to 12:9 p.m.	Up ..	118·4	1,000	118·4	82·2	400	490	118·40	105·40	101·00	..	..	..	Av. kw. lost in Highfield booster = 6·86.
	Down	110·4	1,000	110·4	70 25	410	500	110·00	103·00	93·30	..	..	..	
	Total.	..	..	..	..	..	..	228·40	208·40	194·30	91·3	93·2	85·2	
12:20 p.m. to 12:35 p.m.	Up ..	113·00	1,000	113·00	112·4	400	490	113·00	106·00	110·30	..	..	..	Av. kw. to line: = 181·4 – 7·69 = 174·15.
	Down	102·28	1,000	102·28	47·17	407	495	102·28	92 40	74·10	..	..	..	
	Total.	..	..	..	..	..	..	215·28	198·40	184·40	92·4	93·1	85·7	
12:45 p.m. to 1 p.m.	Up ..	113·20	1,000	113·20	109·9	400	490	113·20	107·50	109·00	..	..	..	Net efficiency: $= \frac{174·15}{213·5} \times \frac{100}{1}$ = 81·65 per cent.
	Down	102·04	1,000	102·04	48·47	406	485	102·04	90·80	73·00	..	..	..	
	Total.	..	..	..	..	..	..	205·24	198·30	182·90	92·1	92·4	85·1	
	Avge..	..	..	..	..	..	..	213·59	..	181·21	91·6	92·0	84·15	

Table S II. (*November 11, 1902.*)

5:13 p.m. to 5:28 p.m.	Up ..	121·5	983	121·5	108·0	400	490	119·40	108·00	112·50	Per cent.	Per cent.	Per cent.	Av. kw. put into battery = 29·25, of which 12 % is lost = 3·51.
	Down	113·0	987	113·0	63·0	410	490	111·50	101·60	86·40				
	Total.	.	..	..	..	..	..	230·90	209·60	198·90	90·8	95·0	86·3	
5:30 p.m. to 5:45 p.m.	Up ..	120·7	983	120·7	108·0	400	490	118·70	107·40	112 00	..	..	..	Av. kw. wasted in Highfield booster = 6·86
	Down	113·0	987	113·0	64·0	400	490	111·50	101·60	86·75	..	..	..	
	Total.	..	..	..	..	..	..	230·20	209·00	198·75	91·0	95·2	86·4	Av. kw. to line: = 199·68 – 10·37 = 189·31.
5:50 p.m. to 6:5 p.m.	Up ..	125·0	985	125·0	112·0	400	490	123·00	111·20	116·00	..	..	..	
	Down	113·0	987	113·0	61·0	410	490	111·40	101·70	85·40	..	..	..	Net efficiency: $= \frac{189·31}{231·80} \times \frac{100}{1}$ = 81·8 per cent.
	Total.	..	..	..	..	..	..	234·40	212·90	201·40	90·9	94·8	86·0	
	Avge..	..	..	..	..	..	..	231·80	..	199·68	90·9	95·0	86·2	

Table S III.

4:17 p.m. to 4:32 p.m.	Up ..	95·0	985	95·0	62·0	412	493	93·60	86·90	77·40	Per cent.	Per cent.	Per cent.
	Down	98·0	990	98·0	70·0	423	479	97·00	88·40	80·60			
	Total.	..	..	..	..	..	..	190·60	175·30	158·00	92·0	90·2	83·0	
4:41 p.m. to 4:56 p.m.	Up ..	104·0	985	104·0	102·0	405	482	102·40	92·30	99·35	..	..	..	
	Down	99·0	990	99·0	47·0	421	473	98·00	88·30	69·10	..	..	..	
	Total.	..	..	..	..	..	..	200·40	180·80	168·45	90·2	92·0	83·0	
	Avge..	..	..	..	..	..	..	195·50	..	163·22	91·1	91·1	83·0	

the amperes delivered to the reducers from the generating station were nearly equal on both sides of the system, being 118 on the up and 102·28 on the down side. The battery on the up side also did more work, both discharging and charging, than the down-side battery. The average efficiency of transmission during the four tests was 91·6 per cent., that of the transmission and transformation 84·15 per cent., while the transformation efficiency was 92 per cent. Allowing for the waste in the Highfield boosters and battery, the net efficiency of the sub-station was 81·65 per cent.

The second set of tests was taken on November 11, 1902, from 5:30 to 5:45 p.m., when the load on the sub-station was heavier. Fig. 10 shows the result of one quarter-hour from 5:30 to 5:45 p.m. In this case the down side has again less load than the up side, but not to the same extent as in the case recorded in Fig. 9. It will be seen that the batteries are also doing more work, at times taking peaks almost equivalent to half the total reducer load, and in the next few seconds changing almost to the same extent. The results of the three evening tests are tabulated in Table S II. The average transmission efficiency was 90·9 per cent., the transmission and transformation efficiency was 86·2 per cent., and the transformation efficiency 95 per cent. Allowing for the batteries and boosters as before, the net sub-station efficiency was 81·8 per cent. Inspection of the voltage curves shows that the voltage regulation is all that could be desired, although the load sometimes rises to 700 amperes, while the maximum drain on the generating station for this peak was only 245 amperes.

The effect of running the sub-station without the batteries was then tried, and the result of two quarter-hour tests given in Table S III. and curves Fig. 11. The shape of the curves is altered, the voltage regulation not being nearly so good as in the other cases, although it is still better than found on many lighting circuits. The motor and generator-armature current follow each other on the up-side, although varying considerably, while the down-side record shows that a large amount of balancing is taking place. The extent of this balancing is clearly marked at one point where the up generator-armature current is 235 amperes, the motor current being 135, at the same instant the down motor current is 80 amperes and the generator current 50 amperes in the reverse direction; or, in other words, the generator-armature has become a motor-armature and pumps current from the down to the up-side of the system. It will also be noticed that the amperes from the generating-station on the up side vary from 60 to 160, while with the batteries this current is very nearly constant. Under these conditions the average efficiency of transmission was 91·1 per cent., the transmission and transformation efficiency being 83 per cent., and the transformation efficiency 91·1 per cent.; the low transformation efficiency being no doubt due to the amount of balancing taken up by the reducers.

It may be argued that a better net efficiency is obtained without

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the batteries, but it must be remembered that the sub-station is not at present fully loaded, and that, by using the batteries, the peaks at the generating station on the high-tension feeders are practically avoided. Further, the batteries are used in cases of emergency, not only for the lift and lighting circuits, but also to feed the working conductor, and have a value in this direction which is rather hard to estimate. The calculated efficiencies for this sub-station were given in curves in *The Electrician*, Vol. XLVIII., p. 567, and it will be noted that the values are somewhat higher than the actual efficiencies obtained in the tests.

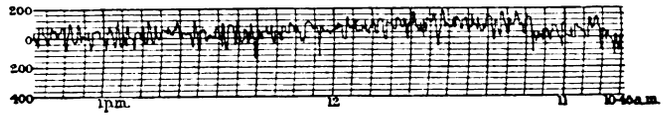

FIG. 12.—BATTERY AMPERES, ANGEL SUB-STATION.

Fig. 12 shows the current going into and leaving the battery. It will be noticed that at 10:45 a.m. the discharge on the whole is transferred to a charge on the whole, and this corresponds with the increased amperes in the high tension feeder. Fig. 13 shows the amperes to the working conductor during the same period, where peaks of 400 amperes are reached, while the sub station feeder current remains at 75 amperes on the down side of the system.

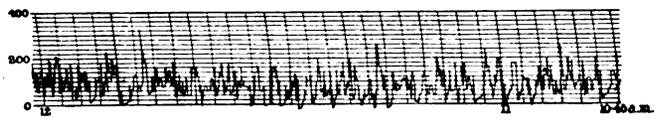

FIG. 13.—AMPERES TO WORKING CONDUCTOR, ANGEL SUB-STATION.

The difference between a battery working with a reversible booster and simply floating on the 'bus bar is shown by Fig. 14, which is a chart from the battery at London Bridge sub-station working in connection with the reducers. The peaks seldom reach 80 amperes, and the average discharge is only about 30 amperes. From 11:35 a.m. to 1:25 p.m. the battery is being charged.

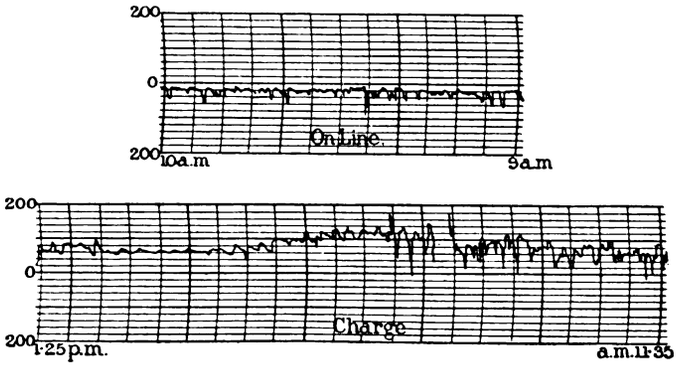

FIG. 14.—LONDON BRIDGE SUB-STATION AMPERES, BATTERY FLOATING.

Balancing and Rail Drop.

Mention has already been made of the useful effects of the reducers at the sub-station acting as balancers, and, in addition, the balance at Moorgate-street station takes up most of the out-of-balance load as shown by the curve Fig 15. With such good balancing the rail drop is naturally small, and it would

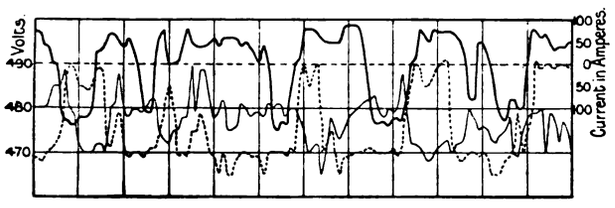

FIG. 15.—BALANCER VOLTS AND AMPERES.

——— Volts on Up Side. ····· Volts on Down Side. ——— Current.

Volts at London Bridge: 470 Up Side, 460-450 Down Side.
Volts at Angel: 480 Up Side, 475 Down Side.

appear that the three-wire system as installed on the City and South London Railway has not yet reached its limits in regard either to the distribution or to the Board of Trade rail drop. An inspection of the recorder charts taken at three points along the line shows that the rail drop does not increase with the distance from the generating station. In fact, it is very little greater at the Angel than it is at London Bridge or at Moorgate-street stations.

Overall Efficiency of Distribution.

About one-half of the total energy generated is delivered to the line at 500 volts, or direct without any tranformation, the efficiency at the various points along the line being as follows:—

Stockwell	99·3 per cent.
Kennington	96·6 ,,
London Bridge	86·0 ,,
Angel	81·6 ,,

the average effiiency over the whole system being 90·9 or, say, 91 per cent. From this must be deducted the loss in the working conductor before the net efficiency of distribution to the locomotives can be obtained. Taking the average current density in the working conductor with the average train service, the maximum loss between the feeding points farthest apart is just over 1 per cent., and with the feeding points closer the loss is just under 1 per cent., so that the average loss between the end of the feeders and the locomotives is well covered by 1 per cent. The net efficiency of transmission from the switchboard in the generating station to the locomotives is thus 90 per cent.

Cost per Unit.

The cost per unit for the half-year ending June, 1902, is given below. The figures refer only to the works cost. To compare the results with a lighting station, the cost of management, directors, office and legal expenses, insurance, &c., should be added; but as the above items are divided over all departments of the railway, and it is purely a matter of opinion what percentage should be charged to generating only, the item can be omitted without materially affecting the results, and a comparison made on the basis of works costs only. The units generated were 3,781,087. The coal per unit generated over the half-year, including all standing-by losses, lighting up, fresh boilers, &c., was 3·91b. of North-country and Midland small coal. During a month of this period when a coal of a slightly higher calorific value was used, the coal per unit was 3·281b, including all losses as before.

Cost per Unit Generated in Pence.

Coal	0·310
Water, oil-waste, and other stores	0·046
Wages, including engineer in charge	0·056
Repairs and maintenance	0·028
Total works costs	0·440
Sub-station charges, including those of battery, maintenance, &c.	0·035
Load-factor	49·2 per cent.

Results of Working of Locomotives.

For the same period the ton-miles were 27,832,000, and if the units per ton-mile on board the locomotive are taken, namely, 0·0552, the coal per ton-mile was 0·215lb. or 3·45oz.

In order to place the results on a basis for comparison with steam locomotives, the coal per ton-mile at the switchboard should be taken, and this amounted to 0·237lb. This figure includes all boiler-house losses, such as lighting up boilers and banking fires, &c. If compared with main-line locomotives the result is in favour of the latter, but it must be remembered that the energy spent upon accelerating main-line trains is only a fraction of that spent on a line with short sections, and, as has already been shown by the author in his Paper* on "Tractive Resistance in Tunnels," the traction resistance per ton is at least double that obtained in main line practice. The published results obtained with steam locomotives are usually taken over short periods, and refer to special tests from which all standing-by losses are excluded. When the time arrives at which electric locomotives can be tried under conditions similar to those of steam locomotives, there is every reason to believe that the coal per ton-mile will be in favour of the electric locomotive.

While on the question of locomotives, it may be interesting to give some details of their upkeep. With the old type of locomotive with Gramme surface-wound armatures, the chief source of trouble was the failure of the armature winding due to its shifting on the core, thereby causing short-circuiting and burning out. The field-magnet winding seldom or never gave any trouble, due no doubt to the liberal allowance of copper, and to the bobbins being on the earth side, and, therefore, subjected only to a pressure equivalent to the drop of volts across the winding. Taking the history of 30 of these armatures in everyday use, after running 100,000 miles the winding began to show signs of failure, at between 100,000 and 120,000 miles the failure became more frequent, and when an armature ran 150,000 miles it was generally necessary to re-wind it, the cost being about £20. 180,000 miles seems to have been the best record with a single winding failure, and several cases of 175,000 have been recorded, the average being 100,000 miles. Cases have arisen where failures took place after 1,000 miles or less, but as a rule

* *Jour.* Inst. Elec. Eng., 1899, Vol. XXVIII, p. 508.

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some external cause was discovered. To obtain the above results the locomotives were only allowed to run about one month, when the armatures were taken out and cleaned, thoroughly varnished with shellac, and baked in an oven. If this precaution was neglected trouble always resulted

The later and more powerful locomotives which were described in the author's Paper on "Electric Locomotives"* have not been in use long enough to institute a comparison on exactly similar lines, but the records so far show that the slot-wound armature is vastly more satisfactory than the smooth-core armature. Some of these locomotives ran 13 months continuously without coming into the repair shops for overhauling, the mileage being 46,000. The highest mileage yet recorded is 110,000 continuous running, the average being about 75,000 miles; and from our experience there appears to be no reason why these figures should not reach three or four times their present magnitude before winding troubles arise. In the 32 locomotives of this class, of course armature failures have occurred, some due to external causes and others to defective insulation; but 50 armatures out of the above locomotives have run an aggregate of 3,245,900 miles without a single winding failure. This is a very satisfactory record, and if the general result of the trustworthiness of the locomotives is expressed as a percentage of the time lost through armature failures, it comes out at 0·16 per cent.; or, for the past six months, of the total running time, only 0·16 per cent. was lost.

The maintenance and running cost are also low, as shown by the following figures:

Oil waste and other stores used on locomotives	0·098d. per train-mile.
Repairs, materials used on locomotives	0·137d. ,, ,,
Wages spent on repairs	0 230d. ,, ,,
Total cost per train-mile, including all salaries and wages connected with the generating of power, running of locomotives, coal, water and other stores, material and wages for repairs	4·61d.

Below is an abstract of the discussion which followed the reading of the Paper on Thursday, December 17th:—

Thursday, December 17th.

Prof. C. A. CARUS-WILSON congratulated Mr. McMahon on the great efficiency to which he had brought his system. The point to which he wished to draw attention related to what he considered to be the most important feature of the whole railway—viz., the method adopted of connecting the two tracks in series, with 1,000 volts between the two. This made it absolutely necessary to use the rails as the return. If the motor circuit went to earth at any point a short circuit would be the inevitable result. With two conductor rails it needed two such earths simultaneously on the motor circuit in order to get a short circuit, and this alone, it appeared to him, constituted a very important claim for consideration in favour of the double insulated conductor system. He was quite aware that practically all the existing electric railways were working with the track rails as the return conductor. There were only one or two exceptions, such as the Great Northern and City Railway, the Mersey Railway and the Metropolitan District lines (when these latter were converted). The date for the extinction of locomotives had already arrived so far as electric railways were generally concerned, but with the City and South London Railway, nothing but locomotives could be used, and this was largely the reason why it had been running all these years without any serious accident. The advantage of locomotives from the point of view of security against short circuits lay simply in the circumstance that the whole of the electrical apparatus and cables (which were worst of all) were contained in a single vehicle which could be completely isolated, so that the chance of short circuit was greatly reduced. the fire on the Paris railway was due to the system employed, as also was the fire on the Liverpool Overhead Railway, but what he wished to point out was, that with a motor-car system and the track as a return conductor there were very great risks of accidents The security of two insulated conductors lay in the fact that an earth in any part of the motor circuit did not constitute a short circuit, and it could be detected before a second earth took place. The Central London Railway working with a rail return and motor cars was really being worked with locomotives, inasmuch as there were motor cars at each end and none in the middle of the train, and if they examined these motor cars it would be found that they were practically locomotives completely isolated. There were two motors at each end enclosed in a steel cab with the whole of the electrical arrangements separated from the passenger compartments. It had been the intention, when these cars were originally put upon the line, to have a motor car in the middle of the train, but it had been abandoned. The system now used constituted a locomotive system of the greatest security. The conditions were entirely different in connection with the cars which would be run upon the Great Northern and City and the Metropolitan District lines. There were motors all along underneath the train as well as controller compartments. This was the real motor-car system, and the possibilities of getting short-circuits were very great. In these circumstances the insulated third rail was a necessity. There was not much likelihood of seeing the system adopted upon the City and South London Railway extended to any other railways. In conclusion, he congratulated the City and South London Company on the persistency with which it went on boring through London. They got up to Moorgate-street, then to the Angel, and now they were going to turn down to Euston, and he suggested that the next thing to do was to change the name of the company from the City and South London.

Mr. H. M. HOBART agreed with Prof. Carus-Wilson as to the disadvantage of a single conductor rail with the track as a return. Mr. McMahon had attained excellent results in spite of an old inheritance—viz, old apparatus, which he was working successfully as part of a modern system, but he presumed that had Mr. McMahon to do all this over again he would not have done it upon this system. He would not surely have had all those auxiliary motor-generators, reducers and multipliers. Further, he thought it was a great mistake to go in so heavily for accumulators. Mr. McMahon admitted that efficiency was decreased by their use, and also that the load acquisition was only improved by about 10 per cent., but he fell back upon the statement that they were beautiful as a stand-by. In a great many projects in which he had tried to figure out an advantage for storage batteries, it had always proved more economical to put in the increased generating plant. The efficiency of a battery could, of course, be anything one chose to make it, if only an expensive enough one was put in and run at a low enough current density. An accumulator was just the opposite of almost all other electro-dynamic apparatus. Its efficiency approached 100 as the load approached zero. But capital cost and depreciation on the heavy investment compelled one to employ accumulators generally at as low as 60 per cent. efficiency, and that was an efficiency which decreased with the deterioration of the accumulator. It also appeared to him that the City and South London Railway would be better if 2,000 volts were used between the outers with 1,000-volt main generators and 1,000 volts on the commutators of the motors. Such a proposal would have been considered impracticable a short time ago, but he was inclined to think that the tendency was now in that direction. The advocates of polyphase systems for railway working were rapidly finding almost unsurmountable difficulties, and were reverting to the continuous-current system. 1,000-volt generators were extremely practicable if driven at low speed. The dynamo-electric machine in very small sizes was handicapped by the high potential at the commutators. In tramway work, if slow speeds were used, 1,000 volts was more economical. There were fewer poles in the generators, less loss in the shunt exciting spools and cores, as well as less friction and C^2R losses at the commutator. He had it from a very reliable source that a motor—many thousands of which were in use all over the world—had been developed with a 1,000-volt winding, and had given excellent satisfaction, although not on the road, only in factories. In conclusion, he asked Mr. McMahon if he knew what the watt-hours per ton-mile were with the system as it was worked at present.

Mr. J. BJORNSTAD spoke as to the working of the lifts on the City and South London Railway, and reviewed the considerations which should guide the dimensions of the pulleys and counter-weights. A difficulty had been found at some of the stations in stopping the lifts level, and he considered that the main cause was that the lifts were run at a speed higher than was originally specified.

Mr. J. S. HIGHFIELD did not think Mr. McMahon's system of feeding the railway had been properly appreciated. There were not many men who understood the extreme ingenuity of the system. The author had told them that the system of feeding at 2,000 volts, 1,000 volts above and below earth pressure—the third rail being earth—with two reducers, involved only the transformation of half the total energy in each sub-station. He should say it was questionable if there were many railways operating a sub-station with a higher efficiency than 82 per cent. There had been some remarks made about the use of batteries in a sub-station. The battery in a generating station was open to question—sometimes it was useful and sometimes not—but when it came to using a battery in a sub-station some miles from the generating station, it was a different matter. It took the place of generating plant in the large station. Such a sub-station plant was justified even if the capital cost was twice the equivalent of steam plant, because if the whole cost of generating plant, high-tension feeders and rotary converters was taken into account, it would be found that the cost of the battery per kilowatt did not exceed the former and generally was very much less. Of course, if a battery was worked in such a way that the efficiency was only 60 or 70 per cent., then the repairs would be so extremely heavy that the battery was not warranted in any event, and unless an efficiency of nearer 80 per cent. could be obtained it was no use putting in the battery. This was purely a question as to whether using a constant current in the feeder was worthy of consideration. The loss in a feeder handling a great number of kilowatt-hours at constant current was less than the loss when the same number of kilowatt-hours were handled in the same time with varying current. For instance, supposing a given amount of energy was transmitted in a given time, and then twice the amount was transmitted in half the time, the amount of loss in the second case would be twice what it was in the first case. In the tables to the Paper Mr. McMahon had given the number of units handled down the feeders, but unfortunately these did not give the whole number of units, and probably it would be found that the units handled by the high-tension feeders, as entered at the sub-station, would be less when working with varying current than when working with constant current. Prof. Carus-Wilson had raised a most interesting point as to the advisability of using an earthed return for a railway system. Personally, he believed the reason why the insulated return was used on the Liverpool Overhead Railway and the Mersey Railway and other lines, was because it was cheaper to use the insulated return with a greater drop than 7 volts in the return conductor than to comply with the Board of Trade regulation that with an uninsulated return the drop should not be more than 7 volts. There was no doubt, however, that there were other advantages. If there was an earth on the positive they could still go on driving the line with the negative. But it should be remembered that in a three-wire lighting system the Board of Trade insisted on earthing the middle conductor in order to provide for the safety of the consumer, and it was

* *Jour.* Inst. Elec. Eng., 1899, Vol. XXVIII., p. 508.

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a rather curious fact that on a railway system the same precaution should not be enforced. Everyone would admit that Mr. McMahon's costs were extremely good—0·44d. at the works. Mr. McMahon's load-factor was approximately 50 per cent. One could get a load-factor of 50 per cent. in many ways. One could get a very high peak at the ordinary time of maximum load, or a series of peaks distributed throughout the day. From railway practice it appeared that a load-factor obtained in the latter way always gave a better chance of low costs than the former. It appeared that the boilers worked at a far better load-factor under railway conditions than under lighting conditions, although the calculated load-factor for the two conditions were exactly alike. It was interesting to note the extraordinarily level pressure curves which the author had shown. He should very much like to claim that as part of the system adopted in one or more of the sub-stations, but the real reason was that the engines were excessively well governed and the generators very beautifully compounded, because he knew that at the battery the volts were exceedingly regular.

Mr. J. N. SHOOLBRED having spoken briefly,

The PRESIDENT said as it was obvious that the Paper admitted of much more discussion than was possible that evening, they would adjourn it until January 14th. On this occasion, too, if time permitted, Mr. Behn-Eschenburg's Paper would be read.

HIGH-SPEED ELECTRIC RAILWAY PROBLEMS.*

BY A. H. ARMSTRONG.

Among the many questions to be considered in a new railway project, perhaps the one of primary importance is the question of the proper speed at which to *operate*, as depending upon this factor is not only the first cost of the road, but its cost of operation and probable receipts. Owing to the wide field covered by the electric railway motor, it is not possible to consider all classes of railways, and therefore this discussion is limited to those of relatively high speed. It is a mistaken idea that acceleration problems are met with only in city or elevated work where the stops are frequent. Although the so-called high-speed railways stop at comparatively infrequent intervals, the relation existing between stops and schedule speeds often calls for the most serious consideration of fractional speed running of the motors. Such railways really act as tributaries to large city street railway systems, and must be able to operate over several miles of city tracks at slow schedule and with frequent stops, and also be adapted for operation at 40 or 50 miles per hour, with infrequent stops on a private right-of-way. While each railway presents its own local characteristics nearly all can be divided into two broad classes: Those having frequent stops and those having very few stops. Both classes of service will probably parallel one or more steam lines, and must make a schedule speed that will compare favourably with that obtaining on the competing steam line. This high schedule speed must also be made with more frequent stops than given by the steam service, and in nearly all cases over a track which has many sharp curves, which have the effect of still further increasing the number of stops. Interurban lines having very infrequent stops, say one stop in 5 or 10 miles, private right-of-way and an alignment free from curves of less than 3deg., can give a service equal or superior to any competing steam line, and can, furthermore, provide the frequent service which has proved one of the valuable assets of electric railways. Moreover, the generating station, feeder system, motor capacity and power consumption will be moderate in first cost.

Suburban lines, however, that pick up their load at frequent intervals along the route, and still have to compete with parallel steam lines, present problems much more difficult to solve from an economic standpoint. It is the custom of such railways to establish stopping points, say 1 mile or less apart, and stop at these points only on signal. During certain portions of the day, however, cars will be obliged to stop at nearly all these stations, and will either fall behind their schedule at such times or will have too much leeway during the remainder of the day when stops are much less frequent. Moreover, owing to the considerable city running at necessarily slow speeds, these suburban lines must make as good time as possible on the suburban route in order to bring the passengers from the more distant points within a reasonable time, including city running. In fact, such roads when paralleling steam lines operating on private right-of-way through the city, and giving excellent service morning and night to commuters, are compelled to face very serious engineering and economic problems due to the tremendous amount of generating apparatus, line copper and motive power required to give equally good service. In considering the possible speeds of a car or train of cars, the investigator is met with the necessity of obtaining some accurate data on the question of car and train friction. The greater part of the data now existing on the subject has been obtained with trains hauled by steam locomotives. Many of these results were obtained by draw-bar pull and hence neglected the wind-friction of the locomotive, and those taken by indicator diagrams are open to the objection that the steam locomotive is not square-ended like a car, and wind-friction results so obtained are not applicable to the operation of the train electrically, without locomotive. Moreover, all these results were obtained with more than a single car in the train and do not apply to suburban electrical operation, which almost universally uses single car trains. Tests are being made from time to time with electrically-operated trains, and due to the refinement of the carefully calibrated voltmeter and ammeter it is possible to obtain wind-friction values at various speeds and with different number of cars in a train with

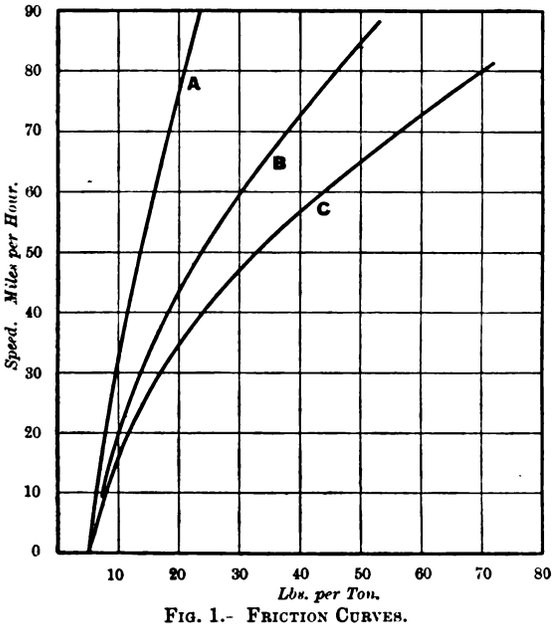

FIG. 1.- FRICTION CURVES.

greater accuracy than in the previous steam tests. These results are not at all complete, and the only attempt known to the writer to obtain friction values with different number of cars was made by W. J. Davis, jun., through the courtesy of the International Railway Company on its Buffalo and Lockport line in March, 1900. Using these tests as a basis, the writer has drawn up three friction curves in Fig. 1, designating them A, B and C. The C curve will

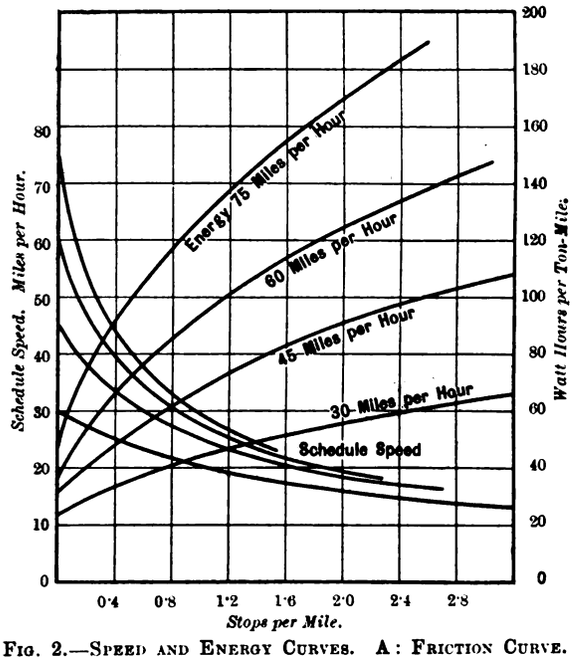

FIG. 2.—SPEED AND ENERGY CURVES. A: FRICTION CURVE.

hold approximately for single car operation where the car weighs in the vicinity of 40 tons. The B curve applies to the operation of two such cars in a train and the A curve to a train of such cars, say, eight or more in a train. These curves are not published with the idea that they are correct; in fact, the speeds at which they were obtained do not exceed 60 miles per hour, and hence extension beyond this speed is based upon a formula which will follow curve shape up to 60 miles per hour. As the results obtained by using them are not dependent upon their numerical values, intermediate

* Paper read before the American Institute of Electrical Engineers.

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points being easily interpolated, it is not of prime importance that the three friction-curves given represent accurately the conditions as set forth. In fact, with the different shaped cars now in use and the different cross-section of cars having the same weight, &c., it is hardly possible to make one friction-curve which would apply accurately to all cases. It is probable, however, that the curves given have the general shape and the numerical values applying to average conditions. The friction curves have been extended to maximum speeds approaching 90 miles per hour in order that

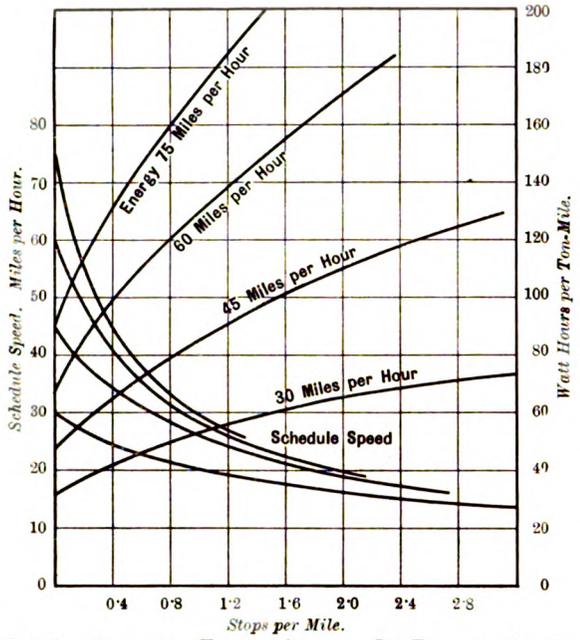

FIG. 3.—SPEED AND ENERGY CURVES. B: FRICTION CURVE.

questions of motor capacity, train energy, possible schedule speeds, &c., can be followed up to maximum speeds equal to or better than those in vogue on the present steam lines. As will be pointed out later in this Paper, the consideration of the proper method of operating a railway service at these high maximum speeds leads to very interesting results as determining the size of trains and frequency of service to be adopted.

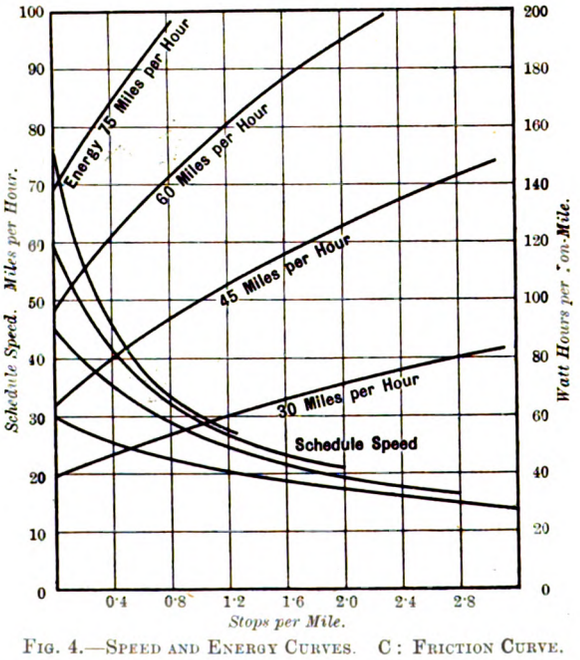

FIG. 4.—SPEED AND ENERGY CURVES. C: FRICTION CURVE.

With the friction curves in Fig. 1 as a basis, the curves in Figs. 2, 3 and 4 have been calculated, showing the possible schedule speeds and energy consumption required for these speeds up to and including 75 miles per hour maximum. The rate of acceleration and rate of braking do not have a marked effect on the energy consumption or possible schedule speeds for these comparatively high-speed lines. The shape of the motor characteristic also is not a determining feature and can be neglected without introducing a possible error of more than a few per cent. The controlling factor in all of these curves is the friction-curve, which includes track, rolling, journal and wind-friction. The constants assumed in calculating the above curves are those pertaining to average high-speed suburban work, as follows:—

Gross accelerating rate	120lb. per ton.
Braking effort (average)	120lb. per ton.
Duration of stop	15 seconds each.

Track assumed to be perfectly straight and level.

In the above curves, due consideration is given to all the losses occurring during acceleration with the standard series-parallel controller and continuous-current motors. If the curves are to be used for alternating-current motors, allowance must be made for the difference in accelerating efficiency of the two types of motors and their methods of control. The inertia of the rotating parts of the equipment generally amounts to 5 per cent., and this value is taken throughout, being perhaps a little high for the higher speeds and low for the lower speeds. The speed-curve of a standard 125 H.P. motor is used throughout. The energy curves given are somewhat affected by the amount of coasting done, although this is not so determining a factor in this high speed work as it is in slow speed rapid transit accelerating problems. In order that the energy curves should be conservative, they are plotted with only 10 seconds of coasting permitted and, therefore, the schedule speeds given are nearly the maximum possible, and the energy curves given are also practically the maximum possible with the maximum speeds assumed. Should power be shut off earlier and more coasting permitted, the energy consumption would have been decreased and the schedule speeds decreased somewhat also, especially with the more frequent stops per mile.

An inspection of these three sets of curves will bring out the very great effect of the wind-friction when using trains of one or two cars at very high speeds; in fact, at 75 miles per hour maximum speed the operation of single car trains becomes impracticable with light 40-ton cars of standard construction, and even at 60 miles per hour is questionable. To quote from the curves, it requires an energy consumption of 47 watt-hours per ton-mile for a train of several cars, as against 137 watt-hours per ton-mile for a single car operating at 75 miles per hour without stops; that is, a single car operation would demand 3·7 times the energy per ton that would be required for the operation of a train of many similar cars. Even a two-car train will require but 92 watt-hours per ton-mile, or only 67 per cent of the energy required per ton for single car operation. As these values are for constant speed running, while more or less frequent stops would obtain, a comparison at, say, one stop in 4 miles would be nearer the actual results in practice. Here a single car requires 157 watt-hours per ton-mile, a two-car train requires 120, and a train of several cars 79 watt-hours per ton-mile. The results would indicate that in a class of service calling for very high maximum speeds, the tendency of electric lines will be to follow steam railway practice, and operate trains of several cars at more infrequent intervals rather than follow the present practice of suburban electric lines, and run single cars at frequent intervals. It will be a question for local consideration whether sufficient additional traffic would be gained by the operation of single cars, say, on half-hour headway, or trains of two or three cars on one hour headway or more, the latter requiring but 60 or 70 per cent. of the power per ton moved, and also effect a considerable saving in train crew expenses. As the maximum speed of the service is reduced, the difference in energy consumption between single cars and trains of cars is also reduced, and at 30 miles per hour a single car will require but slightly more energy per ton than a train when operated at the frequent stops characteristic of low-speed service. Another very interesting feature which is well known, but perhaps not fully appreciated, is brought out by the curves of schedule speeds possible for different maximum speeds. Thus, with one stop in 8 miles, it is possible to make a schedule of 61 miles per hour, with maximum speed of 75 miles per hour, and a schedule of 28 miles per hour with maximum speed of 30 miles per hour. If stops be increased so that that they average one per mile, however, the schedule speed possible with a maximum speed of 75 miles per hour is dropped to 29 miles per hour, while the 30 miles per hour maximum speed permits of a schedule speed of 22 miles per hour. Thus, while 30 miles is but 40 per cent. of the higher maximum speed, it permits a schedule at one stop per mile of 76 per cent. of that possible with 75 miles per hour maximum speed. The fallacy of using high-speed equipments for frequent stops is forcibly brought out by referring to the energy curves in Figs. 2, 3 and 4. With one stop per mile it requires 200 watt-hours per ton-mile, with 75 miles maximum speed equipment, and the 30 miles maximum speed equipment can obtain 76 per cent. of the same schedule with an expenditure of only 28·5 per cent. of the energy. The two values taken for the maximum speed are the extreme, but serve the purpose of bringing out the tremendous price paid for high-schedule speeds at frequent stops. The conditions of acceleration and braking are the same in both these equipments, while if higher schedule speeds were required with, say, one stop per mile, a higher rate of acceleration and, if practical, a higher rate of braking would be adopted. The difference in energy varies would be considerably reduced thereby, but neither the average

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rate of acceleration nor the braking could be very largely increased without incurring the possibility of discomfort to passengers.

Before considering the application of the previous curves to a concrete case, it is necessary to include the effect of the different friction curves at high speeds upon the capacity of the motor equipment. A sample motor capacity curve of 125 H.P. equipment operating at a maximum speed of 45 miles per hour is shown in Fig. 5. The means taken to determine the capacity of this motor is to obtain from a series of temperature runs made upon an experimental track the degrees rise per watt loss in differents parts of the motor for different ratio of losses for armature and field. It is obvious that so long as the motor losses and their distribution are the same, the temperature rise of the different parts of the motor will also be practically the same. This assumes that the car will travel at the same average speed, which is not necessarily the case owing to the fact that the same motor cycle could be obtained with a considerably different train cycle. A service

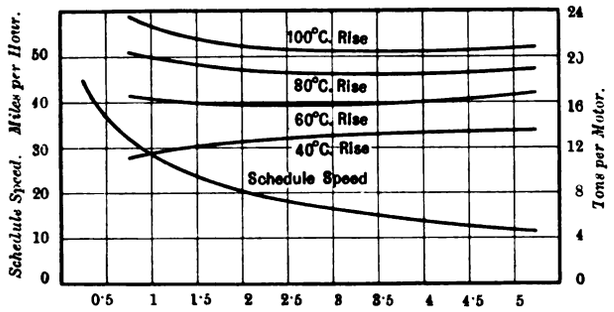

FIG. 5.—MOTOR CAPACITY CURVES 125 H.P. MOTOR. B: FRICTION CURVE.

capacity curve similar to Fig. 5 on the 125 H.P. motor is, therefore, not absolutely correct unless the thermal capacity curves be obtained from actual tests giving the same train-cycle as that indicated. It is not necessary to conduct so elaborate a series of tests, as a sufficiently close result can be obtained for practical purposes by obtaining the experimental thermal capacity curves at moderate average speeds upon an experimental track, and assuming that the conditions of ventilation so obtained will hold true for all the schedule speeds. It is admitted that a source of error is thus introduced, and that motor-service capacity curves will read too conservative at the very high speeds, and will possibly be too liberal at the lower speeds; but conservatism at speeds approach ng 75 miles per hour could not be criticised as poor engineering, and the results given in following curves are therefore presented with full confidence that they will meet a long-felt want, and will, moreover, be approximately correct for types of motors

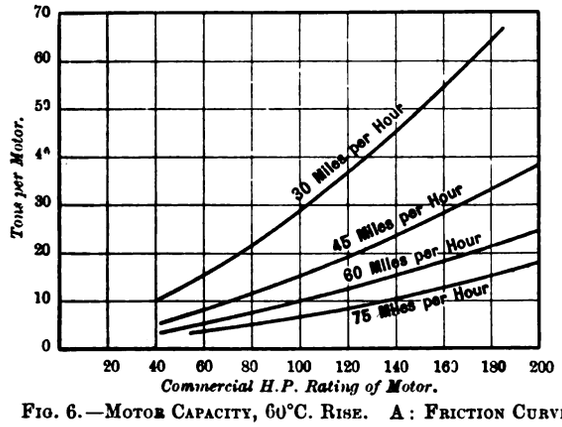

FIG. 6.—MOTOR CAPACITY, 60°C. RISE. A: FRICTION CURVE.

similar to those serving as basis of calculation and experiments. An inspection of the curves given in Fig. 5 discloses the fact that for a given temperature rise the capacity in tons per motor is practically a fixed amount. For example, a temperature rise of 60°C. will be obtained with approximately 16·2 tons per motor over a range extending from one stop in 4 miles to five stops per mile. It is thus sufficient to associate a given motor and gear ratio with a definite car weight which it can operate with a given temperature-rise, and with any schedule speed which the number of stops per mile will permit. This at once affords a means of comparing motors of different capacity by means of the "tons per motor," which is permitted for, say, 60deg. rise and a given maximum speed equipment. In presenting the curves in Fig. 6, the results of a large number of experiments and calculations are incorporated on motors of similar design, giving the relation between the commercial one-hour rating of the motor and the number of tons which that motor will carry at maximum speeds of 30, 45, 60 and 75 miles per hour. The curves of 30 and 45 miles per hour are probably accurate, those at 60 miles per hour may be open to the criticism of being conservative, and at 75 miles per hour, with the superior ventilation afforded by the schedule speeds incident to such high maximum speeds, the motor-capacity curves perhaps indicate too low a ton weight for 60deg. rise As no electric road as yet affords means of obtaining experimental values at this high maximum speed, the degree of error cannot be determined, and in any case should not exceed more than a possible maximum of 15 per cent. Figs. 7 and 8 are plotted for 60deg. also, but using friction curves B and C, so that by means of Figs. 6, 7 and 8 it is possible to determine the capacity of motor required for any maximum speed and any weight of train; while from Figs. 2, 3 and 4, the possible schedule speed and energy consumption can be obtained for any

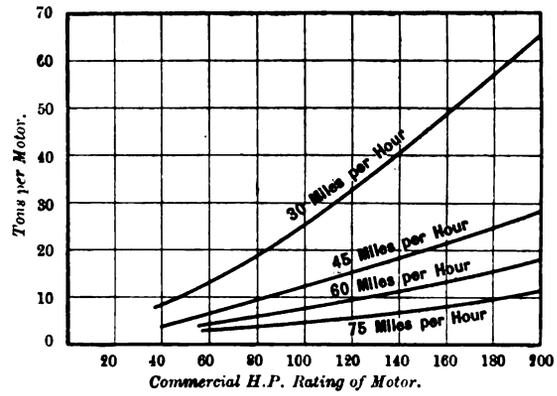

FIG. 7.—MOTOR CAPACITY 60°C. RISE. B: FRICTION CURVE.

maximum speed and frequency of stops. The maximum speeds of 30, 45, 60 and 75 miles per hour have been chosen as covering the present field of electric railroading, and intermediate values may be readily interpolated.

The relation between the commercial one-hour rating of a railway motor and its service capacity performance is very difficult to express. In fact, it is almost impossible to compare two motors differing essentially in their mechanical design, as the stand-test of a motor has no direct bearing on its service performance with its different distribution of losses and better facilities for ventilation. It is necessary, therefore, to obtain by experiment the performance of each individual motor under conditions approximating service operation, and determine the relation of stand-test to service operation for the particular motor in question. By carrying on a series of exhaustive tests on each individual motor it becomes possible to plot the results of such tests in curve form and show the relation between stand tests and service capacity, provided motors are of the same general design. Having obtained the capacity in tons per motor for

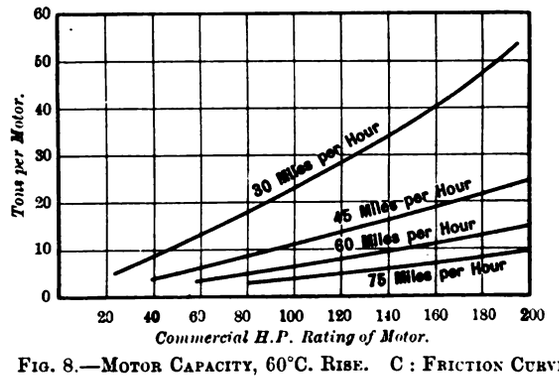

FIG. 8.—MOTOR CAPACITY, 60°C. RISE. C: FRICTION CURVE.

different maximum speed equipments, the results were all found to follow the general law noted in Fig. 5; that is, the temperature rise was found to be practically constant over a wide range in stops per mile and schedule speed. With this simplification it becomes possible to compile curves 6, 7 and 8, giving the capacity motor required for any train weight, schedule and frequency of stops, the motors all being of similar design. These curves are all plotted with motors of the closed type, it being assumed that in miscellaneous operation advantage cannot be taken of opening ventilators. Where motors can be operated partially or fully open, the capacity, especially at high speeds, will be considerably increased. It is probable, however, that motors operating at speeds approaching 60 to 70 miles per hour will be upon a surface track where it would be advisable to protect the motor from dust and moisture, and thus operate closed. The results brought out by curves 6, 7 and 8 are very instructive as determining the probable trend of very high-speed electric railroading where trains of one or more cars are used. For

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example, a 40-ton car equipped with four motors, thus giving 10 tons per motor, will require a 133 H.P. motor for 60deg. rise when operating a train of several cars at 75 miles per hour maximum speed, while the same weight of car would require a motor of at least 230 H.P. if operated as a single car with the same temperature rise and similar design of motor. That is, the motive power is doubled in going from train to single car service. Thus, not only is train friction the determining feature of energy values, but it is the controlling feature as well of the motor capacity required to perform a given high-speed service. As pointed out in the earlier part of this Paper, it is not necessary that the friction curves A, B and C shall in themselves correctly give the numerical values for train, single-car and two-car work. The general shape of the curves is undoubtedly that pertaining to their respective size of train, and as the three curves are taken and subsequent calculations are all made upon a three-curve friction basis, it is relatively an easy matter to interpolate and obtain the energy, schedule speed and motor capacity required for any train friction expressed in pounds per ton. The friction curves are of use, therefore, only in determining the fundamental values of train energy and motor capacity given in the subsequent curves, and the energy, schedule speed and motor capacity can be obtained from these curves whether the friction pertaining to the case in hand is, say, 33lb. per ton at 50 miles per hour for single car operation, or more or less than this value. The application of the motor and energy curve is, therefore, universal, and it is only necessary to obtain sufficient experimental data of the particular type of car or train proposed to determine accurately its friction for a given maximum speed and obtain the various values required by interpolation in the curves given. Having obtained the data upon which to base calculations for the proposed electric line, perhaps the best method of showing its application would be to take a concrete case. Let the distance from A to B be, say, 100 miles, or great enough to get over the consideration of location of sub-stations in relation to the length of the line. Assume also that the proposed line will parallel a steam line, or that there are other reasons necessitating a high schedule speed, and that stops will occur every 4 miles and will be of 15 seconds duration, and that the motors will be continuous-current supplied from sub-stations fed from a single central generating station. It is desired to know the effect that single car or train operation will have upon first cost and cost of operation.

It is assumed that the competing steam railway will have a schedule speed in the vicinity of 40 miles per hour. Such express trains as exceed this schedule will offer such very infrequent service, and will, furthermore, be so restricted to their through travel that they will not enter as a factor for consideration. By referring to Fig. 4 we find that a schedule speed of 40 miles per hour can be obtained with a maximum speed of approximately 48 miles per hour with one stop in 4 miles. The energy consumption will be 82 watt-hours per ton-mile, and the motor capacity will consist of four 110 H.P. motors operating a single 40-ton car with a temperature rise of 60deg. (Fig. 8). The energy consumed at the car will, therefore, be 131kw. or 144kw. at the sub-station 'bus bar, allowing an average drop of 10 per cent. in the third rail. With a sub-station 'bus bar potential at 600 volts, each car will average 240 amperes. Assuming that there will be double track with 80lb. track rails and 100lb. third rail, the distance apart of the sub-stations will be approximately 13 miles, with a maximum drop of 170 volts when two cars are passing midway between sub-stations, one of which is accelerating. This drop is permissible as it is momentary only. Each sub-station must be able to accelerate one car and supply another at full speed, or must give 850 amperes momentary output and a sustained output of 500 amperes. The sub-station will, therefore, be called upon to deliver momentarily 510kw., and should contain not less than one 300kw. rotary converter, and preferably two, one being a reserve. This size of converter is based upon the assumption that cars run always as single units and not in trains, and that converters can stand a momentary over-load of 100 per cent. With half-hour service cars will be spaced 20 miles apart, so that there will be required a generator capacity of two cars every 20 miles (double track) or 340kw. assuming 15 per cent. loss in rotary converter sub-stations and transmission line. The generating station capacity per mile of track will, therefore, be 17kw., and the sub-station 46kw. with reserve, and 23kw. with no reserve. Taking the cost of generating station in round numbers at $100 per kilowatt and sub-station at $35, the cost of a 40-ton car complete with four 110 H.P. motors, controllers, &c., at $9,000, we arrive at the following approximate cost for installing:—

Approximate First Cost per Mile. Single-car Train.	
Generating station	$1,7 0
Sub-stations with reserve	1,610
Equipment (plus 20 per cent. reserve)	1,120
Total	$4,430

The above total of $4,430 thus represents the approximate first cost of the various items noted when operating a single 40-ton car every half-hour at 40 miles per hour schedule speed, and stopping 15 seconds once in 4 miles. Following through the same process with two 40-ton cars operating on one hour headway at 40 miles per hour schedule, with the same track and third rail construction, we arrive at the following conclusions:—

Watt hours per ton-mile	63.
Train energy at train (80 tons)	202kw.
Distance apart sub-stations	9·1 miles.
Size of sub-station	two 400kw. units.

Each train consisting of two 40-ton cars will consume 224kw. at the sub-station, or 264 at the generating station, allowing the same percentage of loss as above. These trains making the same schedule speed at double the headway will be spaced 40 miles apart, and the generating capacity will, therefore, be 528kw. every 40 miles, or 13·2kw. per mile. The sub-stations, consisting of two 400kw. units (with reserve) every 9·1 miles, will have capacity per mile of 88kw. Expense for cars will be the same as before, and the following approximate costs obtain:—

Approximate First Cost per Mile. Two-car Train.	
Generating station	$1,320
Sub-stations	3,080
Equipments	1,120
Total	$5,520

The first cost of the two-car train system will be $5,520 as against $4,430 with single-car train. The energy consumed for the two methods of operation is 17kw. per mile of track with single car as against 13·2kw. per mile with two-car train. Thus, while the two-car train at one hour headway will cost 24½ per cent. more to instal (for the items mentioned only) it will consume but 77·6 per cent. of the energy required to operate a single car individually. The difference in power required is 3·8kw. per mile of track. Assuming 12 hours per day operation at the above headway, the total kilowatt-hours per day will be 45·5, which at $0·007 per kilowatt-hour would be $116·50 per year, or 10 per cent. on $1,165. It would, therefore, pay to invest the $1,090 per mile of track difference in cost between one-car and two-car operation, as found above, provided the same receipts could be secured with one hour headway as with 30-minute headway. The relation of traffic receipts and frequency of travel is a question which can only be determined experimentally, and while the desirability of the two-car service seems evident from the data at hand in the above case, it might result in a falling off of receipts to such an extent as to then make up the saving in operating expenses. There is an additional saving in train crew expenses which was not entered into above, and which would amount to something more than half as much as the cost of power. With two-car operation it is possible to reduce the motor capacity per car from four 110 H.P. motors to four motors of approximately 95 H.P., thus reducing the cost of the equipment item. Owing to the fact, however, that it might be desired to operate a single car during certain parts of the day, which would result in overheating the smaller motor equipment, it would be more conservative to consider the same size of equipment, whether one car or two-car train were operated. With more than two cars in a train, advantage could be taken of the smaller equipment required, but it is probable that in two-car work this advantage of the smaller motor possible for two cars would only result in the cooler operation of these motors when operated in two-car trains and would show up, therefore, in the repair account rather than as a first cost. The sub-stations with two-car trains being placed somewhat closer together would have a labour account per mile of track in excess of that for single-car operation. This may be balanced against the saving which would result from smaller crew expenses of the two-car train. These examples serve to illustrate the very broad application of the foregoing curves. Although it has been necessary to assume a number of constants, acceleration, braking, coasting, &c., these constants are those pertaining to average operation, and can vary considerably without making a serious difference in the results. The curves given are not, therefore, absolutely correct, but are sufficiently so for approximation purposes. For the slower speed work where stops are more frequent and where acceleration is a more important factor, it will be necessary to have more complete curves to determine the proper rate of acceleration to use, especially if the problem is one calling for very high schedule speeds in relation to the number of stops. As previously stated, it is not necessary that friction curves A, B and C should represent the actual friction in pounds per ton of train two-car and single-car work. Having the motor capacity and energy values for three different friction rates at a given maximum speed, it is possible to interpolate and secure the proper motor capacity and energy value for the friction value corresponding to the case in hand. The importance of the wind friction as affecting electrical operation at a very high speed in service which has followed along the lines of very small light trains of one or more cars, will probably lead to the construction of special cars reducing wind friction to a minimum when the higher maximum speeds are put into commercial operation. No conclusive data is at hand upon the effect of different-shaped car ends on single or two-car operation. When such data becomes available, and special cars are constructed, their operation can be predicted from the foregoing curves by interpolation for the new friction values thus obtained.

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ELECTRIC TRACTION WITH ALTERNATING CURRENTS.*

BY A. C. EBORALL.

Concluded from page 330.)

So much for the rheostatic control of three-phase railway motors; there remains to be considered the alternative to it already referred to—namely, tandem parallel control. This method of controlling the speed of mechanically-connected three-phase motors was devised and put into actual use as far back as 1892 by Messrs. Siemens and Halske,† but it was not until Messrs. Ganz employed it on the Valtellina Railway in 1900 that it came to the front in connection with important work. As usually arranged, the rotor of the secondary motor is in series with the rotor of the primary motor, the stator of the former being short-circuited at half-speed, while that of the latter is, of course, directly on the lines. Intermediate speed regulation is obtained with the help of resistances in the stator of the secondary motor, although other intermediate speeds can be obtained without them by using special arrangements, such as arranging the mechanical connection of the two motors so that the speed of the one is greater than that of the other, or by the use of a different number of stator poles on the two motors, or by a combination of both methods; but such extensions of the original arrangement of tandem coupling have not yet been utilised in practice.

The tandem control of two mechanically-connected three phase motors which run at the same speed when in parallel is then analogous to the series-parallel control of direct-current motors, inasmuch as half-speed can be obtained without the employment of resistances; but the analogy does not extend beyond this, as a little consideration will show. The curves of Fig. 6 illustrate what occurs when two such motors are in tandem—here the torque, current, efficiency, power-factor and slip curves are given (as functions of the load on the motors, at constant pressure) for the case of two three-phase motors in tandem, and (dotted) for one of them operating in the usual way at double the speed. It will be seen that the maximum torque that can be exerted by the two motors together in tandem is somewhat less than the maximum torque which can be exerted by the one running alone; hence, as the speed is practically double in the latter case, it follows that the maximum output of the two motors in tandem is about one-quarter of that of the two motors when in parallel, constant line pressure being assumed in both cases. It will also be noticed that for a given value of stator current (primary motor) the total torque exerted by the motors in tandem is considerably greater than the corresponding value for the case of either motor working alone, and, further, that both the efficiencies and power-factor, for a given torque, are considerably worse (especially the power-factor) when the motors are in tandem. These are the principal electrical characteristics of three-phase motors connected in tandem and running at half synchronous speed, or, rather, a little below it. When running above this speed, the stator of the primary motor being still connected to the lines, the combination returns power to the lines, which is a matter which will be referred to later on.

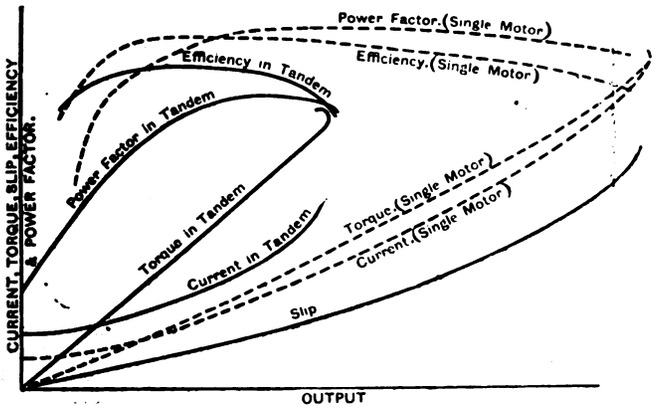

FIG. 6.—CHARACTERISTIC CURVES FOR THREE-PHASE MOTORS WHEN WORKING IN TANDEM AND SINGLY.

* Paper read before the Manchester Local Section of the Institution of Electrical Engineers on Tuesday, December 15th.

† The tandem, or cascade, or concatenation control of three-phase induction motors, as it is variously called, was actually devised by Prof. Gorges, the chief electrician of this firm at the time. Those intetested in the theory and calculation of three-phase motors in tandem should refer to Dr. Breslauer's excellent little treatise on the subject, entitled "Das Kreisdiagramm des Drehstrommotors und seine Anwendung auf die Kaskadenschaltung."

If a given motor equipment has to operate, when all the motors are in parallel, at an output nearly corresponding to the maximum torque of the individual motors, and if, moreover, the motors have to give this same torque when in tandem, it is clear from Fig. 6 that a means for increasing the torque of the motors when in tanden will have to be provided. Thus, for instance, the stator windings of the primary motor could be mesh-connected while in tandem, afterwards being in star, which would result in an increase of torque of 50 per cent. or thereabouts. A better arrangement, on account of the lesser complication, would be to increase the pressure during the period of tandem connection by means of a boosting transformer on the car, or if step-down transformers are used in connection with the motors (as at Zossen) by reducing the transformation ratio of these.* However it is done, however, it means additional losses.

On the other hand, if all the motors are not required when in parallel, half of them running idle above half-speed (except when braking), the double number of motors operating in tandem evidently gives a torque about equal to the maximum torque that can be exerted by half the number operating in parallel. This is, in fact, the Valtellina arrangement; here there are four motors of equal size per motor car—namely, two primary (3,000/330-volt) motors, and two secondary (330/330-volt) motors. The secondary or low-pressure motors are used only from standstill to half-speed when accelerating, and from full speed to half-speed when braking; during the rest of the time they are running idle, and, of course, out of circuit. Resistances are used in the rotors of the primary motors from half-speed to full speed and in the stators of the secondary motors from standstill to half-speed. With these arrangements then, no auxiliary apparatus is necessary for bringing up the torque of the four motors in tandem to nearly the same value as when the two motors are in parallel.

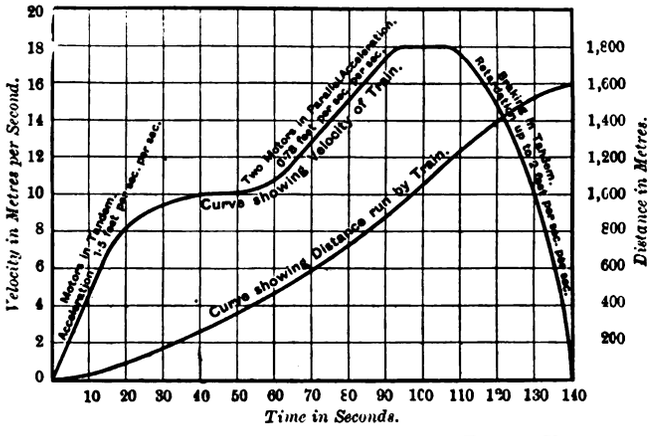

FIG. 7.—ACCELERATION TEST WITH EXPERIMENTAL TRAIN. VALTELLINA RAILWAY.

Run No. 5, with Car No. 322. Gradient, 1 per cent. Start, 4h. 15m. 30s.; finish, 4h. 17m. 50s.; time, 2m. 20s. Distance run, 1,600 metres. Max. speed, 18 metres per sec. Rolling weight, 54 tons.

Compared with the rheostatic control of three-phase railway motors, it is evident that tandem-parallel control offers considerable advantages from the point of view of rapid acceleration and economy; quite apart from the considerably diminished losses in the rheostats an appreciable amount of energy can be returned to the lines during retardation. At Valtellina this is some 12 per cent. (watts per ton-mile basis), while according to Messrs. Ganz it would have been about 9 per cent. for the case of the Inner Circle on the Metropolitan District Railway. Of course, this regenerative action of three-phase motors can be taken advantage of under certain circumstances without using tandem control—the use of the latter merely makes it possible to do so under all circumstances. Thus, on Messrs. Brown, Boveri & Co.'s mountain lines the cars coming down can run somewhat above synchronous speed for long periods, and thus help to brake themselves by acting as generators. But in ordinary railway work, the amount of energy returned to the lines in this way would be very small without the tandem arrangement. With the help of the latter, the braking occurs over a wide range, and below full speed—thus, if the motors of a train running on the level at 50 miles per hour (synchronous speed) are switched into tandem connection, energy would be returned during the time taken to reduce the velocity of the train from 50 to 25 miles per hour.

But the advantage of the tandem parallel control in being able to run at half-speed without rheostatic losses, and in returning power to the line during retardation, have to be paid for. In the first

* Dr. Reichel (of Messrs. Siemens and Halske), who has done so much to make the work at Zossen a success, has worked out in detail several arrangements of this kind, with the object of increasing the torque of the motors when in tandem. The chief difficulty is to reduce the number of connections, and to get simple arrangements of the same, and of the controllers, especially when working with high-pressure motors.

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place, as already noted, both the efficiency and power-factor, when running in tandem, are considerably worse than the corresponding values when the motors are working in parallel. At Valtellina the full-load efficiency of the primary motors is 89½ per cent., that of the secondary motors is 90 per cent., while the efficiency of the combination in tandem at half-speed is 80 per cent.: the power-factors are respectively 92½, 94 and 77½ per cent. At the light loads, the values (especially those of the power-factor) are much worse. The reduced efficiency is due to the fact that, for a given output, the total loss in the two motors in tandem is about double the loss in one motor alone, the total loss in the primary motor being about double that in the secondary motor when the two are in tandem. The reduced values for the power-factor are due to the inductive character of the rotor circuit of the primary motor; the rotor current, instead of being practically in phase with the rotor pressure, is lagging considerably behind it, because the rotor is now short-circuited on the rotor windings of the secondary motor, instead of being closed non-inductively. This is, indeed, the reason why the maximum torque of the two motors in tandem is so much less than that of the same two motors in parallel.

The above-mentioned electrical disadvantages of the tandem control are inherent to the method, and independent of the manner in which it is carried out. They become very serious indeed at usual frequencies, it being doubtful, as a matter of fact, whether tandem parallel control is commercially practicable at frequencies much above 25 cycles.

In order to get anything like good results with tandem parallel control, the power-factor of the secondary motors must be very high —considerably above 90 per cent. In practice (apart from the employment of compensating arrangements) this means that the number of poles in the motors must be as small as possible, as, considering the relatively small diameter of the motors, it would not be possible to get power-factors of this order if they had many poles. It would appear that six, or, at the most, eight poles, is about the limit for motors which have to work in tandem, which corresponds to frequencies lying between 15 and 25 cycles, the lower values being taken for gearless the higher for geared motors, taking into account the usual maximum running speeds, wheel diameters, &c.

The other disadvantages possessed by the tandem parallel control may be said to be of a mechanical nature; their extent depends upon the manner in which the method is employed. If, for instance, all the motors are utilised during the period of parallel connection, they must all be alike, which means that when in tandem, separate rotor resistances will have to be used for the secondary motors, and these will have to be designed for the same pressure as that of the line. For instance, with a four-motor 3,000-volt equipment, four separate resistances would be necessary—namely, two suitable for 3,000 volts and two double ones for (for instance) 300 volts and heavy currents. Bearing in mind that if the same torque is required in tandem as in parallel, the flux in the stators of the primary motors will have to be increased, as already indicated, it will be seen that the equipment becomes not only excessively complicated, but very expensive as well.

If, however, the Valtellina arrangement is adopted, matters become greatly simplified; no high-pressure resistances are required, and the two rotor resistances are employed alternately for the secondary and primary motors. Further, no boosting or other special arrangements are required for increasing the torque of the motors in tandem. But it must be admitted that the fact of half the motors being idle most of the time constitutes a certain disadvantage; clearly, on a fairly level line with infrequent stops, the carrying round of so much dead weight would not be warranted. Again, it follows that with this arrangement the primary motors must work when in parallel well below the point of maximum load in order that over-heating may be prevented, and generally such an equipment is altogether rather expensive.

Whichever form of tandem multiple control is employed, the motorman has in general to operate two controller handles which are not interlocked, as it is not possible to pass directly from the parallel connection to the off position through the tandem position, in an analogous manner to the handling of a series-parallel controller.

The commercial application of tandem parallel control in any form to multiple unit trains with two or more motor cars would be difficult, if not impossible. It is, of course, perfectly possible with rheostatic control of the motors, and hence for those cases in which such trains are required, worked by three-phase motors, the system of control used would be in general decided by this point, quite apart from other considerations. In connection with the operation of mechanically-connected induction motors for such work, it is of importance to see that the difference in diameter of the various pairs of driving wheels is as small as possible, in order that the individual motors may properly share the load when operating at full speed on the level. Otherwise, as a little consideration will show, owing to the small slip under these conditions, the slower running motor might get badly overloaded; a comparatively small difference in the speeds would transfer the load to one motor, the other even acting as a generator, being driven by the first.

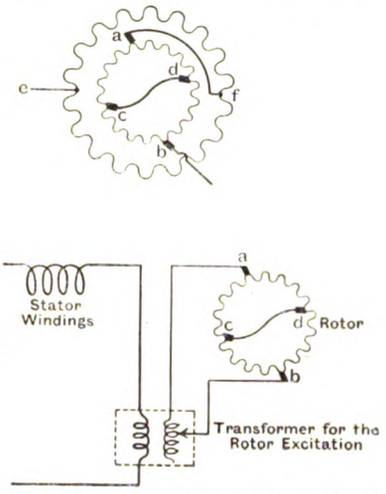

Fig. 8A and B.—Diagrammatic Representations of Latour and Winter-Eichberg Single-phase Repulsion-Series Railway Motors.

Table II. and Fig. 8 may fittingly conclude these remarks on the subject of speed control. A comparison is given in the table between the starting performance of direct-current and three-phase equip-

Table II.—*Comparison of Acceleration and Power Consumption Tests carried out with Direct Current and Three-phase Electrical Equipments.*

Installation.	Nature of supply.	Total weight of train in tons.	Maximum speed in miles per hour.	Normal rating of motors in B.H.P.	Average acceleration (ft. per sec. per sec.).	Average watts per ton during acceleration period.	Watt-hours per ton-mile during acceleration period.	Watt-hours per ton-mile during acceleration & retardation period.
*G.E. trials (Schenectady)	Direct current at 575 volts	71·5	47·0	8 × 165	0·95	6,500	170	129
*Ditto	ditto	118·5	43·0	8 × 165	0·79	4,650	133	99
†Liverpool Overhead Railway	Direct current at 500 volts	46·3	32·0	4 × 100	0·88	4,000	170	137
‡Burgdorf–Thun Railway	Three-phase current at 750 volts and 40 cycles	70·0	24·5	4 × 65	0·46	2,570	195	..
‡Ditto	ditto	55·0	24·5	4 × 65	0·63	3,450	240	..
§Valtellina Railway	Three-phase current at 3,000 volts and 15 cycles	82·5	40·0	4 × 150 (2 motors idle above half-speed)	0·38	2,770	..	65
‖New York Central Steam Loco. trials	..	130·0	51·0	Drawbar pull = 25,900lb.	0·86	..	..	..

* Each of the eight motors employed is rated at 3,000lb. pull at 23 miles per hour and with 280 amperes. Average speeds 34·6 and 32 miles per hour respectively. Two motor cars with four motors per car. † Two motor cars with two motors per car, each rated at 2,000lb. at 25 miles per hour and 160 amperes. ‡ Rheostatic control. Full-load speed of motors 585 revolutions. Gear ratio 1 : 2·96, driving wheels 40in., weight of complete motor 3,400lb. § Drawbar pull per gearless motor with 46in. wheels at 300 revolutions = 2,200lb. Pull at starting in tandem with idle motor 3,960lb. per pair of motors. ‖ Locomotive specially built to meet requirements of suburban traffic.

Note.—On the Valtellina Railway the four motors are connected in tandem up to half speed, while from half speed to full speed two are idle, the other two being in parallel; when braking, the four motors are in tandem from full speed to half speed. The author is indebted to Mr. H. F. Parshall for the above test figures; the watt-hours during acceleration were 10,200 and during braking 1,300, the total distance of 1·66 miles being traversed in 240 seconds. All the above tests were carried out on the level.

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ments, as determined by actual trials; to extend the comparison, certain figures relative to the trials of a steam locomotive are also given. Regarding the relative performance of the electric equipments, it must be pointed out that the comparison is not altogether a fair one to the three-phase motors; but it is the best that could be made, based upon actual tests. The two equipments are working under different conditions, and, moreover, the three-phase motors were not designed for such rapid accelerations as those in the direct-current cases—in the latter it is pretty clear that the series-parallel control was worked for all it was worth. In Fig. 8, however (to which the author is indebted to Mr. Blathy), the results are embodied of a special test made by Mr. Kapp on the Valtellina Railway, for the express purpose of seeing what results could be obtained by the use of the tandem-parallel control in the form advocated by Messrs. Ganz & Co.

An inspection of the curves in Fig. 8 shows that the electrical performance of the equipment leaves little to be desired. The 54-ton train attained a speed of 59ft. per second in 95 seconds, which corresponds to an average acceleration of 0·62ft. per second per second, the acceleration with the two pairs of motors in tandem being about 1½ft. per second per second, while with the two primary motors in parallel it is about ¾ft. per second per second. These are excellent results,* while, at the same time, partly on account of the energy returned to the line during the retardation period, the results with regard to power consumption are excellent, as will be seen from the following summary of this particular test made by Mr. Kapp:—

Test No. 5 (see Fig. 8.)

Distance covered	5,280ft.
Time from start to finish	140 seconds
Highest velocity attained before braking	40·5 miles per hour
Electrical energy supplied to car	20,574kw.-seconds
Power consumption per ton-mile	106 watt-hours
Useful energy up to the moment (106 seconds from start) when brake was put on by the motors being switched in tandem	14,300kw.-seconds
Total energy supplied in the same time	21,960kw.-seconds
Efficiency during the above period	65 per cent.

NOTE.—The high efficiency of 65 per cent. is partly accounted for by the fact that at the end of the period in tandem, when the load is quickly falling, the generating plant increased its speed, enabling the rotor resistances to be short-circuited during a portion of the time—from 29·5ft. to 32·7ft. per second. On the other hand, when braking in tandem, the generating plant also increased its speed, being driven by the current returned from the car, and thus the frequency went up. This did not enable the car to return as much energy as would have been the case at constant frequency, and accounts for the smallness of the energy (1,386kw.-seconds) returned to the line.

From Table II. and Fig. 8 it will be seen that, on the whole, the figures for the three-phase equipments are excellent; but with rheostatic control they would not compare so favourably with the direct-current equipments at the higher accelerations. With tandem parallel control, while there is little to choose between the two equipments, the good performance of the three-phase equipment is attained at the expense of the disadvantages which have already been referred to.

From what has been said it is clear that, with regard to which is the better system of control for three-phase equipments, the rheostatic or the tandem parallel, this depends to a great extent upon the class of work for which the equipments are employed. But the author thinks, in the present state of knowledge, that the use of alternating currents should only be contemplated for work of the class comprised under (*c*) and (*d*), and then only when the length of the lines is such that many converting sub-stations are necessary. For these classes of work, the inefficiency of the rheostatic control is of relatively small importance, and it is thought that its use is preferable, notwithstanding the disadvantage of having to take the worst gradients at full speed. If, however, for any reason, three-phase working is employed for cases where it is necessary to attain rapid accelerations with economy, the tandem parallel system of control must be used, and of the two forms in which it can be applied that advocated by Messrs. Ganz is, it is thought, preferable, on account of its greater simplicity, this point outweighing the disadvantage of the exceedingly heavy character of the electrical equipment.

However, an attempt has been made to put forward the characteristic features of each method of control, and to dwell rather upon the weak points of each, as whichever method is selected in any particular case, these are the points that require the most attention.

SINGLE-PHASE WORKING.

The desirability of single-phase working for long-distance lines is self-evident, assuming that suitable motors are available. As the whole question turns upon the motors, it is now proposed to consider very briefly the various types of single-phase motors at present available; these types, apart from synchronous motors, are as follows:—

1. Pure induction motors.
2. Series motors (Lamme, Finzi).
3. Repulsion-induction motors (E. Arnold Deri, Schuler).
4. Repulsion-series motors (Latour, Eichberg-Winter).

The first-mentioned class of single-phase motors can be dismissed in a few words, as they cannot be directly applied to electric traction purposes. Their efficiency and power-factor are less than is the case with the corresponding three-phase motors, their speed cannot be regulated within commercial limits, their overload capacity is relatively small, and their starting performance is indifferent. The best that can be done in the latter respect, under favourable conditions with regard to frequency, is full load torque with 1¾ full load current—this with the help of a rotor resistance and a phase-splitting arrangement. Such motors could, therefore, only be used indirectly as far as electric traction work is concerned, although they possess the advantage (unlike the motors of the other three classes) of being without commutators.

B. J. Arnold has proposed to utilise such motors for traction purposes, with the help of an air-compressor on the car, the object of the latter being to get over the starting difficulties, as well as those of speed regulation; the motor is always running on load, this consisting of the car and the compressor, or the latter alone, as the case may be. The Oerlikon Company, on the other hand, has suggested the use of single-phase induction motors in connection with heavy locomotive work, the motor working from a single overhead conductor at 15,000 volts, and forming part of a direct-current motor-generator combination carried by the locomotive, which supplies current to separately-excited direct-current motors on the car axles. Although a certain amount of experimental work has been done in connection with each of these suggestions, it is hardly likely that such methods of working will come into general use.

The single-phase motors comprised in the second class are what used to be known a good many years ago as "laminated field" motors; before the advent of the single-phase induction motor quite a number were built in this country for the 83 and 100-cycle supply circuits then in existence. At that time they were built in very nearly the same way as the corresponding direct-current series motors, the principal difference in the design being the substitution of a laminated field structure for the standard cast or wrought-iron field frame. Such motors possessed every fault it is possible for a commutator motor to have—low efficiency, overheating and bad sparking being the worst—while being abnormally heavy for their output, mainly on account of their very low power-factor.

After remaining in the background practically since 1893, these motors have recently re-appeared as possible railway motors. By reducing the frequency to 15—20 cycles (and with the help of sundry auxiliary devices, which have been more or less well known for years), aided by careful designing, a very good imitation of the direct-current series motor has been obtained, which is likely to come to the front in the future. Up to the present, as far as the author is aware, by far the best results have been attained with these series motors by Dr. Finzi, the trials of whose 15-cycle 160-volt tramway motor are fully dealt with in an article in the *Electrical Review* for November 13, 1903.

The following are the principal difficulties connected with the design of single-phase series motors, together with the methods which are adopted in order to get over them:—

1. *Sparking.*—The coils which are short-circuited as the commutator segments, to which they are connected, pass under a brush, become the seat of very heavy induced currents, these coils being cut by the alternating field flux. These heavy short-circuit currents, being interrupted when the segments leave the brushes, cause heavy sparking; moreover, they tend to demagnetise the field system, and also waste energy in the short-circuited coils, brushes, &c.

The remedy is to connect the armature coils to the commutator by means of nickeline or other resistance strips (Finzi), or to employ a Weston winding on the armature (two independent windings alternately in circuit), to employ the proper width and quality of brush and to reduce the frequency.

2. *Relatively Low Efficiency.*—This is due to the fact that both the iron and copper losses are considerably more than in the corresponding direct-current motor or induction motor. In the latter not much more than half the total weight of laminated iron is traversed by a flux of the full frequency (at speeds near synchronism), while for the case of the series motor the entire weight of active iron comes into consideration. Again, owing to the extra losses in the commutator connections, brushes, &c., and to the rather low power-factor at heavy currents, the copper losses are increased.

A reduction in the frequency improves matters.

3. *Low Power-factor at Heavy Currents—Armature Reaction.*—The field and armature windings in series offer an impedance to the alternating current traversing them, and the greater the value of this current the more it lags behind the supply pressure—in other words, the worse the power-factor. The latter, in fact, falls from a high value at light loads to zero at standstill. As far as the field system is concerned, the only remedy is to reduce the frequency as much as possible, but with regard to the armature, seeing that it is

* Since writing the above, Mr. Blathy has informed the author that the motors at Valtellina would be capable of giving considerably greater accelerations if these were necessary; the only alteration that would have to be made would consist in a re-arrangement of the rotor resistances. Mr. Blathy states further that he has figured on accelerations up to about 3ft. per second per second for similar three-phase lines where high acceleration was necessary.

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the armature flux that causes not only the inductive E.M.F. in the armature, but a reaction on the field system as well, it is advisable to reduce it to a minimum. This can be done either with the help of damping coils (Stanley) or by saturating the pole shoes (Lamme), or by dividing the poles in the axial direction by means of slits (Finzi). The first-mentioned arrangement tends to wipe out the armature flux altogether, and thus to get rid of field distortion and armature reactance; the second and third arrangements tend to reduce the armature flux in amount. As far as the inductive E.M.F. of the armature winding is concerned, this decreases with the frequency.

It will be seen from the above that the real remedy for nearly all the troubles consists in lowering the frequency as much as possible, which, as already stated, is what is being done by the present constructors of these motors. The only disadvantage of this, as far as railway work is concerned, lies in the more costly nature of the generators and transformers; from the point of view of the inductive drop in the rail return, it is, of course, directly beneficial.

For the rest, the alternating-current series motor has speed, torque, and other characteristic curves generally similar to those of the direct-current series motor, except that the maximum values of the current and torque occur at a point which is relatively much nearer to the normal values.

Railway motors of this type necessitate step-down transformers being carried on the car, as they can only be worked at low pressures; the speed control is effected by varying the transformation ratio and is hence very economical, this feature of the motor tending to compensate for its relatively lower efficiency.

The motors of the third class are mixed action motors; they start as repulsion motors, and after a certain speed has been attained, all the segments of the commutators are short-circuited, and they continue to run as induction motors. The type originated with Prof. E. Arnold, under whose patents the Wagner Company of America has built many motors for ordinary industrial purposes, but as the Schuler motor is the best representative of the class, it will suffice to refer to it in particular here.

The characteristic features of the pure repulsion motor are its good starting performance and poor running performance. The efficiency and power-factor are both low, and for a given output the motor is relatively very heavy. On account of this, and especially in view of the fact that the change can be readily effected, it was but natural to change it into a pure induction motor at or near normal speed, because near synchronism the single-phase induction motor operates at its best. Arnold does this by short-circuiting the commutator segments by a centrifugal device (and raising the brushes simultaneously), while Deri does it by altering the number of stator poles in a similar manner. In both cases the conversion is suddenly performed and accompanied by undesirable current fluctuations; there is, moreover, a want of flexibility about it, which puts such motors out of the question as far as traction work is concerned.

In the Schuler motor, however, the transition from repulsion to induction motor is almost imperceptible, as it is effected with the help of slip rings and a star-connected rotor resistance, through which the rotor windings are gradually short-circuited. The commutator brushes remain short-circuited, and more or less current passes through them, in accordance with the manipulation of the resistance; at normal speed practically no current passes through them, as the rotor windings are, at this speed, completely short-circuited at the slip rings. At speeds intermediate between standstill and synchronous speed, part of the rotor current passes through the short-circuited commutator brushes and part through the rotor resistances; under these conditions the rotor is working partly as a repulsion motor, partly as an induction motor.

To sum up, the Schuler motor presents the possibility of starting with a large torque without an excessive current consumption, and of speed regulation over a long range with smaller losses in the rotor resistances, than would be the case with the corresponding three-phase motor operating under similar conditions. Its efficiency, power-factor and overload capacity are, however, much inferior to the latter, while, with regard to commutation, it is comparable with the series motor, and what has been said in connection with the commutation of the latter is equally applicable to it. It is thought that while the Schuler motor is exceedingly well worked out, and the best of its class, it will not find a place in single-phase traction work, or, any rate, that it will not take precedence of the pure series motor, or of the series repulsion motors referred to below; its sphere of utility is more likely to be in connection with elevator and similar work. At the same time, it must be pointed out that the addition of an efficient compensating arrangement to it, so that it would work at a power-factor approaching unity over its whole range, would alter the situation; in any case, it has one advantage over the series motor—namely, that no step-down transformer is required. Its stator construction is that of a standard three-phase motor with one phase of the winding always out of use, and the limiting value of pressure would be the same. Its rotor, which in construction resembles the armature of a rotary converter, must always work at low pressure.

This ability to work directly at high pressure is a property also shared by the fourth class of single-phase motors—the Latour and Winter-Eichberg motors. These motors are partly repulsion motors, partly series motors, and are the most interesting, and perhaps also the most promising, single-phase motors that have yet been devised. They differ in two important respects from all other series or repulsion motors—the power-factor is nearly unity under all conditions of working, while the field flux is produced by the rotor instead of by the stator, the ampere-turns of the latter being less than those of the former.

In Fig. 8 (*a* and *b*) the Latour and Winter-Eichberg mixed action motors are respectively indicated in diagrammatic form, and, as will be noticed, there is no essential difference between them. Indeed, these designers seem to have reached practically the same point by different and independent paths. By supplying the commutators at constant pressure (if necessary, through a step-down transformer of suitable size) instead of variable pressure, as indicated in the figure, motors can be obtained the performance of which is analogous to that of direct-current shunt motors, and such motors would be applicable to ordinary industrial work, as Latour has pointed out.

The windings indicated in Fig. 8 (two-pole motors being represented for the sake of clearness) correspond to series-wound direct-current motors, and hence will be alone referred to in connection with the subject of electric traction. As far as constructional features are concerned, the stators of these motors are just like the stators of ordinary induction motors; Latour, however, prefers to distribute the winding all round the periphery to form a closed circuit, there being thus (in the two-pole motor) two parallel paths traversed by the single-phase current. The rotors are simply specially-proportioned direct-current armatures with amply-dimensioned commutators of many segments; these commutators have to be arranged to work at 200 volts between brushes, or less, which can be readily arranged for if the current transformer of Winter and Eichberg is provided.

Consider, for instance, the motor of Fig. 8A, with the brushes *ab* removed, and the single-phase current traversing the stator only. A pure repulsion motor of favourable design would result, the characteristics of which would be (as Latour has shown) an excellent torque at starting, which decreases with the speed, together with perfect commutation at synchronous speed. As already indicated, however, the power-factor of such a repulsion motor is very low, while, unless special arrangements are adopted, the motor sparks badly below synchronism. These defects disappear almost completely, however, directly the armature, with its short-circuited brushes *cd*, has current from the external circuit led into it (directly or indirectly) by means of the brushes *ab* placed at right angles to the brushes *cd*, which arrangement results in a repulsion-series motor. The motor now has a power-factor of nearly unity at all loads, a starting torque equal to that of a three-phase motor, but not requiring resistances in order to obtain it, a possible speed variation over wide limits by varying the pressure at the brushes *ab*, and excellent commutation under all conditions at these brushes. Working under fixed conditions of supply, the speed and torque characteristics are generally similar to the corresponding characteristics of the direct-current series motor.

Briefly, the current C_1 passing through the rotor from outside by way of the brushes *ab* produces a rotor flux which, in conjunction with the rotation of the rotor in it, causes a current, C_2, in quadrature with C_1, to flow through the rotor by way of the short-circuited brushes *cd*. The flux due to one component of the current C_2 cancels the stator flux, and thus renders the stator windings practically inductionless, and, moreover, by doing away with the stator flux, allows of perfect commutation at the brushes *ab*, as the heavy currents in the short-circuited coils, which would otherwise be caused by induction from the stator, are now no longer present. Again, the magnetic flux along *cd* forms, with the flux along *ab*, a resultant flux which rotates nearly synchronously with the rotor, and the latter, therefore, also becomes nearly inductionless, just as is the case with the rotor windings of an induction motor operating near synchronism. It would appear that the only serious difficulty with this motor is the commutation at the brushes *cd* at speeds below synchronism, but the difficulty can be got over perfectly well at frequencies of the order of 25 cycles, with the help of the means already alluded to.

As far as the author knows, the only difference between the above motor and that of Winter and Eichberg, apart from constructional details, is that in the latter motor the rotor is indirectly in series with the stator, as indicated in Fig. 8B. The use of the current transformer for supplying the brushes *ab* allows the stator to be worked at the full-line pressure, no step-down transformer being, therefore, required on the car; at the same time the entire switching and speed control* is performed on the low-pressure side—that is to say, in the secondary circuit of the current transformer. Naturally, the arrangement lends itself well to multiple unit trains, the control being characterised by the absence of rheostatic losses and by the permanent connection of the various motors in parallel.

* The author has been unable to ascertain whether *the whole* of the speed regulation is effected by means of varying the transformation ratio of the transformer. It may quite well happen that supplementary arrangements are provided in the exciting circuits in order to get a means of fine regulation.

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In Fig. 9 are given the results of some tests made by the Union Company on an experimental coach fitted with motors of Messrs. Winter and Eichberg's design; this coach has been running since August on a short line near Berlin. The coach weighs 52 tons in running order, and is equipped with two motors of 125 B.H.P. at 6,000 volts and 25 cycles; the weight of the entire electrical equipment is about 6 tons. In Fig. 9 are also given the curves (shown dotted) for the new 125 B.H.P. motors on the Central London Railway* in order that a ready comparison may be made between a standard direct-current equipment of latest design and the single-phase equipment. For the latter it will be noticed that two sets of curves are given; these correspond to the maximum and minimum transformation ratios employed, and hence indicate the conditions prevailing at light and heavy loads respectively. Between these limiting transformation ratios of 24 : 1 and 8·3 : 1 there are a number of others, the motor having similar characteristic curves for each. It will be seen that the efficiency of the single-phase motor is not much below that of the direct-current motor, while the speed control is equally flexible. The power-factor, moreover, is good over the whole range, while with regard to the commutation under different conditions the author has no information.

Whether one or other of these types of single-phase railway motor will eventually succeed in taking the place of the three-phase motors remains to be seen, but from what has been said above it will be

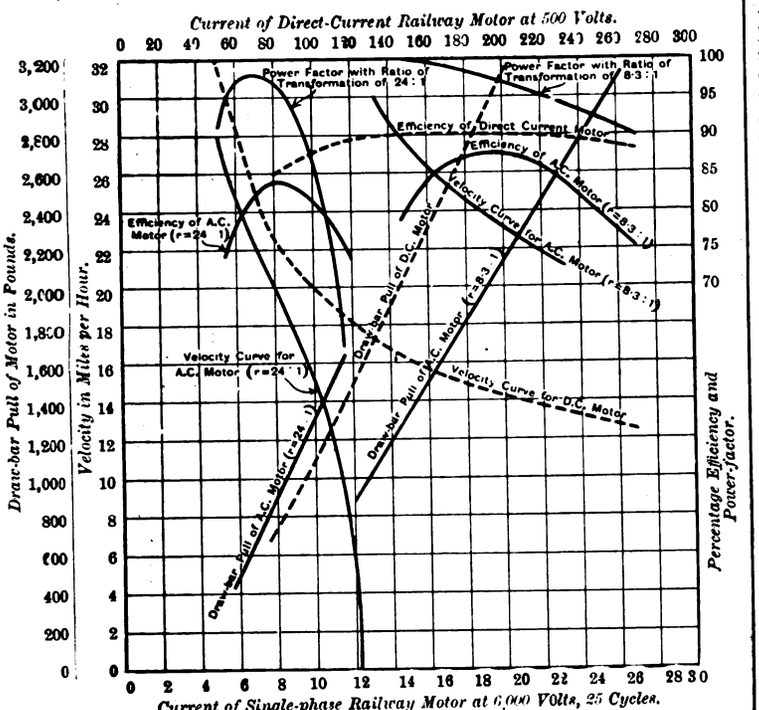

FIG. 9.—CURVES OF 125 B.H.P. WINTER-EICHBERG RAILWAY MOTOR AND OF 125 B.H.P. G. E. DIRECT-CURRENT RAILWAY MOTOR.

recognised that a lot of good work has been done in this direction during the last year or so. The commercial application of such motors will largely depend upon the quality of the commutation under traction conditions, and with regard to this it must be borne in mind that the difficulties are, and always will be, very much greater than with direct-current motors. But one thing is quite certain—what with the new type of compounded alternators, the compensated three-phase motors and the various new single-phase motors, electrical engineers will have to reckon with the commutator in alternating-current machinery, and some modification of certain ideas at present held may confidently be expected in the near future.

Accumulator Traction in Italy.—According to the *Elektrotechnische Rundschau*, accumulator traction on the Bologna–San Felice–Poggio Rusco and Bologna–Modena lines has not proved satisfactory, and permission has been obtained to re-establish steam traction. On the other hand, the Lecco–Colico–Sondrio and Colico–Chiavenna lines, which are equipped on the overhead system, have proved successful, and a continuation from Lecco to Milan is now being contemplated. Equally satisfactory results are reported from the Milan–Varese–Porto Ceresio line, and, in consequence, the management intends to convert the Varese–Laveno and Gallarate–Sisto Calande–Arona lines to electric traction on the same system.

* "The Central London Railway," by H. F. Parshall, E. Parry and W. Casson. *Traction and Transmission*, Vol. VII.

ROYAL COMMISSION ON LONDON TRAFFIC.

At the sitting of the Royal Commission on London Traffic on Friday last week, December 18.

Ald. T. WALTER L. EMDEN, mayor of Westminster gave evidence. He dealt with the general causes of traffic obstruction in the streets, the most important, in his opinion, being the continual breaking up of the streets by statutory companies such as electric light, telephone and other undertakings. After laying down what he considered to be the best method of dealing with these matters, substantially the same views as those already expressed by other local authority representatives, witness discussed at some length the question of providing subways under the streets, and exhibited a model embodying his ideas concerning this matter. This obviated the necessity for purchasing the vault rights from the frontagers on both sides of the road, and allowed sufficient space to run two lines of tramways down the centre, gangways for passengers on either side and also space for taking electric light and telephone cables, gas and water pipes, &c. The centre space could be some 18ft. or 20ft. in width, and a street of the width of the Strand in its narrowest portion would allow sufficient margin for the passenger footways, &c., without coming underneath the pavement. Platforms would be erected for the use of tramway passengers, these platforms being reached by stairways. At the platforms the pipes, &c., would pass underneath. The following estimates of the cost of construction, revenue, &c., had been prepared by the engineer to the City of Westminster. Cost of subway with stations, 100ft. in length at intervals of ⅛th mile, together with tramway complete, £440,800 per mile. Net receipts from tramway £22,000 per mile per annum; rent for use of subways by statutory companies, &c., £2,000; gain to City Council by increased life of streets through use of subways, £3,000; total receipts, £27,000 per mile per annum. Deduct cost of inspection, &c., of subway £1,000 per mile per annum, leaving a net income of £26,000 per mile per annum. This income, it was estimated, would be sufficient to pay nearly 6 per cent. for interest and sinking fund on the capital outlay. The initial outlay would be large, but he was of the opinion that it would not be impracticable to prepare a scheme whereby capital and interest could be paid off and the working of the subways carried on at a profit. Summing up a few of the advantages which would accrue from the adoption of such a system, he said that the inconvenience by reason of the roads being constantly broken up and obstructed and the consequential loss to the shopkeepers would cease, there would be a vast amount of time saved to the public generally by the extra speed with which they would be able to progress both above and below ground, and the statutory companies would be able to attend to their pipes, &c., with vastly greater economy and certainty.

By the CHAIRMAN: His idea was that the local authorities should construct such subways, the tramways therein being worked, say, by the London County Council, The initial cost would be borne by raising a loan, and the sinking fund met out of the rates. So far as Westminster was concerned, he considered that such a means of communication was immediately necessary under Victoria-street and Piccadilly. The main demand for such communication was from east to west and north to south.

By Sir JOHN WOLFE BARRY: He had always been against a tramway along the Embankment, but the trams from the North of London could run into the County Council subway at Theobald's-road, and thence by means of a tunnel under the Thames, and come to the surface again at some convenient and less congested spot further to the south of the river.

Mr. JOHN HUNT, town clerk to the City of Westminster, dealt with similar matters to the previous witness. On the question of the subways already referred to, he gave the following figures as to cost of construction, &c., for a route from Hammersmith Broadway via Piccadilly and the Strand to Bishopsgate. Taking as his basis an average cost of £700,000 per mile, the total 7 miles of route would cost £4,900,000, or, say, £5,000,000. The initial sum to be set aside for sinking fund, with interest calculated at 3½ per cent. per annum for 60 years, would be £3,562 per mile, and thus on the total cost this amount would be £25,443. Interest on capital at 3½ per cent. would amount to £175,000 per annum, or a total annual charge of £200,443. This was equivalent to about 1½d. in the £ on the county rate. These figures, which were worked out from a report by the London County Council engineer, were much less than had been experienced hitherto as to the cost of constructing a new thoroughfare such as the Holborn to Strand improvement.

The Commission adjourned until Thursday, January 7.

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"Electric Traction." By J. H. Rider. (London: Whittaker & Co.) 10s. 6d. net.

"Modern Electric Practice." Edited by Magnus Maclean. Vol. I. (London: Gresham Publishing Co.) 9s. net.

"Transactions of the American Electrochemical Society." Vol. IV. Niagara Falls Meeting, Sept., 1903. (Philadelphia: American Electrochemical Society.)

"Diagrammes et Surfaces Thermodynamiques." By J. W. Gibbs. Translated by M. G. Roy; with an introduction by M. B. Brunhes. No. 22 Scientia Series. (Paris: C. Naud.) 2fr.

"Fortschritte der Elektrotechnik." By Karl Strecker. 1902. No. 4. (Berlin: Julius Springer.) 10m.

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ELECTRIC RAILWAY PROBLEMS.

The three Papers by Messrs. McMahon, Eborall and Armstrong, published in this and the last issue of *The Electrician*, make a timely appearance when so many engineers are considering how suburban transit problems can be best solved by means of electric traction. Each of these Papers has the value attaching to a record of experience, and from that point of view Mr. McMahon's easily takes the first place. The City and South London Railway has now been working for 13 years. It has recently nearly doubled the length of line in operation, and it has yielded a small dividend to its shareholders. Add to this that it uses continuous-current generation, five-wire transmission and three-wire distribution, and its claim to be unique technically and historically hardly needs argument. The principal technical lessons to be gathered for future guidance from Mr. McMahon's Paper relate to the practicable range of economical continuous-current distribution. It is true that the Paper does not deal with the capital expenditure on transmission and distributing plant, but this is no great defect, because the City and South London figures would not be readily applicable to any new case, and every case must be considered on its own merits. On the other hand, the figures given in much detail for the working economy of the system apply directly and are very remarkable. The result may be written down shortly as follows:—Using continuous-current generation with only 2,000 volts maximum pressure (1,000 volts either side from earth) the Angel sub-station, at a distance of 5¼ miles, delivers 83 per cent. of the power generated to its 'bus bars. The result is not materially different from the all-day efficiency of a three-phase rotary transformer working on a similar load-factor, but is attained with a lower working pressure, and very much less expensive transforming apparatus. The main reason for this is that the current has not to be transformed in kind, consequently the high-tension mains and the transforming apparatus have to deal only with a portion of the current, and transformation losses are incurred upon that portion only. The total result over the whole line is that from generating station switchboard to locomotive the net efficiency is 90 per cent. This figure is decidedly higher than the all day efficiency of a rotary transformer on a traction load, and the capital expenditure is obviously on the side of the continuous-current. The application of batteries at the Angel sub-station and the ingenious and successful arrangements for balancing merit notice which we cannot give here. The important question of the initial and maintenance cost of the batteries is not dealt with in much detail, and no doubt further experience is necessary as to the latter item, but that battery maintenance

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will be as favourably affected by the "Highfield" gear as efficiency has been, seems extremely probable. In which case Mr. HOBART'S remark, in the discussion, that battery efficiency increases as the output diminishes will cease to be true.

To get back to the main point. Mr. MCMAHON shows that for such lines as his, a continuous-current generating station has an economical radius of at least six or seven miles. The Stockwell generating station is not well situated for coal supply or water facilities—all coal has to be carted, all condensing water tower cooled. In spite of these drawbacks the generating costs are excellent, and the cost of the power delivered to the locomotives apparently lower than in any British three-phase system at present on record. No doubt lower station costs might have been secured by the adoption of a more suitable site, on the river side for example, but had this been done much greater capital and maintenance expenditure would be unavoidable, if such a site involved the use of a high-tension transmission, and the overall efficiency would be materially lower. The cost of the power delivered to the loco motive—taking into account all the capital and maintenance charges—is the objective of the engineer on this side of his work; and if he commences by considering only station costs, and then adapts his distributing system to the site so indicated, he may make a serious mistake. Generating and distributing costs must be considered together, and the combination giving the highest total economy in any given case adopted. The ingenuity and resource shown by Mr. MCMAHON in adopting his original machinery and cables to meet the needs of the extension are worthy of all praise, and teach a lesson that is rather moral and intellectual than technical, although its economic application is obvious.

Leaving now this testimony of our pioneer tube line to the merits of continuous current, we may pass on to the valuable lessons to be obtained from Mr. ARMSTRONG'S Paper dealing with train resistance, or "friction curves" as he calls his graphic records. The influence of the length of a train upon its tractive resistance at high speeds appears to be much greater than has been generally recognised. For example, at 60 miles per hour the resistances are 44lb., 30lb. and 16lb. per ton for trains of one, two and eight cars respectively, but at 20 miles per hour the figures are 12lb. and 10lb. and 8lb. Before accepting these figures (which are presumably for the "short ton" of 2,000lb.) English engineers will doubtless endeavour to check them by their own experiments to see to what extent they hold good for English conditions. We have reason to think that they are considerably too high for modern English cars on bogies, but however this may be, it is not likely that there is any serious error in the order of the increase, or the influence of the length of the train. The inference is that the ahead air resistance becomes a very important part of the total at high speeds, and is almost entirely borne by the forward end of the train. The consequence, as ably pointed out by Mr. ARMSTRONG, is that for equal speed and carrying capacity a frequent service of single cars calls for much greater expenditure of energy than a less frequent service of longer trains. On the other hand, the expenditure on acceleration is not affected by length of train, and the maximum acceleration demand made by any train on the station and feeders is directly proportional to its weight. From this it follows that with frequent stops the single-car service may give a load-factor so much more favourable than that of heavier trains as to prove the more economical, as well as the more attractive to the public. Any attempt at solution of the suburban transit question must treat it as an economic one, in which all the conditions have to be considered, and the alternative practicable methods compared on a balance-sheet basis. Mr. ARMSTRONG'S figures have the merit of giving ascertained values in place of indefinite conjectures, and they may lead to improvements in the forms of high-speed vehicles.

The chief interest of Mr. EBORALL'S Paper is in the latter part, which deals with the "Repulsion-Series" single-phase motors of LATOUR and WINTER-EICHBERG. Everyone recognises that for main-line traffic the continuous-current low-tension motor demands a very serious capital expenditure for distribution, and that there are difficulties of current collection that are by no means trifling. Three-phase collection is not much better. The single-phase motor which will admit of high-tension distribution and the collection of a moderate current from a single wire will put an entirely different face upon the question. The "Repulsion-Series" motors described by Mr. EBORALL are attempts to find the desired solution, and the results set out in the curves of performance of the Winter-Eichberg machine are extremly promising. The regulation by variable transformation supply to the rotor appears to give a range of speed and torque superior to that of a continuous-current series motor, and, although the motor efficiency is lower, the absence of rheostat losses may quite compensate for the difference. The power-factor of the motor can be kept above 90 per cent. over a considerable range of speed, and the starting torque is high. It is easy to arrange for "multiple unit" equipment and control.

The vital points on which no information is yet available are whether commutation is sufficiently good, and whether the weight and cost of the equipment are sufficiently low. If the answers to these questions are in the affirmative, it may be confidently reckoned that a practicable commercial system for heavy railway work is in sight. It would even seem possible that the "Repulsion-Series" motor may be so arranged as to work satisfactorily when directly fed with low-tension current, either continuous or alternating, in shunting yards, stations, or on suburban lines, and with high-tension alternating-current out on the main lines. That such a universal equipment is within reach may seem too good to be true; no one will question its desirability. Who will say it is unattainable?

In conclusion, we would point out that, on the technical side, the outlook for electric traction on railways is becoming very promising. What with the experience of lines already constructed, both here and abroad, and an increasingly wide and accurate knowledge of the conditions to be met, the engineer is already able to advise the capitalist what it will cost to equip and work a given line electrically by proven methods. Moreover, even where these methods promise no satisfactory commercial results at present, it is still reasonable to expect that a very little patience will put into our hands such resources that electric traction will become the standard railway motive power.

RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 323.)

The experiments described in the last article showed that of the three main phenomena which go to make up the normal radio-activity of thorium compounds (1) α-radiation, (2) β-radiation, (3) production of a radio-active emanation, only 25 per cent. of the α-radiation can be considered to be specifically due to the thorium atoms, the remaining α-radiation,

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.
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together with the β-radiation and the emanating power being caused by the presence of a non-thorium type of matter—thorium X—present in infinitesimal quantity. Whereas, however, the thorium X on keeping rapidly loses its radio-activity, the thorium from which it was separated regains its lost radio-activity, until at the end of a month it again possesses its normal or maximum value. In the same time the thorium X becomes completely inactive. If, now, the thorium that has completely recovered its radio-activity is again precipitated with ammonia, a new amount of thorium X is obtained from the filtrate of the same radio-activity as that originally extracted, and the thorium is again freed from the major part of its activity. This cycle of operations can be repeated indefinitely. If, however, the precipitations are carried out without lapse of time, the radio-activity of the thorium is not further reduced below a certain minimum value, and when this is reached no more thorium X is obtained and the residues from the filtrates are inactive. By waiting for any period less than one month between successive precipitations a new quantity of thorium X is obtained, in amount (as judged by its activity, which is the only criterion we have of its presence) the greater the longer the time waited. If it is admitted that thorium X is a specific kind of matter, the only explanation of this behaviour is that it is being continuously produced by thorium. This is equivalent to saying that thorium is *changing* into thorium X, unless we suppose that thorium has the power of *creating* the new matter, which is hardly conceivable in the present state of science. The view that thorium X is a specific kind of matter therefore necessitates the belief that an element is capable of undergoing a slow spontaneous change, and it will be convenient to designate this by the special name of *radio-active change*. As this is the point of departure from which springs the whole theory of atomic disintegration as applied to explain radio-activity, it is necessary to bear in mind the precise character of the fundamental proposition. The alternative is to suppose that thorium X is not a specific kind of matter, but is ordinary inactive matter of some kind unknown, in which strong radio-activity has been "induced" by association with the thorium, and which loses again this property when it is removed from the thorium. The evidence in favour of the first and opposed to the second view is drawn not only from the behaviour of thorium X and uranium X, but from the behaviour of at least six other similar types of temporarily radio-active matter. The most conclusive evidence is drawn from the study of the radio-active emanations of thorium and radium, which have still to be considered. On the other hand, the second view finds to-day no supporters, and no attempt has been made, since the processes of radio-activity have become better understood, to reconcile the idea of radio-active "induction" with the overwhelming evidence that can now be brought against it. There is no experimental evidence that the effect exists in the sense of the communication of radio-activity to an inactive molecule. Even if it did, it would merely constitute an additional fact to be explained without itself aiding in the explanation of any of those already known.

Once, however, the possibility of an element undergoing change is admitted, the varied phenomena of radio-activity can be explained from a consistent point of view without further difficulty.

A quantitative study of the rate of recovery of the activity of the thorium and the rate of decay of the activity of thorium X (Rutherford and Soddy, *Phil. Mag*, 1902, VI., 4, p. 378) revealed a simple connection between the two processes. Fig. 23 represents the curves obtained in which the radio-activity is plotted on the vertical and the time in days on the horizontal axis. Curve I. represents the decay of activity of thorium X, the initial activity being represented as 100, and curve II. the recovery of activity of thorium to a constant maximum value, represented also as 100. For the first day the effects are abnormal, the activity of the thorium X increasing slightly before commencing to diminish, while that of the thorium at first slightly diminishes and then proceeds to increase in a regular manner. These initial irregularities will be examined later. For the present they may be neglected and the subsequent regular changes considered, without involving any serious error. It will be noticed that the recovery curve if produced backwards cuts the vertical axis at about 25 per cent., and this can be shown to be due to the thorium possessing a constant non-separable radio-activity specific to the element itself. In Fig. 24 the relation between the two curves is more clearly brought out. Curve I. represents the percentage proportion of the activity recovered by the thorium after the second day, the activity recovered from the beginning to the end being taken as 100. Curve II. represents the activity of thorium X on the same scale during the same period.

It will be seen that the proportion of the radio-activity recovered by the thorium during any interval throughout the whole period is equal to the proportion of the radio activity lost by the thorium X during the same interval. If I_0 represents the original activity of the thorium X, and I_t the activity after any time t, I'_t the activity recovered by the

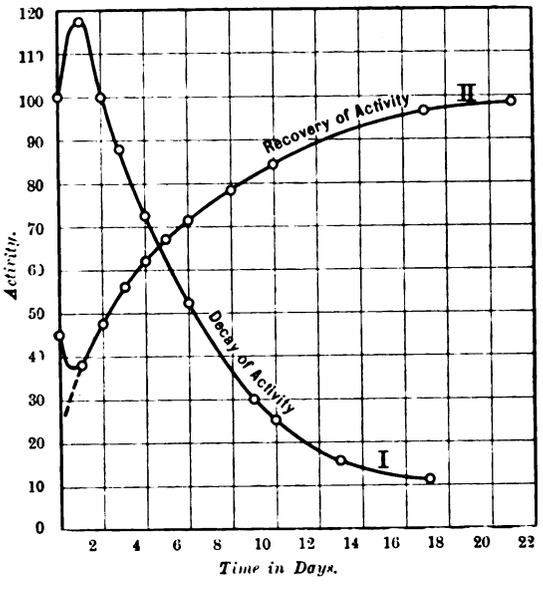

Fig. 23.

thorium after time t, and I'_∞ the maximum activity recovered by the thorium when the constant value is attained,

$$\frac{I'_t}{I'_\infty} = \frac{I_0 - I_t}{I_0} = 1 - \frac{I_t}{I_0} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The activity of the thorium X decays very approximately in a geometrical progression with the time, falling to half-value in four days. Thus, in eight days, it is one-quarter of the original, in 12 days one-eighth, and so on. This is expressed by the equation

$$\frac{I_t}{I_0} = e^{-\lambda t}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where λ is a constant and e the base of natural logarithms. Since $\frac{I_t}{I_0} = \frac{1}{2}$ when $t = 4$ days $= 345{,}600$ seconds, $\lambda = 2 \times 10^{-6}$.

From equations (1) and (2) we can write at once

$$\frac{I'_t}{I'_\infty} = 1 - e^{-\lambda t}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

which represents the recovery of activity by the thorium with time. The law of the decay of activity of thorium X in a G.P. with the time (equation 2) is a general law for temporarily radio-active substances. Many such substances are known, decaying at characteristic rates, varying from a few seconds to a few years, but always according to the same law. Moreover, the rate of decay has been found to be independent of the most powerful chemical and physical agencies. Extremes of temperature and drastic chemical treatment do not at all affect it. In consequence, λ (equation 2) serves as a perfectly definite constant for the identification and characterisation of any of these new bodies, none of which have been obtained in sufficient quantity for the ordinary methods of investigation. λ may be called the *radio-active constant*,

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and we shall see later that it possesses a profound physical meaning.

The chemical separation of thorium X from thorium therefore, cannot have any effect on the activity of the former in causing it to decay. The activity of thorium X must always be decaying at the same rate, whether it is present in the thorium compound producing it or whether it is separated from it. The apparent constancy of activity of the radio-elements results from the continuous production of fresh matter possessing evanescent radio-activity. When the increase in radio activity through the production of new active matter balances the decrease through the decay of the activity of that already formed, the activity remains constant. This point may be termed the *radio-active equilibrium.*

The rate at which thorium X is produced by thorium next calls for consideration. The constancy of the activity after radio-active equilibrium is attained shows that the production of new matter must proceed at a constant rate. The same holds true, not only for the condition of radio-active equilibrium, but also for all other conditions. Thus, equation (3), which was obtained as the experimental relation holding for the recovery of activity of thorium, is that theoretically required for the rise of activity of a system in which—(1) the rate of supply of fresh radio-active matter proceeds at a uniform rate; (2) the radio-activity of the matter supplied decays with time, according to equation (2).

The form of the recovery curve is not altered by the conditions under which the change occurs. It was found that different parts of the same specimen of thorium which had

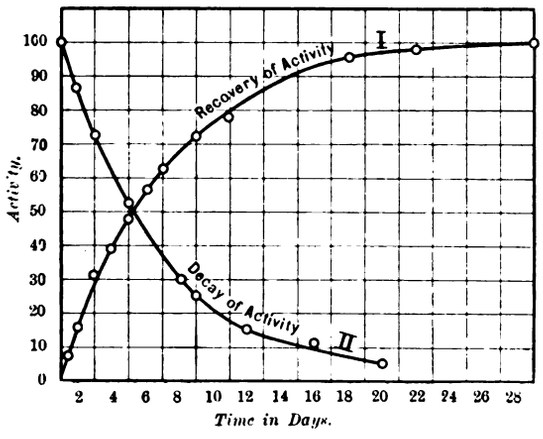

FIG. 24.

been freed from thorium X, kept under widely different conditions of temperature, state of chemical combination, &c., recovered their radio-activity at the same rate. This absolute independence, so far as we know at present, of the rates of recovery and decay, towards all the agencies at our disposal, is one of the most striking features of radio-active change. In this respect it is sharply differentiated from all the other kinds of material change, whether physical or chemical. The process which proceeds spontaneously in Nature and gives rise to the phenomenon of radio-activity is entirely beyond the range of ordinary molecular forces. This of itself furnishes strong presumptive evidence in favour of the view that radio-active change involves an alteration in the internal structure of the chemical atom and its transmutation into other atoms. For since molecular forces are quite incapable of transmuting one elementary form of matter into others, it is not to be expected that such forces would produce any effect on the course of a natural process of transmutation which was proceeding spontaneously. For a similar reason it is extremely improbable that any such effect as radio-active induction, or the rendering of an inactive substance radio-active, can exist.

On the new views the source of the energy dissipated by radio-active substances no longer presents any fundamental difficulty. If a change occurs in the atoms of radio-active matter whereby new atoms result, the energy of the change would be derived from the internal energy of the changing atom. This has hitherto been regarded as unknowable on account of the impossibility of changing atoms into each other, but the existence of such internal atomic energy has been generally recognised. By radio-active change we have the first means by which this source of energy is tapped, and rendered capable of investigation and measurement. Direct experimental data, to be considered in the sequel, show that this energy is of the order of a million times greater than is ever present in the matter in the form of the molecular energy which is manifested by ordinary chemical change. It is in the enormous stores of energy liberated during radio-active change that the disintegration theory derives its most unanswerable argument. A fuller consideration of this aspect of the question must wait until the case of radium has been considered. It is probable that the order of the energy liberated is *for equal weights of matter changing* similar in all three radio-elements. But in the case of radium the change proceeds a million times faster than in the case of uranium or thorium and this accounts for the surprising nature of the properties of the first-named element

(To be continued.)

PHYSICAL SOCIETY.

At a meeting of the Physical Society on December 11th, Mr. James Swinburne, vice-president, in the chair, a Paper on

"A Method of Mechanically Reinforcing Sounds,"

was read by the Rev. T. C. PORTER. If a tuning fork be sounded and placed in a flame, there is a very marked reinforcement of the sound. This is proved not to be due to resonance in the ordinary sense, but to the change from continuous to intermittent combustion. Under certain circumstances the impulses given to the air external to the flame, by the waves of burning gas, are more forcible than those given by the unaided sounding body. Thus a new way of reinforcing the sounds given by a vibrating body is found; and the rest of the Paper demonstrates this for the phonograph, a *flame* being used instead of the ordinary *trumpet*. Coal gas and air are brought by tubes into the chamber of the "reproducer" and thence to a jet, where they are burnt. The vibrations of the reproducer are thus impressed on the issuing gas and air, which burn synchronously with them, the sounds thus emitted being easily heard over a large room. In practice it is found best to spread out the flame by a second jet of air or of mixed air and gas placed close to the first jet and at right angles to it. The author describes the nature and quality of the sounds emitted by the flame, and the modifications of these which may be produced. If the first jet is used alone, and a common blowpipe-flame obtained from it, it is found that the sound is markedly reinforced by introducing a thin sheet of platinum foil near the blue tip of the inner cone. This reinforcement is attributed to the rapid expansion and contraction of the platinum in response to the variation in the heat of the flame caused by the sound-waves from the phonograph, and not to simple reflection of these waves from the platinum surface.

The CHAIRMAN read a letter from Mr. Chichester A. Bell expressing his interest in the subject of Mr. Porter's Paper, and pointing out that the whole matter had been described by him at length in a Paper on "The Sympathetic Vibrations of Jets" (*Phil. Trans.* 1886).

Mr. W. DUDDELL suggested that the flame was in a condition of instability, so that any disturbance created in it tended to increase in amplitude. If the energy for the increased sound came from the tuning-fork, and the flame simply acted as a trumpet, then the fork would be rapidly damped; but if the flame was unstable the tuning-fork would not be rapidly damped. He asked the author if he had tried experiments on this point.

Prof. A. S. HERSCHEL referred to the ways in which energy could be transmitted by a gas: (1) By a flow; and (2) by the passage of undulations. The second method was concerned in the experiments shown by the author. In reply to a question by Prof. Ayrton, he said he did not think that the increased sound was due to an increase in the amplitude of vibration of the tuning fork.

Mr. D. J. BLAIKLEY asked if the flame could be so adjusted as to restore a wave form having a complicated distribution of upper partials, or whether it could only reinforce pure tones. (The chairman pointed out that in the experiments shown with the phonograph the distinctive character of the notes emitted by the various instruments could be easily recognised.)

Prof. H. L. CALLENDAR referred to Prof. Dixon's experiments on the propagation of explosive waves through gases, These waves had been photographed, and proved that the passage of a detonation wave through an explosive mixture caused a local heating, shown by a corresponding brilliance in the photograph. Complicated effects were produced by the meeting of a detonation and a retonation wave, but in every case there was an increase of chemical action in the flame. He suggested that the

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behaviour of the platinum foil in the blowpipe jet might be ascribed to the meeting of two such waves.

Mr. PORTER, replying to Mr. Duddell, said a tuning fork was unquestionably rapidly damped when placed in a flame. With regard to Prof. Callendar's observations, he said he had looked in vain for anything corresponding to the existence of loops or nodes in the flame. Referring to Mr. Blaikley's remarks, he said that a small flame reinforced the high notes better than the lower ones and vice versa.

A paper on

"The Simmance-Abady 'Flicker' Photometer"

by Messrs. Simmance and Abady was read by Mr. SIMMANCE. The principle of the flicker photometer, discovered by Prof. O. N. Rood ten years ago, has frequently been remarked on, but attempts to design a reliable apparatus depending on this principle have hitherto been unsuccessful. The authors, guided by the following rules, have designed a photometer which is capable of balancing and comparing the most violently contrasted tints:—The light-effects must be in juxtaposition without any apparent division line, and must move, oscillate, or rotate so that the point of juncture of the rays of the two lights passes and returns entirely across the vision field. Any hiatus, or longer exhibition of one light than the other, biasses the result. The observation surfaces, or surfaces upon which the light rays fall, must be at exactly the same distance from the eye, at exactly the same angle in relation to the line of sight, and must be of pure white, such as is afforded, for example, by a clean chalk, plaster of paris, magnesium carbonate, or barium sulphate; any tint affects the accuracy of the result. The observation surfaces must also themselves in turn occupy the field of vision; an apparent movement or optical illusion does not afford accurate results.

Observations made with the photometer by operators suffering from colour blindness, astigmatism, &c., make it certain that the relative intensities of two lights, whether of the same colour or different, *can* be accurately and easily gauged by the method. The authors submit that the Purkinje phenomenon does not affect the accurate working of the instrument, as it is a purely colour effect, and colour does not enter into consideration in this photometer. The photometer itself consists of a wheel of a white material with a specially shaped periphery, which is caused to revolve before an eyepiece by means of a suitable motor. At right angles to the line of sight and parallel with the axis of the revolving wheel, are the two lights undergoing examination, the rays of which fall upon the shaped periphery of the wheel, enabling the effect of each light to be seen in turn through the eyepiece.

Prof. W. E. AYRTON said it was an important question to settle exactly what the photometer measured. The fact that different observers using the same photometer obtained the same results for the ratio between two lights did not prove that the instrument actually compared intensities. He had come to the conclusion that when the distances between the sources of light and the photometer were great the results were not affected by the Purkinje effect.

Mr. T. C. PORTER expressed his interest in the instrument, and said there was no doubt that the flicker photometer measured intensity independent of colour. The results obtained directly from a flicker photometer agreed with those deduced by indirect methods from observations with ordinary instruments.

Mr. L. GASTER said that the photometer shown was a valuable contribution to the existing number of flicker photometers which enable us to eliminate, to a large extent, the colour difficulty when dealing with dissimilar lights. This type of photometer was becoming more important because of the great number of improvements made during the last few years in the manufacture of incandescent lamps and arc light carbons by the addition of other substances to the pure carbon. A great step towards the simplification of the process of photometry had been attained by Prof. C. P. Mathews, by the aid of whose photometer one is enabled to get in one reading an illumination upon the screen proportional to the mean spherical intensity of the source.

Dr. W. WATSON said the authors had compared a red light with a white light and also a blue light with a white light. He asked if they had compared a red with a blue directly, and, if so, how the results agreed with those deduced from the comparison of both with a white light.

Mr. W. DUDDELL asked what was meant by the equality of two lights of different colours. Was it judged by the eye, the bolometer, or the flicker effect? On account of the Purkinje effect the inverse square law could not be used, and he asked for the real fundamental relation underlying the use of the instrument.

Mr. J. ABADY, replying on behalf of the authors, said the discussion had turned mainly on two points: (1) Does the instrument measure candle-power? and (2) is it independent of the Purkinje effect? If a Bunsen disc were taken and used to compare the candle-powers of two lights of the same colour, the grease-spot vanished at a certain point. If a flicker photometer was substituted for the Bunsen disc, the flicker disappeared at the *same* point. In both cases candle-power had been measured. In reply to Prof. Ayrton, he said that results obtained from the photometer by different observers agreed among themselves and also agreed with results obtained from the Bunsen disc photometer. With regard to the Purkinje effect, he did not think it affected the readings of a flicker photometer because the same values for the ratio between the intensities of two different coloured lights were obtained by varying the distances of the lights from the instrument within wide limits. Answering Dr. Watson, they had carried out the experiments suggested, and the results from the direct and the indirect comparison were in absolute agreement.

Mr. ROLLO APPLEYARD exhibited a

Conductometer

the theory and mechanical details of which are fully described in the *Proceedings* of the Institution of Civil Engineers, Vol. CLIV., Session 1902–3, Part 4.

Prof. L. R. WILBERFORCE exhibited

A Model to Illustrate Various Properties of Wave-motion.

The model consists of a series of brass balls suspended in a line by spiral springs and capable of transverse or up and down motion. The balls can be set in vibration by releasing them from extreme positions by means of triggers, one set of triggers controlling the up and down motion and another set the pendular. If the vertical and transverse periods are unequal, the release of the triggers in rapid succession produces a disturbance similar to that produced by the passage of light through a crystal. If the periods are nearly equal, effects are shown similar to those observed with Lissajous figures. If the balls are joined together by horizontal springs, condensations and rarefactions can be exhibited. If two of the balls near one end are constrained to move up and down only and two near the other end are constrained to move transversly, the phenomenon of polarisation can be illustrated. If the balls are put in neutral equilibrium, by supporting them on the upper ends of vertical rods when suspended by spiral springs which very nearly balance their weights, the reflection of both transverse and longitudinal waves at surfaces of infinite and zero density can be illustrated. By substituting, for some of the vertical rods, vertical rectangular frameworks with heavy pendulum-bobs hanging from the upper sides, the phenomenon of anomalous dispersion can be exhibited.

DEATH BY ELECTRIC SHOCK IN A BATH.

A fatal accident, similar in some respects to the fatality that occurred at Fulham in December, 1902, took place at East London (South Africa) last month. Mr. Denham, the acting Government electrician to Cape Colony and chief electrical engineer to the railway department, was asked to prepare a report on the subject, and we are indebted to him for sending us a copy of the report, together with other information with regard to the accident.

It appears that an insulator on a trolley line broke, and the trolley wire came into contact with the iron pole. This, in some way or other, conducted the electricity to a bath on the first floor of a neighbouring house, and a young man on entering the bath received a fatal shock. The sketch plan and section, which we give below, show the relative positions of the pole, the house and the various pipes entering the house; and Mr. Denham has marked on them the differences of potential between the various points tested after the accident by connecting the trolley wire once more to the iron post. The pole in question carried conductors from three distinct circuits. One was for supplying the arc lights in the street at a continuous current of 10 amperes and a maximum pressure of about 550 volts, but this circuit was entirely shut off from the power station some time before the accident happened, and need not, therefore, be considered. The second circuit was the electric lighting distributing mains at a pressure of 110 to 115 volts alternating, and the tapping to the house was taken off at the pole, the services being laid through double-pole fuses fixed to the pole, and then run through a 1in. iron pipe down the pole, across the road, underneath it, at a depth of 14in. to 18in., and terminating at a meter fixed on the outside of the wall of the front room. Mr. Denham tested the lighting wires and found no leakage from wire to wire, or to earth, on either of them. The third circuit was the tramway circuit already mentioned, which was charged at a pressure of 550 volts.

Measurements were at first taken of the pressure between the bath itself and the water pipe, and there was found to be a steady pressure of 400 to 420 volts between the two. The resistance between the bath and the trolley wire was so small that a group of five incandescent lamps could be lighted between the bath and the water pipe. Continuing his tests, Mr. Denham found 420 volts between the water pipe and the bath waste pipe on the stoep, and between the water pipe and the end of the waste pipe, where it emerged from underground into the gutter at the side of the road, there was a difference of potential of 300 volts. Further tests were taken by means of spikes driven into the ground at various points. The bath in question was on the first floor, as already stated, and rested on a wooden flooring covered with linoleum, and there was also a cork mat. It was an ordinary iron bath boxed in with wood at the sides and round the edges. The young man who was killed entered the room, and when filling the bath with water noticed a slight shock from the tap. He pointed it out to his elder brother, who followed him, but the latter said it was nothing and jumped into the bath first without experiencing any inconvenience. Owing to the scarcity of water, the younger brother entered the bath afterwards, and "on straightening himself up" collapsed with a groan. The elder brother pulled him out without getting any shock, and one of the family attempted artificial respiration but without success.

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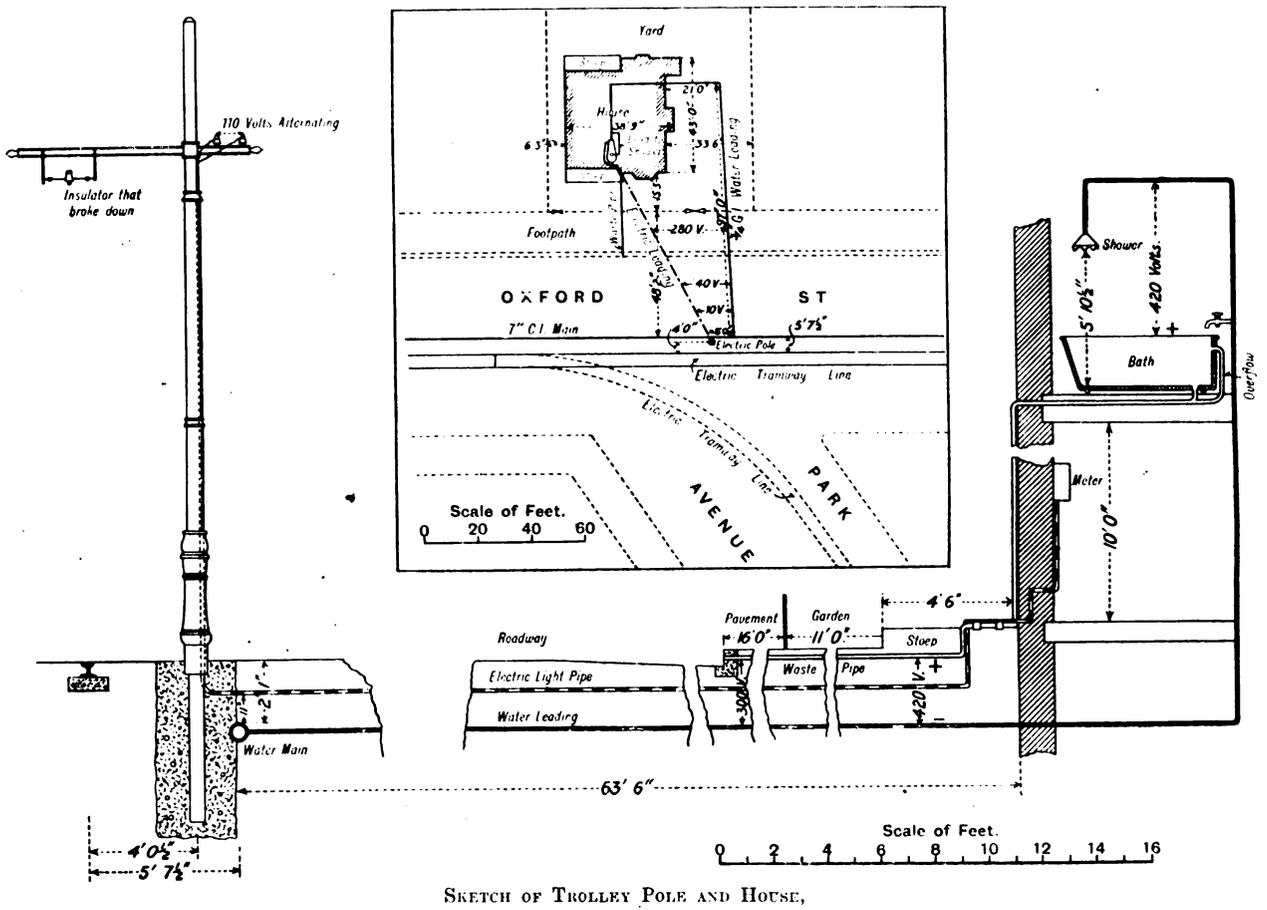
A peculiar feature of the case Mr. Denham points out to us is that the two pipes between which this high pressure existed were in close proximity and both buried underground, and the ground was soaking wet beneath the surface, so that sufficient current ought to have passed, by rights, to have actuated the circuit-breaker, which was set at 125 amperes on that section of the trolley line. Moreover, the electric lighting pipe was not only within some 3ft. of the tramrails, but actually crossed 11in. above the main 7in. water pipe, and ran for some 20yds. almost parallel with the branch water pipe supply in the house. Subsequent tests showed that a leakage current of 114 amperes flowed between the two. Mr. Denham is of opinion that contact with earth must have been made by the young man's head touching one of the ornamental zinc spikes on the shower rose, and, of course, the bath being charged at 420 volts, this was enough to kill him. The path of the current from the tramway pole was evidently through the iron pipe of the electric lighting service. The pole, it will be noticed in the sketch, is set in concrete, and therefore fairly well insulated from the rails, and evidently there must have been a path of low resistance between the electric light pipe and the waste pipe from the bath.

The colonial tramway regulations do not call for any connection between the trolley poles and the rails, and Mr. Denham reports that he is doubtful whether the Colonial Government has even the power to frame such a regulation, seeing that Act 42 of 1895 only grants power to enforce regulations not more stringent than those of the Board of Trade. The East London municipality has, however, already taken precautionary measures without waiting for pressure from the Government authorities. Mr. Denham cabled an inquiry with regard to this matter to Mr. Trotter, the electrical adviser to the Board of Trade in London: "Is it customary in England to bond tramway poles to rails? Reply urgent," and he received the reply: "Every fifth pole carrying guard wires." From this, he infers, that if there are no guard wires on the poles bonding is not done.

BLOCK PLAN OF MR. KNOBEL'S HOUSE.
Showing relative positions of Tramline, Pole, Water Main Leading, &c.



SKETCH OF TROLLEY POLE AND HOUSE,
Showing relative positions of Water Main, Pipe carrying Electric Wires nearest Rail and Foundation of Pole, &c.

CORRESPONDENCE.

CUT-OUTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent Mr. C. C. Garrard, while correcting the errors of your editorial notes of December 11th, is himself also in need of correction. This subject is one which I discussed in your columns in the early portion of the year 1897. Circumstances have not greatly altered since. Reversed current cut-outs are good in themselves, but no magnetic device will, under the usual conditions, ensure safety. Now, short circuits in armatures very seldom occur. What does usually happen is an earth in the armature, the earth circuit being completed through faulty mains. With a two-pole dynamo at a speed of 300 revs. per min. there is for one-half of the revolution little or no current being taken, for the other half of the revolution the current rises, zero—maximum—zero, and this, be it remembered, in one-tenth of a second. Probably for only one-fifteenth part of a second is the current taken sufficiently great to actuate the switch. But what is the time period of the operation of the switch? I am certainly not acquainted with any which can operate in one-fifteenth of a second; and, if there be none, then, for accidents such as these, reversed current cut-outs are useless. Your correspondent must also remember that the make and break of this circuit 600 times per minute gives rise to undulatory currents superimposed on the main current, and their effect would be to demagnetise his polarised relay. I agree that minimum cut-outs are no good whatever. The rate of change of direction of current is too great to bring them into action under circumstances such as these. But your own notes were nearer right than your correspondent's remarks. Maximum current cut-outs would have saved the good machines by disconnecting them from the circuit, therefore allowing an earlier restart.

If your correspondent, or anyone else, can devise a safety appliance, worthy of the name, for purposes such as these and which will disconnect without fail a *faulty* machine, there is a market ready for him. For myself, I am content to reiterate

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the opinion which I expressed in your columns nearly seven years ago—viz., that it is not possible to design a magnetic apparatus to do this.—Yours, &c., ROBERT C. QUIN.

Westminster, S.W., Dec. 18.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Mr. Garrard's letter in your issue of the 18th inst., may I be permitted to say there is an objection also to the polarised type of reverse current cut-out, as the relay is called upon to close an intermediate circuit, which introduces a strong possibility of failure, and the chances are this failure will take place just when the instrument is most required. The shortest distance between any two points lies in a straight line, and an instrument designed upon this principle has been before the trade since the early part of July last. It does not appear to have come before Mr. Garrard's notice so far. It is claimed that it will do, in a direct manner—*i.e.*, without closing an intermediate circuit—all that is claimed for the polarised type instrument, and more. If Mr. Garrard cares to communicate with me I shall be pleased to go into this question with him.—Yours, &c., W. E. GIBSON.

Palmer's Green, Dec. 22.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent on above subject appearing in the current issue, makes the following statement: "A minimum current cut-out on a generator is worse than useless." I should be glad if Mr. Chas. C. Garrard would explain why he thinks it useless.—Yours, &c., W. S. T.

Manchester, Dec. 21.

SINGLE-PHASE MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Latour's letter of December 3, 1903 I should like to state, in Mr. G. Winter's and my name, that our common work has been carried on absolutely independently of Mr. Latour, and only shows similarity in one point—namely, in respect to the excitation through the armature. This method of exciting is contained in our German patent application of November 15, 1901, while Mr. Latour claims that it is shown in his French application of December 12, 1901.

We beg to state that Mr. Latour's remark that this method of exciting is given very clearly in his letter on p. 220 of *l'Industrie Electrique* and in his French patent application of December 12, 1901, is absolutely incorrect. On the contrary, this article and patent shows that Mr. Latour means a method of excitation for synchronous, or nearly synchronous, machinery only. This patent application does not refer in any way to monophase synchronous, or nearly synchronous, machinery, and, even according to the letter in *l'Industrie Electrique*, p. 220, the relative situation of the axis of excitation and of that of the stator-winding is not defined. That means that a new invention would be necessary to find out the most important point.

This method of exciting, given very clearly for single-phase motors in our patents, by-the-way, becomes especially valuable in connection with our system of speed regulation, for only in connection with this system is it possible to run within a wide range of speed with a power-factor of 0·95 to 1·0.

While the practicability of our system has been proven in actual service, the incompleteness and incorrectness of some of Mr. Latour's methods and views are self-evident.—Yours, &c.,

Berlin, N.W., Dec. 19. FRIEDRICH EICHBERG.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Latour's letter in your issue of December 11, 1903, we beg to state that the single-phase motor of the Union Elektricitäts Gesellschaft has been designed exclusively on the basis of the patents and investigations of Messrs. Winter and Eichberg, and has been developed in entire independence of Mr. Latour's work and without knowledge of his system. All we have read subsequently of Mr. Latour's work, which only touches our system in a single point, leads us to request your readers not to infer that the partly incorrect, or, in reality, impossible suggestions of Mr. Latour are in any way identical with our system.—Yours, &c.,

UNION ELEKTRICITÄTS GESELLSCHAFT.

Berlin, N.W., Dec. 18.

THE DE FOREST WIRELESS TELEGRAPH SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The communication by Count Arco in your last issue concerning the description of the de Forest system appearing in *The Electrician* of December 4th merits reply. Originating from a source where the essentials of the recognised wireless system are so palpably the result of early disclosures of Lodge and Marconi, and that despite explicit patents granted in Germany, the zeal so suddenly displayed for British patent rights appears somewhat pharasaical. One is led to recall the remarks made some time ago by a prominent English electrician anent that same subject.

In view of arrangements of Leyden jars and inductance coils explained by Lodge in 1897, no great claim to originality can be made for any of the obvious modifications which are now employed in the several wireless systems.

The application of the Oudin transformer with Leyden jars to wireless transmitters was made in America considerably prior to Braun's application (No. 1,862 of 1899), and is covered by patents to Shoemaker and Ehret, owned by the de Forest Company, and which, among others, the Slaby-Arco system in the United States is at present infringing.

The use of two or more antennæ wires instead of one is so obvious that it is futile to say who was the first to employ the arrangement.

So for the small spark-gap connection to the antenna, as well as that astonishingly ingenious device, a switch ("Empfangsschalter"), for which we are certain we do not claim exclusive rights! The electrolytic receiver under discussion was first employed in Chicago in 1900. It is broadly covered by our British patent No. 10,452 of 1902, as is any form of detector depending for its action upon the electrolytic effect produced by high-frequency oscillations.

We will not gainsay Count Arco's statement that the Germans have patented certain devices which we, and others also, are using, and have used for a long time. That procedure is, we believe, not entirely unique in patent history! But fortunately for justice, *awards* (in certain countries) take into consideration priority of use and genuine invention.—Yours, &c.,

DE FOREST WIRELESS TELEGRAPH CO.

London, W.C., Dec. 20. Dr. Lee de Forest.

THE OSCILLOGRAPH AND THE ONDOGRAPH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your remarks on Prof. Hospitalier's Paper in your issue of Friday last you refer to the apparatus described by Messrs. Barr, Burnie and Rodgers at the British Association Ipswich meeting. May I draw your attention to the fact that M. Blondel has also used an automatic point-by-point method, in which photography was the recording agent (*The Electrician*, Vol. XXVII., 1891, p. 603). Prof. Rosa described before the British Association Toronto meeting a semi-automatic method in which pen-recording was employed. Prof. Callendar has also adapted his recorder for the same purpose (see *The Electrician*, Vol. XLI., p. 583). However, so far as I am aware, none of these instruments have given in so simple and compact a form the excellent results obtained by Prof. Hospitalier. With reference to your remarks about my oscillographs, you are possibly not acquainted with the later designs with a permanent magnet field, which are much more robust and compact.

The great advantage of oscillographs, or the direct method, as Prof. Hospitalier calls it, over the point-by-point or indirect method, lies in the fact, as you point out, that oscillographs are applicable to any phenomenon however irregular and non-periodic it may be, whereas the point-by-point methods are only applicable to periodic phenomena or those which can be rendered periodic by repetition. If the phenomenon is periodic, then, with an oscillograph, photographic recording can be easily dispensed with. A number of phenomena may also be recorded absolutely simultaneously by means of oscillographs; thus, with three double instruments, six curves can easily be recorded at the same time on the same plate or observed and traced if periodic.—Yours, &c., W. DUDDELL.

London, S.W., Dec. 19.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: Among the "Notes" in the current number of *The Electrician* there is one regarding the ondograph of M. Hospitalier, wherein reference is made to Mr. Duddell's oscillographs. While showing your appreciation of the wonderful range and adaptability of these instruments you are apparently inclined to regard them as somewhat costly and delicate to handle. You suggest that, if possible, Mr. Duddell should "develop one or two somewhat cheaper and hardier forms of his instrument, that can be operated successfully by those who have not the opportunity to acquire an intimate knowledge of their 'tricks and their manners.'" Now, Mr. Duddell has been fully alive to the need for a cheaper and hardier type of instrument, and has, in fact, anticipated your very reasonable suggestion by designing two distinct forms of oscillograph more easily manipulated than the research type of instrument. Of these, the projection oscillograph, primarily intended for lantern demonstrations, and its vibrator, is comparatively stoutly constructed, the tension on the double strip being about 6lb. This instrument can be used in conjunction with a tracing desk, and is well adapted for the general run of commercial work. On the other hand, the permanent magnet oscillographs, both single and double, while retaining the small dimensions of the high-frequency type of vibrator, have but one-third of the tension upon the phosphor-bronze strips. They also have the advantage of being lower in cost than the ordinary high-frequency instrument. Moreover, the apparatus for recording wave forms—whether periodic or not—is in one form reduced to a photographic plate falling vertically under gravity. Although in this case the time scale is not perfectly uniform, the difference from the mean over one complete period being only ± 2½ per cent., the records obtained with this simple apparatus are of the utmost service in practical investigations.

An engineer can now obtain a photographic outfit complete with oscillograph, revolving mirror, &c., at a very moderate cost.—Yours, &c.,

CAMBRIDGE SCIENTIFIC INSTRUMENT CO. (LTD.),
Cambridge, Dec. 19. Robert S. Whipple, Manager.

STEAM TURBINES v. RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Many red herrings have been passed over the trail of this correspondence, and it is difficult to keep on the scent. We will try to get on the line again, but before doing so must reply to some of the criticisms, so that we may not leave a wrong impression. Mr. Campbell Swinton will find "load-factor" defined in the *Electrical Times* tables as $\frac{\text{"Units} \times 100\text{"}}{\text{"Max. load} \times \text{hours"}}$ We say that even if the units always mean the same thing, such a load-factor is of little use in comparing stations under different circumstances. For example, a Coronation night in Cambridge or some festive occasion in Scarborough might seriously increase the usual maximum load and spoil the load-factor for the year.

If, as Mr. Swinton allows, the plant installed was considerably in excess of requirements at both these places at the time, we have no doubt an enterprising station engineer would see his way to do more than he could have done if he had only the allowance of spare plant usual in reciprocating engine stations. We have drawn all this storm about our ears because we suggested that the excess of plant (since admitted) over the usual maximum requirements might be installed for fear of stripped blades and other difficulties.

We quite agree with Mr. Henry Lea and Mr. Merz that the returns from which the figures have been obtained do not give all the information required to enable a very exact comparison to be made, and although we made out our list as impartially as possible from the only available statistics, we fail to see that any further discussion of details is in any way useful.

Instead of the lists which have been under discussion, we will adopt Mr. Barker's suggestion, and have taken from the provincial list given in the *Electrical Times* issue of the 11th inst. the exclusively steam turbine stations—viz., eight—and all the remaining stations—viz., 160. The coal and works costs for the steam turbines run out at 0·78 and 1·6, as compared with 0·738 and 1·4 for the 160 others. Instead of the steam turbines being, as claimed, as good as the best reciprocating engines, the figures for the turbine stations are not even up to the average of the good and bad of all sorts. These figures will, we think, appeal to an open-minded reader, as many of the 160 stations have old type and uneconomical plant of various kinds.

Even in the station of the Newcastle Company, which has been referred to by the steam turbine advocates, the published results show that the reciprocating engines supplied by the Wallsend Slipway Co. gave a much better result than the steam turbines under similar conditions of vacuum and superheat.

Mr. Barker is disappointed that we have not accepted his figures in connection with the value he assigned to the inch of vacuum, but we really do not see why we should prefer Mr. Barker's figures to the 4 per cent. per inch in Mr. Wilkinson's Paper, or the 6 to 7 per cent. for every inch above 25, as given in a Paper on the Curtis turbine by Mr. W. R. Emmet, published in various electrical papers last October.

There is no doubt that the steam turbine requires, for economical running, a much better vacuum than would be required for the same economy with the reciprocating engine, and a vacuum that it would be very difficult to obtain in many places. Mr. Barker has shown great ingenuity in manipulating the tables to prove his point, but we do hope he will be content with the full average results we now give him, and turn his attention to more useful points.

We are afraid he is splitting hairs in raising the point he does concerning the results of a re-trial of a Belliss engine without overhaul after five years work in a central station. The vacuum was on the average about 1½in. better on the re-trial, and for a compound engine the correction for this would be about 3 per cent., and the consumption at full load would then be 19·79 on the re-trial, against 19·4 on the official trial five years before. But trials were also made at three-quarter, half, and quarter loads, and taking an average of all the loads the result, after correcting for vacuum, comes out 20·2lb. per brake horse-power after five years, against 20·9lb. per brake horse-power originally, or 0·7lb. better. The engine was put on the test-plate exactly as received, without the cylinders being opened out or any adjustments made.

Central station engineers, steam engine manufacturers and probably consulting engineers are longing for a chance to use or make steam turbines whenever they feel that they can safely do so without risking their reputation. At present the problem before them is about as follows:—The high-speed self-lubricating triple-expansion double-acting reciprocating engine has proved itself capable of doing central station work more comfortably, more economically and with less risk than any steam turbine yet built, especially when the electric generator attached to it is taken into account. The steam turbine advocates would like to get the idea abroad that for central station work the steam turbine is overhauling the reciprocating engine, and will soon displace it. How absurd this position is can be easily ascertained by anybody who will take the trouble to find out what is being done. We, ourselves, for example, have put through our gates during the nine months just completed of our present financial year 56,000 H.P. of our engines, say, at the rate of 75,000 H.P. per annum, which is a considerable increase on anything we have previously done, and other builders are probably in the same position. Steam turbines in hand, at the present time at least, are a very small item in comparison with the reciprocating engines which are being turned out in this country.

Advocates of steam turbines assert that the reciprocating engine is played out, and has reached its limit, but we know of no such finality. We have made great advances in recent years, and are looking forward to still better results in the near future.

On the other hand, the steam turbine position is about as follows:—

1. For more than 20 years it has had the continuous attention of some of the best and most ingenious mechanical engineers in this country or elsewhere, but up to date the

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chief difficulty—viz., that in connection with the clearance—has not been solved, and is probably incapable of practical solution.

2. The amount of the clearance permitted to obtain the results published is so small, that grave practical difficulties are produced by expansion under the temperature of the working steam. Certainly this clearance can never get less during the working period, and we assert that the published figures show that it increases.

3. To enable results to be obtained approaching those we can get from triple-expansion reciprocating engines, superheat of a considerable amount must be employed, and the clearance must be proportionately increased. It is impossible under working conditions in a station to keep the superheat within any but very wide limits, and as the clearance must be made large enough to meet the maximum superheat, waste of steam through the clearance at working temperature must be largely increased.

4. Stripping of blades may be caused by the superheat overheating them, or over-expanding the rotating part as a whole, and it may also be brought about by water, or a very small foreign substance at this very high peripheral speed.

5. The improvement in economy in the steam turbine is limited by this question of practical clearance, and there does not appear to be much chance of further improvement in view of the great care and thought which has already been expended.

6. The one big point in connection with a steam turbine plant that appeals to everybody, is the fact that the larger sizes especially can be manufactured much more cheaply than the same power of reciprocating plant, but against this must be taken into account the fact that with the steam turbines go boilers and condensing plant much larger than in the case of the reciprocating engine. Any big difference in economy or unreliability of the plant would make the difference in first cost a trivial matter compared with the trouble which might result from the change.

As the writer will be out of England during the next three or four weeks, he hopes to find on his return that the discussion has been continued on lines useful to your readers.—

Yours, &c., ALFRED MORCOM, Managing Director.

Birmingham, Dec. 22. (Belliss and Morcom, Ltd.).

DINNER TO MR. GEORGE DRAPER.

The Marquess of Tweeddale, K.T., presided at the Hotel Cecil on Thursday evening last at a dinner given by his former colleagues to Mr. George Draper, F.R.G.S., on his retirement from the service of the Eastern Telegraph Co. Mr. Draper was presented with a beautifully-engraved silver salver, a pair of silver candlesticks, fruit dishes, &c., and Mrs. Draper was the recipient, through her husband, of a handsome diamond brooch. The seats on the immediate right and left of the chairman were occupied respectively by the guest of the evening and by Sir James Pender, Bart.; and the vice-chairs were filled by Mr. H. A. C. Saunders, Mr. A. R. Hardie and Mr. W. Hibberdine. The guests included Mr. Kenneth Anderson, Mr. A. Brown, Mr. R. T. Brown, Mr. T. A. Bullock, Mr. W. H. Burman, Mr. P. Burrell, Mr. J. Cambrook, Capt. Cato, Mr. H. G. Cheesman, Mr. T. Clark, Mr. S. Collett, Mr. J. T. Crowe, Mr. F. Dawes, Mr. D. Gair, Mr. W. P. Granville, Mr. E. Steer Hodson, Mr. H. Jamieson, Mr. W. C. Johnson, Mr. W. Judd, Capt. Leach, Mr. W. R. Lyne, Dr. A. Muirhead, Capt. Pattison, Mr. H. E. Plank, Mr. F. T. Preddle, Capt. Price, Mr. T. Richardson, Mr. A. D. Shuter, Mr. H. St. L. Smith, Mr. W. O. Smith, Mr. C. E. Stuart, Mr. J. L. Verne, Mr. F. Ward, Dr. Wholey and many others.

The loyal toasts having been duly honoured,

The CHAIRMAN, who was warmly received, proposed Mr. Draper's health, expressing a hope—in which he was sure all present would join—that their guest might be long spared to enjoy good health and prosperity on his retirement from the offices which he had held for so many years, and with so much credit to himself. When he looked around the table he could not but congratulate Mr. Draper on the evidence which it afforded of the kindly feelings of all present towards him and of the esteem with which they regarded him (cheers). It was not necessary for him to dwell upon the events of Mr. Draper's career in connection with the telegraph companies, because most of those present, like himself, were aware of those events. He might, however, recall the fact that his first connection with submarine cable interests was so far back as 1869, when he first joined the pioneer company to the East, which was known in those days as the Anglo-Mediterranean Telegraph Co. In 1872 he was appointed secretary to the Eastern Telegraph Co., which became the leading company having cables to the East, and he discharged the onerous duties of that position for 32 years. In addition, he was appointed in 1879 as secretary of, perhaps, the most prosperous of all the companies—namely, the Eastern and South African. In that capacity he was able to do some very useful work in the course of his journey to the Cape, when he helped on the negotiations connected with the extension of the telegraph system on the east coast to Mauritius and on the west coast along the various stations on the road to England. Those schemes were not carried out at once, but they were subsequently, and probably those present were aware that nothing helped this country so much in its conquest of the Boers than the fact of those cables having been laid on each side of the African continent (cheers). Mr. Draper remembered, as well as he himself did, the early days of submarine telegraph enterprise, when it was viewed with distrust and suspicion by the public and by investors generally; and he must also remember the fierce attacks which used to be made at the shareholders' meetings on the chairmen, the directors and others connected with the companies referred to (laughter). However, that was followed, after some years, by a better state of things, and at length the very companies which used to be abused in those days had become the soundest and the most prosperous of any in the City of London—or, at any rate, as sound and as prosperous as any of them (cheers). He did not know in what way their guest intended to enjoy his leisure, but whatever course he chose to adopt, he could give Mr. Draper this positive assurance—that he would carry with him into his retirement the kindest and best good wishes, not only of those present, but of those who had found it impossible to be present.

Lord Tweeddale then, amid cheers, made the presentation.

The toast was drunk with the utmost enthusiasm.

Mr. DRAPER, who was greeted with cheers on rising to respond, thanked the chairman for his kind references that evening, and remarked that they were only a confirmation of the many acts of kindness which he had received from his lordship. Allusion had been made to the old Anglo-Mediterranean Company, which was their chairman's "child," his lordship being very proud to remember even now that the Anglo-Mediterranean was the "golden egg," paying dividends of 15 to 17 per cent. He (the speaker) was for a short time secretary of that company and of the Falmouth, Gibraltar and Malta and the British India Companies. In 1872 they were all amalgamated into the Eastern Company. There were great difficulties to contend with in those days, but they were all overcome. The fact was that the shareholders and the public at that time did not appreciate the submarine cable companies; but they did now, and pleasant things even were sometimes said about the Eastern Company and the great enterprise into which it had developed. The late Sir John Pender, its chairman, possessed in a special degree the faculties of foresight and of untiring energy, as he proved in the management of the companies with which he was associated (cheers). After recounting several interesting and amusing reminiscences in connection with the past history of the companies with which he had been associated, Mr. Draper expressed his great pleasure at the presence of Sir James Pender, and said he had received kind letters from all his late directors and from many friends connected with the companies at home and abroad. He was delighted to see so many old friends present. He wished them all every kind Christmas greeting and many happy returns of the New Year which was coming. His wife, who knew most of them, had desired him to say that she sent them her kindest regards (cheers).

Sir JAMES PENDER proposed the health of the chairman, recalling the large and influential gathering held about four years ago, when the Marquess of Tweeddale was presented with his portrait and entertained at a banquet. Their chairman was one of the pioneers in submarine cable enterprise who had had to contend with the numerous difficulties to which reference had been made. These difficulties had been successfully surmounted, but he was told that others had now arisen in connection with Mr. Marconi's invention (laughter). No one would deny that that gentleman had made many additions which were very useful for communicating with ships, lighthouses, &c., but he did not think that wireless telegraphy would be any competitor commercially with the great cable system (hear, hear). On behalf of all present he tendered to the chairman their respect, esteem and affection (cheers).

The toast was drunk with great cordiality.

The CHAIRMAN, in response, thanked Sir James Pender for the extremely kind terms in which he had proposed the toast and the company for the hearty manner in which they had received it.

ST. MARYLEBONE ELECTRIC LIGHTING BILL.

We are able to give a summary of the bill St. Marylebone Borough Council have deposited in Parliament, relating to the question of electricity supply in St. Marylebone. The preamble of the bill briefly traces the arbitration proceedings and subsequent circumstances, and points out the expediency for empowering the Borough Council to borrow money for the purpose of carrying out the terms of the arbitration award in connection with the purchase of the Metropolitan Supply Co.'s undertaking in that district. The amounts of the estimates of the sums which it is necessary that the Council should borrow are set out as follows:—

1. For the purchase money and compensation due from the Council to the company for the St. Marylebone undertaking and business as defined in the Act of 1901 (except the offices of the company at No. 16, Stratford-place, and the extra high-pressure trunk mains of the company); for the further sums payable by the Council to the company or into court under the said judgment of August 7, 1903, or otherwise; and for the payment of the costs, charges and expenses of the transfer of the said undertaking (including the costs of the arbitration and of the said action)—£1,365,000.

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2. For paying the costs, charges and expenses of the Order of 1901 and of the Act of 1901—£1,444.

3. For the purchase of land for, and for the erection and construction of, a station for generating electricity under the powers of this act, including the buildings, machinery, engines, lay-bys, quays, wharf, works and conveniences connected therewith or for the purpose thereof, and the provision, laying down and construction of mains and works for connecting the generating station with the existing mains, and the alteration and extension of mains and works—£460,000.

4. For the provision, erection, laying down and construction of lamps, pillars, works and conveniences for the purpose of public lighting—£15,000.

5. For the alteration of the works and mains of the Council and of any lamps and fittings of consumers of energy consequential upon the alteration of the pressure at which energy is supplied—£30,000.

6. For the provision, fixing and setting up of lamps, electric motors and other electric fittings—£10,000.

Thus the total sum to be borrowed amounts to £1,881,444.

There are also one or two other interesting clauses in the bill. For instance, clause 34 reads as follows:—Notwithstanding any provision in any act or order relating to the company prohibiting the company from supplying electrical energy beyond their areas of supply, the company and the Council may respectively carry into effect any agreement made before the passing of this act for the supply of electrical energy in bulk by the company to the Council.

Under clause 13, power is taken to charge for electric energy under the maximum demand system at the rate of 8d. and 2d., and sub-section 2 of the same clause provides that in the event of the average price of current exceeding 6d. per unit, a reduction shall be made which will bring the price down to not less than 6d. per unit.

Clause 14 relates to stand-by supply and disentitles any person from demanding a supply if he has a separate supply unless he shall have previously agreed to pay to the Council a minimum annual sum to give a reasonable return on the capital expenses, and to cover the standing charges incurred in order to meet the possible maximum demand of such consumer.

Clause 15 provides that the Council shall refuse to supply electrical energy to persons in debt for current. Another clause gives the Council power to provide, sell, let for hire, fix, &c. (but not manufacture) lamps, fittings, motors, &c.; for this purpose authority is sought to borrow £10,000. A clause which follows relates to the issuing of bye-laws with respect to wires, apparatus, fittings, &c.

With regard to finance it is stipulated that the amounts borrowed under headings 1, 3, 5, 6 mentioned above shall be repaid within 42 years, under heading 4 in 10 years, and under heading 2, within five years of the date of borrowing. Further, it is provided that the Council may borrow any other sums that may be necessary, with the consent of the London County Council or Local Government Board, such amounts being repayable within a period prescribed by either of those bodies. The sums under headings 1, 2, 3, 4, 5 and 6, the £10,000 for motor hiring, &c., and the costs of this act, are to be raised by mortgage or the issue of debenture or annuity certificates.

LEGAL INTELLIGENCE.

Patent Exploitation (Ltd.). v. American Electrical Novelty and Mfg. Co.

In the Court of Appeal on Saturday, before Lords Justices Williams and Stirling, an application of the respondent company for security for costs of an appeal in the above matter was in the paper.

Mr. GRAY said that in view of the appeal pending in the House of Lords in another case by the same plaintiffs, the plaintiffs or the defendants might desire to consider the decision in that case, and under the circumstances it had been agreed that both the motion and the appeal should stand over until after the judgment in that case, with liberty to either party to apply.

This course was sanctioned.

Campbell v. Krauss & Sons.

This case came before the Master of the Rolls and Lords Justices Mathews and Cozens-Hardy, in the Court of Appeal, on Friday, on the appeal of defendants from a decision of the County Court judge at Leigh, Lancs., sitting as arbitrator under the Workmen's Compensation Act. Messrs. Krauss & Sons are tramway engineers and contractors, and were contractors for certain work in connection with the South Lancashire Electric Tramways near Leigh. The main line having been completed, it became necessary to lay down a by-line leading to the generating station. Plaintiff was a labourer in the employ of defendants and was engaged in excavating work. The soil after being loaded into carts was discharged in a field close by belonging to a Mr. Dixon, who was paid 3d. for each load so discharged on his land. Plaintiff having loaded two carts was sent to assist in unloading them. In tipping up one of the carts his thumb was so seriously injured that it had to be amputated, and it was in respect of this that he claimed compensation. The question arose whether the plaintiff met with his accident "in, on, or about engineering works," within the meaning of the statute. The County Court judge held that he did and awarded him compensation.

For the appellants it was argued that as the place where the accident happened was 33yds. 1ft. from the nearest point of the generating station and 120yds. from the place where the excavating work was going on, that the accident did not occur on, in, or about an engineering work so as to bring plaintiff within the statute.

The MASTER OF THE ROLLS (without calling upon counsel for respondent) gave judgment. He said there was ample evidence to support the finding of the County Court judge and the appeal must, therefore, be dismissed with costs. The Lords Justices concurred.

Garforth v. Halifax Corporation.

At Halifax County Court on Tuesday, plaintiff sought to recover £50 from Halifax Corporation for injuries received by him while travelling on defendants' tramways between Halifax and Hebden Bridge on June 10 last. Plaintiff stated that while seated on the outside of a car, and pointing out some cows to a child on his kneee, his hand came in violent contact with a telegraph pole, and his thumb was dislocated and fractured. At the time the car was travelling at a rapid speed. There was a space of only 2ft. 3in. between the outer rail and the telegraph pole, and as the car overhung the rail 12in. there were only 15in. between the car and the pole. Plaintiff was off work nine weeks, and had not yet completely recovered. It was contended that the car was at the time being driven at an excessive speed.

The Corporation denied liability. The car was not travelling at an excessive speed. The line had been passed by the Board of Trade inspector, and the telegraph pole did not belong to the Corporation, and had not been placed on the road by them.

His HONOUR, notwithstanding, held that the Corporation were liable, and gave judgment for plaintiff for £43.

Smith v. Cheltenham Light Railway Co.

Last week at Cheltenham County Court, Judge Ellicott granted a new trial of this action, originally brought against the company for damages for alleged breach of contract to convey plaintiff to Cleeve Hill. The proceedings at the first hearing were reported in our issue of Dec. 11. The new trial takes place at the first Court in January.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Birmingham Asylums committee require a resident working engineer in connection with the new Hollymoor Asylum, capable of taking charge of the electric lighting and laundry machinery, &c. Wages 50s. per week, with house, coal and gas. The committee also require an electrical assistant to work under the resident working engineer. Applications to Mr. Wm. Hutton, Council House, Birmingham, by Jan. 4. See advertisement.

A junior draughtsman is required for the Hornsey (London) electricity works. Applications by 28th inst. to the borough electrical engineer (Mr. Norman Staniland), electricity works, Tottenham-lane, Hornsey, N. See advertisement.

An assistant electrical engineer is wanted by the Bengal-Nagpur Railway Co. (Ltd.), with thorough mechanical and electrical training. Further particulars are given in an advertisement. Applications to the Company, 132, Gresham House, Old Broad-street, E.C., by Jan. 15.

The Guardians of St. George's (Hanover Square) Union require a clerk of works in connection with the installation of the electric light at Fulham-road Workhouse. Salary 3 guineas per week. Applications to the clerk, Mr. Thos. Worlock, St. George's (Hanover Square) Hall, Mount-street, London, W., by Jan. 11. See advertisement.

A first-class commercial man is required as manager of the cable department of Messrs. I. Frankenburg & Sons (Ltd.), Salford. See advertisement.

An electrical engineer with good commercial knowledge and experience in estimating costs and preparing tenders is required by Messrs. Vickers, Sons and Maxim (electrical department), Sheffield. See advertisement.

An electrical engineer is required by shipbuilders in China for repairing and installing electric lighting plants on board ship. Applications to "Aralia," 16, Philpot-lane, London, E.C. See advertisement.

The Southend-on-Sea Light Railways and Electric Lighting committee require two tramway inspectors with previous experience. Applications to borough electrical engineer and general manager (Mr. W. E. J. Heenan), London-road, Southend-on-Sea, by noon of Jan. 18. See also advertisement.

A competent dynamo and switchboard attendant is wanted at once for the Brecon and Radnor Asylum, Telgarth, R.S.O. Applications to the medical superintendent. See advertisement.

Leicester Tramways committee require a resident electrical engineer for their electric tramways, Commencing salary £250 per annum, increasing by £25 per year to £350. Applications to chairman by Jan. 1.

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An assistant, with factory experience, competent to give instruction in the theory and practice of electric machine design, is wanted in the department of electrical engineering of the City and Guilds of London Institute, Exhibition-road, S.W. Salary £150 per annum. Applications to Prof. Ayrton.

Wellington (N.Z.) Technical Education Board require a director for their technical school. Salary £500. Further particulars from the Agent-General, 13, Victoria-street, London, S.W. See advertisement.

In consequence of the appointment of Mr. Edwards to the position of manager of Gloucester tramways, Bradford Tramways committee have appointed Mr. G. R. Blackburn, engineer in the workshop, as assistant electrical engineer, and Mr. John Foster, foreman of the Thornbury depot, as rolling stock superintendent.

Owing to the resignation of Mr. Carr and Mr. Medley, Maidstone Corporation electricity department has been re-organised, and Mr. Saunders and Mr. Empson have been appointed respectively outside and inside superintendents, and Mr. Goulburn and Mr. Williams shift engineers.

Mr. P. N. Hooper, A.M.Inst.C.E., M.I.E.E., at present resident electrical engineer at King's-road station of the St. Pancras (London) Council, has been appointed borough electrical engineer at Poplar in succession to Mr. A. Blackman, recently appointed to Bradford. There were 75 applicants, but this number was reduced to three—viz., Messrs. P. N. Hooper, C. C. Atchison (Rochdale), and J. F. Jones (Crystal Palace District Co.).

Mr. Sibley, district manager of the National Telephone Co. at Leicester, has been promoted to the position of manager of the Dublin district.

EDUCATIONAL NOTICE.

A course of lectures and practical work in electro-chemistry will be given by Prof. Lehfeldt on Wednesday evenings at East London Technical College, Mile End-road, E., commencing Jan. 13. This session will be devoted mainly to the theory of the lead accumulator.

Aberdeen.—The Streets and Roads and Finance committees have had an interview with Mr. W. E. L. Gaine, general manager of the National Telephone Company, on the subject of the diminution of the number of overhead wires in the city. Mr. Gaine recommended putting the telephone wires underground, at an estimated cost of £60,000, and offered, on behalf of the company, to pay the whole of the cost. The committees, however, sought in addition to obtain a £7 rate for subscribers instead of £8. 10s., as at present. Mr. Gaine could not promise so much, but offered to charge large groups of subscribers on party lines 25s. for a minimum of 600 calls per annum and ½d. per call after. The committees declined to recommend the acceptance of these terms.

Aberystwyth.—A new agreement has been entered into with the Aberystwyth and Chiswick Electricity Supply Corporation at £395. 2s. 6d. per annum for public lighting.

Acton.—A deputation from the District Council waited upon the Board of Trade on Thursday last and it is reported that the Board will favourably consider the proposed agreement for the supply of electrical energy, in bulk, by the Metropolitan Electric Supply Co. If, however, it should be thought desirable to revoke the Council's order, the Acton Council would again be heard.

Argentina.—The Compañia de Obras Publicas del Rio de la Plata commenced supply of electric current in May last from their station at Concepción del Uruguay, Entre Rios. The total connections in November were equivalent to 2,240 8 c.p. (to 130 consumers) out of a total plant capacity of 4,000. There are two General Electric-Willans generating sets aggregating 120kw. in the station, overhead vulcanised rubber cables being used. There is no gas supply in the district, and no traction.

Aston.—The consulting engineer (Mr. Robert Green) has been appointed arbitrator in relation to the purchase of so much of the tramway undertaking of the City of Birmingham Tramways Co. as lies within the Council's area, and the Town Clerk has been authorised to take the necessary steps in relation to the arbitration and purchase of the tramways. The remaining tramways in the town include the Perry Barr, Lozells and Witton routes.

Ald. Gittings announced, at the Council meeting last week, that the parties were not to indulge in costly arbitration proceedings as the company were prepared to take the view of the Council's expert as to the financial value of the undertakings.

Award.—In connection with the acquisition of the Sardinia-street station of the Metropolitan Electric Supply Co. by the London County Council for their Holborn to Strand improvement scheme, the owners of the freehold premises have now been awarded £24,750 for the site. This is in addition to the sum of £183,150 awarded in August last to the Metropolitan Electric Supply Co. for the acquisition of their undertaking (see *The Electrician*, Sept. 4, 1903, p. 823.)

Barberton (Transvaal).—Moodie's Gold Mining and Exploration Co. supplies current to leaseholders of the company's properties for mining purposes, but does not supply to the public. At present the works are but little employed, from the fact that only one of the mines taking power from the company has resumed work since the war. The equivalent of about 1,220 8 c.p. was connected at Oct. 24, including some small motors. The company generate power from a watershed of about 100 sq. miles in extent, with an available fall of 150ft., with estimated available horse-power about 500 H.P. There are a number of water-power driven plants in the Barberton district, but none of these supply power outside their own works.

So far, nothing has come of the proposal made some time ago to light the town of Barberton electrically, although good terms were offered by at least two contractors to carry out this work.

Basutoland.—A report recently issued upon the trading and general interests of Basutoland for the period 1902-3 contains much interesting matter relating to this colony. Telegraphic communication has during the period been extended to Peka, and the telegraph line throughout Basutoland has been doubled and strengthened. Telegraphic communication has been completed between all the stations.

Beverley.—The Council rejected some time ago proposals for the establishment of municipal electricity works, and the area is now scheduled in the Lincolnshire and Yorkshire Electric Power Bill.

Blaydon.—An agreement has been made for the supply of electricity in bulk by the Priestman Power Co. to the Council, the latter providing the capital and the company paying sinking fund, interest, and depreciation charges.

Brighton.—At the Council meeting on Thursday last, Ald. Stafford moved the rejection of the recommendation of the Tramway committee to permit advertising on the tramcars, and this was carried.

Bristol Tramways.—Keynsham Rural and Brislington Parish Councils will oppose the bill for certain extensions of the Bristol Tramways Co.'s lines.

Cairo.—The Ministry of Public Works recently authorised the Cairo Gas Co. to extend their electric lighting mains to several additional thoroughfares in the Fagallah quarter.

Cardiff.—The Electric and Lighting committee last week approved of the proposed extensions of the generating plant and buildings at the Roath power station.

Cardiff-Penarth Electric Tramway Scheme.—Dinas Powis Parish Council will support the bill for the construction of this line.

Coleraine.—The Council have decided not to oppose the scheme of the Belfast and North-East Electric Lighting and Gas Power Co. who propose to erect a generating station here.

Companies Struck off Register.—The following were, on 22nd inst., removed from the Register of Joint Stock companies :—

Brianne Electric Lamp Co.	Herne Bay and Canterbury Light Railway Synd.
Collier's Patent Syndicate.	Hire Purchase Elec. Wiring Co.
Economic Steam Producer Synd.	Lancashire and Grand Trunk Elec. Tramways.
Electric Propulsion.	Lancashire United Elec. Tramways.
Electrical Guarantee and Trust.	London Electrical Cab.
Electrical Undertakings.	Road and Tram Car Elec. Traction.
Electro-Ceramic Syndicate.	Ryde Elec. Light and Power.
Ferrolite Electric Syndicate.	
Haulage and Traction Co.	

Conway.—The Rural Council is considering a suggestion that the Cefn Estate authorities should be asked to submit terms for supplying electricity by means of plant to be operated by the water power of the Old Mill stream.

Coventry.—The Corporation discussed on Monday a recommendation by the Electric Light committee that, subject to sanction being obtained, £31,575 be expended on extensions of the generating plant and distribution system as recommended by the manager (Mr. J. A. Jeckell) in September last.

Mr. JECKELL had reported that, after the capital proposed had been spent, he did not anticipate, unless there was some considerable increase in the size of the town, that it would be necessary to spend much more. It would take 11 months to obtain the additional plant, and, as that would be required by November of next year, it was imperative that it should be ordered at once.

Mr. WEST (chairman of the committee) moved the adoption of the recommendations, and said the extensions was only the fulfilment of a policy decided upon more than two years ago. Mr. Jeckell had shown that their electricity undertaking could not be made entirely self-supporting until they had a capacity of 1,200kw., and the amount set forth as necessary to be spent was £73,000, bringing the capital up to £150,000. The policy of doubling the capital and reducing the price was, doubtless, daring, but the committee thought it was the only course. When the extensions now proposed were completed they would have 600kw. further capacity for an expenditure of £35,000.

The proposals were agreed to.

Cromer.—Last week the Council authorised payment of £7,345 to Edmundson's Electricity Corporation on account of their contract for the erection of electricity works. The extension of the electric lighting mains to Suffield Park was also authorised.

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Devizes.—The consulting engineer (Mr. E. Wingfield Bowles) has drawn up a preliminary report on electricity supply, in which the Council are recommended to establish electricity works at an estimated cost of about £17,000. The Electric Lighting committee have approved the scheme, and Mr. Bowles has been instructed to prepare detailed plans and specifications. Application is to be made for a loan of £19,000.

Doncaster.—An inquiry was held on Friday into the application of the Corporation for permission to borrow £9,920 for extensions of the electricity undertaking.

Mr. R. A. H. Tovey (the town clerk) stated that the period for the repayment of previous loans of £57,700 was 25 years, and, if possible, the Corporation desired that period extended. The amount for which sanction was now sought included £3,302 spent in excess of previous loans sanctioned (£57,700), through circumstances over which the Council had no control, and additions to the works, which had been carried out at a cost of £4,903. 19s. 4d., besides £1,624 for projected extensions. The excess expenditure had been chiefly incurred in augmenting the plant for supplying energy to the tramways. Private consumers had increased from 259 to 321 since March last.

Mr. Wm. Wyld (the borough electrical engineer) gave technical details of the scheme to which there was no opposition.

Dublin.—A special meeting of the City Council was held on Friday to consider the report of the Electric Light committee upon the communication recently received from the Local Government Board (see *The Electrician* last issue) as to the application for loans for electricity supply and the comments of the consulting engineer (Mr. Robert Hammond) thereon:—

Mr. Irwin (the chairman of the committee) moved the adoption of the report, and said an explanation was due to the Council as to the cause of their being obliged to amend the application which they had made to the Local Government Board for an additional loan. Their adviser (Mr. Hammond) submitted to the committee on Aug. 5 last what purported to be a full and complete statement of all extras which, in his judgment, had been or could possibly be incurred in completing his scheme. When Mr. Hammond was preparing that list of extras he (Mr. Irwin) impressed upon him the importance of making it so comprehensive as to obviate the necessity of having to apply for a further loan until such time as they could show financial results which would warrant the Board in sanctioning a further loan for extensions. Mr. Hammond assured him that he had done so, and at his (Mr. Irwin's) suggestion he then added a further sum for contingencies amounting to £1,870, which brought the amount to the round figure of £48,000. The committee approached the Council, and relying upon the assurances given them, asked the Council to forward the application. Upon the morning of the opening of the recent inquiry he observed that Mr. Hammond had considerably varied his figures. (Mr. Irwin proceeded to refer to certain modifications in the amounts set down.) He feared he must agree with the Local Government Board that, according to Mr. Hammond's own estimates and evidence at the original inquiry, there should have been a saving of £6,000 by reason of his dispensing with the step-up transformers and generating by a cheaper method. He had suggested to Mr. Hammond that, if possible, they should have a further sum reserved for still further contingencies. Then there was the problem of dealing with the old and best area of the city, which Mr. Hammond, in conjunction with Mr. Ruddle, was now considering. That in itself would involve a considerable expenditure. During the carrying out of the constructional work of the extensions Mr. Ruddle pressed upon Mr. Hammond and himself the absolute necessity of laying some extra mains in certain leading streets, and accordingly portion of the £6,500 referred to by the Board as having been expended in extending the scope of the scheme was spent in laying three-phase mains. There was, however, more still required to be done in that connection, and Mr. Hammond had stated that undoubtedly an application for a further loan must be made at an early date. At present they had no funds available for laying distributing mains and giving supply to many important places. In conclusion, he desired, in fairness to his colleagues on the Lighting committee and himself, to say that they felt very keenly the criticisms which had been passed upon them, and he stated most unhesitatingly that in no single instance did they get their sanction to any extras, as brought before them by Mr. Hammond, until they had thoroughly discussed the point with him, and were satisfied that, in the interests of the scheme itself, it was a vital necessity to do so. In the bill of extras there were no doubt some large items which were not submitted to the committee, but which Mr. Hammond claimed that he was empowered to order as the work progressed, under the terms of his original appointment by the Council, and the committee had supported Mr. Hammond in every possible way, whether the question was the ordering of necessary extras or the providing of additional technical assistance in working out his scheme.

The motion for adoption having been seconded, Mr. R. Jones said the Board had called attention to two facts: (1) That the scheme had been seriously under-estimated and (2) and that the additional capital asked for was unremunerative. The wildest charges had been made against members of the Corporation, and had, on examination, been scattered to the winds. After long and serious consideration, the Council decided that Dublin should be provided with the benefits enjoyed by other cities from an improved and extended system of electric lighting, and they also decided that that undertaking should not be handed over to any private monopoly. On the very highest recommendations, they engaged one whom they were assured was eminently fitted as a consulting and a constructing engineer to plan and carry out such an undertaking. Accordingly Mr. Hammond, in 1899, prepared and submitted a scheme for their approval. The Corporation took steps to satisfy themselves that the three-phase system was working well and profitably in some of the largest centres of industry in Europe, and they instructed their engineer to go forward and carry out the plans. The opinions expressed by the Local Government Board came with surprise upon members of the Council. It was only now, four years after the original report was made, that they were put in possession of the full figures upon which the financial success or failure of the scheme would depend, and he confessed that the results he had arrived at were of a startling character. A number of serious defects had also been discovered, and a definite report from Mr. Hammond as to their extent and their probable effect upon the undertaking ought now to be given. There ought to be no friction between their officers at that stage. If the scheme was to be made a success—and he believed that electric lighting would be made successful—it could only be made so by the whole-hearted co-operation of Mr. Hammond and his staff and Mr. Ruddle and the Corporation staff.

Mr. Kelly thought it was now too late for Mr. Irwin to stand up and impeach Mr. Hammond. The money was spent, and now they would have to make the best of their scheme.

After further discussion, the Lord Mayor said there appeared to be some misapprehension. The Council had already sanctioned the application for a certain loan, and the Local Government Board had practically approved of that. Further, the Board said to the Corporation: Increase your application by another £4,300. What was before the Council to-day was an actual request from the Board to increase their application. In face of all that, it seemed an extraordinary thing that that discussion should be initiated when the Local Government Board not only approved what the Council had done, but actually invited them to increase their demand. Mr. Hammond still adhered to his statement that electricity could be produced at a cost of 1·5d. per unit. Let them keep him to that, and if he should fail to make good his words they should require from him a satisfactory explanation. But let them give him a free hand in spirit as well as in letter.

Mr Irwin, in reply, said he felt terribly disappointed at the enormous amount of the under-estimate. Every business man would be prepared for a certain amount of extras on work costing a quarter of a million sterling, but the position now was that the whole £254,000 had been absorbed, and £52,300 further was required. Mr. Hammond had not, he considered, gone into the matter of extras in the manner an expert of his standing should have done. He then replied seriatim to the various criticisms.

Ultimately the report was adopted with one dissentient.

Dumbarton-Balloch Electric Tramway Scheme.—At an influential meeting of ratepayers and public men of the Vale of Leven held last week, it was decided to support the proposals of the Electric Supply Corporation for the construction of this electric tramway.

Dunfermline.—Negotiations have been opened with the Fife Electric Power Co. for the supply of electricity in bulk to the Corporation. The company offer to establish generating works and to supply current for lighting, power and traction.

East Barnet.—The Council have decided, on the recommendation of the Electric Lighting committee, to accept the proposal of the Sir Hiram Maxim Electrical and Engineering Co. for the erection of electricity works, and the committee have been requested to continue the negotiations with the company.

Electrolysis.—Even so prosaic a subject as "Electrolysis" has found its poet laureate in the not altogether likely district of Christchurch, New Zealand. The following was, it is stated, recently found on the Christchurch *Star's* Marconigraph receiver, and was inserted in that journal without apologies to the author of "Tommy Atkins." It may be added that the war between the gas interests and the promoters of electric tramways in the district has been raging furiously. The portion of this inspiring poem which we have omitted is not of empirical interest:—

Oh, we take him from the lightning and the clouds,
We break him in until he's like a lamb,
We make the beggar draw the folk in crowds,
In the latest up-to-date Electric Tram.
When he's done his work we train him to return,
But sometimes he develops little vices,
And without the slightest warning says he won't go
home till morning,
Producing what is called electrolysis.
He plays up with the water and the gas,
He starts to fool around the telephones,
Till he makes you swear the Central is an ass,
And consign the whole concern to Davy Jones.

* * * * * *

Yes, Mister Bottled Lightning,
You're a handy little chap;
But if you get the cork out
You're inclined to paint the map.
You've gentlemanly manners
Till you get upon the burst;
You're all right when we hold you,
But we've got to hold you first.

Electric Mining Plant in Victoria.—Cathcart Proprietary Gold Mining Co., Ararat, have ordered from Ganz & Co. (through their Melbourne agents, the Austral Otis Engineering Co.) a complete electric power plant, comprising a 160 B.H.P. Belliss engine, a Ganz 110kw. three-phase generator (supplying current at 500 volts, 50 periods), boilers, feed pumps, surface condenser, air pumps, electric motors for winding, pumping and other purposes.

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Electricity in Mining.—The chairman of the Ottos Kopje Diamond Mines (Ltd.), stated at the meeting last week that a complete electric lighting and power installation had been installed at the mines and was working satisfactorily.

Fire.—Official announcement is made that the extent of the loss by fire recently at the new works of the British L. M. Ericsson Manufacturing Co., at Beeston, Notts., was £15,000. The loss was covered by insurance in the London and Lancashire Office.

Forthcoming Publications.—"The Electrician" Printing and Publishing Co. have in course of preparation an important textbook on "Radio-activity," by Mr. Frederick Soddy, M.A. This book will be fully illustrated.

The same will also shortly issue, in Blue-Book form, full reports of the proceedings at the important Telephone Inquiries recently held at Hull and Portsmouth.

The Caxton Publishing Co. are about to publish "Modern Engines and Power Generators," by Rankin Kennedy, C.E.

France.—The Council of State is about to give its decision on the validity of a concession for a tube railway obtained by M. Berlier from the Paris Municipal Council. This deep level line is to cross the city from north to south, and is, in many respects, it is stated, similar to the Central London Railway.

According to recent statistics electric traction is making comparatively slow progress in France. After making rapid strides in 1900 and 1901, a reaction set in owing to financial causes. Up to January, 1901, the total length of lines had been doubled within one year, and the aggregate capacity of the power stations had nearly trebled; at present the total length of electric lines is 1,994km., an increase of only 500km. in the past two years.

Fremantle (West Australia).—According to the *Australian Mining Standard* the local authorities of Fremantle and East Fremantle have decided to establish electricity supply works, to construct electric tramways and to borrow £150,000 to cover the cost.

French Guiana.—Paramaribo municipality is negotiating for the lighting of the town by electricity. The population of French Guiana is about 34,000. There is not, we understand, any telephonic communication established in the district.

French Indo-China.—It is projected to establish a telephonic service in Haïphong and Hanoï, the work being carried out entirely by the Government.

The Société Indo-Chinoise d'Electricité of Paris have established at Haïphong since 1893 a system of electricity supply, and there is now the equivalent of 3,000 8 c.p. lamps installed on the company's lighting service to 220 consumers.

At Hanoï, the capital of Tongking, the same company have an electric lighting service of similar capacity to that at Haïphong (450kw.).

The Société Durand & Cie. of Paris have a system of electric tramways at Hanoï consisting of 11 miles of 1 metre gauge track. This service has been working since 1901 on the overhead trolley system.

Although a large network of running waters drains Tongking to the sea, no attempt has yet been made to utilise this water power.

There have for some time past been attempts made to grow rubber in this country, but no satisfactory result has yet been scored.

Fulham (London).—The Establishment committee have given their sanction to the demand of the borough electrical engineer (Mr. Arthur J. Fuller) for permission to construct three further substations at an estimated cost of £1,800, and to extend the mains along Crabtree-lane at a cost not exceeding £1,000. Mr. Fuller submitted a very satisfactory report, which showed that the motor load, which at the beginning of March last was only 40 H.P., had increased to 300 H.P., and showed signs of further development.

Gillingham (Dorset).—It is proposed to form a local company for the erection of electricity works in this district. Current for private lighting will be supplied at 5d. per unit. The scheme has been prepared by Messrs. Parry, Ross and Richards.

Gosport.—The Provincial Tramways Co. have agreed to carry out the terms of the Council's provisional order and it is expected that a supply of current will be available by next winter.

Glasgow.—It was reported to the Corporation last week—

(1) That, in order to meet the demands of the electricity department during next winter, the Electricity committee would require as soon as possible to provide at Port Dundas and Pollokshaws-road stations additional generating plant to the extent of at least 4,000 H.P., apart from the current which had already been arranged to be taken from the tramways department for peak load; and (2) that the tramways department had already agreed to give to the electricity department the maximum amount of power they could afford to furnish by means of their existing plant, having in view the requirements of the tramways department itself.

It has been decided by the Council to adopt these arrangements and to send a deputation of three members of committee, along with the chief engineer (Mr. Chamen), to visit Sunderland and other English stations where turbo-generators are in operation.

The Electricity committee have appointed a small sub-committee to consider and report upon the applications of Rutherglen and Pollokshaws Councils for the supply of electricity by the Corporation.

Greenock.—The Council have requested the local tramway company to discontinue the exhibition of notices in their cars stating that the company's liability for injuries to a passenger is limited to £25.

Grenada.—Reconstruction work in connection with the telephone service, which was commenced in 1901, is being steadily proceeded with. The local climatic and other conditions necessitate constant activity and attention to the service, which has proved as popular as it is indispenable in the colony.

Hamble.—Southampton Council will oppose the application of the Inland Waterways Limited for a provisional electric lighting order for this district.

Heavitree.—The Council have asked Exeter Corporation to submit their terms for supplying electricity in the district. These terms will be considered at the same time as the proposals of Messrs. F. Suter & Co. and Dr. Purves for the erection of electricity works.

Hull.—The Hedon-road section of the municipal electric tramways was opened for traffic on Thursday last.

Ipswich.—The new electric tramway routes were opened for traffic on Monday.

Islington (London).—The revised charges for electric current for motive power and for the lighting of places of worship, theatres, &c., set out in our last issue, have been adopted by the Council, and certain extensions of the mains, including private and arc lighting mains to Bride-street to give a supply of current to the new exchange of the National Telephone Co., have also been authorised.

King Williamstown (S Africa).—On Oct. 23 was commenced the supply of current from the station owned by the King Electric Light and Cold Storage Co. (Ltd.), King Williamstown, Cape Colony, public street lighting and a few private consumers being all the load the station had then to supply. Street lighting is effected by 200 25 c.p. incandescents, and the private lighting to 30 consumers represents 2,500 8 c.p. lamps. At the end of November, 60 further consumers were waiting connection. The generating plant consists of two Belliss-E.C.C. sets, with Davey Paxman boilers. Glover's cables are used. The electric lighting has displaced lighting by oil lamps.

Kirkcaldy.—On the recommendation of the burgh electrical engineer (Mr. O. F. Francis) it has been decided to supply electric current for power during the day at 1½d. per unit.

Leicester.—An inquiry was held on Tuesday into the application of the Corporation for permission to borrow £100,000 for electric lighting extensions.

The town clerk (Mr. Hiley) who supported the application, gave figures showing the growth of the electricity undertaking, the total capital being £173,982. In order to keep pace with the increasing demands for current another £30,777 had had to be spent, and the balance of the sum applied for would be devoted to future extensions. It was proposed to light the principal thoroughfares by arc lamps.

There was no opposition.

Light Railways.—The East Anglian Light Railways (Transfer, &c.) Order has been submitted to the Board of Trade for confirmation. This order transfers to Lowestoft Corporation the powers conferred on the East Anglian Light Railways Co. by their 1902 order. Objections by Jan. 9.

The Board of Trade have made an additional rule under the Light Railways Act, 1896, with respect to the allowance of expenses to local authorities.

Liverpool.—The Corporation electric tramways department have decided to run an illuminated electric tramcar over the principal routes on Christmas Eve.

Llanelly.—Notwithstanding the Council at its last meeting decided not to proceed with the bill for sanctioning the agreement for the transfer of the electric lighting order to the British Insulated and Helsby Cables and for constructing electric tramways, the bill has been deposited, and another special meeting of the Council has been called to consider the position.

London County Council.—At Tuesday's weekly meeting it was agreed to lend St. Pancras £12,055 for electric light installation and meters. In connection with a loan of £1,058 to Shoreditch, £44 was for the electric wiring of tenements, and it was agreed that this sum be repayable in 10 years.

Tramways.—The Highways committee recommended that an expenditure of £90,000 be authorised for the reconstruction for the conduit system of the cable tramways between Kennington and Streatham.

Telephones.—It was agreed that steps be taken for the termination of the agreements with the National Telephone Co. for private telephone lines between the central office and Blackwall Tunnel, Boundary-street Estate, and the Council's five pumping stations. By using the exchange lines instead of private lines the net saving to the Council will be £126 per annum.

Electric Bells.—It was agreed to extend the contract with Messrs. F. J. Coleby & Co. for the maintenance of the electric bells of the fire brigade.

Belgian Rails.—The Highways committee recommended that an expenditure of £150 be incurred in inquiring into the hours worked and

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the rate of pay of men employed by foreign firms in making rails for Government, provincial corporations and London tramways and railways, and the amount of mining royalties paid by foreign firms as compared with those paid in Great Britain.

Col. ROTTON challenged Mr. Benn to say whether he had not got the figures.

Mr. BENN said he could not give the information asked for.

Mr. FLETCHER thought that workmen should be sent to make the enquiry.

The motion was agreed to.

Purchase of the London Southern Tramways Co.'s Undertaking.—The Highways committee reported that the company's lines could only be made remunerative if they were worked electrically. The Lambeth Borough Council had offered to contribute only £20,000 to cost of street widenings, the Council to use overhead traction where required. The committee recommended that the Council do not acquire the undertaking at present.

Mansfield.—The Council last week decided to provide water filters at the electricity works for filtering river water for the boilers.

Municipal Fire Insurance.—Some time ago the Corporation of London referred a petition by citizens (chiefly from the Cripplegate wards) urging the Corporation to take such action as might be deemed expedient to relieve them from the excessive charges demanded by fire insurance companies, and to start a system of municipal insurance of buildings within the City area to the City Lands committee, who have reported on the matter, but do not favour the proposals of the petition.

On the recommendation of the Finance committee, Camberwell Borough Council have decided to join the scheme of municipal mutual insurance of the Municipal Mutual Insurance (Ltd.).

Municipal Telephony.—During a discussion at Brighton Council meeting on Thursday last on the minutes of the Telephone committee containing the letter of the Postmaster-General (which appeared in our last issue) forbidding the Corporation to give to subscribers an exchange service without charge until the subscribers number 750, Ald. Carden, chairman of the committee, said the Postmaster-General could not have known that the subscribers connected only numbered 284 and were in a very limited area. They had no subscribers connected in Hove or Kemp Town, and very few at Preston, and therefore it could not fairly be called an effective exchange service. The Telephone committee's decision to pay for the present all terminal fees for local calls incurred by Corporation subscribers was approved.

Norwich Council have decided to release the £2,000 deposited by the Norwich Mutual Telephone Co. under the agreement of Dec. 21, 1900, for the equipment of a telephone exchange.

New Cable Steamer.—The new cs. "Levant," which has been built on the Clyde for the Eastern Telegraph Co., to replace the old "Levant" on duty on company's Levant station, makes her trial trip to-day (Friday).

Newport (Mon.)—The Electricity and Tramways committee recommend the Council to proceed with the construction of the Stow-hill single track electric tramway route.

Overcrowding in Tramcars.—Manchester Watch committee recently decided not to rescind the regulation permitting the carriage of extra passengers in the cars in wet weather, but have given orders that the excess number of passengers allowed (four in a small and six in a large car) must be strictly adhered to.

Paignton.—Messrs. J. and J. S. Enright have been appointed, at a fee of £400, consulting engineers in connection with the electricity supply scheme. The works are to be erected and maintained by the National Electric Construction Co.

Presentation.—Mr. A. L. C. Fell, who has been general manager of the Sheffield city tramways for six years and was recently appointed manager of the London County Council tramways, met, on Monday last, some of the employés of the tramways department at a smoking concert. About a week ago, when Mr. Fell attended the first gathering, he was presented with a Sheraton writing desk and bookcase, a silver inkstand, silver entrée dishes, &c., and a case of Sheffield cutlery. At the concert on Monday Mr. H. E. Yerbury presided, and amongst those present were Councillor W. E. Fenton, Messrs. E. J. Marsh, R. G. Thomas, A. H. Lowe, M. F. Newton, J. R. Williams, H. Baron, &c.

Mr. YERBURY said that, although the formal presentation took place last week, they were met on that occasion to show their late manager that they joined with their comrades who attended on the former occasion in congratulating Mr. Fell on his attainment to the high position of general manager of the London County Council tramways. They felt they were losing a gentleman who had given his best service, not only to the management of the Sheffield tramways, but also to the welfare of the staff which had worked under him.

Mr. R. G. THOMAS, who spoke on behalf of the clerical staff, referred to the great progress in the conversion of lines to electric traction under Mr. Fell's management.

Mr. FELL, in reply, said he had been with the Sheffield electric tramway undertaking from its birth, and had stayed with it until it had grown into one of the best tramway systems in the country. They had some excellent results, and he was going to work hard to make the results in London as good. He thanked all the employés for the loyal way in which they had supported him, and he hoped they would give the new manager the same loyal support, and would also stand by Mr. Yerbury, who had been appointed to a most important position as chief electrical engineer. He also thanked the Tramways committee for their kindness to him.

Queensland.—In February last the Government railway locomotive workshops department commenced driving by electric power. The station has a total plant capacity of 600kw., the two-phase four-wire system of distribution being adopted. Westinghouse generating plant is installed with Callender mains.

Railway Station Lighting.—Ayr Corporation have decided to supply electricity at 3d. per unit, provided the annual consumption is 30,000 units, for lighting the local station of the Glasgow and South-Western Railway Co. If the annual consumption is 50,000 units the charge will be 2½d. per unit.

Rubber Industry in the Straits Settlements.—It has been found that the cultivation of Para rubber in Malacca promises remarkably well, and the area planted to this crop is steadily increasing. In all the adjacent native States, including Johore, rubber cultivation is spreading rapidly, and the samples so far obtained have proved highly satisfactory. Gutta-percha plantations in the Straits Settlements also show good prospects.

Runcorn and Widnes Transporter Bridge.—The trolley of the Runcorn and Widnes transporter bridge, now in course of erection, will be about 77ft. long by 100ft. across. There will be 16 track wheels on each side, and the car, capable of accommodating four two-horse waggons and 300 people, will be suspended from the trolley by steel wire ropes. To enable the trolleys to be brought to rest rapidly, Westinghouse magnetic brake equipments will be fitted to the wheels of the truck, the equipments being modified to suit the special requirements.

Sevastopool.—The Russian Government has decided to construct an electric railway between Sevastopool and Yalta, via Balaclava, Bida, Aloupski and Livadia.

Siemens-Schuckert Amalgamation.—In continuation of the information given in our issue of the 11th inst. (p. 312) notice is given that the liquidation of the British Schuckert Electric Co. (Ltd.) is in consequence of the Schuckert and Siemens amalgamation in Germany, and the interests of the Schuckert Company in Great Britain have now been entrusted to Messrs. Siemens Bros. & Co. of Westminster, London, who will give attention to all future inquiries for Schuckert plant.

Singapore.—A contract has been entered into between the Municipal Commissioners and the Singapore Electric Tramways Co. for the latter to supply to the former a minimum of 200,000 units of current per annum for electric lighting and power at 18 cents per unit (equal about 8d. at the present rate of exchange). At this price current is to be delivered at 'bus bars at the power house. The lighting service is not yet started.

The Tramways Company own 27 miles of track now being constructed by Messrs. Dick, Kerr & Co. to 1 metre gauge.

At Penang the Municipal Commissioners have an electric lighting undertaking under construction which will probably start operations in January, 1904.

There are general indications that the present backward state of the Straits Settlements electrically will be materially improved in the near future, as several schemes are under consideration. A correspondent informs us that in Singapore electric light fittings and plant and material for installing would find a market; also electric fans, and gasoline or petroleum engines for dynamo running.

Smethwick.—The Birmingham and Midland Tramways Co. have submitted to the Council for approval plans, &c., for a new power station.

Spain.—It is reported that the Jesuits intend establishing at their unique residence at Roquetas, Tortosa, a complete astronomical, meteorological, electrical, magnetic and seismetic observatory fitted with the latest instruments and appliances—of German manufacture.

Stepney (London).—In a recent report the consulting engineer (Mr. Arthur Wright) stated that

In view of the steady financial progress of the electricity undertaking, and the large area now covered by their obligations to supply electricity wherever required, he would recommend the Council to seek permission to at once increase the present generating station and the system of distribution in order to be able to meet the constantly increasing demand for electricity. As it would probably be quite three years before a complete power-station could be erected on the recently-acquired Blyth's Wharf site, the Osborn-street buildings must be extended in order to temporarily house the generating machinery required for that period, and ultimately to house the converting machinery required in connection with the Blyth's Wharf supply. The estimated cost of the additional machinery and distribution system was approximately: Steam generating plant, £13,690; electricity generating plant, £23,880; switchboards, £2,840; miscellaneous items, £1,510; extension of network, £10,500; additional house-services, £7,560; building extensions, £18,300; total, £78,280.

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In recommending the above scheme for adoption, the Electricity committee report that

At present the machinery is fully loaded, whereas the full distributing capacity of the mains already laid and the additional mains being laid is by no means reached. It is necessary, in order to cope with the anticipated demand for current in the winter of 1904-5, that immediate steps be taken to obtain borrowing powers for the necessary money, and the statement prepared by the borough treasurer upon the probable financial result of the working of the undertaking during the next three years amply justified them in recommending that the expenditure suggested by Mr. Wright should be incurred.

The Finance committee also recommend that steps be taken to obtain the necessary sanction for a loan.

Sydney (N.S.W.)—The City Council of this go-ahead Australasian city is about to supply electric current at exceedingly low prices, and a correspondent points out that there will be a good opening for the sale of all kinds of electrical fittings, motors, fans, hoists, &c. Gas is 4s. to 4s. 6d. per 1,000 cubic ft., and the advantages of electric lighting and electric driving are becoming recognised. The demand for apparatus and material is considered likely, therefore, to increase largely.

Street Railways in the United States.—According to latest statistics, there are 1,540 miles of streets and 480 miles of street railways in Philadelphia; St. Louis has 875 miles of streets and 321 of street railways: Boston, 495 and 215; Baltimore, 450 and 353; Cleveland, 500 and 218; Buffalo, 550 and 293; San Francisco, 750 and 258; Cincinnati, 390 and 208; Pittsburgh, 390 and 172; New Orleans, 700 and 175 miles respectively. Fifteen years ago the total length of electric railways in the United States was 86 miles, on which 172 cars were used, but on June 30 last year there were 22,589 miles and 67,199 cars, requiring 1,298,133 H.P. for their operation. During the preceding twelve months nearly 6,000,000,000 passengers were carried, the gross earnings were $241,584,697, the operating expenses $139,012,004, leaving net earnings of $102,572,693. In the twelve months ended June 30 last nearly 3,500 additional miles of road were laid, bringing up the total length of electric railways to nearly 26,000 miles.

Telephone Amenities.—At Vienna a telephone subscriber has, it is said, been fined £8 for calling a telephone operator a liar over the telephone.

Telephone Communication for the Police.—It is stated that all the important Metropolitan police stations are to be connected with the Post Office telephone service.

Tewkesbury.—The Council will oppose the application of the Southern District Electricity Corporation for an electric lighting order.

Theft of Cable.—At the West Ham Quarter Sessions last week Leonard Davy was indicted for having stolen one mile of electric cable, two half-coils of copper cable, and various telephone fittings, the property of his employers (Messrs. Young and Marten). Two men, named Ryan and Fetteroll, were also indicted for receiving cable knowing it to have been stolen. The jury acquitted Ryan, and convicted Davy and Fetteroll, recommending the former to mercy on account of his youth. Davy was sentenced to three months' and Fetteroll to six months' imprisonment each in the second division.

Thirak.—It is expected that electricity supply will be available by Jan. 1.

Tokio (Japan).—This is a city of 1,500,000 inhabitants, and is chiefly supplied electrically by the Tokio Electric Light Co. The company has 10,000 consumers on its books, and a total connection equivalent to 97,000 10 c.p. incandescents, 200 arcs, and a considerable number of motors. The area of the company's operations is over 40 sq. miles.

Trowbridge.—The Council will oppose the Western Electric Distributing Corporation's application for a provisional order for the town and for the revocation of the Council's order obtained in 1901. Steps are being taken for carrying out the Council's order.

Ulster Electric Power Scheme.—Dungannon Rural Council have decided to petition in support of this project. Strabane Council have declined to assent to the promotion of the bill.

Walthamstow.—The District Council resolved on Tuesday to apply for sanction to a further loan of £24,960 for extensions of the electricity works as follows:—

Buildings, £2,500; gas plant, piping, &c., £3,700; engines, dynamos, starting and cooling plant, &c., £12,500; boosters, £1,100; switchboard, instruments and connections, £1,000; battery, £1,800; contingencies, £2,360.

There is at present the equivalent of 39,838 8 c.p. lamps on order (38,050 being connected), against 28,577 at the corresponding period last year.

The electrical engineer (Mr. F. A. Wilkinson), in a report upon a drop in voltage, stated that—

The cause of the voltage falling for a period of about one minute was due to one of the large engines miss-firing. The charges of gas and air in the cylinders of the engines was fired by means of an electric spark, the current for which was generated by means of a special sparking generator for each engine. Miss-firing was due to several causes, amongst which may be mentioned the carbonising of the igniter points, water being taken into the cylinders with the gas, or the sparking coil breaking down. There were three igniters on each engine, and they were taken out and cleaned once a week. In view of the small load on Sunday evenings they only ran one large and one small generating set, so that the effect of the large engine being suddenly thrown out of action would, of course, cause a drop in the voltage. If the same thing happened on a weekday, when most of the plant was running, the effect would not be noticed nearly so much. Every effort was taken to guard against miss-firing, but it was impossible to prevent it happening occasionally.

Watford.—Last week a ratepayers' meeting was held to consider the proposal to dispose of the municipal electricity works.

The chairman of the Electric Light committee (Mr. Benskin), who presided, said the undertaking was approaching a point when it would yield a profit. A resolution in favour of the town retaining ownership and control of the undertaking and protesting against any steps being taken to dispose of it without obtaining the sanction of the electors was carried by a large majority.

Workhouse Lighting.—Salisbury Guardians, who propose to adopt electric lighting at their workhouse, have instructed Mr. Leonard Andrews to prepare a report on the matter.

Surbiton Guardians have adopted a scheme for extending their electric lighting at an estimated cost of £1,400.

Wrexham.—Wrexham and District Electric Tramways Co. have decided to extend their electric tramways to Ruabon and Cefn Mawr, and eventually to Llangollen.

Yeovil.—The Council decided last week to defer for six months any action with regard to the proposal to establish electricity works.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Erith Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, brickwork settings and steam feed pump; steam, &c., pipes; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam engine of 500kw.; and extensions to main switchboard and cable connections. Specifications from the clerk to the Council (Mr. Charles H. Fry), Council Offices, Erith, Kent. The works are to be carried out in accordance with plans and specifications prepared by the consulting engineers (Messrs. Hawtayne and Zeden), 9, Queen-street-place, London, E.C., from whom further information may be obtained. Tenders to the clerk by noon Jan 18. See also advertisement.

The Guardians of *St. George's* (Hanover-square) Union invite tenders for the electric wiring and mains required at their Fulham-road workhouse. Specifications, &c., from the consulting engineers, Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster, after 29th inst. Tenders to the clerk, Mr. Thos. Worlock, St. George's (Hanover-square) Hall, Mount-street, Grosvenor-square, London, W., by 10.30 a.m. Jan. 13. See advertisement.

Kettering Urban District Council invite tenders for supply and delivery of electricity meters. Specifications can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to the clerk (Mr. John Bond), Council offices, Kettering, by Jan. 9. See also advertisement.

Belfast Gas and Electric committee invite tenders for electricity meters. Specifications from the city electrical engineer, Mr. Victor A. H. M'Cowen. Tenders to the town clerk (Sir Samuel Black), Town Hall, Belfast, by noon Jan. 15. See also advertisement.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring installations of May-Oatway automatic fire alarms for direct communication with the fire brigade headquarters of Glasgow, Aberdeen, Paisley and Dundee, as set out in an advertisement. Particulars from the managing director, 49, Queen-street, Glasgow, and tenders by Jan. 2.

Wallasey Urban District Council invite tenders for the supply and delivery only of about 7,100 yds. of concentric armoured cable, together with joint boxes and section boxes. Tenders to Mr. H. W. Cook, clerk and solicitor, Public offices, Egremont, Cheshire, by Jan. 16.

Long Eaton Urban District Council invite tenders for engine and dynamo (250kw. set) and accessories, one Lancashire boiler, overhead hand travelling crane and economiser. Tenders to the engineer and manager (Mr. Frank Worrall, M.Inst.C.E.) by noon Jan. 1.

Walthamstow District Council invite tenders for (*a*) permanent way, (*b*) feeders, (*c*) switchboard and plant, (*d*) overhead equipment, bonding and pillars. Tenders to Mr. Sydney Watson, clerk and solicitor, Town Hall, Walthamstow, by Jan. 1.

Tenders are invited for wiring the *Kent and Canterbury* Hospital for electric lighting and other works in connection therewith.

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Further information from the secretary (Mr. A. J. Lancaster), 36, St. George's-street, Canterbury.

Hackney (London) Borough Council invite tenders for feeding and distributing mains. Tenders to the town clerk (Mr. George Grocott), Town Hall, Hackney, by 4 p.m. Jan 4.

Hackney (London) Electric Lighting committee are also inviting schemes (by noon Jan. 4) for wiring consumers' premises on a rental system.

Manchester Paving, Sewering and Highways committee require tenders by Jan. 11 for laying underground telephone pipes, &c.

Messrs. Preece and Cardew are authorised by the Municipal Council of *Sydney* (N.S.W.) to invite tenders for the supply, delivery and erection of one or two 600kw., or one 1,200kw., steam alternators (three phase), with condenser, pipework, motor generators, static transformers, switchboards, &c. Tenders to Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W., by noon Jan. 12.

TENDERS RECEIVED AND ACCEPTED.

The following tenders were received by the London County Council for the supply of 12,500 tons of rails, fastenings, conductor tees, &c., for the re-construction for electric traction of the Council's tramways:—

I.—*Track Rails, &c.*

Bolckow, Vaughan & Co. (*accepted*)	£43,748	9	0	Walter Scott (Ltd.)	£47,685	5	0
Jacobs Bros. & Co.	50,707	6	0	Lorain Steel Co. ..	43,389	3	0
Steel, Peech & Tozer	49,825	0	0	J. G. White & Co...	43,353	1	0
P. and W. Maclellan	48,899	13	2	M. Korten	43,250	0	6
Ditto	44,501	14	2	Bolling and Lowe..	42,414	8	2
Ditto	41,531	17	10	A. Penney & Co. ..	42,065	19	0
Barrow Hæmatite Steel Co.	48,146	8	0	Charles Frère, jun. (Brussels)	40,418	13	6

II.—*Slot Rails, &c.*

Frodingham Iron & SteelCo.(*accepted*)	£36,461	15	0	Charles Frère, Jun.	£38,013	5	0
Earl Dudley's Round Oak Works (Ltd.)	49,755	0	0	A. Penney & Co. ..	37,035	0	0
Jacobs Bros. & Co.	48,500	0	0	Steel, Peech & Tozer	36,923	0	0
P. & W. Maclellan	48,284	4	2	Bolckow, Vaughan & Co.	36,871	12	6
Ditto	34,067	12	6	Pennsylvania and Maryland Steel Co. (U.S.A.)	35,958	10	0
Barrow Hæmatite Steel Co.....	47,748	10	0	Bolling and Lowe ..	34,896	19	2
Walter Scott (Ltd.)	44,673	5	0	J. G. White & Co.	34,649	10	0
M. Korten	40,297	17	6	Lorain Steel Co. ..	33,979	0	0

A tender was also submitted by the Shelton Iron, Steel & Coal Co., for a portion only of the slot rails.

The committee reported:—"The engineer has advised us that, as regards the supply of track rails, the six lowest tenders provide for the use of basic steel, while the specification issued required that the rails should be made of acid steel. The chief engineer advises that, as the rails which have hitherto been supplied have been made of basic steel, it was important that, in order that a fair comparison might be made of the relative life of rails made of these two forms of steel, it was desirable that the rails now required should be made of acid steel. The next lowest tender cannot be considered, as the company is unwilling to accept the clause with reference to penalties in the event of non-delivery within time specified. The tender of Bolckow, Vaughan & Co. should, therefore, be accepted. With reference to the supply of slot rails and conductor-tees, the engineer advised that the tender of the Frodingham Iron and Steel Co. be accepted. The lowest tenderer (the Lorain Steel Co.) in this case also intimated that they could not accept the penalty clause. The four next tenders lower in amount than the Frodingham Company provide for rails of Belgian or American manufacture, and, in view of the extra expenditure incurred in arranging for proper inspection and supervision of the carrying out of the work, the tender of the Frodingham Company should be accepted. This tender provides for steel of English manufacture.

Answering various criticisms, Mr. Benn (chairman of the Highways committee) said that acid steel was insisted on for this contract to give the engineer the chance of comparing it with basic steel. The Council had given out four contracts for rails, the first of which was confined to British manufacture, the next two went to Belgium, and the fourth was now obtained by a British firm. The first contract worked out at £7. 5s. per ton, and the present one at £5. 16s. 6d. per ton. The raw material at the time the first contract was entered into cost 61s. 6d. per ton, and the present cost was 54s. per ton. Labour and other things were about the same, and it therefore looked as if British manufacturers took the opportunity in the first contract to protect themselves. By their policy of free trade the Council had, taking the cost of the raw material as the basis, saved £39,092 to the ratepayers of London on the four contracts.

Among the recent orders of the British Westinghouse Co. is one for additional magnetic brake equipments by the Leeds Corporation tramways department, and an order for a 45kw. continuous-current dynamo for direct connection to a Westinghouse gas engine at Messrs. B. Napier & Son's motor-car works, Acton Vale, London, for lighting and power. The company is also supplying two 80 H.P. motors with starting gear to Messrs. Merryweather & Sons for fitting to fire pumps. These will eventually form part of the extensive gas-driven lighting and power plant which the Westinghouse Company are erecting at Heysham Harbour for the Midland Railway Co.

The May-Oatway Fire Appliances Limited, 92-94, Paul-street, Finsbury, London, and Glasgow, have accepted the tender of the National Telephone Co. for wiring and installing May-Oatway automatic fire-alarms at J. Brown & Son's (Glasgow); that of Pratt & Keith for the Donside Paper Mills and Fiddes' Sawmills (Aberdeen); that of J. Kilpatrick & Sons for Paton's Box Works; that of McAulay, Clark and McLaren for J. Young & Co.'s Sawmills (Paisley); that of the Aberdeen Electrical Engineering Co. for Sangster and Henderson's; and that of Allan Arthur and Ure for Paisley Provident Co-operative and Kinning Park Co-operative Societies' installations.

Faversham Council have accepted the tender of the British Westinghouse Co. for pumps at £134. 16s., and that of the Brockie-Pell Arc Lamp Limited for arc lamps with automatic switches for incandescent lights.

Radcliffe Council have accepted the tender of J. G. Statter & Co. for lighting and traction switchboards at £1,345. 12s. 6d.; that of W. Metcalf (Ltd.) for coal-tar pitch at 52s. 6d. per ton, and creosote oil at 2d. per gallon; and that of Etheridge and Clark for engine-house platforms and switchboard gallery at £168. 6s. 4d.

Birmingham, Tame and Rea District Drainage Boards received 17 tenders for three Lancashire boilers, varying from £1,412. 12s. to £1,879. 12s., and the lowest (Robert Taylor & Sons) has been recommended for acceptance.

West Ham Education committee recently received 17 tenders for wiring and fitting up Whalebone-lane school for the electric light. These ranged from £692 to £1,491. 0s. 8d., and the lowest tender (Murrell Bros.) has been recommended for acceptance. For the Shipman-road school 17 tenders (varying from £540. 4s. 3d. to £1,200. 8s. 6d.) were received, and the lowest (Bakewell & Co.) has been recommended for acceptance.

London County Council received eight tenders for wiring sub-stations and tramcar sheds, varying in amount from that of the accepted (A. H. Marshall & Co.) at £2,203 to £4,420.

The Gilbert Arc Lamp Co., of Chingford, is carrying out the street lighting of Kettering for Messrs. Kennedy and Jenkin, who have advised the use of the company's 6ft. carbon open-type lamps.

King's Norton and Northfield District Council received seven tenders for supplying and laying tramway feeder mains in connection with the Pershore-road tramway scheme, and the tender of Callender's Co. has been accepted at £3,076.

Halifax Guardians have accepted the tender of Sunderland & Co. for wiring the new board room at £258. 12s. 6d.

Ipswich Corporation have accepted the tender of the Electrical Co. for a 360 I H.P. set for their electricity works at £1,611.

Dorking Council have accepted the tender of Edmundson's Electricity Corporation for wiring the Council offices, &c.

Croydon Corporation have accepted the tender of Dick, Kerr & Co. for a 750kw. single-phase steam alternator.

Cardiff Tramway committee have placed an order with the British Westinghouse Co. for 15 single-deck combination electric cars at £610 each.

BUSINESS NOTICES.

Mr. Robert Robson, electric light and power engineer, 5, St. Mary's-place, Barras Bridge, Newcastle-on-Tyne, is taking into partnership on Jan. 1 Mr. Arthur C. Coleman, who has acted as manager for him for some time past. Mr. Coleman has had extensive experience in all branches of electrical engineering, having been with Messrs. Armstrong, Whitworth & Co. for about seven years, and with other leading electrical engineers in the district.

Messrs. Joseph Mason and W. M. Hawnt (trading as Montague Hawnt & Co.), insulating material manufacturers, &c., 146, Clerkenwell-road, London, E.C., have dissolved partnership.

LIQUIDATIONS, BANKRUPTCIES, &c.

Claims against the Northern Counties Traction Co. (Ltd.) are to be sent by Jan. 19 to Mr. W. C. Spencer, Central-buildings, North John-street, Liverpool.

A statutory meeting of creditors and contributories of the Automobile Supply Co. (Ltd.) was held last week at 33, Carey-street, London. The gross liabilities were returned at £6,152. 18s. 5d., of which £2,751. 10s. 8d. was expected to rank, assets £1,618. 11s. 2d.

In the failure of J. W. M. Storr, electrical engineer, 29, Grange-road, Dudley, the first meeting of creditors will take place on 29th inst. at 199, Wolverhampton-street, Dudley, and the public examination on Jan. 18 at the Court House, Dudley.

Plant for Sale.—Messrs. Bottone & Son, Wallington, Surrey, have for sale a 1 H.P. Tangye dynamo gas engine, a ½ H.P. gas engine and accumulator-charging dynamo, a ¾ H.P. high-speed vertical steam engine, X-ray coil, 4in. spark, 1 H.P. direct-current series motor, and ¼ H.P. 200-volt direct-current motor, a 3 H.P. petrol engine, &c. Further particulars in advertisement.

Three 20 N.H.P. Marshall horizontal compound engines and three 20 H.P. Marshall multitubular high-pressure boilers, with feed-water

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heater, two Worthington pumps, &c., are for sale. Applications to inspect the plant (in working order) to the clerk to the Governors, People's Palace, Mile End-road, E. See advertisement.

Works, &c., for Sale.—Some modern well-equipped car-building works, occupying a covered area of 8¾ acres, with 25 acres available for future extensions, are advertised for sale in another column. Applications to Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C.

Some manufacturing premises are advertised for sale or letting on lease with or without steam power. The premises adjoin Laindon station, Essex, 22 miles from London. Particulars from Messrs. I. Levy & Son, 62, Albany-road, Old Kent-road, London, S.E.

A site for a manufactory, on freehold property on the banks of the Chelmer and Blackwater, 2½ miles from the Great Eastern Railway main line, is advertised for sale in another column. Applications to Messrs. Nicholas, Denyer and Co., 45, Pall Mall, London, S.W.

Flexible Metal Tubing.—Messrs. John Lawman & Co., British agents for the Gasindustrie Ulm (Germany), have sent us price lists and a sample of flexible metal tubing. Amongst the various uses to which these tubes may be put is in connection with electric wiring. The tube is of steel, which is zinc, brass, copper, or nickel plated. In order to suit different conditions a light tube, varying in diameter from ⅛in. to ¾in., and a stronger tube, from ¼in. to ¾in., are offered. It is not stated to what length or weight of tube the prices refer, whether they are per cwt., stone, furlong, decimile, centimile or 100ft.

Export Merchant Shippers' Directory.—Messrs. Dean & Son, 160A, Fleet-street, London, have in preparation the 38th annual issue of the "Export Merchant Shippers' Directory of Great Britain and Ireland," which gives a compact list of the principal exporters, merchant shippers, &c., of this country.

Gas Engines.—Messrs. Merritt and Hatcher, publishers, London, have issued, price 1s., a "popularly-written" little book on "Gas Engines, their Advantages, Actions and Applications," by W. A. Tookey.

"Daily Mail" Yearbook.—Those who seek information respecting "20,000 facts of the day: biographies, tables, diagrams and maps," may very well be referred to the "Daily Mail" Yearbook, price 1s. 6d., which is now ready. The book has been edited by Mr. P. L. Parker, and is published by the Amalgamated Press, London. Apart from much information on general subjects, the book forms a contribution to the subject uppermost in many men's minds—the fiscal policy of the British Empire.

Post Office Express Delivery Service.—Business firms will be interested in a leaflet, No. 7,475, issued by the Post Office, dealing with the express delivery service, which the Postmaster-General desires should become more generally known.

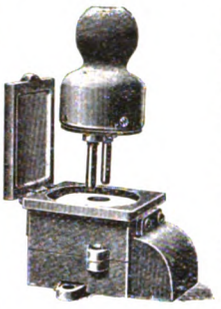
Engineering Standards Committee.—We have received from Messrs. Crosby Lockwood & Co. List 8 (No. 4) of the British Standard Sections issued by this committee, which deals with "Beams." Price 1s. net.

Catalogues, &c.—The British Prometheus Co., Kingston-on-Thames, have ready a new catalogue of electric radiators and heating stoves. These twentieth-century goods need little recommendation at this stage, as the demand for this class of article is becoming increasingly general. There are several new designs of radiators listed and several improvements which have been embodied in their general construction. The copper radiators have now their elements placed more forward in the radiators than hitherto, with the result that the apparatus itself works cooler and discoloration of the metal is avoided. Immediate access to the elements and connections is secured by a simple arrangement at the back of the radiator, permitting the whole of the electrical portion to be easily and quickly removed for examination. The new type of Prometheus radiator gives out a considerable amount of radiant heat in addition to the heating effected by conduction. This makes the apparatus particularly suitable where it is only required for use for a very short interval of time. A cheap pattern of this radiator in copper is now ready for delivery of plain design and good appearance, identical in construction with the more expensive patterns.

The Woodward Governor Co., Rockford, Ill., U.S.A., makers of governors for waterwheels, send us their new catalogue. For modern practice for plants operating apparatus for electrical working, the company recommend their compensating type of governor, which they claim will operate the gates of a turbine at a rate of from 4 to 10 seconds over the full range with no racing, and under favourable flume conditions will maintain the speed within as close limits as a modern steam engine. This type of governor is made in both horizontal and vertical forms. The catalogue is well illustrated.

The L. B. Allen Co., Chicago, U.S.A., send a pamphlet entitled "Soldering Sense," and describing the Allen soldering stick, which is claimed to be a convenient, non-corrosive and effective substitute for resin, acids and soldering salts in all classes of electrical work. The material is also supplied in paste form for use in switchboard and similar work.

The Power Plant Co., 20, New Bridge-street, London, E.C., have ready a new catalogue of portable two-stage, one-cylinder compressors for driving from electric motors, for use for outside or underground work in mines, &c. In the construction of the trans-Siberian railway 15 compressors of this design were in constant use. Three-speed electrical hand drilling machines are also listed by this company. These machines are made for drilling holes up to ⅝in. diameter in iron and steel.



Two-Pin Stage Plug.

Particulars of a two-pin type of stage plug, manufactured by Ernest F. Moy (Ltd.), Camden Town, London, N.W., are issued. The diameter of the pin is $\frac{5}{16}$in., set at $1\frac{3}{16}$in. centres, making the pin interchangeable with other two-pin plugs on the market of foreign manufacture and of less substantial design The box is of enamelled cast iron fitted with a hinged cover controlled by a strong spring to make it keep open or shut. The curved front acts as a guard over the cables when entering below the box, and may be taken off if the cables can be more conveniently led in from the side. The plug sockets are clamped in position in the box between two blocks of porcelain. The design is especially intended to stand hard stage work.

A new catalogue is issued by Messrs. Robert W. Blackwell & Co., 59, City-road, London, E.C., showing the "Crown" and patent "Solid Terminal" bonds which have been supplied by this firm in large quantities in all parts of the world for tramway working.

Messrs. W. N. Brunton & Sons, Musselburgh, N.B., forward a price list of special galvanised arc lamp rope of new construction, which renders the material very flexible. Sashcords of various classes are also listed.

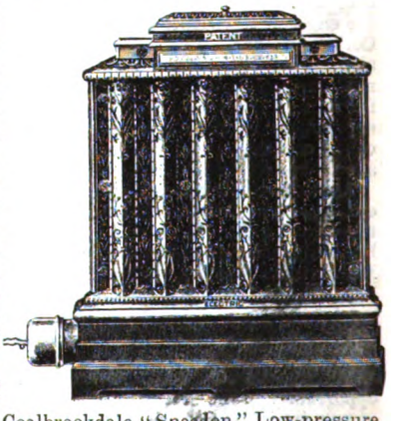
A catalogue of electrical specialities for theatrical and scientific purposes is to hand from Messrs. Beaumont & Co., York. Projectors, automatic arc lamps, hand-feed slow-motion arc lamps and closed arc hand-feed lamps, resistances, &c., are listed.

A group of sheet lists relating to a variety of machines is being sent out by Messrs. Neville Bros., James-street, Liverpool. The machines listed include slot broaching and slitting machines, armature disc varnishing machines, automatic feed-coil winders, bare and covered wire-winding machines, rotary shears, safety couplings, &c.

A sheet list of carbon resistances is issued by Messrs. Ernest F. Moy (Ltd.), Camden Town, London, N.W.

A trade list is ready of the new "E. V." patent enclosed arc lamp of the Union Electric Co., 151, Queen Victoria-street, London, E.C. The company claim to have made this lamp in a very small size, and at the same time to have maintained its capacity to burn from 100 to 120 hours. The network and ash tray have been eliminated. Every part of the new lamp is standardised and is interchangeable.

The Coalbrookdale Co. of Coalbrookdale, R.S.O., Shropshire, forward particulars of the "Speedon" radiator for electricity, which, the company claim, works more economically than any other type of radiator for electricity, and provides low-pressure hot-water circulation by electric heating. The illustration shows an example of this apparatus which is arranged for three gradations of current—that is, after the first hour's heating current can be reduced to one-third the maximum required, which is sufficient to keep water in radiator to a temperature capable of heating rooms of the sizes set out in the particulars now available. Two sizes of these radiators, with 4 tubes and 6 tubes respectively, give heating surface of 14½ sq. ft. and 20¾ sq. ft.



Coalbrookdale "Speedon" Low-pressure Hot-water Radiator for Electricity.

The Allgemeine Elektricitäts Gesellschaft of Berlin send us a sheet containing particulars of their electric heating apparatus for dissipating ice, frost, &c., on shop and show-room windows, &c. Special precautions are taken against the possible ignition of materials exhibited in shop windows. The cable department of the same company sends us a circular giving information as to specific resistance and insulating properties of "Stabilit."

A new catalogue of feeder pillars and joint boxes, to be used in connection with underground electric mains, has been issued by Callender's Cable and Construction Co., Hamilton House, Victoria

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Embankment, London. A number of original designs which the company have recently introduced are given. Arrangements have been made for keeping stocks of these for prompt delivery.

The time is propitious for the issue of a new map of the coalfields of South Wales, Gloucester and Somerset, which is published by Messrs. W. and A. K. Johnston, 7, Paternoster-square, London, E.C., price 6s.

Diaries, Calendars, &c.—The new "Gloucester Diary and Directors' Calendar" for 1904 of the Gloucester Railway Carriage and Wagon Co. is to hand, and will be found of service not only to customers of the company, who are provided with a good deal of special information, but to all who may require any of the special class of manufactures made at the Gloucester works. These include all kinds of vehicles for all kinds of purposes, not the least important of these being electric cars, narrow gauge light railway and tramway car bodies, and both light and heavy vehicles for contractors, &c.

The "Ironmonger" Diary for 1904, a work of considerable importance to wholesale and retail dealers in all classes of ironmongery goods, is to hand, and is as complete as ever. This is the 36th year of publication of a useful book.

From Messrs. Robson and Coleman, of 5, St. Mary's-place, Newcastle, we have to acknowledge a neat aluminium pocket memorandum case.

On the subject of diaries, we must not omit to mention the year-book for 1904 of the "Gas World," which for bulk and importance of contents ranks with the best of the trade publications of this character. Any of our readers who desire to know anything about gas, and the plant and apparatus connected with the industry, may well be referred to this year-book and directory. A notable feature of this issue is an excellent portrait of Prof. Vivian B. Lewes, the famous gas expert.

The smoker will find use for a souvenir of the Royal Ediswan lamp which is being sent out by the Edison and Swan United Electric Light Co., Queen-street, Cheapside, London, in the form of a smokers' cigar and cigarette rest and ash tray. This is not the least effective advertising device that has come before us lately.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Dec. 16 to 22, with the ports of destination:—

Africa—Alexandria, £238; Cape Town, £307; Delagoa Bay, £643 (telegraph material and 205 tons telegraph poles); Durban, £4,274 (including £3,827 telegraph material); East London, £158; Port Elizabeth, £169 (including £119 telegraph material). *Australasia*—Adelaide, £127; Auckland, £20; Melbourne, £49; Otago, £72; ; Perth, £1,802; Sydney, £2,164. *Brazil*—Maceio, £49; Rio Janeiro, £78. *Canada*—Halifax, £23. *Ceylon*—Colombo, £45. *China*—Shanghai, £218. *France*—Rouen, £740. *Holland*—Amsterdam, £310. *Hong Kong*, £117. *India*—Calcutta, £331. *Japan*—Nagasaki, £240; Yokohama, £1,240 (including £1,089 telegraph cable). *Java*—Batavia, £35. *North Atlantic*, £2,500 (telegraph cable). *Straits Settlements*—Penang, £52. Total, £16,001, against £6,609 for three days last year (Dec. 17 to 19).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1902.

16,354 Danzer. Accumulators.
20,645 Siemens Bros. & Co. (Siemens and Halske A.G.). Regulating consumption of current by electromotors.
21,021 Atkins. Electrodes of electrolytic apparatus and the like.
22,657 Gibbs. Means for applying electricity to the human body.
22,712 Fynn. Alternate current motors.
22,808 Solomon and Sheppard. Optical lantern for use with Nernst lamps.
23,243 Sefton-Jones (Isola Werke A.G. in Oerlikon). Insulating material.
23,288 Winter and Eichberg. Alternating current apparatus.
23,333 Edgar. Telegraphing or telephoning to or from a railway vehicle.
23,344 Malam. Electrical billiard marker and indicator.
23,565 Dickson. Electrically actuated musical instruments.
23,694 Eckstein and Angold. Automatic shunting switch for protecting shunt coils and carbon holders of arc lamps.
23,842 Hesse and Heurtley. Telegraphy.
24,102 Carolan (G.E. Co., U.S.). Surface contact structures for electric railways and tramways.
24,231 Oliver. Appliance for testing for electric currents.
24,477 Sidebottom. Coupling metallic cables and the like.
24,707 Carolan (G.E. Co., U.S.). Arc lamp hangers.
25,240 Tyer, Hollins and Leake. Electric signalling on railways.
25,840 Howarth. Conducting current to cars on underground system.
25,905 Carolan (G.E. Co., U.S.). Systems of electrical distribution.
25,906 Carolan (G.E. Co., U.S.). Phase modifiers and systems of electrical distribution.
26,035 Carolan (G.E. Co., U.S.). Photometers.
26,037 Carolan (G.E. Co., U.S.). Electric railways on surface-contact or like systems.
26,379 Carolan (G.E. Co., U.S.). Magnetic clutches.
26,385 Carolan (G.E. Co., U.S.). Arc lamps.
26,658 Holmes and Holmes. Guiding tramcars and their trolley wheels at rail and conductor points.
26,673 Lake (Arno). Measurement of electrical energy.
26,706 Bray, Markham, Reiss and Bray, Markham and Reiss. Resistances.
26,717 Swinburne. Electric locomotives.
26,735 Kemp. Electric light pendants and electroliers.
27,056 de Labarthe. Automatic electric signalling for railways.
27,161 Evans (A.E.G.). Electricity meters.
27,232 Blake. Rotary contacts for high-tension circuits.
27,253 Lake (Stone). Selective electric signalling.
27,295 Lake (Stone). Amplifying electromagnetic signal waves.
27,486 Johnson (E.A.G. vorm. W. Lahmeyer & Co.). Controlling or regulating supply of electricity in installations subjected to considerable fluctuation in the demand.
27,628 Thézard. Electric ignition devices for explosion motors. (Date applied for, Dec. 16, 1901.)
27,739 and 27,742 Lake (Stone). Transmitting and receiving electrical signals.
27,746 Lake (Stone). Determining the direction of magnetic waves.
27,752 Carolan (G.E. Co., U.S.). Arc extinguishing devices.
27,753 Carolan (G.E. Co., U.S.). Bearings for measuring instruments.
27,754 Carolan (G.E. Co., U.S.). Apparatus for forming coils.
27,759 Carolan (G.E. Co., U.S.). Control systems for search light projectors.
27,762 Carolan (G.E. Co., U.S.) Electric condensers.
27,763 Carolan (G.E. Co., U.S.). Means for varying the voltage of alternating electric currents.
27,764 Carolan (G.E. Co., U.S.). Systems of phase transformation.
27,766 Carolan (G.E. Co., U.S.) Potential indicators for high voltage.
27,781 Lake (Stone). Determining the direction of magnetic waves.
27,883 Hamilton-Adams. Solenoids.
28,039 Morrall. Standards or brackets for electric light.
28,448 Brander. Polarised electric bells.

1903.

846 Devonshire. Conduits and troughs for conductors.
1,523 Oliver and Philpott. Insulating material.
2,976 Knipping. Switches.
6,063 Ferguson. Brackets for attaching electrical devices to desks.
10,541 Bijur Processes and apparatus for making battery plates.
11,128 Otto. Support and cooling of statical ozonisers.
12,032 Johnson (Ford). Electrolytic apparatus.
13,373 Margowski and Gorick. Electromagnetic work-holder for machine tools.
13,750 Kington. Electro-deposition of gold.
14,561 Ball. Automatic circuit-breakers.
14,562 Ball. Circuit-breakers.
15,048 Bonemeyer. Electric signalling for railway trains
16,698 Boot. Means for actuating valves, cocks, switches and similar apparatus at predetermined times.
16,878 Stiner. Printing telegraph instruments.
18,508 Folger. Sparking plugs for explosion engines.
18,740 Evans (A.E.G.) Actuating switches.
18,907 Fairweather (Diehl Mfg. Co.) Electrical controllers.
18,953 Wille. Indicator for controllers of electric vehicles.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BRITANNIA ENGINEERING CO. (LTD.)—Reg. Nov. 25, capital £40,000 in 2,000 £5 5 per cent. cum. pref. and 30,000 £1 ordinary shares, to acquire and carry on the business of general engineers, engineers and machine tool manufacturers, &c., carried on as the Britannia Company at Colchester, and to carry on the business of iron, brass and steel founders, ironmasters, steel converters, boiler makers, electricians, electric light and other fitting manufacturers, &c. First directors: V. P. Nicholson (chairman), G. Comer, H. G. Nicholson and J. Blomfield. Reg. office, Britannia Works, Colchester.

BRITISH JOHNS-MANVILLE CO. (LTD.)—Reg. Nov. 28, capital £5,000 in £1 shares, to carry on the business of dealers in and importers, exporters and manufacturers of all kinds of electrical, chemical and other machinery, apparatus and appliances, &c., and in particular steam packing, asbestos goods, paint, vulcabeston fuses, overhead material, insulating material, heaters. Possible agreements with the Johns-Manville Co. are provided for. First directors, H. J. Joseph, G. W. Becker and E. Bergtheil. Office, 81, Fenchurch-street, London, E.C.

ELECTRO-SULPHUR AND LIGHT CO. (LTD.)—Reg. Dec. 15, capital £5,000 in £1 shares, to establish, equip and carry on business as proprietors of light, electric and other baths, and appliances for the curative and sedative treatment of the organs of the body, to administer light and colour treatment, involving the use of electricity with or without sulphur, &c. Reg. office, 142, Gray's Inn-road, London, W.C.

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PADDINGTON MOTOR CO. (LTD.)—Reg. Dec. 11, capital £1,000 in £1 shares, to carry on the business of manufacturers of motor cars, motor cycles, tractors, trolleys, mechanically-propelled vehicles, rolling stock, dynamos, accumulators, electrical plant and apparatus, &c. First directors are J. Neave, W. S. Cutler and S. G. Neave. Reg. office, Banister-road, Kensal Rise, London, N.W.

PRIESTMAN POWER CO. (LTD.)—Reg. Nov. 26, capital £40,000 in £1 shares, to erect generation station at Blaydon, Durham, for utilising gases and waste heat to be produced by ovens to be built by owners of Priestman Collieries, Blaydon, and for generating electric energy for distribution and sale to the Newcastle-upon-Tyne Electric Supply Co. (Ltd), Priestman Collieries and others, and to carry on the business of suppliers of electrical energy, &c. First directors are F. Priestman, J. H. B. Noble, J. T. Merz, H. Peile, S. J. Leybourne and J. H. Armstrong. Reg. office, 2, Princes-buildings, Newcastle-on-Tyne.

THOS. SPIR & CO. (LTD.)—Reg. Nov. 27, capital £2,000 in £1 shares, to carry on the business of electrical, mechanical, gas and general engineers, contractors, &c.

TORQUAY ELECTRO-THERAPEUTIC INSTITUTE (LTD.)—Reg. Dec. 16, capital £2,000 in £1 shares, to provide and maintain an establishment for the cure and relief of diseases and ailments by electricity or other treatment, to provide and administer electric light baths, to carry on the business of electricians, &c. Reg. office, 5, Forward-street, Torquay.

STATUTORY RETURNS.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—According to return to Nov. 20 the capital is £1,000,000 in 150,000 A and 50,000 B shares of £5 each, of which 116,400 A and 23,564 B shares have been taken up. 10s. per share has been called up on 89,261 A, and £44,630. 10s. has been received. £456,667. 10s. is considered as paid, being £5 per share on 17,139 A and 23,564 B, £2. 10s. per share on 89,261 A and £3 per share on 10,000 A shares. Mortgages and charges, £444,023.

WALSALL ELECTRICAL CO. (LTD.)—The return to Oct. 22 gives the capital as £25,000 in £1 shares, of which 16,380 have been taken up. £1 per share has been called up on 14,380 shares, and £14,380 has been received. 2,000 shares are considered as fully paid. Mortgages and charges, £4,000.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC CALIBRATED FUSE CO. (LTD.)—Issue on Dec. 4 of £750 debentures, part of series created same date to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder: J. Lang. No trustees.

BURNAND TRANSFORMER CO. (LTD.)—Issue on Dec. 3 of £1,275 debentures, part of series created same date to secure £2,000, charged on company's property, present and future, including uncalled capital and (as floating security) the company's undertaking and property. No trustees.

UNITED KINGDOM TRAMWAY, LIGHT RAILWAY AND ELECTRICAL SYNDICATE (LTD.)—Memorandum of satisfaction in full of mortgage dated Oct. 20, 1902, securing certain liabilities unascertained at the date of the mortgage (which was stamped to cover £3,800), including an advance of £300, has been filed.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 25⅞d. per oz. (Dec. 23). Consols 88$\frac{3}{16}$—88$\frac{5}{16}$ for money, 88$\frac{5}{16}$—88$\frac{7}{16}$ for account; 2½ per cent. annuities 88—88¼ (Dec. 23). Consols Pay Day, Jan. 6; Stocks and Shares Continuation Days, Dec. 28 and Jan. 12; Ticket Days, Dec. 29 and Jan. 13; Pay Days, Dec. 30 and Jan. 14; Mining Share Carry-over Day, Dec. 24.

BIRMINGHAM AND MIDLAND TRAMWAYS CO. (LTD.)—The directors have entered into a provisional agreement to acquire from the British Electric Traction Co. certain interests of that company in the undermentioned tramway companies in Birmingham and districts adjacent:—Dudley, Stourbridge and District Electric Traction Co.; South Staffordshire Tramways (Lessee) Co.; Wolverhampton District Electric Tramways Co.; City of Birmingham Tramways Co. The effect of these arrangements will be to give the Birmingham and Midland Tramways Co. controlling interests in the various tramway and light railway companies in Birmingham and district. These companies operate an aggregate of 90 route miles of tramways and light railways, and have obtained powers for constructing 31 route miles of new lines, the greater portion of which are already working by electric traction on the overhead system.

At a meeting on Friday last the above agreement was approved, and the preference and ordinary shareholders have agreed to alter their respective rights accordingly. The registered offices of the Birmingham and Midland Co. are to be removed to Central House, New-street, Birmingham.

BLACKPOOL ELECTRIC TRAMWAYS (SOUTH), LTD.—A special meeting will take place on 30th inst. to consider resolutions to reduce the capital of the company from £350,000 to £150,000.

BLACKPOOL, ST. ANNE'S AND LYTHAM TRAMWAYS CO.—At the meeting on Thursday last, the chairman (Mr. Blane) said the company had got to the end of their difficulties and the prospect was now very bright. Mr. Rutherford, M.P., said they were bad on capital account to the extent of £25,713 and £6,000 in arrears on preference shares, and some re-arrangement of capital would be necessary.

BRITISH WESTINGHOUSE ELECTRIC AND MFG. CO. (LTD.)—The directors' report for the year ended July 31 states that the profit was £107,609. 7s. 6d., which included about £60,000 special discounts allowed by the American companies on the orders executed at Pittsburg. Deducting the interim dividend on the 6 per cent. preference shares, and providing for interest, &c., the balance is £47,106. 8s. 1d., out of which the directors recommend payment of the balance preference dividend (absorbing £45,961. 13s.), and to carry the balance (£1,144. 15s. 1d.) to reserve. As this was the first year during which the company's works had been equipped, it has not been thought necessary to make provision for depreciation of buildings and machinery. The total authorised share capital has now been issued, and the directors have created a further £450,000 4 per cent. debenture stock to rank with the £787,500 previously created, and £50,000 of this further debenture stock has been issued. To provide for maintaining a sufficient supply of stock at the works and for other purpose to meet the requirements of the increasing business of the company, the directors propose that an additional 100,000 6 per cent. preference shares of £5 each, ranking with those already existing, shall be created. The works at Trafford Park, Manchester, are now employing over 5,000 hands. The orders received during year ended July 31, 1901, represented £738,000, during year ended July 31, 1902, £932,000, and during year ended July 31, 1903, £1,657,114. Among other important contracts obtained during the past year were those with the Admiralty, the Midland, Metropolitan and North-Eastern Railway Companies, the Underground Electric Railways Co. of London, Buenos Ayres Western and Buenos Ayres Great Southern Railway Companies, De Beers Consolidated Mines, London County Council, the Corporations of Aberdeen, Bath, Bournemouth, Glasgow, Hackney, Ipswich, Liverpool, Salford and Dunedin (N.Z) and the Savoy Hotel Co.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS (LTD.)—At the meeting on Tuesday Mr. T. J. Hutchinson moved the payment of the 7 per cent. preference dividend, carrying forward £359. In spite of the bad weather, he said, they had done exceedingly well. They had no accidents and their plant was in good condition. The seasons were so short that in the whole of their eight years' running they had only run 960 days. Each year they did not get more than a sixth of a year's work out of their plant, and even then they were not always carrying passengers to the full extent of their power. They were running on the Douglas Marine Drive for 10 years, and at the end of that period they could demand of the Marine Drive Company either the purchase of the whole of the tramways undertaking at cost price, or that they should grant the Tramways Company a further lease for two years.

ELECTRICITY IN MINING.—At the meeting of the Champion Reef Gold Mining Co. of India (Ltd.) last week the chairman, Sir Charles Tennant, Bart., stated that the Cauvery electrical power scheme had proved such a success that they had had no hesitation in availing themselves of their right, under agreement with the Mysore Government, to call for further power. Preparations were being made for that supply, which it was expected would be available in about nine months, and the extra power obtained would be utilised for driving their new air compressor. The new electric power station would, it was hoped, be completed before the end of next year, and the investment by the company of £11,340 in the undertaking would, it was anticipated, prove most advantageous, owing to the further economies which would be effected through the substitution of electricity for steam as motive power.

HARWICH ELECTRIC LIGHTING AND TRAMWAYS CO. (LTD.)—This company, which has a capital of £50,000 in £1 shares, has during the week invited applications for 25,000 shares.

ISLE OF THANET ELECTRIC TRAMWAYS AND LIGHTING CO. (LTD.)—The chairman (Lord Arthur Butler) stated at the meeting on Wednesday that the past summer had been most disastrous as regards receipts for an undertaking such as theirs, which mainly depended for revenue on visitors to the Isle of Thanet during the summer and autumn months The difference between a fine and a wet week during the season would be from £300 to £400. Lighting receipts were only in their infancy. Mains were being put down in Margate, where there was considerable demand for electric lighting, which should improve the receipts materially next year. The debenture and preference interest due Sept. 30 had been met. From £10,804 brought forward from last year £1,853 had been deducted, chiefly for compensation for injuries and legal charges resulting from the unfortunate accident in August, 1901. £3,403 had been carried to appropriation account to meet various charges, leaving £5,047 to be carried forward. The traffic receipts for the year were £33,465, against £35,088, a decrease of £1,623. The number of passengers carried (4,406,821) showed a falling-off of 165,575. The highest single day's takings since the opening of the system was on August Bank Holiday last, when the amount was £452, and the lowest on record £14. 6s. 1d., was on Dec. 5, 1902, when the line was practically snowed up. The report and accounts were adopted.

At a subsequent extraordinary meeting the bill which is being promoted in the name of the company, but at the risk and expense of the contractor, was approved.

MASCHINENFABRIK OERLIKON.—This company, which paid dividends of 5 per cent. last year and 10 per cent. in each of the two previous years, has been obliged to pass its dividend for the present year, the net profit amounting to only 6,057fr. Losses have been incurred in the steam turbine department and in connection with the Russisch-Schweizerische Aktiengesellschaft Oerlikon.

METROPOLITAN DISTRICT RAILWAY CO.—At a special meeting on Thursday last, the chairman (Mr. R. W. Perks, M.P.) referred to the company's bill, section 23 of which related to the new rates to be adopted consequent upon the adoption of electric traction. They had not been able at present to formulate a bill dealing with the new rates and fares which would ultimately be necessary. The ideal to which they must

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endeavour to attain was a uniform rate for the whole of the railway—one rate and one class; and they were coming to the conclusion that that ultimate rate would probably be a twopenny rate for everybody everywhere over the District Railway, with special provision by means of another car, on such trains as might be necessary for people who wished to travel under somewhat more luxurious circumstances. There were various reasons, including the sittings of the Royal Commission on London traffic, which was still collecting evidence, which prevented them proposing a uniform rate at present. They proposed to fix zone fares, with Hammersmith as zone centre. They had suggested to the Metropolitan Company the establishment of a uniform twopenny rate all round the inner circle, for the long distance or short distance, and he hoped they would be able to effect an arrangement with that company which would apply to the inner-circle service with regard to a uniform twopenny rate. They intended to run 40 trains per hour, against 18 now, and they also proposed to give sitting accommodation for 140,000,000 people in the rolling stock which was being constructed, as they anticipated to at least double their traffic. On the Metropolitan Railway, just before they had to meet the competition of the Central London Railway, they carried 96,000,000 people, and the Central London at present were carrying 45,000,000 people. They had taken the best advice they could command, and were of opinion that their railway would certainly carry at least 100,000,000 people. In regard to the electrical equipment, they had nothing upon their line that would catch fire. They were even going to abolish the wooden platforms and substitute cement. Their staircases were all to be removed, and would be constructed of non-flammable material, and the cars were about to be built with non-flammable materials. He went on to explain the finanical relations of the District Railway to the Underground Electric Railway Co., with whom they had three agreements which threw upon the Underground Company the absolute obligation of converting the line from steam to electricity, providing the whole of the rolling stock, and building the power-house at Chelsea without imposing any monetary obligation upon the District Company beyond the contract to issue to the Underground Company stock for the work they did. They had not made the rapid progress which they expected, for they had hoped that the railway would have been opened for electric traction in the spring, but it would be deferred to the end of next year. The delay had arisen chiefly through the gigantic operations which the Lot's-road power-house had assumed. That power-house, which it was originally intended should cost £400,000, and be used for the District Railway alone, was now costing £1,250,000, and would be used for four other railways—the Baker-street and Waterloo, the Brompton, Piccadilly and Great Northern and Charing Cross and Euston portions of the South-Western, and Whitechapel and Bow lines. The bill was approved.

NEW GENERAL TRACTION CO. (LTD.)—A meeting of the mortgage debenture-holders was held on Tuesday to consider a resolution authorising the creation and issue of 4 per cent. prior lien debentures not exceeding £80,000, and redeemable in whole or in part at any time at six months' notice at £103. The Hon. Arthur Brand presided, and moved the resolution. He said that the hope expressed at the meeting in July that the company would be able to obtain the £40,000 required for the extension of the Coventry tramways by the sale of a sufficient number of bonds of the Philadelphia line during the year had not been realised. The company had had great difficulties in Philadelphia, and the line would not be in complete working order until May. £60,000 of the proposed new issue had been underwritten by firms who were interested in the concern at no commission and at moderate interest. Sir Alfred Hickman emphatically protested against the proposal, and said that no one looking at the names on the prospectus could have believed it conceivable that the directors and trustees would propose to put aside the security of present debenture holders and place £60,000 or £80,000 before them. The motion was, however, adopted.

NEW GUTTA PERCHA CO. (LTD.)—At Friday's meeting, the chairman (Mr. H. Woolner) moved the adoption of the report, which stated that during the past year the directors had been occupied in preparations for the development of the business, including the selection of a suitable site for a factory (ultimately decided on at Greenwich), in adapting existing buildings and in obtaining and erecting plant and machinery. Considerable delay was caused by the difficulty experienced in obtaining portions of the plant, and it was not until September that the work of erection was completed. The factory is now fully equipped for an output of about 1 ton of "new gutta" per day. Provision had been made for extensions, and the output can be substantially increased at comparatively small outlay. In order to convince intending users that the "new gutta" could safely be employed as a substitute for the natural product a length of submarine cable core, insulated with "new gutta," was submitted to Mr. James Swinburne, and a preliminary report on tests carried out by him had already been communicated to the shareholders. Mr. Swinburne had now completed his tests and was preparing a final report, which the directors were pleased to state was of a highly satisfactory character. Working samples of the material had been supplied to Government departments and to many of the larger railway companies, &c., but in each case the intending user asked for time in which to make his own tests. The distribution of these working samples had recently resulted in the receipt of firm orders for substantial supplies, which the company was now proceeding to carry out, and the directors felt confident that in the ensuing year a large and remunerative business would be done. The chairman referred to the difficulty in introducing their substance, owing to the failure of the numberless substitutes for rubber. They had received an order for insulated wires from the General Post Office, and product had been accepted in open tender by one of the railway companies. There was a large field for their substance as a substitute for vulcanised indiarubber for the insulation of electric light wires and cables. Their horizon was not limited by known applications of rubber, for in view of the developments of the last 30 years they anticipated that new directions for its use would be found.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—We are informed that the recent issue of 1,000 ordinary shares of £10 each at £2 premium has been over-applied for to the extent of nearly 100 per cent. by existing shareholders.

VULCANITE LIMITED.—The report for the year ended Oct. 31 states that the trading profit, including balance from last year, amounted to £11,871, and, after deducting directors' fees, &c., the balance was £7,630. An interim dividend at the rate of 7½ per cent. has been paid previously, and it is now proposed to pay a further similar dividend to Oct. 31, making 7½ per cent. for the year, to place £1,500 to depreciation reserve, to write 20 per cent. off preliminary expenses, and to carry the balance (£853) forward.

WESTERN TELEGRAPH CO. (LTD.)—The coupons of the second issue of 5 per cent. debentures, due 31st inst., will be paid on and after that date at Parr's Bank, Bartholomew-lane, London, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Dec. 19	1,687	+ 270	29	35,983	+ 6,296
Ayr Corporation	,, 19	163	+ 7	31	9,959	+ 19
Barnsley	,, 11	146	...	49½	8,848	- 1
Bexley District Council	,, 18	126	...	11	1,800	...
Birkenhead	,, 20	998	...	...	...	...
*Birmingham Tramways	,, 19	5,012	- 22	24	123,513	+ 3,461
*Blackburn Corporation	...	...	+ 3	...	...	...
Blackpool Corporation	,, 17	262	+ 2	§37	37,316	- 144
Blackpool and Fleetwood	,, 19	153	+ 8	25	20,528	- 100
Blackp'l,St.Anne's&Lytham	,, 17	140	+ 115	‡7	1,000	+ 547
Bolton Corporation	,, 20	1,609	+ 70	38	69,817	+ 8,229
Bournemouth Corporation	,, 16	805	...	38	30,293	...
*Bradford Corporation	,, 20	3,353	+ 168	36	143,545	+ 19,678
Brighton Corporation	,, 20	751	+ 21	38	35,409	+ 2,729
Brisbane Tramways	Nov. 4	2,397	+ 27	18	42,086	+ 443
*Bristol Trams & Carriage	Dec. 18	4,425	+ 81	4	17,357	+ 929
*Buenos Ayres & Belgrano	Nov. 22	3,276	+ 266	5	15,026	+ 523
Burnley Corporation	Dec. 19	769	+ 110	38	38,347	+ 6,645
Burton Corporation	,, 20	282	...	20	7,192	...
Calcutta Tramways Co.	,, 19	R35,550	+R3,462	25	R834,620	+R145,456
Camborne-Redruth	,, 21	101	...	7	6,915	...
Cardiff Corporation	,, 19	1,829	+ 237	38	74,803	+ 20,149
Carlisle Tramways Co.	,, 19	163	+ 19	¶50	9,657	+ 861
Central London Railway	,, 19	7,254	+ 156	25	160,408	- 7,059
Chatham and Dist. Lt. Rys.	...	...	...	...	...	...
City & South London Rly.	,, 21	3,070	- 329	25	67,715	- 10,188
Cork Electric Trams Co.	,, 17	389	- 2	40	25,798	- 3,370
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 11	463	+ 129	49½	22,793	+ 1,593
Dover Corporation	,, 19	169	- 7	†38	8,820	+ 99
Dublin & Lucan Railway	,, 20	97	+ 10	25	3,119	+ 191
Dublin Southern District	,, 18	704	+ 24	¶24	25,295	+ 8,333
Dublin United	,, 18	3,642	+ 94	¶24	96,650	
Dudley—Stourbridge	,, 11	715	+ 77	49½	41,148	+ 8,836
Dundee Corporation	,, 16	786	+ 38	...	...	...
East Ham Council	,, 19	594	+ 120	†38	25,547	+ 7,451
Gateshead & Dist. Trams	,, 11	843	+ 18	49½	43,346	+ 5,115
Glasgow Corporation	,, 19	13,179	+ 1,207	29	396,223	+ 41,390
Gravesend—Northfleet	,, 11	197	+ 49	49½	11,884	+ 1,294
Greenock & Port Glasgow	,, 11	494	+ 85	49½	26,940	+ 2,257
Halifax Corporation	,, 9	1,043	+ 110	37	51,276	+ 5,741
	,, 16	1,049	+ 100			
Hartlepool Tramways	,, 11	235	+ 38	49½	13,339	+ 893
Huddersfield	,, 19	1,108	+ 110	37	47,221	+ 7,303
Hull Corporation	,, 19	1,940	+ 217	†38	71,235	+ 4,284
Ilkeston Corporation	,, 16	114	...	5	597	...
Ipswich Corporation	...	...	...	...	...	...
Isle of Thanet Co.	,, 19	240	+ 7	25	22,080	- 984
Kidderminster & District	,, 11	93	+ 7	49½	6,269	+ 183
Kirkcaldy Corporation	,, 16	189	...	42	7,372	...
Lanarkshire Trams Co.	,, 17	525	...	§18	13,311	...
*Leeds Corporation	,, 19	4,957	+ 406	39	209,834	+ 13,010
Liverpool Corporation	,, 12	9,526	+ 667	50	502,309	+ 17,122
*Liverpool Overhead Rly.	,, 20	1,589	+ 73	25	41,351	+ 2,683
London County Council	...	...	...	...	...	...
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 19	11,040	+ 2,953	27	316,778	+ 162,570
Mersey Railway	,, 19	1,356	+ 252	25	33,245	+ 6,519
Merthyr	,, 11	184	+ 37	49½	9,817	+ 30
Middleton	,, 11	224	+ 22	49½	15,557	+ 1,890
Newcastle-on-Tyne Corp.	,, 19	3,517	+ 888	25	87,201	- 1,510
*Newport (Mon.)	,, 19	415	+ 242	11	4,774	+ 2,401
Oldham, Ashton & Hyde	,, 11	474	+ 8	49½	27,975	+ 1,609
Perth (W. A.) Elec. Trams.	,, 18	1,871	+ 207	§50	59,095	+ 6,903
Peterborough	,, 11	102	...	46	7,205	...
Poole and District	,, 11	213	+ 50	49½	14,836	+ 2,185
Portsmouth Corporation	,, 19	1,374	+ 125	†38	68,650	+ 4,618
*Potteries	,, 11	1,566	+ 86	49½	78,438	+ 3,640
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 11	40	+ 10	49½	6,919	+ 1,605
Salford Corporation	...	...	...	...	...	...
*Sheerness	,, 9	46	...	35	2,948	...
Sheffield Corporation	,, 20	4,239	+ 299	25	114,230	+ 9,160
*Southampton Corporat'n	,, 17	844	+ 17	...	...	...
Southend Corporation	,, 16	196	+ 86	37	12,617	+ 2,036
Southport Tramways	,, 11	224	+ 38	49½	15,397	+ 2,685
S. Staffordshire Trams.	,, 11	934	+ 382	49½	45,436	+ 8,401
*Sunderland Corporation	,, 20	1,071	+ 55	38	46,852	+ 2,219
*Swansea Trams	,, 11	450	+ 51	49½	25,577	+ 2,164
Taunton Trams	,, 11	45	+ 10	49½	2,968	- 193
Tynemouth and District	,, 11	181	- 8	49½	15,227	+ 761
Tyneside Trams Co.	,, 16	258	+ 70	50	16,075	...
Wallasey District Council	,, 19	596	+ 61	†38	26,809	+ 3,397
Weston-super-Mare	,, 9	22	+ 1	49	5,692	- 514
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 11	522	+ 95	49½	19,170	+ 7,708
Wrexham	,, 11	102	...	36	5,016	...
Yorkshire Woollen District	,, 11	443	...	42½	16,600	...

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Tuesday Dec. 22.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, 6 Days to Dec. 22 Highest.	Business, 6 Days to Dec. 22 Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
£5	2/6	Anglo-Arg'tine Sh(1to260,007)5% Cm.Pf.	4⅞–5	4 17 6	April, Oct	5	4⅞
St.	6%	Do. Permanent 6% Deb. Stock	127 –132	4 13 0	..	128½	..
£10	10/0	Barcelona Tramways Ord.	7½–8½	5 17 8	..	..	..
£10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 5	..	..	..
£100	5%	Do. 5 per Cent. Debs.	97 –102	4 18 10	..	..	..
£5	..	Brisbane Electric Trams. Invest. Ord.	2 –3	..	..	..	..
£5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	99 –101	4 8 5	..	102½	..
£10	8%	Bristol Tramways and Carriage Ord.	20 –21	3 10 10	Feb, Aug	..	..
£10	4%	Do. Cum. Pref. (fully paid)	10½–10¾	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 1	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	80 –83	3 12 3	..	..	..
St.	5%	Do. Pref. Ord. Stock	91 –94	5 6 2	..	92	91⅝
£10	4/2½	Do. 5% Cum. Perp. Pref.	10 –10½	4 15 3	..	..	..
£40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝–104¼	4 6 7	..	..	..
£10	6/0	†British Electric Traction Ord.	11½–12	6 13 4	..	11⅝	11⅞
£10	6/0	Do. 6 per Cent. Cum. Pref.	11¼–11⅝	5 2 2	Feb, Aug	11⅝	11⅞
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –123	4 1 4	..	122½	122
£5	..	Buenos Ayres and Belgrano Ord.	2⅞–3⅛	..	..	3⅛	3
£5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼–5⅜	5 4 0	..	5⅛	..
£5	3/0	Do. "B"	4⅜–5¼	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	106 –109	4 12 10	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 –101	5 0 9	..	100¼	99⅛
£5	2 6	Calcutta Tramways	6¾–7⅛	3 2 1	..	6⅞	6⅞
£100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 –108	4 4 11	..	..	..
£1	1/2⅝	Cape Electric Tramways Shares	1¾–2	7 10 0	..	1⅝	1⅝
St.	4%	Central London Ordinary Stock	93 – 96	4 4 9	June, Dec	95¼	93
St.	4%	Do. 4 per Cent. Pref. Stock	99 –102	3 18 10	..	99¼	99
St.	4%	Do. Deferred Stock	93 – 96	4 3 4	..	96	..
£100	4%	Do. 4 per Cent. Debs.	115 –118	3 7 11	..	..	..
£5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 – 5½	4 10 11	..	..	..
£100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
St.	2¾%	City and South London Rly. Con. Ord.	47 –50	6 5 0	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 –129	3 18 7	Feb, Aug	..	..
St.	5%	Do. (1896)	123 –126	4 0 4	..	..	..
St.	5%	Do. (1901)	120 –125	4 1 1	..	122½	122
St.	4%	Do. 4 per Cent. Perpetual Debs	109 –112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	100 –103	4 17 0	..	..	..
£10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 –13	4 4 7	..	..	..
£10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
£5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3¾–4¼	6 13 4	..	..	..
.	5%	Do. 5 per Cent. Deb. Stock (red.)	95 –98	5 2 0	..	..	..
£0	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 –8	3 15 0	..	7¾	7⅞
£0	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	9⅝	9⅝
£10	10%	‡Imperial Tramways Ord	20 –21	4 13 0	Mar, Sept	..	..
£10	6%	‡ Do. 6 per Cent. Pref.	14 –14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	110 –111	4 3 1	Jan, July	..	..
£5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¾–4¼	5 17 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 –95	4 4 3	..	..	..
£10	1¼%	Liverpool Overhead Railway Ord.	5⅞–5⅞	2 7 1	Feb, Aug	..	..
£10	5%	Do. 5 per Cent. Pref.	10¼–10¾	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	4 1 0	Jan, July	..	..
£10	5/0	London United Trams. 5% Cum. Pref.	11¼–11⅜	4 5 1	..	11⅜	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	104 –106	3 16 8	..	105	104½
St.	..	Mersey Con. Ord. Stock	8 –11	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12–15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
£1	..	Metropolitan Electric Trams Def	⅞–1	..	..	..	..
£1	0/6	Do. 5% Cum. Pref.	⅛–⅜	4 8 11	..	..	..
£100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 –104	4 16 2	..	..	..
£100	4½%	Do. Sterling 4½% Debs. (1922)	105 –107	4 4 1	..	..	..
£5	..	New General Traction Ord.	½	..	..	..	..
£5	..	Do. 6 per Cent. Cum. Pref.	1½–2½	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	100 –103	4 19 0	..	..	..
£10	10/0	Potteries Electric Traction Ord.	8½–9½	5 5 3	..	..	..
£10	5 0	Do. 5 per Cent. Cum. Pref.	8½–9½	5 5 3	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 –105	4 5 9	..	..	..
£1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
£1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 –94	3 9 8	June, Dec	..	..
		TELEGRAPHS.					
£100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 –103	3 18 0	Jan, July	..	..
£10	..	Amazon Telegraph	2½–3½	..	Jn, Dec ..	..	..
£100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	49 –52	6 1 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	92 –94	6 8 3	F,My,Ag,N	93⅜	92⅜
St.	1/0	Do. Deferred	7⅜–8⅛	0 12 5	F,My,Ag,N	7⅜	..
£100	$2	Commercial Cable Capital Stock	145 –155	5 9 8	Ju,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	Jn Ap,Jy,O	91	..
£10	7/0	Cuba Submarine Ord.	7 –8	10 0 0	Feb, Aug	..	..
£10	10/0	Do. Preference 10 per Cent.	16 –17	5 17 8	Feb Aug	..	..
£5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
£5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	..	..
£0	4½%	Do. 4½ per Cent. Deb.	97⅞–101⅝	4 10 10	Jan, July	..	..
£20	3/0	Direct United States Cable	10 –10½	6 3 10	Ja,Ap,Jy,O	..	..
£100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	99 –102	4 8 10	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	121 –126	5 11 1	Ja,Ap,Jy,O	123	122
St.	17/6	Do. 3½ per Cent. Pref. Stock	85 –88	4 0 4	Ja Ap,Jy,O	88	87½
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –108	3 14 1	May, Nov	106	..
£10	2/6	Eastern Extension	11 –11½	6 1 9	Ja,Ap,Jy,O	11⅛	11⅛
St.	4%	Do. 4 per Cent. Deb. Stock	106 –109	3 14 4	Feb, Aug	..	..
£100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 –102	3 18 10	Feb, Aug	99½	99
£25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞–102%	3 18 11	May, Nov	..	..
£10	5/0	Great Northern of Copenhagen	25 –26	4 16 2	Jan, July	25¼	..
£10	4½%	Halifax & Bermuda4½%1stMt.Db.(red.)	99 –102	4 8 4	June, Dec	..	..
£25	12 6	Indo-European	37 –40	6 5 0	May, Nov	..	..
£100	6%	London Platino-Brazil. 6% Debs., 1904	98 –102	5 18 3	Mar, Sept	..	..
£100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 –100	4 0 0	June, Dec	..	..
£10	4/0	West African Telegraph Shares	5 –6	3 6 8	..	..	..
£½	..	West Coast of America	⅛	..	..	..	..
£100	4%	Do. 4 per Cent. Debs.	95 –98	4 1 8	Jan, July	..	..
£10	..	West India and Panama	⅜–½	..	May, Nov	..	..
£10	8/0	Do. 6 per Cent 1st Pref.	6 –6¼	9 4 8	May, Nov	..	..
£10	..	Do. 6 per Cent. 2nd Pref.	4½–5¼	..	May, Nov	..	..
£100	5%	* Do. 5 per Cent. Debs.	101 –104	4 17 7	Jan, July	..	..
£10	5/0	Western Telegraph	11⅞–12½	5 14 3	Mr,Jn,O,D	12¼	..
£100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 –103	4 17 1	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 –102	4 0 0	..	..	..
		FINANCIAL, INVESTMENT, &c.					
£5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4⅜–5¼	5 14 3	..	..	..
£10	2/0	Globe Telegraph and Trust	8¼–8¾	4 11 5	Ja Ap Jy O	8⅞	..
£10	3/0	Do. 6 per Cent. Pref.	12½–13	4 12 4	Ja Ap,Jy,O	12¾	..
£8	4/0	Reuter's	6¼–7¼	5 6 8	April, Oct	..	..
£100	6%	Submarine Cables Trust (Cert.)	116 –121	4 19 7	April, Oct	120	..
		TELEPHONES.					
£5	6 0	Chili Telephone (fully paid)	4⅜–5¼	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	101 –103	5 18 9	..	102⅜	102
St.	5%	Do. Def. Stock	76 –79	6 3 5	..	78	77
£10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 5 9	Feb, Aug	..	..
£10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 –14	4 5 9	Feb, Aug	13¾	13¾
£5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛–5⅜	4 13 0	Feb, Aug	5⅜	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96 –98	3 12 9	June, Dec	96¼	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	102 –104	3 17 5	..	103⅛	102½
£1	0/7⅛	Oriental	⅞–1	6 13 4	April, Oct	..	..
£1	..	Do. 6 per Cent. Cum. Pref.	1 –1⅛	..	..	..	..
£5	4/0	United River Plate	5½–6	5 16 8	July	..	..
£5	2/6	Do. 5 per Cent. Cum. Pref.	4¾–5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	104 – 107	4 13 9	June, Dec	..	..
		ELECTRICITY SUPPLY.					
£1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝–⅞	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	114 –117	3 17 7	..	..	..
£10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½–13½	5 18 6	..	..	..
£10	4/6	Do. 4½ per Cent. Cum. Pref.	10 –11	4 1 10	..	..	..
£10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	..	..
£.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 –106	4 5 3	..	..	..
St.	4½%	Bromley (Kent) El. Lt. &Power 1stDebs.	100 –103	4 7 5	..	..	..
£5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–10¾	4 3 9	..	10½	..
£5	3/6	Do. 7 per Cent. Pref.	9¾–10¼	3 8 4	Mar, Sept	..	..
£5	3,0	Calcutta Electric Supply Ord.	6¾–7½	4 6 8	..	7⅛	..
St.	4%	Central Elec. Sup.Co.4% Guar.Db.Stock	105 –108	3 13 11	..	..	..
£5	4/0	Charing Cross & Strand Electric Sup.	8¾–9½	5 8 1	Feb, Aug	..	..
£5	2/3	Do. 4½ per Cent. Pref.	5½–5¾	3 18 3	Feb, Aug	..	..
£5	2/0	Do. City Undertaking 4½% Cm. Pref.	4¼–5	4 10 0	..	..	..
St.	4%	† Do. 4% Deb. Stock (red.)	103 –105	3 16 3	..	104½	103¾
£5	2 0	Chelsea Electric Supply Ord.	5⅛–6	4 3 4	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 –110	4 3 0	Jn, Dec ..	..	..
£10	5/0	City of London Electric Lighting Ord.	10¾–11	6 16 4	Feb, Aug	..	..
£10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	12	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 –127	3 18 11	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	102 –105	4 9 5	..	..	..
£10	4/0	County of London & Brush Prov. Ord.	7½–8¼	4 14 2	..	..	..
£10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Mar, Sept	12¼	11⅞
St.	4¼%	Do. 4¼% Deb. Stock (all paid) (red.)	108 –111	4 2 8	..	109½	..
St.	27,6†	Do. Second Deb. Stock Prov. Certs.	99 –102	..	..	100½	..
£5	2 0	Folkestone Electricity Supply Co. Ord	5¼–6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 –103	4 7 5	..	..	..
£1	..	Havana Electricity Co. Shares (£8 paid)	7¼–8¼	..	..	..	..
£5	3 6	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	..	..
£5	5/0	Kensington & Knightsbridge Ord.	10¾–11¼	4 6 11	..	..	..
£5	6%	Do. 6 per Cent. 1st Pref.	6¾–7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. &NottingHill Co. (Joint Station) 4% Deb. Stck.(red.)	101 –104	3 16 11	..	..	..
£3	..	London Electric Supply Ord.	1¾–2¼	..	..	..	..
£5	3/0	Do. 6 per Cent Pref.	5 –5⅜	5 9 1	..	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb.	97 –100	4 0 0	Mr,Jn,S,D	..	..
£10	8 0	Metropolitan Electric Sup. Ord.	17–18	4 6 1	April, Oct	17¾	17⅜
£5	..	Do. 4½ per Cent. Cum. Pref.	4½–4⅝	..	..	4½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	110 –114	3 19 8	Jn, Dec ..	..	..
St.	3¼%	Do. 3¼ per Cent. Mrt. Db. Stock (red.)	96 –99	3 11 7	..	..	..
£1	6 0	Notting Hill Electric Ord.	12½–13¼	4 8 11	March	..	..
£100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
£5	2 6	Oxford Electric Ord.	5¼–5⅜	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 –101	4 0 6	..	..	..
£1	..	Rand Electric	⅜–1⅛	..	..	..	..
£100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb	99 –102	4 8 11	April, Oct	..	..
£5	5 0	St. James's and Pall Mall Electric Ord.	14½–15½	4 13 9	Feb, Aug	14½	14¾
£5	3 6	Do. 7 per Cent. Pref.	7½–8½	4 2 4	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 –101	3 10 4	..	..	..
£5	2/6	Smithfield Markets Electric Sup. Ord.	3 –3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	..	..
£1	1/9	South London Electric Supply Ord.	3¼–3⅝	4 13 4	..	..	..
£5	2 6	Urban Electric Supply Ord.	4¾–5⅜	4 17 7	..	5	..
£5	2 6	Do. 5% Cum. Pref.	4¾–5¼	4 17 7	..	5	4⅞
£5	6/6	Westminster Electric Supply Ord.	12 –13	5 0 0	Mar, Sept	12⅝	12⅜
£5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	6⅜	..
		ELECTRIC MANUFACTURING, &c.					
£1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜–¾	6 13 4	..	..	..
£1	..	Aron Electric Meter 6% Cum. Pref.	⅝–1⅛	..	Mar, Sept	..	..
£5	4 0	British Insulated & Helsby Cables Ord.	6 –6½	7 13 10	July, Feb	..	..
£5	3 0	Do. 6 per Cent. Pref.	5¼–5½	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	103 –108	4 4 10	..	105½	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	103 –105	4 5 8	..	..	..
£5	3/0	British Westinghouse 6% Pref.	4½–5	5 0 0	..	4¾	4¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	97 –100	4 1 8	..	..	..
£1	..	Brush Electrical Engineering	¾–1¼	..	March ..	..	..
£1	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼–1⅜	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	78 –85	5 8 9	Jan, July	83½	78¾
£5	5/0	Callender's Cable Construction Ord.	11 –12	6 5 0	Jan, July	..	..
£5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5¾	4 6 11	Jan, July	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.	106 –110	4 1 10	Nov, May	..	..
£1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝–¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	90 –95	4 15 3	..	..	..
£1	0,7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March ..	..	..
£3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅞–2¼	6 13 4	Jan, July	..	..
£100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	99⅝–103⅝	4 19 4	Jan, July	..	..
£5	..	Edison & Swan United("A"Sh.)(£3 pd.)	¼	..	Feb, Aug	..	..
£5	..	Do. (£5 paid)	¾–1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb.Stock(rd.)	72 –77	5 5 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 –81	6 3 5	..	..	..
£5	4/6	Edmundson's Elec. Corp. Ord.	6 –6¼	4 12 4	..	..	..
£5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6¼	4 5 4	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 –107	6 8 0	Jan, July	1¾	..
£2	1/2½	Electric Construction Co.	1⅝–1⅞	4 13 4	July	..	..
£2	2 9⅜	Do. 7 per Cent. Cum. Pref.	2⅜–3	4 0 9	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 –101	..	..	..	..
£1	..	Electrolytic Alkali Ord.	½–¾	..	..	..	..
£1	7%	Do. 7 per Cent. Cum. Pref.	¾–1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
£10	5/0	General Electric (1900) 5% Cum. Pref.	9¾–10¼	4 17 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	96 –99	4 0 10	..	..	..
£5	6/0	Henley's Telegraph Works Ord.	13½–14½	6 17 11	Feb, Aug	..	..
£5	2/3	Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb.Stock(rd.)	108 –112	4 0 9	Feb, Aug	..	..
£10	5/0	India Rubber, Gutta Percha, &c., Wrks.	19 –20	5 0 0	Feb, Aug	19⅜	19
£100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 –103	3 17 8	Mar, Sept	..	..
£10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾–11½	4 8 11	Mar, Sept	..	..
£12	12/0	Telegraph Construction & Mainten'ce.	34 –37	6 9 8	Mar, July	34½	..
£100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –104	3 17 6	Jan, July	..	..
£5	3/0	Willans and Robinson Ord.	4¼–5¼	5 18 2	Apr, Oct	..	..
£5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6¼	4 12 4	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –101	3 18 5	May, Nov	98½	..

In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

Electrical engineers, and especially those connected with supply stations, will regret to hear of the disastrous fire which occurred at the Bristol electricity works last week. At any time the occurrence would have been unfortunate, but coming as it did in Christmas week, just when the demand was a maximum, the effect was greatly intensified. By dint of much hard work and unselfish devotion to duty, however, Mr. H. Faraday Proctor and his staff succeeded in getting the system to work again in an incredibly short space of time. A word of praise is due to the Electrical Committee, who wisely left matters entirely in the hands of their officials, thereby displaying their confidence and materially assisting in the work of reconstruction.

Retribution, swift and sure, overtook the man who, in a spirit of revenge, disconnected the field circuit of a tramway generator at Cardiff. "A little knowledge is a dangerous thing," and if only the offender had been wiser he would not have made such a colossal blunder. Evidently he thought that, as the exciting circuit was of lower voltage than the tramway 'bus bars, he would not receive such a severe shock, but he has now learnt the effect of breaking a highly-inductive circuit. His efforts to cause trouble to the station were not nearly so successful as he might have wished, and it is to be hoped that for the next few years he will have considerable leisure to ponder the matter.

Although comparatively few in number, the patents which will expire during 1904 comprise several of more than usual interest to electrical engineers. Patent No. 1,110 of 1890, granted to C. A. Hitchcock is the one which is now the subject of a patent action in the Law Courts; but even if it is finally entitled to rank as a master patent for dry batteries, its expiry this month will prevent the decision from having any effect on the future of the dry battery industry. W. L. F. Hellesen's dry battery patent also expires this month; it relates chiefly to efficient ventilation for the escaping gases without the promotion of evaporation. Rudolf Langhans, in his patent No. 3,082, expounds means for lessening the detrimental effect of oxidation of electric incandescent lamp filaments. To this end he provides them with a coating of silicon or boron, which is deposited by electro-chemical means on the filaments treated. Both of the expiring Ferranti patents refer to electricity meters. The first comprises the principle of magnetic suspension for reducing friction losses as well as details of construction relating to the mercury bath type of meter.

Electric measuring instruments form the subject of several expiring Weston patents. The first claims the employment of oppositely-acting controlling springs, and relates also to details of construction of the well-known instruments of the moving coil pattern. Another patent refers to instruments of the dynamometer type, used chiefly for alternating currents, and the last patent deals with mechanical means for securing quick and aperiodic readings, and temperature compensation for the series resistance of voltmeters. A patent taken out by Prof. Ayrton and T. Mather, relating to details in electrostatic measuring instruments, also expires this year. Lord Kelvin's name appears in the list of expiring patents; he describes means for lessening the damage done to marine compasses by violent vibrations such as occur particularly on board of warships. The compass bowl is suspended by hangers from supports, which themselves take the form of loaded plungers, supported by coiled springs. A method for supporting and guiding the azimuth on the brass rim of the compass is also included in the specification.

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Mention may also be made of the patent covering TYER'S tablet apparatus for replacing the staff system on single lines of railway. The manufacture of switches and fuses will be facilitated by the expiry of the patent for the Mordey powder fuse and also by a patent owned by B. M. DRAKE and J. M. GORHAM relating to spring contacts for switches. In a patent by M. VON. DOLIVO-DOBROWOLSKY and P. MAMROTH a claim is apparently made for the use of a neutral wire, connecting the neutral points of a star-connected polyphase distributing system to the station or sub-station to enable separate regulation of the voltage on each phase. Another Dobrowolsky patent, claiming the insertion of resistance in rotors of induction motors for regulating purposes, also terminates this year.

MR. B. A. BEHREND'S Paper on "The Experimental Basis for the Theory of the Regulation of Alternators," recently read before the American Institute of Electrical Engineers and reproduced in slightly abridged form in another column of this issue, is full of interest, not only to theorists, but also to practical men. To the former it suggests forcibly our inadequate knowledge of the conditions which govern the drop in voltage of alternators, or, at least, our present inability to express in mathematical terms the combined effect of the various forces and conditions which influence the terminal pressure of an alternator at different loads and with different power-factors. The practical man, on the other hand, will learn from the treatise how far he may trust for his calculations to either of the two existing methods considered by Mr. BEHREND, and by weighing the arguments put forward by the author and carefully scrutinising the numerous experimental diagrams given, he will be able to form an opinion as to which of the two methods is likely to give the better approximation to truth in a definite case. For, considering the admitted complexity of the problem, and notwithstanding Mr. BEHREND'S strong condemnation of both methods referred to, it may safely be said that, until a new and accurate method for determining the drop of voltage in alternators under load be thought out—and such a perfect solution of the problem is nowhere in sight at the present time—methods of approximation must necessarily be relied upon. Mr. BEHREND discredits the old methods, and it must be regretted that he has not given us a new and better one instead. Perhaps, however, the present publication is but the forerunner of another one dealing in a new light with this interesting and important question of alternator regulation.

LARGE power transmissions over long distances have grown to be so associated in mind with alternating currents that an installation on continuous-current lines, such as that carried out between Lausanne and St. Maurice, and described elsewhere in this issue, may appear to the engineer of to-day as hopelessly out of date. In addition to the increase in conductor section when compared with a three-phase transmission line for the same maximum R.M.S. pressure, the constant continuous-current system has the disadvantage that it will not serve for a scattered load. Obviously it would not pay to construct long loops of the transmission line for the sake of feeding motors of small output and consequently low voltage situated at a distance from the route, for these loops on the constant-current system would have to be of the same sectional area as the main line. For point-to-point power transmission, however, there is something to say in favour of the system, especially if there can be an appreciable gain in efficiency sufficient to balance the extra cost of, or extra pressure drop in, the transmission line. The system is certainly most ingenious, and installations designed on similar lines, but working at lower pressures, have been in operation in Switzerland and Northern Italy for many years. Yet the majority of engineers in this country will regard the St. Maurice–Lausanne 20,000-volt 34-mile continuous-current transmission rather as a curiosity than as an example to be followed.

IT will be remembered that, during the recent Wireless Telegraph Conference at Berlin, Dr. STRECKER referred to an apparatus for the direct measurement of wave-lengths of Hertzian waves to assist in bringing wireless telegraph stations into syntony. A description of this instrument, which has been devised by Herr J. DÖNITZ, will be found on another page. It will be seen that it is a development of Count ARCO'S apparatus for the same object, which was described in *The Electrician* last February. The instrument appears to afford a practical means of enabling a man, inexperienced in laboratory tests, to measure a wave-length, and it will doubtless prove of considerable service until an even simpler modification of it has been developed.

Electrical Association of New South Wales.—At the annual meeting recently Mr. J. R. W. Gardam was re-elected president and Mr. E. F. Moates secretary. The new vice-presidents appointed are Messrs. Oswald Haes and A. C. F. Webb.

Personal.—Mr. Herbert Tomlinson, F.R.S., the principal of the South-Western Polytechnic, has tendered his resignation. A resolution of appreciation of Mr. Tomlinson's services was passed at the last meeting of the governors of the Polytechnic.

Radium.—It is announced that the French Government has allowed the Paris University a special subsidy of 34,000fr. for facilitating researches relative to radium. This grant will be applied to fitting up a laboratory for M. Curie, who has recently been appointed professor of general physics at the Sorbonne.

Electrification of the Great Western Railway.—The Great Western Railway Co. are contemplating the conversion of certain of their suburban lines from steam to electric traction. To effect this a contract for engines, three-phase generators, condensing and auxiliary plant, aggregating about 10,000 H.P., has been let to the Electric Construction Co.; Messrs. Babcock and Wilcox are to supply the boilers. The generating station will be at Park Royal, and the first section of line to be "electrified" is that from Bishop's-road to Hammersmith.

Opening of the Bath Electric Tramways.—Trial trips have been made upon the electric tramways in Bath, and they will be put into service to-morrow (Saturday). The lines have been constructed by the Bath Electric Tramways Co. under a light railway order, an agreement having been entered into with the Corporation. A separate power house is being built; and the Westinghouse Company have carried out the electrical equipment of the system. Messrs. Harper Bros. and Messrs. G. Hopkins & Sons are acting as consulting engineers, Mr. R. D. McCarter having been appointed manager.

Accidents on the Central London Railway.—On Sunday afternoon, at about 3 p.m., one coach of an empty train, which

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was being shunted at the Bank cross-over road, jumped the track, and, as a consequence, all traffic had to be suspended between the Bank and the British Museum. A second and similar occurrence took place at the British Museum station at about 20 minutes to six on the same day. This stopped all traffic except between the Marble Arch and Shepherds Bush. Fortunately, no trains were stopped in the tunnels, but several hours elapsed before normal traffic was resumed.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Anjer—Kalianda	Aug. 2, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Paramaribo—Cayenne	Feb. 27, 1903
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Cape St. Jacques—Haiphong	Dec. 15, 1903
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903
St. Kitts—San Thomé	Dec. 22, 1903
St. Vincent—Grenada	Dec. 29, 1903

British Astronomical Association.—An interesting lecture on "Some Speculations Regarding Stars and Atoms" was delivered by Sir William Ramsay on Wednesday before the British Astronomical Association. In the course of the lecture he referred to Arrhenius's hypothesis to account for the aurora borealis, and he sketched the present views with regard to it and allied phenomena. Referring to the scarcity of radium, he deplored the fact that Messrs. Johnson, Matthey & Co., who had been working with uranium ore and extracting uranium from it, had been throwing away every day the residue, which would contain radium, and was lying somewhere now in the dust heaps of London. The lecture was illustrated by numerous experiments.

Salford Corporation Electricity Department.—The first annual dinner and smoking concert of the staff and employés of the Salford Corporation electricity department was held on Wednesday the 16th inst., and was attended by Mr. Councillor Hodgson, deputy-chairman of the Electricity committee, Mr. C. D. Taite, borough electrical engineer, and over 100 members of the staff. Mr. C. D. Taite, who occupied the chair, gave some interesting figures respecting the growth of the demand for electricity, especially for power purposes. From the year 1896 to 1903 the units sold had risen from 52,000 to 4,750,000. He also mentioned that since 1898 the number of men employed had risen from 89 to 147, the corresponding wages per week increasing from £111 to £217.

Electrical Developments in Austria.—H.M. Consul at Trieste reports that the Kerka (Dalmatia) electricity works, developing 20,000 H.P., will be opened shortly. Power will be transmitted to Sebenico, where carbide of lime works have been erected. The transmission line will be 12km. (nearly 7½ miles) long. The central electric station at Jaruga contains two 3,500 H.P. sets; and an annual production of 5,000 tons of carbide is anticipated. The Consul further states that the company formed for the utilisation of hydraulic power of Dalmatia, under the name of "Società Romana," has also commenced operations on the Manojlovac waterfall, from which it is hoped 25,000 H.P. will be obtained. There will be altogether 30,000 H.P. from the four Kerka waterfalls; and the annual production of the carbide of lime will be 30,000 tons. The total capital employed will be over £350,000.

Italian Hydraulic Power Station.—The hydraulic power installation which has—according to *l'Electricien*—recently been completed at the foot of Mont Cenis is interesting on account of a head of water of no less than 865 metres (2,830ft.). Electrical energy is transmitted to Turin, 64km. (40 miles) distant. Water to the extent of 1,000 litres (35·3 cubic ft.) per second is taken from the mountain river Cenischia, and this produces 11,500 H.P. By regulating the flow of water by means of a dam 16,000 H.P. may be obtained if necessary. In order to avoid excessive pressures in the pipes, the head is utilised in two stages, and at present only the lower stage is completed. Three generating sets, each consisting of a turbine directly coupled to a 1,400kw. alternator, are installed at present. One set acts as reserve. The head of water of this lower stage is 420 metres (1,380ft.), and the turbines rotate at a speed of 500 revs. per min. It is stated that the alternators, which weigh 33 tons each, and deliver energy at 3,000 volts, have a full-load efficiency of 96·5 per cent. Exciting current is generated by a 110 H.P. turbo-generator set. Water-cooled transformers raise the voltage to 30,000 volts, and at this pressure the energy is transmitted to Turin, where it is reduced in voltage to suit the various requirements.

Some Practical Points in the Design of Continuous-current Machinery.—In a recent Paper on the above subject, read by Mr. Cecil P. Poole before the Franklin Institute of America, the following formulæ were suggested for determining the details of continuous-current machines. For motors of moderate size the author has found it usually sufficient to make the number (C) of coils and commutator segments: $C \geqq 0{\cdot}8PE^{\frac{1}{2}}$. For motors of from 30 H.P. to 100 H.P. the formula is $C \geqq 1{\cdot}2PE^{\frac{1}{2}}$, and for very large dynamos and motors he advocates to make the number of segments according to the formula: $C \geqq 1{\cdot}6PE^{\frac{1}{2}}$, in which P denotes the number of field magnet poles and E the E.M.F. of the armature. As regards slot dimensions, Mr. Poole is of opinion that the ratio of slot depth to slot width should not exceed five in very small machines and four in armatures of about 18in. in diameter. For larger diameters, this ratio may be used also, but it is preferable to reduce it slightly whenever other considerations are favourable. The author has found it good practice to make the ratio of pole-tip proximity to pole-tip air-gap not less than 15 for machines having armatures 24in. or more in diameter, and to reduce the minimum ratio progressively to 12 at a diameter of 18in.

4,000 H.P. Turbo-generator.—The following particulars of a test on a Brown, Boveri-Parsons 4,000 H.P. turbo-generator installed in a power station in Frankfurt-a-M. are published in the *Elektrotechnische Zeitschrift*. With steam at a pressure of 186lb. per square inch, superheated to 300°C. and a power-factor of 0·8, the turbo-dynamo has an output of 2,600kw. at a speed of 1,360 revs. per min. and at a pressure of 3,000 volts. The overall length of the set is 54ft., the maximum height and width not exceeding 8ft. 3in. By loosening a number of screws, easy of access, the upper half of the turbine may be lifted, exposing for inspection the interior. It is stated that the turbine may be warmed up ready to run in as short a time as 15 minutes. Since the working steam flows from the inlet to the outlet in a fraction of a second, the speed may be regulated promptly, and the running in parallel of the various alternators presents no difficulty. In the following table are recorded some consumption tests, carried out during actual service:—

Steam pressure at stop valve, lbs. per sq. in.	Temperature of superheated steam, °C.	Output, kw.	Vacuum, per cent.	Steam consumption in lbs. per kw-hour.
181·0	298	1,945	93·2	16·0
183·5	295	2,518	91·8	15·75
152·0	312	2,995	90·0	15·1

Report on the Explosion at the Brompton and Kensington Electricity Works.—The report of the preliminary inquiry by the Board of Trade into the explosion which occurred on August 23, 1903, at the power station in Richmond-road, has appeared. According to it, the explosion, which took place in the steam piping, was caused by the fracture of two cast-iron T-pieces. These were five years old, and had been tested at the manufacturers' with a hydraulic pressure of 400lb. per square inch. They showed, after the explosion, fractured surfaces of sound metal, free from flaws and other defects. At the time of the accident the steam pressure was 150lb. per square inch. The explosion resulted from water-hammer action following the admission of steam to the main range before the pipes were sufficiently drained, causing the 9in. T-piece to fail at the root of a flange where the metal was in a severely strained condition owing to the means adopted to secure a tight steam joint. The 5in. T-piece was probably twisted off by the movement of the branch pipe which was attached to it when the end of the steam main was forced from its position after the failure of the 9in. T-piece. It appears that the water from the drain valves was conveyed into a reservoir, the open ends of the pipes being out of sight, and the report recommends that piping should be arranged so that the drain outlet is visible. Non-return valves in the outlet pipes of steam traps or other

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drainage arrangements are also criticised by the report, the reason being that such an arrangement is favourable to the formation of a partial vacuum in the steam pipes, and the consequent accumulation of water in them if steam leaks past the the boiler stop valves.

America's New Year Greeting.—The *Electrical World* of New York states that the following arrangements were made by the United States Naval Observatory at Washington, D.C., to send telegraphic time signals throughout the world to mark the beginning of the new year. The signals were sent out at the end of 1902 for each of the four great standard time belts of the United States. This year, not only was a wide distribution of these new year signals secured throughout North and South America, by the co-operation of the telegraph and cable companies, but one or more of the four series of signals were sent around the world and back to the room in the Naval Observatory where they started. The signals commenced at 11:55 p.m. and ended at midnight, Eastern time. The same series were sent out an hour later, ending at midnight, central standard time; again, an hour later, ending at 2 a.m., for midnight of mountain standard time, and, again, an hour after that, ending at 3 a.m., for midnight of Pacific Coast standard time. During each of these four five-minute intervals the transmitting clock sent an electric impulse practically every second. On the world circuit signals went by land lines to Cape Canso, N.S., thence by cable to the Azores, Lisbon, Gibraltar, Malta, Alexandria and Port Said; by land to Suez, by cable to Aden and Bombay, by land to Madras, by cable to Penang, Singapore, Saigon, Hong Kong, Manila, Guam, Midway, Honolulu and San Francisco, and by land back to Washington. It was proposed to receive both the outgoing and incoming signals on the same chronograph at the Naval Observatory, and thus preserve a permanent graphic record of both on a single sheet of paper. It is suggested that, besides demonstrating the possibilities of practical astronomy and telegraphy, working together through international co-operation, benefits will result from the general attention that it will direct to the advantages of the use of accurate standard time throughout the world.

Electric Traction for the New York Central Railway.—According to the *Electrical World* of New York the New York Central and Hudson Railroad Co. has placed a contract for the equipment of steam turbine power plant and the building of electric locomotives, to be employed at the New York terminal of the system, with the General Electric Co. of America. The contract includes eight turbo-generators of the Curtis four-stage vertical type, of a capacity of 7,500 H.P. each. To each turbine will be directly coupled a generator delivering 25-cycle three-phase current at a pressure of 11,000 volts. The company has also ordered 30 electric locomotives from the General Electric Co. of an entirely new design. They will weigh 85 tons each and will have an adhesive weight on the drivers of 67 tons. Each locomotive will have a capacity of 2,200 H.P. and will be capable of hauling a train of 500 tons at 60 miles an hour. Through the use of the Sprague multiple unit system as developed by the General Electric Co., it will be possible to operate two of these huge locomotives in multiple unit for the heaviest trains on the system, so that not a train within the radius of 40 or 50 miles from New York city would require to come in under steam. As each of these locomotives singly would give easily 2,200 H.P., they would have a capacity to develop jointly not less than 4,500 H.P., or practically three times as much as the best steam locomotive record. The total cost of the change in equipment of power plant, locomotives, &c., is estimated at between $15,000,000 and $20,000,000. At the present time no details are forthcoming as to the sub-stations, the location and equipment of which, involving contracts for transformers, rotaries, storage batteries, &c., are understood still to be under study and consideration. It is assumed or understood that for straight run work, the third-rail method in some form will be adopted, although this would not be applicable around the yards. It is further understood that the locomotives will operate at a pressure around the normal 550 volts, so as to render available the resources of current supply obtainable in and around New York city, as a further guarantee of uninterrupted operation.

Strange Revenge at Cardiff.—A remarkable case of attempted revenge for an imaginary injury is reported from Cardiff, and Mr. Arthur Ellis, borough electrical engineer, has sent us the following account:—

For some time past I have had a few men wiring the extension of our power station and also our new car depots for electric lighting and other purposes. I have repeatedly complained about these men and the progress which they have made with their work, and from time to time warned them that it would not be tolerated much longer. This matter came to a head on Thursday last, and ended in all these men being dismissed, with a view to getting others who would make satisfactory progress. One of the wiremen, a man named Frederick Parks, evidently got it into his head that we had no right to dismiss him, and, in consequence, struck upon the idea of taking his revenge, evidently upon myself, through the department generally, and what he did was briefly as follows:—Being known to the watchman on duty for months past as having work to do in connection with the power station, he walked straight through the car depot about 9 p.m. on December 24th without seeing anyone but the watchman, who, thinking he was going to work, did not challenge him. By going through the car shed he was able to get right up to the top end of the power station without being seen by anybody, as the car depot was in semi-darkness, all the cars being on service. From the top of the car shed he crossed over to the power station, and worked his way into the same, by what means I do not at present know. He, however, gained access to the chamber immediately underneath the Ferranti switchboard which we have installed, and inside this chamber regulating rheostats are fixed and stand upon a platform about 8ft. from the ground level. This chamber cannot be seen from the engine room, as otherwise the man would have been seen by the engineers in charge. Having once gained access to this chamber, he took particular care not to turn the lights on, knowing that if he did so he would immediately light a signal light on the switchboard gallery above, which would warn the engineers on duty that somebody was in the chamber working. He then proceeded to disconnect the cables from the field regulating rheostats.

The first machine which he came to was one of 1,100kw., which was not working at the time, but which was in readiness to be put on quickly in case of emergency, consequently nothing happened when he pulled the wires out of the terminals. Very different results were obtained with the second machine which he tampered with; this machine was taking the whole of the tramways load of 105 cars, and consequently was fully loaded up at the time. Of course, two things happened: the whole of the load was thrown off the machinery and the tramways service stopped; secondly, the man received a shock severe enough to throw him off his feet, with the result that he fell from the platform upon which he was working to the floor 8ft. below. Injuries sustained consisted chiefly of slight concussion caused by the fall. Fortunately, the switchboard attendant on duty at the time suddenly saw the load go off the machine, and reported to the engineer-in-charge that he had heard a peculiar thud underneath. The man was subsequently discovered lying unconscious. The spare machine being disconnected also, it was impossible to get the car service under way again until the field wires had been connected to the rheostats. Everything was going on again in less than 20 minutes, and, considering that all the traction feeders had to be put in again, the performance is a very creditable one.

By a fortunate coincidence I got in communication with the power station about 5.30 to 6 o'clock to ascertain what sort of a load they had on at that time, and also as to what machines were taking the load, and I was told in reply that the two large sets of 1,100kw. each were working, one taking the tramways load and the other the electric lighting load. I then gave instructions for the electric lighting load to be transferred over from the large set to the four 300kw. sets, as I realised that if anything happened to one of the sets the other three would be able to take up the load comfortably, consequently we should insure continuous supply for that evening, and the other machine which this man disconnected first was the machine from which the lighting load was transferred.

I gave the man in charge, after which he was taken by the police ambulance to the infirmary, where he is now, and when he is discharged from that institution he will then be brought before the magistrates and charged under the Electric Lighting Act, 1882, 45 and 46 Vict., chap. 56, sec. 22. The penalty is five years' penal servitude or two years' hard labour, and this is as little as the man deserves. Our staff have worked nobly during the holidays putting the machine right, because the effect of breaking the circuit suddenly, as this man did, was to burn out one of our large field coils, and these are somewhat difficult to get at and put in order again.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, January 5th.

LONDON ELECTRICAL CONTRACTORS' ASSOCIATION.

8 p.m. Meeting at Frascati's Restaurant, Oxford-street, London. Paper to be read: "The Necessity for the Standardisation of Wiring Rules," by R. B. Johnson.

THURSDAY, January 7th.

RUGBY ENGINEERING SOCIETY.

8 p.m. Meeting in the Lecture Hall, Lower School, Clifton-road, Rugby. Paper to be read: "The Design and Construction of the Electric Tramway Car," by R. H. Simpson.

RÖNTGEN SOCIETY.

8:30 p.m. Meeting at 20, Hanover-square, W. Paper to be read: "The Revelations of Radium," by Dr. G. B. Batten.

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ELECTRIFICATION OF THE LANCASHIRE AND YORKSHIRE RAILWAY.

Little more than 12 months ago the Lancashire and Yorkshire Railway Co. decided to electrify the portion of their line between Liverpool and Southport, and although at that time much of the detail of the work had to be decided, a start was made early in 1903 upon the work, which has steadily and quickly progressed. The original scheme has since been extended, and a service at certain times of day will be given to the stations as far as Crossens, on the north side of Southport, on the old West Lancashire line, so that residents in these districts will eventually be able to go to and return from Liverpool and district without change of carriage. The amount of track to be electrified amounts in all to about 23 miles of double line, nearly all of which has been completed. All the high-tension alternating cables have been laid. The sub-station buildings are all completed, and progress is being made with the erection of machinery in them. The rolling stock is in an advanced state, and is now being electrically equipped. The power-house building is complete, and every effort is being made to get the machinery ready for operation early this year (1904). Satisfactory experimental runs have been made with one of the new four-car trains between Southport and Formby, high-tension alternating current being obtained from the power house at Formby and transformed into continuous-current at Birkdale sub-station.

The trains generally are composed of two first and two third class cars, the third class cars being equipped with four motors of 150 H.P. each. To operate these motors current is obtained from a rail alongside the running tracks, which is fed with continuous-current at about 600 volts from four sub-stations, three of which are situated at Birkdale, Seaforth and Sandhills respectively, while the fourth is in the main power house.

The power station adjoins the railway, on the banks of the River Alt at Formby, is a building 290ft. long by 130ft. wide, and consists of an independent steel structure, the steel stanchions of which, in addition to carrying the roof, support travelling cranes over the engine room, the spaces between the stanchions being filled with brickwork. It has two spans, one containing 16 Lancashire boilers, 8ft. 6in. in diameter, by 32ft. long, for a working pressure of 160lb. per square inch, together with superheaters, feed pumps, induced draught plant, &c.; the other and larger span contains four horizontal cross compound condensing engines of 1,500kw. capacity, also one subsidiary vertical compound condensing engine of 750kw. capacity, capable of taking large overload for short periods. The generators in connection with these engines are of the three-phase type, with a frequency of 25 $\sim$ per second and a voltage of 7,500. The engine room also contains steam-driven exciters, sub-station plant, and a main switchboard. Three-core paper-insulated metallic-sheathed cables laid "solid" convey the high-tension current to the sub-stations. The sub-station equipments, similar in character, consist of 12 air-cooled transformers, which reduce the voltage from 7,500 volts to the requisite tension for conversion by four 600kw. rotary converters to continuous current at 600 volts. The third rail is of special steel, Vignoles section, weighing 70lb. to the yard, and is supported at intervals of 10ft. on insulators, the centre of the rail being exactly 3ft. 11½in. from the centre line of the track, and the top of the rail 3in. above the surface of the track rails, these being dimensions agreed upon between all the railway companies. Timber guarding is being provided at all the busy places on the line, to prevent the possibility of any person coming in contact with the third rail. For the return, an exactly similar rail, supported on wooden blocks, has been placed in the four-foot way, bonded, of course, to each running rail.

The cars are 60ft. long and 10ft. wide, being the widest carriages in this country. This width was adopted because it was found before any operations were begun that it was possible on the Southport line, as distinguished from other parts of the main line, to have wider stock, some slight alterations to the permanent way and some trifling ones to the platforms along this length alone being necessary. The carriages have centre passages throughout, with vestibules to allow passage from one carriage to the next.

The motor vehicles are at the end, and the outer end has a small compartment for the motorman, containing all the apparatus for controlling the train. Most of the seats are cross-wise, to seat three on one side of the passage and two on the other, but at the ends they are fixed lengthwise, to allow more room for passengers entering or leaving the cars. The cross seats are reversible, so that passengers may sit as they choose. All seats are covered with rattan, and the interior of the cars is fitted with oak. The trailers or first class cars have seats arranged after the same design, but only two on each side of the passage; they are upholstered in "Epingle," the interior decoration being mahogany, with light wood panelling, and the roof covered with millboard. Special attention has been given to the electric lighting and heating of these vehicles. A four-car train will carry 270 passengers, the third class seating 69 and the first class 66 people.

The motor compartments have, with the exception of the roof, which is covered with sheet-steel plates, been lined with "Uralite," a well-known fireproof material, the floor also being fireproof. In addition to the cable troughs, in which the cables are placed for conveying current to the motors, and equipment being lined with uralite, the whole of the floor over the motors is covered with the same material and thin steel plates. All the trains carry fire appliances, and ample steps have been taken to ensure safety in this respect, though the danger on surface lines is practically nil. The vacuum brake used on the trains is, with some slight differences, the same as that used all over the Lancashire and Yorkshire Railway. It is fitted with quick-acting valves, and, as will be seen, an exhauster must be provided in place of the steam ejector on the locomotive. This is the first case of the use of the vacuum brake upon electrically-worked trains.

When the service starts there will be a service of stopping trains in both directions between Liverpool and Hall-road with not more than 10 minutes' interval; every second train will go on as a stopping train to, or come from, Southport, thus forming a service to Southport every 20 minutes. In addition to this, however, there will be an hourly express in each direction between Liverpool and Southport, and at certain times the trains arriving at Southport from Liverpool will go on to Crossens. The stopping trains between Liverpool and Hall-road and those between Liverpool and Southport will be run in less time than at present, but it is not intended that the expresses to Southport shall do the journey in less time than the fastest steam trains now running. The work, with the exception of the rolling stock, which is being made at the Horwich and Newton Heath works of the railway company, is being carried out by Messrs. Dick, Kerr & Co. (Ltd.), who are now fast completing at their Preston works the main and subsidiary generators, the sub-station equipment, the control equipments of the trains and other electrical plant.

Electric Traction and Telephones in Australia.—The *Australian Mining Standard* states that the report of the Electrical Board of the Commonwealth on the question of interference by overhead systems of electric tramways with telephone lines has been handed to the Postmaster-General. The report deals with not only the existing interference with the telephone system at Bendigo, but the whole question of the protection of the lines from injury by any other lines or works. Various methods are suggested for reducing this disturbance, but the only complete cure is reported to be the adoption of the metallic telephone system. Leakage and stray currents also gave trouble. To prevent this, it is suggested that all electric lines for lighting and tramway service should be substantially constructed and efficiently maintained, and the Board recommends, as a basis for further prevention of such leakages, that the Board of Trade's regulations on the subject should be adopted. It is suggested that these regulations should be printed, and the representatives of tramways and other authorities invited to peruse them and offer suggestions.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 379.)

An examination of the recovery and decay of the radio-activity of uranium and uranium X (Rutherford and Soddy, *Phil. Mag.*, 1903, VI., 5, p. 422) showed that the considerations just developed for thorium apply equally well for the case of uranium. Nearly six months is required, however, before the radio-active equilibrium is attained in this case. Since the uranium X gives all the β or penetrating rays of uranium, the course of the production of uranium X can be followed by measuring the penetrating radiation from uranium after the uranium X has been separated chemically. Fig. 25 shows the curves of recovery and decay of the penetrating radiation of uranium and uranium X with time. When separated from the uranium producing it, the activity of uranium X decays in a geometrical progression with the time, as shown in Fig. 25, and falls to half-value in about 22 days. The value of λ (equation 2) for this case is, therefore, about $3{\cdot}6 \times 10^{-7}$ when t is expressed in seconds. When free from uranium X, uranium gives practically no penetrating rays. The gradual recovery of the β-radiation by the uranium is shown by the second curve of Fig. 25. The proportionate loss of activity of uranium X is for any time approximately equal to the proportionate recovery of the β activity of the uranium, and equation (3) with the value of λ just given applies to the recovery of the activity of uranium equally to that of thorium.

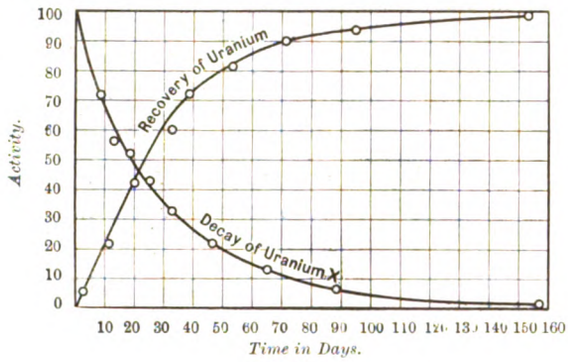

FIG. 25.

Special interest attaches to the case of uranium on account of its simplicity. The radiation can be analysed into its two constituents and the uranium shown to be responsible for the whole of the one type, the uranium X for the whole of the other. Then, again, uranium, unlike thorium and radium, does not produce radio-active emanations or impart radio-activity to its surroundings. These secondary effects cause the initial irregularities in the curves of decay and recovery for thorium which are absent in the case of uranium. On the other hand, the non-separable activity, which in the case of thorium is a relatively small fraction of the whole, in the case of uranium comprises the whole of the α-radiation, and therefore 99 per cent. of the total energy radiated. The existence of this non-separable radio-activity is general for all three radio-elements, and does not appear to be merely due to the insufficiency of our chemical methods in analysing the sources of the radio-activity. It is possible that further chemical investigation will show that what is here termed non-separable activity is in reality due in part to new types of matter not yet separated from the radio-elements. But it is unlikely that the latter will ever be obtained by any chemical process entirely free from radio-activity, and recover it with the lapse of time. In fact, the non-separable activity has a very important and fundamental bearing on the final view we adopt of the cause and nature of radio-activity.

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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The Radio-active Emanation of Thorium.—A detailed investigation of the radiation from thorium (Owens, *Phil. Mag.*, 1899, V., 48, p. 360) brought to light a curious fact. It was found that the ionisation current through the air in a closed space under the influence of the rays from the various thorium compounds increased with time up to a maximum value. If air was then drawn continuously through the apparatus by means of a pump, the current immediately decreased to a minimum value. This effect was more marked for a thick layer of thorium compound than for a thin layer. In the former case the maximum current was three times as great as the minimum. Rutherford (*Phil. Mag.*, 1900, V., 49, p. 1), showed that this effect was due to thorium compounds possessing the property of continuously emitting into the air particles of some kind which possessed temporary radio-activity. That is, the air in the neighbourhood of a thorium compound possessed the power of giving out radiations on its own account, and this power persisted in the air for some time after the thorium compound was withdrawn. Rutherford named the radio active substance communicated to the air in this way the "emanation," to distinguish it from the radiations which thorium also emits. He found that the latter are completely absorbed by covering the salt with a single thickness of foolscap paper, whereas the emanation readily finds its way through 20 layers, so that the effect of the emanation alone can be well studied by enclosing the thorium salt in paper. Under these circumstances the ionisation current observed when the package is placed between the plates of the testing apparatus is reduced to a very small fraction of its original value when a blast of air is directed between the plates. The thinnest sheet of mica or glass is, however, completely impervious to the passage of the emanation. In this and all other respects in which it has been examined, the emanation behaves like a gas distributed in infinitesimal amount through the atmosphere which carries it, each particle emitting rays on its own account and acting as a centre of ionisation in the atmosphere.

The "emanating power," or ability to give the radio-active emanation, is proportional to the quantity of the thorium compound employed, whereas the radiating power is proportional to the surface exposed. Thus, in very thin layers the ionisation is caused chiefly by the radiation, and as the layer is increased in thickness, the additional ionisation due to the emanation is increased. Hence, in the former case a blast of air has little effect on the value of the radio activity. Thin layers of thorium preparations are in this respect little different from those of uranium. With thicker layers the difference is, however, very marked, and the value of the radio-activity is greatly affected by slight currents of air. All these phenomena are quite independent of the nature of the atmosphere employed.

The properties of the radio-active emanation itself will be first considered, without reference to the manner in which it comes to be produced by the thorium. The experiments quoted show that thorium transmits to the air an ionising agent with the properties of a gas, but the question remains open as to whether the ionisation is produced by *rays* of the kind which constitute radio-activity. This is a difficult point to establish experimentally in the case of the thorium emanation, and was accomplished by Rutherford in the following manner. A vessel was constructed, through which the thorium emanation could be led by a current of air. In one side of the vessel was a window of the thinnest mica sheet, which, although gas tight and impervious to the passage of the emanation, was thin enough to allow a sufficient fraction of α-radiation of ordinary penetrating power to pass through unabsorbed. The effects of the imparted activity (*q.v.*) were eliminated by keeping the vessel positively charged with respect to an internal electrode placed out of the direct line of fire to the mica window. In this way any imparted activity, produced by the emanation, was concentrated on the negative electrode, the radiations from which were unable to penetrate to the outside of the vessel. Under these circumstances the outside air in the line of fire from the mica window was found to be ionised by rays which could only come from the gaseous emanation inside the vessel. Rutherford proved with this arrangement that the rays from the thorium emanation consist entirely of the easily-absorbed

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and difficultly-deviable α-rays, and no detectable amount of β-rays are present. This experiment, difficult for the thorium emanation, has been shown in the simplest manner for the millionfold more powerful radium emanation (*q.v.*). The emanation particles do not appear to move appreciably under the action of an electric field, and Rutherford concluded that they are uncharged. Our present knowledge shows that this result proves, rather, that if the emanation particle is charged it can give up its charge without losing either of its essential characteristics—viz., its volatility or radio-activity. The point will be again referred to when the actinium emanation is dealt with.

(To be continued.)

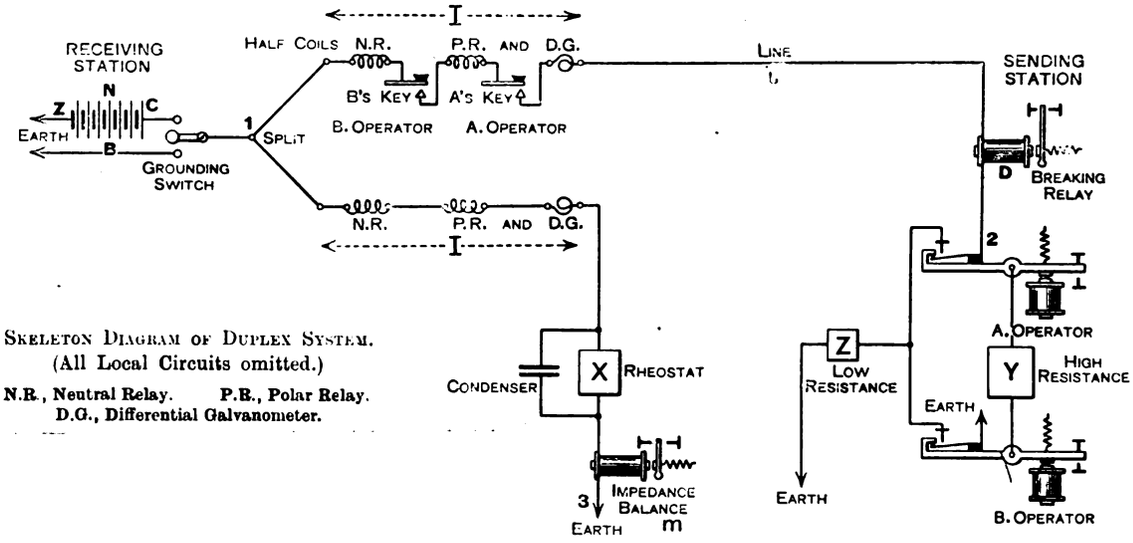
DIFFERENTIAL DIPLEX TELEGRAPH SYSTEM.

Duplex working under the usual conditions, with batteries at each end of the line, led shortly after its introduction to various suggestions for its improvement. Among the proposals put forward for the extension of duplex working to small or unimportant places was one which provided for the employment of batteries at one end of the line only, the necessary alterations in the current values to ensure the receipt of signals at the end of the circuit where the batteries were employed being produced by alterations of the line resistances at that end of the circuit where battery power was not available. It is not known whether this mode of duplex working has ever been adopted practically, although experiments have been made which seemed to give satisfactory results.

Mr. H. W. Jenvey, of the Australian Telegraphic Administration, has, however, recently revived and improved a method of diplex working which is said to have been originally invented by Mr. W. J. McGaurin, and introduced experimentally 20 years ago. In this system batteries are used at one end only, and the more important office—namely, the office having the necessary main voltage—is not the sending, but the receiving office, the sending office requiring local batteries only. Mr. Jenvey claims that the system is adapted for use at race or political meetings, although it would appear that as the date and place for such meetings are usually known some time before their occurrence, the claim that the McGaurin-Jenvey apparatus obviates the necessity for the use of more elaborate systems has, in this country, little practical value. The advent of accumulator working and generating plant has, no doubt, given an impetus to central battery systems in general, but it is well known that the weak point of all methods of working which depend on alteration of current values by the insertion of a resistance at a distant point, is the variation of insulation. We must congratulate the Australian Administration on the possession of an equable and reliably dry climate, if it is seriously intended that the McGaurin-Jenvey system is a suitable method of diplex working on unexpected occasions and in unexpected and badly-equipped localities.

The method of producing the changes of line resistance which actuates the relays at the receiving office is very ingenious, and will be understood by referring to the accompanying diagram. The receiving office has an ordinary quadruplex set, but instead of the usual reversing and increment keys, two keys are inserted, so as to enable either the A or B receiving telegraphists to disconnect the line circuit, and so attract the attention of the senders by operating an electromagnet at the sending station. At the sending end of the circuit, when the keys (which close the local circuits of the transmitters marked "A operator" and "B operator") are at rest, the resistance added to the line is very much higher than that inserted in the balancing rheostat at the receiving or battery station, from whence a current of the same polarity is constantly passing on to the line—the receiving station's rheostat-current will, therefore, be in excess of that passing out to the line when both sending stations' keys are at rest—this will produce a spacing current on the A polarised receiving relay, but not of sufficient strength to actuate the armature of the B relay.

When the A key at the sending end is depressed it offers an alternative path of lower resistance to the incoming current,



SKELETON DIAGRAM OF DUPLEX SYSTEM.
(All Local Circuits omitted.)
N.R., Neutral Relay. P.R., Polar Relay.
D.G., Differential Galvanometer.

and cuts off the higher resistance path to earth via the B transmitter. The lowered resistance produces a preponderance of current through the line coil of the polar relay, the actual value of which is similar in amount, but opposite in magnetic effect, to that caused by the rest position. A signal is, therefore, produced on the A side only. When B alone depresses his key, the line is disconnected, increasing the flow of current through the distant, or receiving, station's balancing rheostat, to such an extent as to bring the non-polarised or B relay into action, thus producing a signal on "B," while pressing the armature of the polarised relay more firmly on the spacing or idle contact.

The depression of both the A and B keys puts the line direct to earth at the sending end, producing not only that preponderance of current in the line coils of the receiving office which produces an "A" signal by a change of polarity, but also that increased amount of current which enables a "B" signal to be received.

It is quite clear that for short, well-insulated lines, or for underground conductors, this system would be perfectly workable, although the adoption of this mode of diplex working would in practice be determined by its suitability for local conditions, as it cannot be said that Messrs. McGaurin and Jenvey can claim any superiority in working value, or freedom from those faults which are occasionally met with in diplex working with batteries at both ends.

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We have been favoured by the receipt of an account of a trial of this system in August last on a loop of 175 miles in length, commencing and terminating in Melbourne. It is stated that this line was of No. 8 gauge iron wire, had a resistance of 15·9 ohms per mile, and a capacity of 0·014 microfarads per mile, while its leakage was not "appreciable," and our impression as to the favourable climate possessed by our Australian friends is confirmed. The presence of trees and the multiplicity of wires on our English lines gives us an average capacity at least 10 per cent. higher than that quoted in the report mentioned, while an insulation resistance which could be easily measured (say, 20,000 ohms, or 35,000,000 per mile) would be considered a high level for a good summer in our erratic climate. The level of summers such as those of 1902 and 1903 would certainly upset all diplexes of the type now being considered, as a disconnection, or an earthing such as is essential in the McGaurin-Jenvey diplex would not produce any perceptible change at the receiving or battery end of the diplex line. It is observed that Mr. Jenvey inserts an impedance coil in the artificial line at the battery station, and this has been for some years the practice of the British Post Office on all their short quadruplex circuits—which were practically unworkable before its introduction, unless the circuits were lengthened artificially.

BREAKDOWN AT BRISTOL.

A total breakdown occurred at the Bristol generating station on the evening of December 23rd, owing to a fire which broke out on the high-tension switchboard. Considerable confusion was caused among tradesmen and others, as the light was extinguished at the busiest time of the day and that day one of the busiest of the year. The following is an official report which has been sent us by Mr. H. Faraday Proctor, the city electrical engineer :—

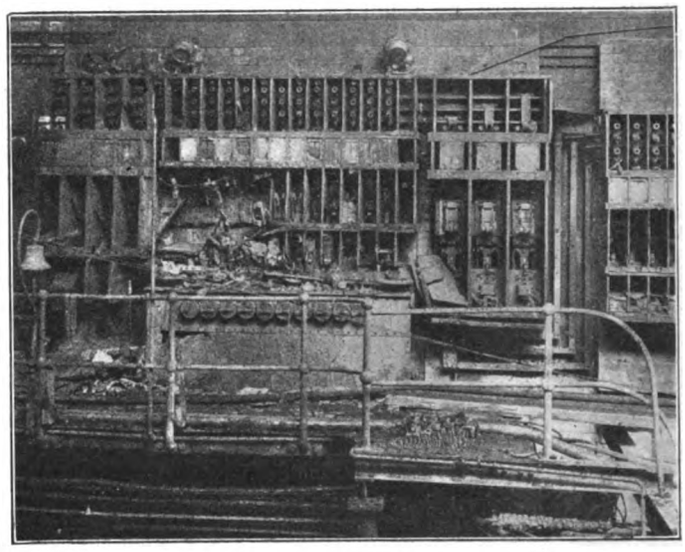
A fire occurred at the Temple Back electricity works belonging to the Corporation of Bristol on Wednesday evening, at 5:15 p.m., resulting in the total destruction of the 2,000-volt high-tension "Ferranti" switchgear and other damage, including the roof and windows of the engine room. The exact spot at which the trouble commenced and the cause of the same cannot at present be ascertained. The machine switchboard, wattmeter switchboard, trunk feeders from the Avonbank electricity works, and the whole of the 44 feeder panels were totally destroyed, as well as all the cables leading up to them from underground. Steps were immediately taken to shut off all current and shut down the boilers. The fire brigade were quickly on the scene and the fire was soon got under control. The whole of the staff and employés immediately turned their attention to getting lighting on the premises to facilitate the carrying out of temporary work which was necessary. The Bristol Tramways and Carriage Co. (Ltd.) most kindly volunteered to start up their St. George's station, which had been out of use for some considerable time, and also to run cables and supplement the continuous-current supply if necessary. The Corporation availed themselves of the offer to the extent of some temporary arc lighting in the engine room, and the tramway company supplied, erected and connected five arc lamps in the engine room, running cables from their Counterslip power station close at hand. By the time this work was done, however, the continuous-current supply of the Corporation was again in operation, the whole of the continuous-current power consumers having energy available at 2:30 a.m. on Thursday morning, thus enabling the different newspapers, all of whom use electricity for printing purposes, to get out their early editions.

Trunk cables from the Avonbank electricity works were joined across to the Clifton and Redland feeders outside the works, thus enabling the alternating-current supply in these districts to be started up at about the same hour. The new 5-ampere arc lamps (365 in number) for lighting public thoroughfares in different districts being supplied from feeder pillars at different parts of the city from the continuous-current supply system, were in operation at about 2:30 a.m. on Thursday morning also. Many other arc-lighting circuits were able to be started up shortly afterwards, the continuous-current switchboards and machinery being damaged to a much lesser extent than was the case with the high-tension gear. Line resistances and other controlling gear, being in a very wet condition from the liberal application of the hosepipe, of course caused some trouble, but the bulk of the lighting was kept going after the hour above mentioned. A temporary distributing switchboard was at once put in hand, and to this were joined the trunk feeders from the Avonbank electricity works, and the whole of the distributing feeders connecting the 60 or 70 sub-stations with the Temple Back works were joined up to this, joints having been made on all these cables in the street outside the works. This being done, all the feeders which were in proper condition were started up, the Clifton and Redland districts being switched off for this purpose, so that all might be put on together. The whole of the supply, both alternating and continuous was in full working order by about 8 p.m. on Thursday evening.

Numberless telegrams and other messages offering assistance and expressing sympathy were received from all parts of the kingdom. These have been too numerous to reply to during the extreme pressure of work, but gratitude is felt towards all those who thus expressed their feelings, and equally so to those who have only refrained from doing so in case they should take up the time of those engaged in rectifying the troubles.

The engine room roof and windows, which were burnt out, were protected as early as possible, the whole roof being covered with tarpaulins and the windows boarded up. Fortunately, there has been little wet weather since the accident, and this has greatly assisted in the work that has been necessary.

The whole of the staff and employés were kept hard at it during Wednesday night and until midnight on Thursday, and, in addition to those at present engaged in the works, some former assistants have most kindly come down to render assistance which, owing to their knowledge of the details in the station, has proved most valuable. Fortunately, some of the machines at the Temple Back works were left in such a condition that, in spite of the great volume of water that was poured upon them, they were able to be started up after being dried out by passing current through them. The boiler house and steam plant is all, so far as can be ascertained, in working order, none of such plant so far having given any trouble. The difficulty to be coped with now is the finding of a switchboard which will really be reliable under similar conditions on a supply system of 2,000 volts alternating.



PART OF BRISTOL SWITCHBOARD.

No meeting of the Electrical committee was held until Tuesday, as Alderman George Pearson, the chairman, expressed the view that it was better to give the officials an absolute free hand to deal with matters, rather than to take up their time by holding committee meetings, or by restricting their efforts in any other direction. This, of course, has greatly facilitated the expeditious reparation. A report of the committee's proceedings is given in another column.

Mr. H. D. Clothier, manager of Messrs. Ferranti's switchgear department, has sent us the following additional information :—

The failure occurred on the single-phase alternating-current system at 2,000 volts, and it will be remembered (from previous articles in your paper) that there are two stations at Bristol, the old one at Temple Back and the new station at Avonbank, and that the whole of the distribution is from the switch gear at the old station, this switch gear being connected up by trunk mains to the new Avonbank switch gear. Both switch gears are of the Ferranti cellular type, the one at Temple Back being ordered from Messrs. Ferranti nearly five years ago. At the time of the accident the load of about 3,000kw. was being taken up by two 400kw. machines at Temple Back and four 750kw. machines at Avonbank.

In such occurrences it is difficult to locate exactly the origin of the fault, but from the appearance of the switch gear it would seem that, for some reason yet to be discovered, one or both of the machine fuses at Temple Back blew. This action was apparently followed by a severe arc in the fuse panel which burnt through the slate above it, melting the fuse contacts and the metallic connections between the fuses and the switches. It would appear from the débris that, although some minutes were taken to shut down the machines at Temple Back and Avonbank, the arc thus formed was confined to the machine panels. A serious conflagration, however, was almost simultaneous with the forming of the arc, the flame igniting the linoleum floor and the insulation over the inner conductor of the cables connecting to the terminals under the bottom switch slate. The flames from this material were intense and quickly spread over the entire switch gear and to the roof of the building.

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A close examination on Thursday revealed the fact that the damage to the power station and machinery was not so extensive as was at first thought. The fire was confined to the woodwork used in the structure, the insulation on the cables and the flooring, although the water with which the fire was subdued injured some portions of the plant.

Great credit is due to Mr. H. Faraday Proctor and his assistants (Messrs. Couzens and Bolam) for the energetic way in which they coped with the most trying situation. Practically, the whole of the cable work in the station had to be cleared, and in order to get down to the sound portions of some of the cables it was necessary to dig up the road adjoining the electricity works.

Although the Ferranti cellular switch gear is apparently at fault, in that the fuse, which is of an obsolete type, failed, yet the arc caused by this failure was confined to the switch and fuse panels of three or four machines; the 'bus bars (there being three inner 'bus bars in number) remaining intact, thus giving a practical demonstration of the utility of the cellular construction in limiting to a minimum the extent of the arc. While admitting that the remainder of the switch gear, including the circuit section, were placed out of commission, it must be taken into consideration that the damage was not caused by a direct electrical failure on the individual sections, but by the heat and smoke resulting from the combustion of materials, which, although they were contiguous and near to the switch gear, did not form an inherent part of the actual cellular switch-gear design.

HIGH-TENSION CONTINUOUS-CURRENT POWER TRANSMISSION AT 20,000 VOLTS.

In 1898 the Swiss town of Lausanne purchased the rights of the waterfalls in Bois-Noir, on the Rhône near St. Maurice, this place being approximately 35 miles distant from Lausanne. The minimum power available is 10,000 H.P., the normal being about 15,000 H.P., but only 5,000 H.P. is at present utilised. Tenders were invited for the complete power transmission between the two places, and the contract was secured by the Compagnie de l'Industrie Electrique de Genève for their high-tension continuous-current system. The company states that the capital costs of the continuous-current (Thury) system amounted to £294,000, and that the initial cost of a three-phase transmission was estimated at £324,000. Although continuous current was proposed by the contracting firm also in connection with the local lighting system of Lausanne, a three-phase current distribution was decided upon for reasons other than technical. The undertaking was successfully inaugurated last May.

Since the normal quantity of water at the power station is 8,800 gallons per second, and the useful head of water is 113ft. in summer and 118ft. in winter, a power of about 15,000 H.P. is normally available. At present the power house contains five 1,000 H.P. continuous-current sets and two 120-H.P. three phase sets, but extensions to the plant will be added when required until the total of 15 1,000 H.P. sets has been installed. Both the large and the small-sized turbines are of the Francis type; they were built by Messrs. Escher, Wyss & Co., and have an efficiency of 75 per cent. at full load. The two small turbines develop about 150 H.P. at 750 revs. per min., the speed being kept constant by means of a governor. Coupled by an insulating coupling to each turbine shaft is a 100kw. 3,000-volt three-phase alternator. These two alternators are used in connection with the lighting system of St. Maurice, which is situated at a distance of about 2 miles from the power house. The armature windings are connected in star fashion, and the pole-shoes of the revolving magnet system are rounded off so as to ensure a sinusoidal alternating-current wave. Contrary to the small turbines, the speed of the 1,000 H.P. sets is varied according to the load on the station. At normal load, however, the speed is 300 revs. per min. As will be seen from Fig. 1, each turbine is coupled to two six-polar continuous-current series machines of a normal output of 150 amperes at 2,250 volts each. The two generators are connected in series, as will be gathered from the diagram of connections (Fig. 2). Not only the coupling between turbine and first dynamo, but also that between the first and the second dynamo is of an insulating and somewhat elastic nature. Since 10 generators have been installed up to the present, and are, according to Fig. 2, connected in series, the normal voltage of the supply is about 22,500 volts. Fig. 3 gives a good idea of the peculiar construction of the generators. The six magnet coils are connected in parallel, each carrying, therefore, 25 amperes. At 20°C. the resistance of the field winding is about 0·20 ohm, and the copper losses in them thus amount to about 1·4 to 1·5 per cent. of the normal output. A series-winding of a patented form is employed for the armature. Its chief characteristic lies in the fact that three distinct brush positions correspond to each pole. Two of these are utilised in the machines in question. Measured at 20°C., the armature resistance is 0·24 ohm; the losses in this direction would, therefore, amount to about 2·2 per cent. of the full load output. The commutator consists of 57 segments and is 5½in. long and 30in. in diameter. For each pole there are two brush spindles, according to the two brush position chosen, and each spindle carries four carbon brushes of a sectional area of 0·465 sq. in. Armature and commutator are rigidly connected together and are effectively insulated from the armature spider, and therefore from earth, by means of mica plates. Paper is used for insulating the magnet coils from the pole cores. Fig. 3 shows plainly how the machine, as a whole, is insulated from earth. Sixteen adjustable screws rest on strong porcelain insulators, which, in their turn, are separated from the concrete foundation by a layer of asphalt and by a plate of glass 3½cm. (1⅜in.) thick and 30cm. (1ft.) square.

Before leaving the works the generators were subjected to the following insulation tests:—First, the machines were run up to a voltage of 3,700 volts, this pressure being kept up for 10 minutes. Then the test was repeated for five minutes, with the sole difference that one pole was connected to the magnet frame. After the completion of the power station and the transmission line, the installation as a whole was subjected to insulation tests carried out with the aid of a small continuous-current dynamo generating 1 ampere at 22,500 volts.*

All cables which interconnect the dynamos and switch gear consist of single rubber-insulated conductors, drawn singly through glazed earthenware tubes. The measuring instruments, as well as their

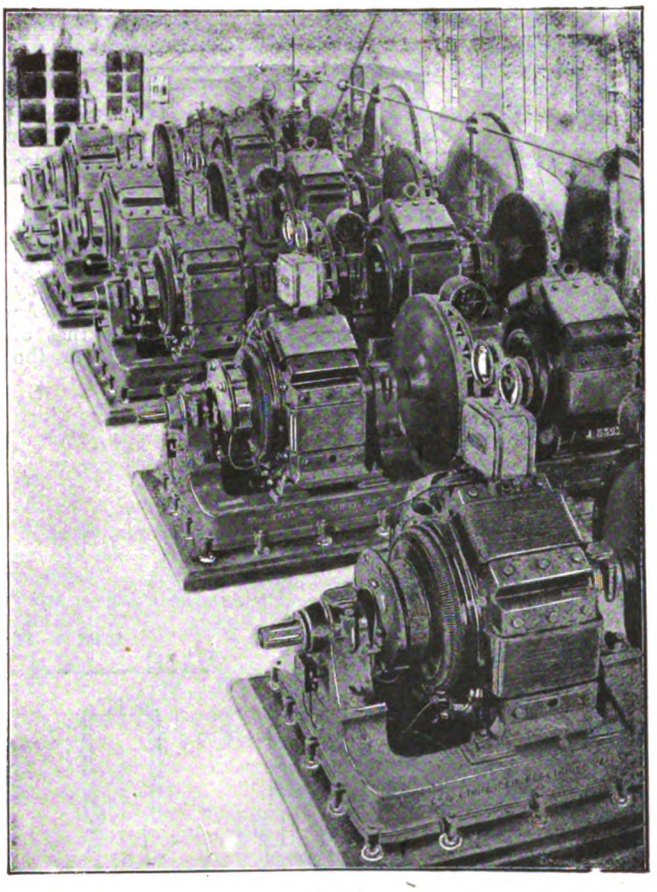

FIG. 1.

boards or supports, are all thoroughly insulated from earth and in a similar manner to the generators. A layer of asphalt-concrete 3cm. (1·2in.) thick covers the machine room, and upon this is laid a second layer 1½cm. (⅜in.) thick and consisting of pure asphalt. In Fig. 2 A denotes the ammeter and V the voltmeter, the resistances of which are mounted in a perforated tin box on top of the front generator, as may be seen from the illustrations. U is a two-way switch, which either disconnects the machines from the power-circuit, completing at the same time the latter, or inserts a generating set in the power circuit in series with the other machines. On a small switchboard is a main ammeter A_o, connected in shunt to a resistance W_a, and a voltmeter V_o, connected in series with a resistance W_v. But the most important instrument of the station is the automatic regulator, Fig. 4, which by suitably regulating the flow of water to the turbines, varies their speed, and thus the voltage of the generators, in such a way that the current flowing through the system remains constantly at 150 amperes. The speeds cannot vary in very wide limits, because after a certain drop in speed—*i.e.*, voltage—any further reduction in pressure may be more economically obtained by shut-

* See *The Electrician*, Vol. XLIX., p. 410.

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ting down a generator set. The switching-in circuit of a generator set is very simple, and the shutting down of any one is easy also. For switching-in, the generating set is first of all short-circuited within itself, then the turbine is slowly set in motion by hand regulation. At a turbine speed of about 6·83 revs. per min. the short-circuit current is 150 amperes, and at this moment the generating set is connected in series with the other generators of the station. Even a considerable difference between the short-circuit current in the generators and the line current is said to be of little or no c n-

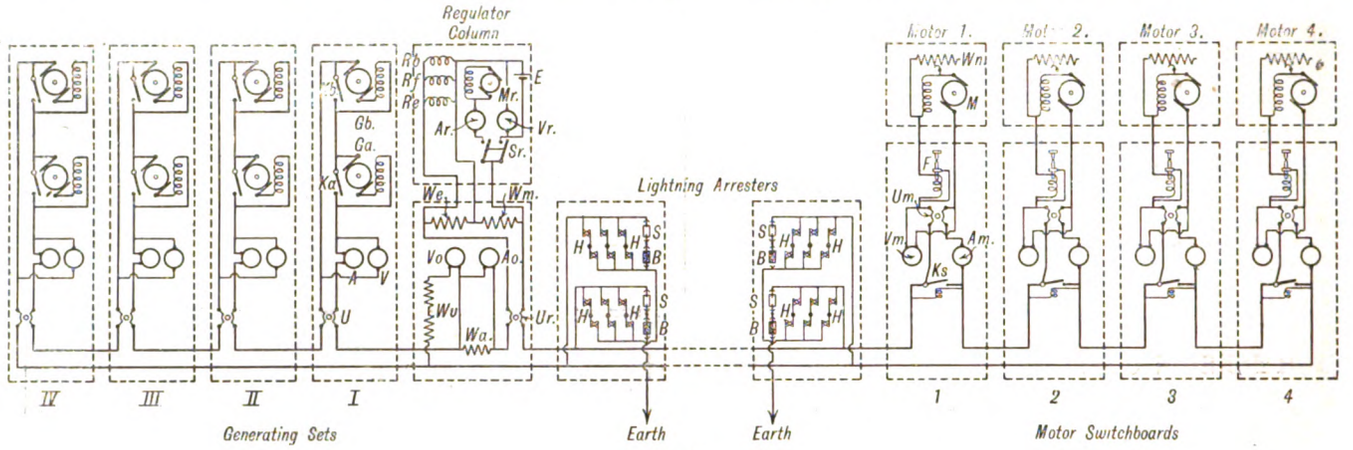

FIG. 2.

sequence. After switching-in, the speed of the turbine is raised by adjusting a hand-wheel which regulates the quantity of water passing to the turbine. As the pressure of this generator set increases, the pressure of all the other machines decreases by the action of the automatic regulator mentioned above. As soon as the voltage of this newly-inserted set equals that of the others, the turbine regulation device is coupled to the

direction. A simple pawl arrangement, however, utilises this reversal of motion for short-circuiting the generator set. In the diagram of connections these short-circuiting switches are denoted as K_a and K_b.

Great care has been given to an effective protection of the plant from lightning effects. A small building, at some distance from the power station, serves for the reception of the necessary devices. Each 'bus bar is connected to earth over three spark interrupters mounted in parallel. Their aluminium arms are released and break the arc as soon as the line current is drawn along with the lighting arc, the release being effected by means of a solenoid. In series with these mechanical lightning arresters are four carbon resistances of a resistance of 50 ohms each. Similar protective devices against lightning discharges have been provided at the station in Lausanne; no lightning arresters have been installed, however, along the transmission line.

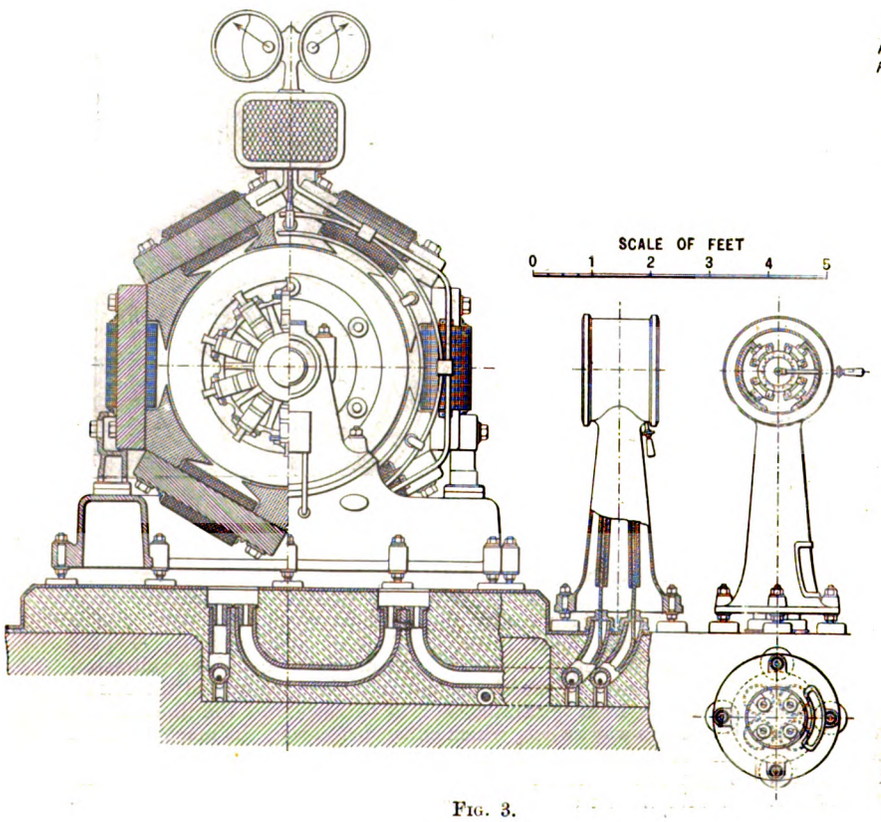

FIG. 3.

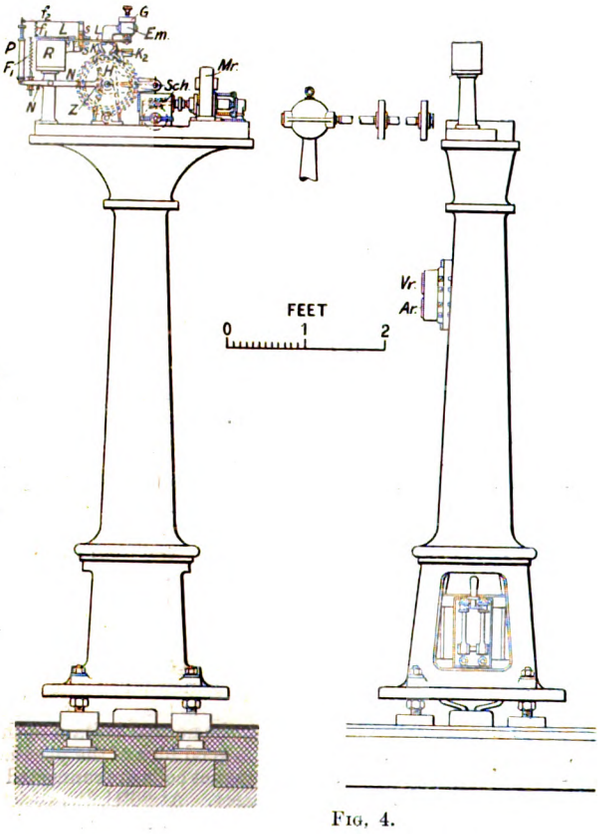

FIG. 4.

common regulator shaft, and from this moment any regulation in the turbine speed is performed by means of the automatic regulator, and in conjunction with that of all the other prime movers. To disconnect a set from the circuit the manipulation is reversed: the regulation mechanism of the turbine is uncoupled from the common regulating shaft, and the flow of water is shut down by means of the hand-wheel. As soon as the work done by the turbine falls below that required to overcome the internal losses of the generator set, this begins to act as a motor, and reverses its

This line consists of a conductor of a sectional area of 150 sq. mm. (0·232 sq. in.), and is composed of 37 strands of a diameter of 2·25 sq. mm. (0·088in.) each. At a temperature of 7°C., the resistance of the line was found to be 12·75 ohms. To save in first cost, wooden poles have been used in the line construction. They are, as a rule, simply let into the ground, but on marshy territory they are embedded at the base in a block of concrete. For the entire distance of 55km. about 1,600 poles were required. The two cables, each forming one side of the loop, are carried by the same posts, and

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are held about 4ft. apart. Beneath these cables are mounted two bronze telephone wires 3mm. in diameter. The insulators consist of an inner and an outer mantle, which are rigidly cemented together; but, whereas the inner part is a simple and completely glazed insulator, the outer part is provided with three petticoats. These insulators are said to have proved very satisfactory. An insulation test, undertaken on the morning following a rainy day and carried out with the aid of the high-tension continuous-current testing generator referred to above, gave the following result:—At an impressed voltage of 20,000 volts between the two cables a leakage current of 0·003 ampere was observed, corresponding to an insulation of 6·7 megohms. Three weeks later, after a light shower, the insulation was found to be 16·6 megohms. In connection with the transmission it may be mentioned that experiments were carried out in the direction of using the earth as return conductor. Some trouble was experienced in obtaining a low resistance

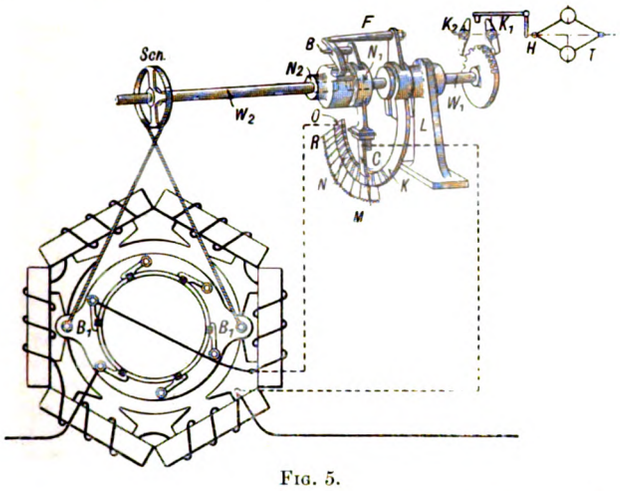

Fig. 5.

earth but after several attempts, the combined resistance of the earthing devices at both ends of the line was reduced to 0·5 ohm. The resistance of the earth was found to be negligible.

In Pierre-de-Plan, near Lausanne, is situated the motor station. Shortly before reaching its terminus, however, the transmission line branches off to a place called Pandex, conveying thither electrical energy for driving a 400 H.P. motor installed in a cement works at this place. About 3km. (1·9 miles) is thus added to the length of the line as given above. So far, no other motors have been connected up to the circuit between St. Maurice and Lausanne, but this could be done, of course, at any time hereafter. In Pierre-de-Plan the equipment consists of motor-generators. Four of these, for use in connection with the lighting system of Lausanne, are composed of four motors, quite similar in construction to the generators in St. Maurice, which are directly coupled to three-phase

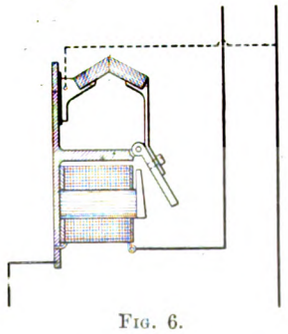

Fig. 6.

generators. Means have also been provided for coupling two of the dynamos to two Sulzer steam engines erected as a reserve. The series motors, running at 300 revs. per min., develop 400 H.P., with a current of 150 amperes, and at a voltage of 2,100 volts. When the motor load drops the speed would rise. To avoid this, a Thury speed regulator (Fig. 5) is provided, which, by shifting the brushes to a corresponding degree, keeps the motor speed constant. This regulation, however, is effective only from zero voltage to a voltage of 1,300 or 1,400 volts, corresponding to about six-tenths of the normal motor output. If the load increases above this figure, the regulator acts on the field excitation and strengthens it in such a manner as to restore the normal speed.

From the point when, corresponding to the increase in load, all the shunt resistance W_n (Fig. 2) has been inserted, and maximum field strength has been obtained, the torque remains constant, and any further rise in the load will lead to a diminution in speed. It is thus impossible to overload such a motor. The speed regulator is driven from the motor shaft by a belt. In certain cases the speed regulator may be discarded for a long range of speed; such is the case, for instance, when the generator, which is driven by the motor, is used for charging accumulators, since in this case an increase in the speed corresponds to an increase in the load. Incidentally, it may be mentioned that such a motor-generator set is in operation on a Thury series system in Zug (Switzerland).

Returning to the speed regulation by means of the regulator, it is said that in actual practice this is very satisfactory, the speed variations not exceeding 1 per cent. of the normal. In conjunction with this it is interesting to note that the paralleling of the alternators is stated to be surprisingly easy. In addition to the already existing motor-generators, several others are at present in course of erection.

Each motor is fitted with a flywheel weighing 3,800kg. (8,400lb.). To each motor belongs a small switchboard, carrying an ammeter, a voltmeter, a short-circuiting arrangement controlled by hand and a magnetic blow-out (Fig. 6). Motor-generators for producing continuous current at 600 volts for traction purposes are also being installed. A buffer battery has been erected to work in conjunction with the tramway plant. Several smaller motors, used for auxiliary purposes, such as for boosting the accumulators, &c., have been installed in the power station.

A diagram of the connections in the Lausanne station is given in Fig. 2. U_m denotes here a two-polar throw-over switch, by means of which the motor is connected to, or disconnected from, the circuit. A_m and V_m stand for the ammeter and voltmeter respectively. T, Figs. 2 and 5, is the magnetic blow-out, which is necessary, when the motors are started, to extinguish the sparks which occur at the throw-over switch in consequence of the motor self induction. Sparking does not occur on shutting the motor down, since no circuit is then opened. Each motor possesses an automatic short-circuiting switch, K_s, which cuts out the motor by short-circuiting its terminals whenever the voltage across these exceeds a predetermined limit. Should an interruption in the circuit of any of the motors take place, the total pressure of the system would be concentrated at the point of discontinuity if means were not provided to avoid this. Before this rise in pressure can take place, however, the switch K_s short-circuits the defective motor in question and re-completes the power circuit for the remaining motors.

A WAVE METER.*

BY JOHANNES DÖNITZ.

After it had become known that the transmission of wireless messages could be rendered more efficient by making use of the principle of resonance, the difficulty arose of adequately proportioning the members of tuned systems. To deal efficiently with the many problems awaiting solution, an instrument was required by means

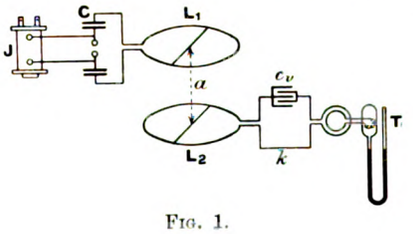

Fig. 1.

of which the actions taking place in an electrically oscillating system could be traced. Two kinds of electrically oscillating systems are to be considered: First, the "open" one, which may be defined as a system possessing simultaneously self-induction and capacity, more or less uniformly distributed at all its points; and, secondly, the "closed" system, the capacity and self-induction of which are located separately at certain points. It is characteristic of "open" systems that the energy of the electricity oscillating in them is very quickly given off in electric radiation. Such systems are said to possess a strong damping effect. A case in point are stretched wires, which radiate their energy very rapidly. Coils, however, which also represent open systems, radiate slower. "Closed" systems, on the other hand, radiate hardly at all, and are but very slightly damped electrically.

Wave-lengths may be measured by means of an open resonance coil, since it has been proved by Dr. G. Seibt† that—at syntony—its length corresponds to one-quarter the wave-length. Count Arco made use of this principle, and he was the first to employ a resonance coil with a variable number of turns‡. As actually used, it is con-

* From the *Elektrotechnische Zeitschrift*.

† *Elektrotechnische Zeitschrift*, 1901, No. 22.

‡ *Elektrotechnische Zeitschrift*, 1903, No. 1; or *The Electrician*, Vol. L., p. 777.

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structed in the form of a cylindrical bobbin, the wire being wound upon this in a single layer. An arrangement is provided by means of which any number of turns may be short-circuited. When a

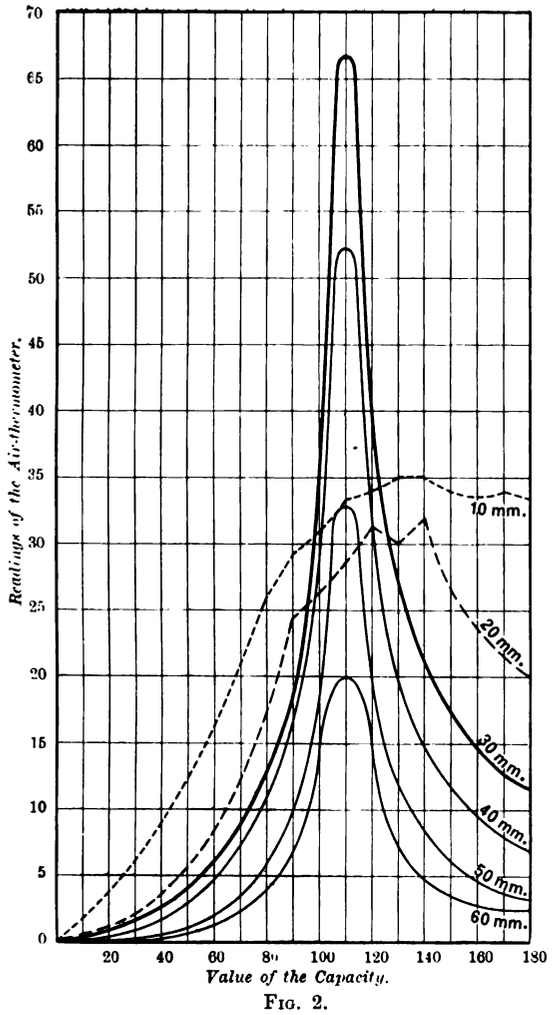

FIG. 2.

measurement is to be taken, the coil is connected up to the system under observation, and the number of turns of the coil is adjusted until the latter is in syntony. This coincides with the maximum

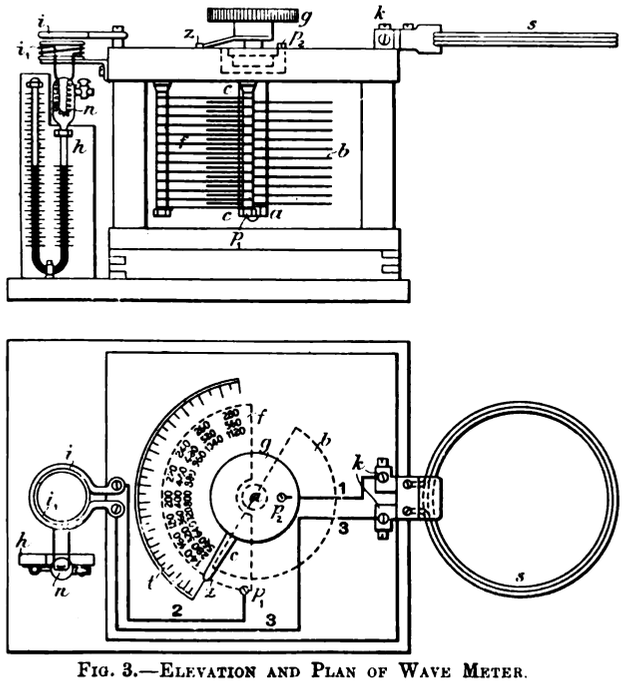

FIG. 3.—ELEVATION AND PLAN OF WAVE METER.

of pressure between the open ends of the coil and may be easily determined from this. The number of turns of the coil being known when syntony has been arrived at, the length of the wave is determined by means of an empirically obtained curve. According to what was mentioned above, the total wave-length is $\lambda = 4nx$, wherein x is a variable factor obtained from the empirical curve and n the number of active turns of the coil.

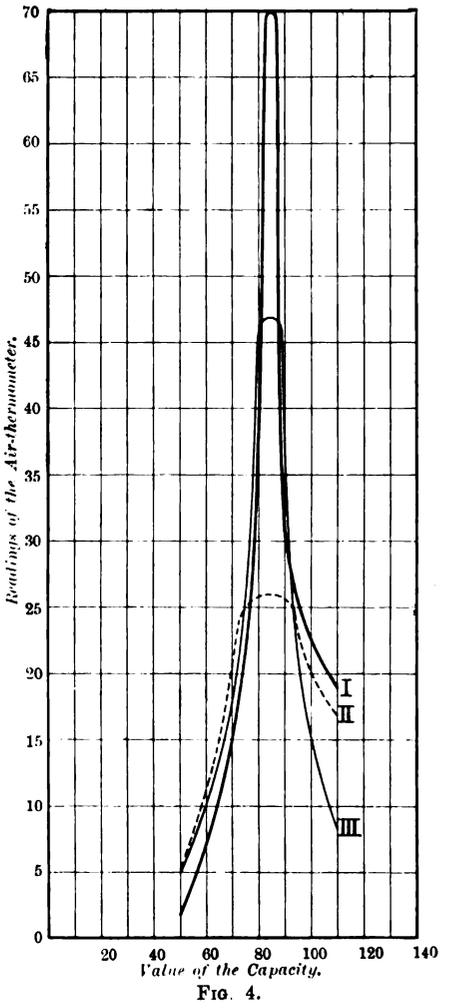

FIG. 4.

Although simple, this method of measuring wave-lengths is not as accurate as present-day requirements demand. More accurate determinations may be made, if the electrical damping of the measuring instrument and the system to be investigated is less. Consequently, measuring instruments with closed circuits are better suited for exact observations. The instrument to be described in this article is constructed with a "closed" circuit, and the determination of a wave-length is carried out by syntonising the instrument to this wave by adjusting the capacity and self-induction of

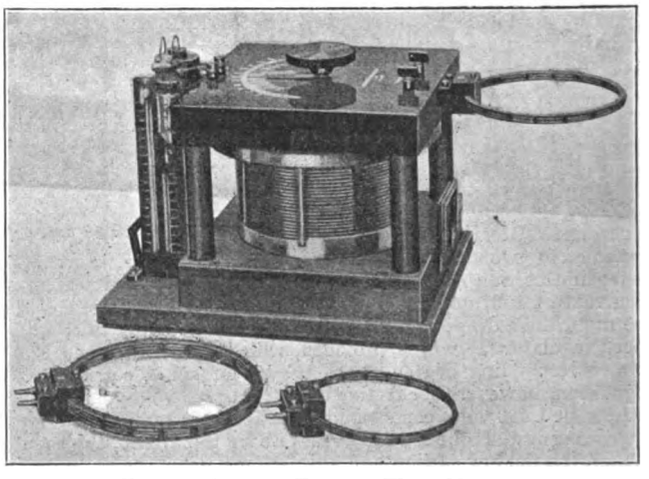

FIG. 5.—GENERAL VIEW OF WAVE METER.

the instrument circuit. When syntony is approached imperfect oscillations are set up in the instrument circuit, and a comparatively small current oscillates therein. Complete syntony coincides with

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Table I.

Test.	Exciting system.				Tuned system.				
	C mfd.	L_1 cm.	L_x cm.	$C(L_1+L)$	c_v mfd.	L_2 cm.	L_y cm.	L'_2 cm.	$c_v(L_2+L_y+L'_2)$.
I.	·001108	126·6	48·6	·19279	·0003162	126	483	..	·19256
II.	·001108	126·6	48·6	·19279	0001485	126	483	703	·19483

the maximum of current induced in the instrument circuit, and all that has to be done in carrying out a measurement is to adjust the capacity and self-induction of the instrument circuit until maximum current flows in it. As shown in the diagrams of connections (Figs. 1, 6 and 7) the current is indicated by an air thermometer T. It is interesting to note that the absolute value of this current depends to a marked degree upon the distance a (Fig. 1) between the self-induction coils L_1 and L_2, and from Fig. 2 it will be seen

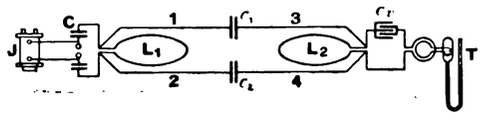

Fig. 6.

that for the particular instrument (connected as in Fig. 1) the critical distance was 30mm. If the distance a is very small, mutual inductance effects take place between L_1 and L_2, and this impairs the accuracy of the results. In order to obtain correct readings therefore, the coils L_1, L_2 are to be separated by the critical distance.

A closed circuit possessing self-induction and capacity has a definite natural period of oscillation and a definite wave-length, the value of this being $\lambda = \tau v$, where $\tau = 2\pi\sqrt{CL}$. By altering separately or together the capacity C and the self-induction L of the circuit, its natural period of oscillation and its corresponding wave-length may be varied within wide limits. If, on the other hand, a certain

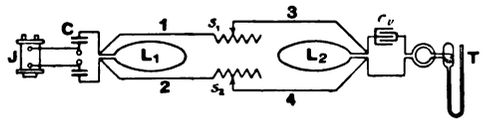

Fig. 7.

wave-length is given, it is possible to tune the measuring instrument to it by the same means. From the formula given above it follows that the measuring instrument may be syntonised to the oscillating system by either altering its capacity or self-induction, or both simultaneously. But for one and the same wave-length the product CL must remain the same. In the instrument in question, a rough adjustment is obtained by altering the self-induction in steps, the more accurate tuning being carried out by altering the capacity. This arrangement was adopted on account of its accuracy and the simplicity of construction of the instrument.

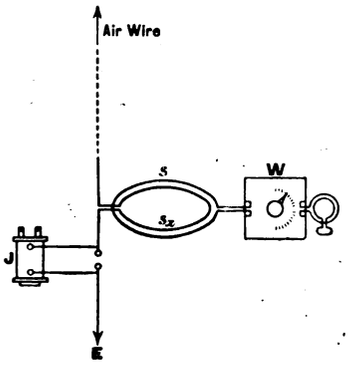

Fig. 8.

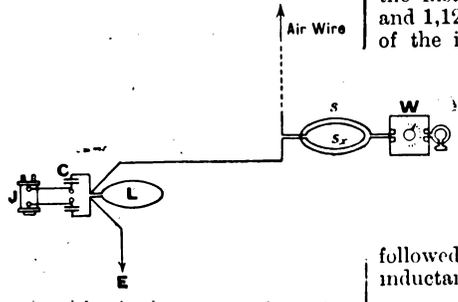

Fig. 9.

It was decided to prove by actual experiment the validity of the theoretical conclusion that the frequency of a system remains the same as long as the product CL remains unaltered. In Table I., which contains the results, L_1 and L_x denote the self-inductions of the primary circuit of the experimental arrangement (see Fig. 1), and L_2, L_y and L'_2 are the self-inductions of the instrument circuit. The self-inductions, consisting of copper rings of a diameter D and a thickness d, were calculated from the formula $L_{cm} = \pi\frac{D}{2}(4\log_e\frac{8D}{d} - 8)$. L_x and L_y were measured. In the second test the self-induction $L'_2 = 703$cm. was connected up to the instrument circuit at k (Fig. 1), the various self-inductions being placed in such relative positions as not to influence one another. As may be gathered from Table I., the theoretical conclusions were confirmed.

Figs. 3 and 5 represent the actual instrument which is made by the Gesellschaft für Drahtlose Telegraphie. It will be noticed that an induced current passes through the air calorimeter. The condenser (b, f) is immersed in a bath of paraffin; p_1 is the terminal of the fixed part of the condenser, p_2 being that of the movable part. In

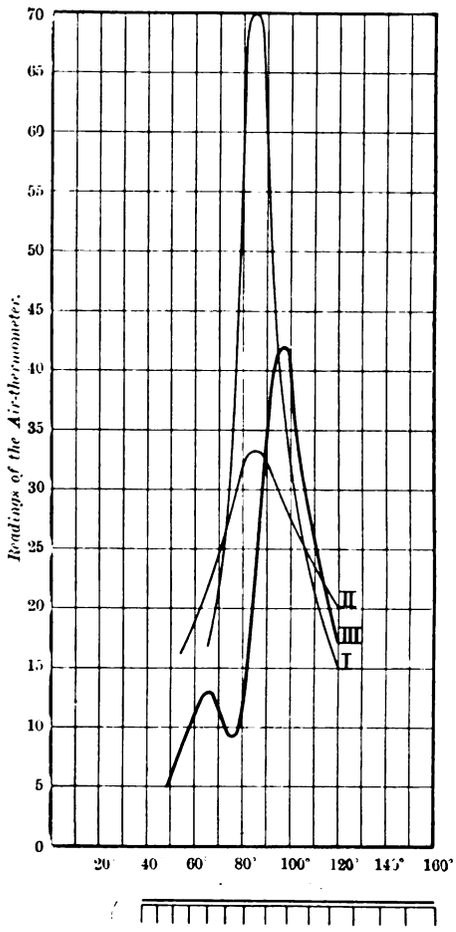

Fig. 10.

the instrument in question, three interchangeable induction coils (s, s_1 and s_2) are provided, their ratio being $\frac{1}{2} : 1 : 4$. By moving the index, connected to the movable portion of the capacity, over the dial from position marked 40deg. to position 160deg., the value of the capacity increases fourfold. With the three coils supplied to the instrument, any length of wave between 140 metres (460ft.) and 1,120 metres (3,670ft.) may be measured. In the construction of the induction coils the conditions as laid down by Stefan* were

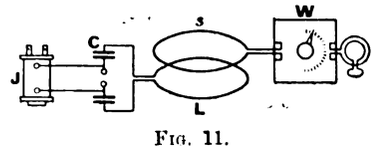

Fig. 11.

followed as closely as possible. For the calculation of their self-inductance, the following formula was used:—

$$L = 4\pi a n^2\left[\left(1+\frac{3b^2+c^2}{96a^2}\right)\log_\epsilon\frac{8a}{\sqrt{b^2+c^2}} - y_1 + \frac{b^2}{16a^2}y_2\right] + 4\pi a n(\log_\epsilon\frac{\Delta}{\delta} + 0{\cdot}15494),$$

wherein a = mean radius of coil, n = number of turns, b = width of space taken up by the wire, c = height of space taken up by the wire, Δ = diameter of insulated wire, δ = diameter of bare wire. The values of y_1 and y_2, which depend on the ratio c/b, are taken from tables. A calculation of the self-induction of the auxiliary connections for the system observed, showed that they were very small as compared with the self-induction of the coils.

* *Wied. Annalen*, 22, 1884.

E.

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By two methods, different in principle, the correctness of the above formula for the self-induction was checked, and the calculated self-inductions were found to coincide very nearly with the experimentally determined ones. The system to be investigated may be coupled to the instrument circuit either electromagnetically (Fig. 1 and curve I. in Fig. 4), electrostatically (Fig. 6 and curve II. in Fig. 6), or through the intervention of inductance coils (Fig. 7 and curve III. in Fig. 4). If waves of different lengths and amplitudes occur simultaneously in the system under observation, the length of each of them is given by one of the maximum readings of the air thermometer upon the capacity and self-induction being varied over the whole range. Moreover, the amplitudes of these simultaneously occurring waves may also be arrived at (at least, relatively), since the amplitudes are nearly proportional to the readings of the thermometer. Also, by varying the capacity on both sides of the position corresponding to perfect syntony, a conclusion may be arrived at of the sharpness or flatness of the wave. By means of three auxiliary coils of one turn each (see Figs. 8 and 9), to be used in connection with the three self-induction coils s, s_1 and s_2, previously mentioned, it is possible to investigate the wave phenomena in a straight air-wire. As a conclusion to the present article we may record the following experiments:—The length of waves emitted by an air-wire which was connected up in Marconi fashion (Fig. 8) was found to be 405 metres (1,330ft.), and its curve of resonance is represented in Fig. 10 (curve II.). Then, the capacity in the transmitter (Fig. 11) was adjusted, until its wave-lengths were also about 405 metres (curve I. Fig. 10). Air-wire and transmitting system were, therefore, tuned to each other, corresponding to a maximum of current oscillating in the air-wire. Now both were connected together as shown in Fig. 9, and the conditions existing in the air-wire investigated with the aid of the instrument. It was found that two waves were oscillating in the air-wire, their lengths being 355 metres (1,160ft.) and 435 metres (1,430ft.) respectively. The longer wave ($\lambda = 435$ metres) has the greater amplitude, and the receiving instruments have, therefore, to be tuned to this wave.

THE EXPERIMENTAL BASIS FOR THE THEORY OF THE REGULATION OF ALTERNATORS.*

BY B. A. BEHREND.

We understand by the regulation of an alternating-current generator the increase in per cent. of the terminal voltage consequent upon throwing off the load, the speed and exciting current remaining the same. Our problem consists in determining the terminal voltage for any current and power-factor for various ampere turns excitation. In practice, it is difficult to make tests under load, especially on very large units. Therefore it is necessary to have a method which enables us to determine the terminal voltage for any current and power-factor from tests which can easily be performed. Dr. Behn-Eschenburg has suggested that if the open circuit saturation curve of the generator were known, as well as the current which the machine generated in short circuit, we could obtain the apparent impedance of the armature by dividing, for a given excitation, the volts on open circuit by the amperes in short circuit for the same excitation. This theory, superficially considered, appears very plausible; but it is evident that it throws together, without explanation or justification, the armature reaction and the self-inductive effects produced by the local fields in the armature. It appears plain that, for all we know, the local fields might be independent of the saturation of the machine, while the effect of armature reaction would, of course, be dependent upon the degree of saturation. The experimental investigation was encumbered by the fact that the power-factor plays such an important part in the magnitude of the inductive drop. In order to simplify the conditions, we have only to consider that the drop in an alternator is a maximum if the power-factor is a minimum. It can also be readily shown that if the power-factor is diminished below 20 per cent., the drop will practically remain unchanged, the error being extremely small in assuming that a power-factor of 20 per cent. or less is equivalent to a power-factor zero, as regards inductive drop. Fig. 1 shows the saturation curves at no load and at 96 amperes load, $\cos\phi < 0{\cdot}2$, as well as the short circuit curve of a large inductor generator built six years ago at the Oerlikon Works. The magnetic circuit of this machine is represented in Fig. 2. Applying Dr. Behn's method to these curves and referring to Fig. 3, where OB represents the saturation curve and OC the short circuit curve, we find the apparent reactance, neglecting ohmic resistance, by dividing AB by AC. If we wish to determine the inductive drop for a current represented by DF equal to one-third AC, we reason, according to Dr. Behn, that as it takes an E.M.F. equal to AB to drive a current equal to AC through the short-circuited armature, it will take an E.M.F. equal to DF÷AC, equal to one-third AB, to drive a current DF through the armature. We thus obtain a point G, BG being equal to one-third AB. Applying the same reasoning to different excitations, we obtain a curve, DHG, which represents the terminal voltage at different excitations for a constant current, FD, at a power-factor zero. Applying this method to Fig. 1, we obtain the results compiled in Table I.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

Table I.

Amperes excitation.	Actual terminal voltage.	Calculated terminal voltage. A.	B.	Regulation per cent. Actual.	A.	B.
10	360	365	356	143·0	140·0	145·0
20	1,110	1,115	1,140	41·5	41·0	37·7
30	1,700	1,688	1,840	24·1	25·0	14·7
40	2,100	2,073	2,290	16·6	18·7	7·4
50	2,330	2,300	2,540	13·7	15·2	4·35
60	2,460	2,431	2,700	12·3	13·1	1·85

In applying the rule of the Committee on Standardisation of the American Institute of Electrical Engineers,* we have only to remember that, referring to Fig. 3, it takes an excitation corresponding to OD to produce a current, DF, in the short-circuited armature. Therefore, following the rule referred to, in order to get the load saturation for a current, DF, on a power-factor zero, we have to deduct the ampere-turns OD from the ampere-turns on open circuit. The result is curve DIK, the distances between this curve and the curve OLB measured along the abscissa being the same.

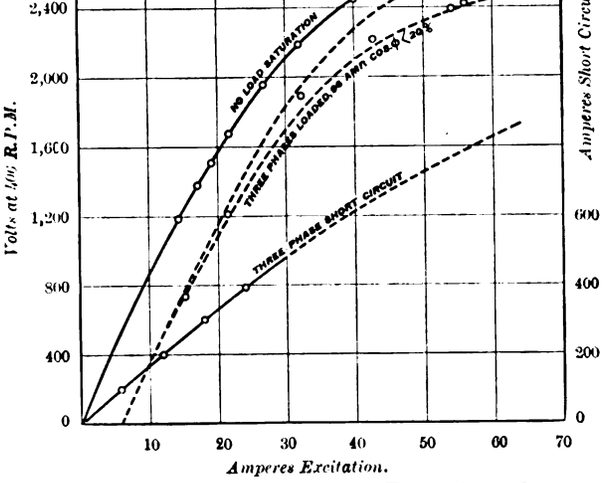

FIG. 1.—REGULATION CURVES ON 500KW. THREE-PHASE INDUCTION GENERATOR.

In Table I. there are placed side by side the actual regulation obtained by experiment and the regulations as calculated from Dr. Behn's method, and as determined by the rule of paragraph 71. The results obtained by the former method are given in column "A"; the results obtained by the latter method are represented in column "B." For the straight part of our saturation curve, both methods give the same results. For the saturated part, method "B" yields in this case a regulation which is several hundred per cent. smaller than the actual regulation, while method "A" yields a regulation which is a few per cent. larger than the actual regulation. These tests were made on a large inductor generator with small air-gap and large pole-pitch, which are the best possible conditions for good regulation. We will now apply the two methods "A" and "B" to a 500kw. three-phase generator, designed with all the finesses that can be employed to obtain good regulation with greatest economy of material. The machine on which the tests were made was designed for 400 volts three-phase 25 cycles, and

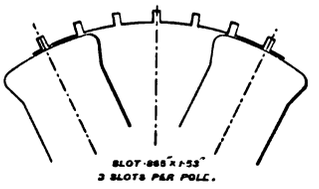

FIG. 2.

* See *The Electrician*, Vol. XLIII., p. 707.

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was run at 150 revs. per min. The load consisted of rotary converters running without excitation. Fig. 4 shows the observed data in the form of a curve, while Fig. 5 shows the magnetic circuit. Leaving it to the reader to check the many observed points for himself, we will refer to a few points to illustrate the argument. For instance, take the point observed at 160 amperes excitation. Here the E.M.F. on open circuit is 512 volts, the terminal voltage at 1,200 amperes load, cos $\phi < 0{\cdot}2$, is 420 volts. The short-circuit current at this excitation is 3,400 amperes. According to method "A," we obtain an inductive drop equal to $1{,}200 \div 3{,}400 \times 512 = 181$

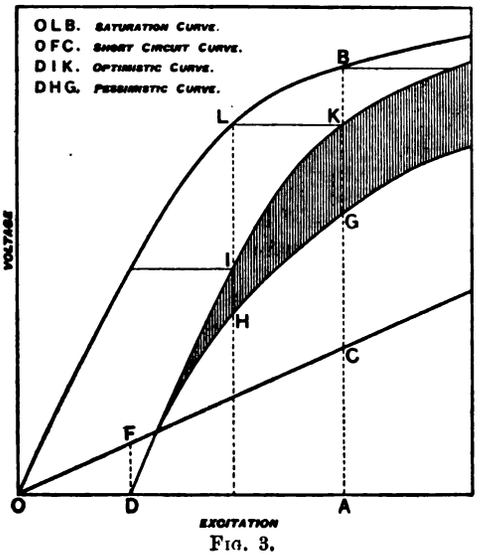

Fig. 3.

volts; by method "B" we obtain 102 amperes excitation as resultant excitation, which corresponds to 448 volts terminal pressure. Hence the following table:—

Table II.—*Regulation.*

Actual.	A.	B.
22%	54·5%	14·3%

Some five years ago the writer named the method "A," which yielded the regulation curve DHG, the "pessimistic method," while he called the curve DIK, obtained by applying method "B," or the Institute method, the "optimistic method." There is some justification for using these terms as, from the standpoint of the designer, the application of method "A," which we will in the future call the

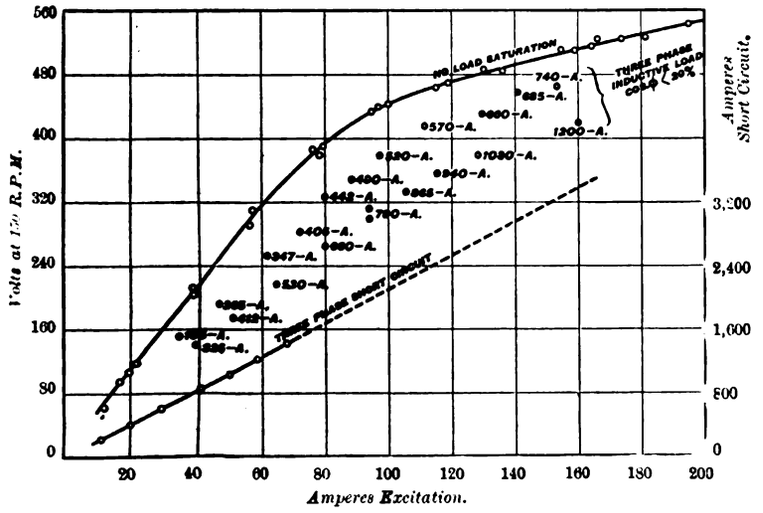

Fig. 4.—Regulation Curves on 500kw. Three-Phase Generator.

"E.M.F. method," yields terminal pressures which are much smaller than the ones he will actually obtain, while method "B," which we will call the "ampere-turn method," yields values for the terminal pressure which are considerably greater than the ones he will actually obtain. A machine designed according to the ampere-turn method will give less volts than required, while the machine designed by the E.M.F. method will give more volts than required. Again referring to Fig. 3, it is clear from the evidence so far adduced that the curve for the actual terminal voltage lies between the two curves DIK and DHG—that is, between the optimistic and pessimistic curves. But, further to corroborate this statement, there are shown regulation curves in Figs. 6, 7 and 8, Figs. 7 and 8 being reproductions of the three-phase and single-phase load curves with the optimistic and pessimistic curves plotted in the diagrams. Fig. 6 shows also the E.M.F. between the open phase and either of the two terminals of the loaded phase. The magnetic circuit of this machine, the shape of the poles and the shape and size of the slots are shown in Fig. 10. The curves Figs. 6, 7 and 8 belong to a generator the normal rating of which is 200kw. at 13,000 volts and 60 cycles. The power-factor varied between 8 and 15 per cent. Fig. 7 represents a three-phase load, while Fig. 8 represents a single-phase load. These curves are well fitted to bear out the essential parts of the theory of the regulation of

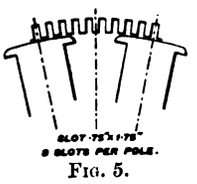

Fig. 5.

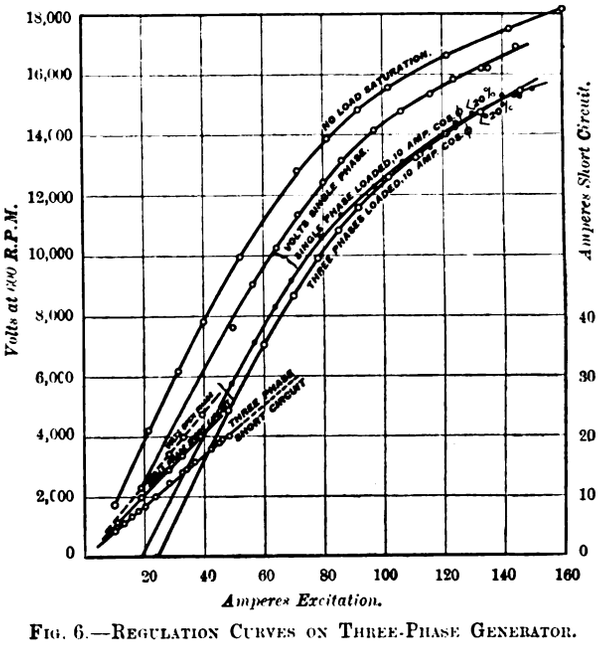

Fig. 6.—Regulation Curves on Three-Phase Generator.

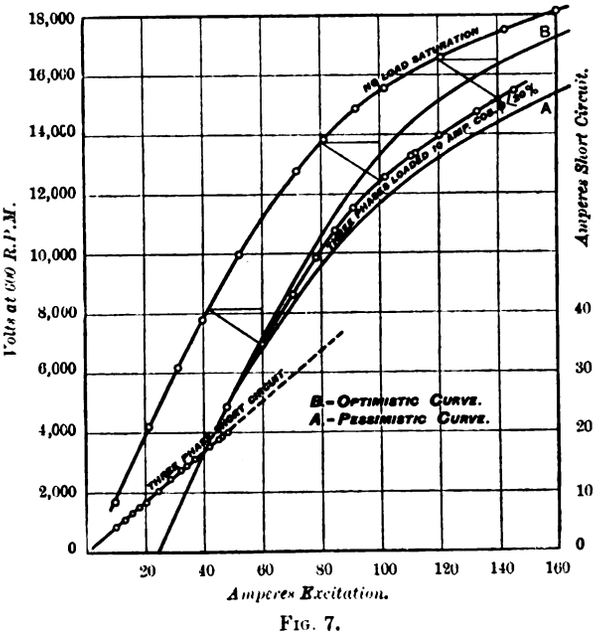

Fig. 7.

alternators, as they indicate clearly that the armature ampere-turns which are opposed to the field ampere-turns are large in the three-phase machine and small in the single-phase machine; while the E.M.F. produced by local armature fields is small in the three-phase machine and large in the single-phase machine. These conditions result in the load saturation curve of the single-phase machine lying very close to the pessimistic curve, while the load saturation of the three-phase machine lies about half way between the optimistic and pessimistic curves. These diagrams show the armature reaction separated from the self-inductive effect of the

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local armature fields. The side of the triangle which is parallel to the abscissa represents the armature reaction, and the side parallel to the ordinate represents the self-inductive effect of the local fields. From the curves in Figs. 7 and 8 it is seen that by resolving the total inductive drop into such components, results are obtained which are very closely in agreement with actual observation. However, there remains the difficulty of separating these two components. We add Fig. 9 to our experimental data, representing the regulation curves of a 100kw. 900 revs. per min. 60 cycle three-phase generator, the magnetic circuit of which is represented in Fig. 11. The curves contain a no-load saturation, a saturation curve for 30 amperes three-phase load of low power-factor, a

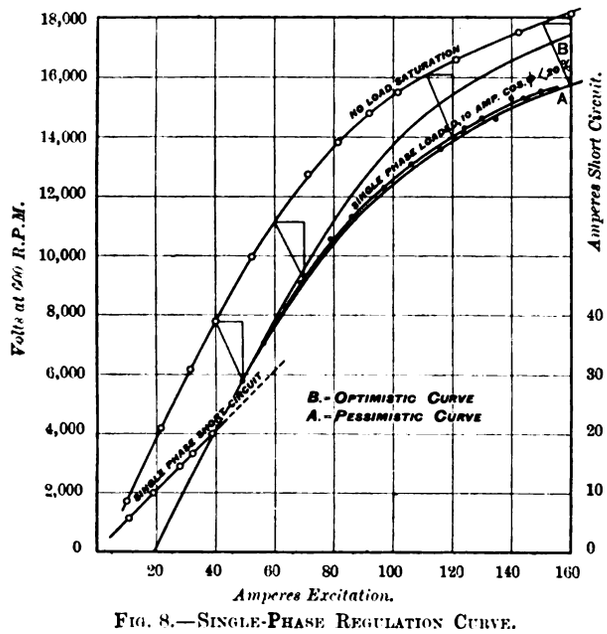

FIG. 8.—SINGLE-PHASE REGULATION CURVE.

saturation curve for 30 amperes single-phase load low power-factor, a curve giving the voltage between either one of the two phases operating single phase, and finally the three-phase and single-phase short-circuit curves. It need hardly be remarked that the single-phase curves were obtained by operating two phases of the Y connected machine in series. The curves in Fig. 9 are condensed in Table III.

A glance at this table shows that as soon as the saturation of the machine begins, the ampere-turn method, which is embodied in the Institute rule, gives results that fall very far from the mark. For

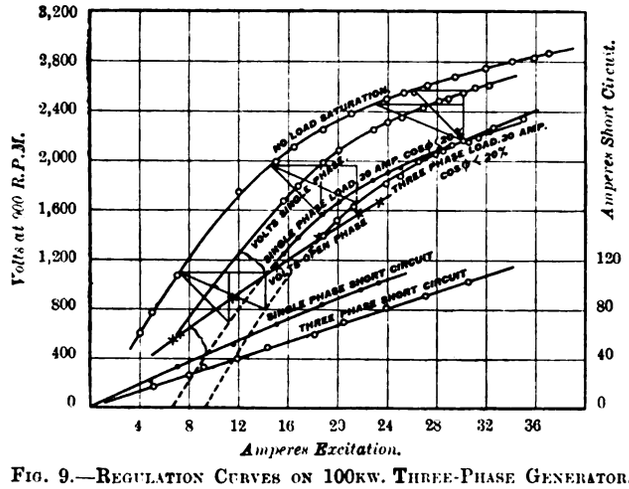

FIG. 9.—REGULATION CURVES ON 100KW. THREE-PHASE GENERATOR.

instance, we observed at 28 amperes excitation a regulation of 28·2 per cent., while we calculated only 16·8 per cent. At 32 amperes excitation the case is even more striking, as we observed 22½ per cent. regulation against 12 per cent., as calculated.

In Fig. 13 are given the regulation curves of a 350kw. two-phase generator operating at 60 cycles and 600 revs. per min. This figure also contains the curves for single-phase load. The magnetic circuit of this machine is shown in Fig. 12. I want again to call attention to the fact that if these curves are checked by the two methods mentioned in this Paper, we find that for two-phase and three-phase machines the curve of the terminal voltage lies between

Table III.—*100kw. Three-phase Generator.*

Amperes excitation.	E.M.F.	Terminal voltage.	Terminal voltage calculated by Institute rule.	Regulation per cent.	
				Observed.	Calculated by Institute rule.
16	2,080	1,050	1,050	98·0	98·0
20	2,330	1,530	1,600	52·5	45·6
24	2,500	1,850	1,980	35·1	26·2
28	2,640	2,060	2,260	28·2	16·8
32	2,755	2,250	2,460	22·5	12·0

Table IV.—*350kw. Two-phase Generator.*

20	1,700	640	640	166·0	166·0
30	2,250	1,440	1,520	56·2	48·0
40	2,550	2,030	2,160	25·6	18·0
50	2,775	2,360	2,500	17·6·	11·0
60	2,960	2,600	2,740	13·8	8·1
70	3,140	2,740	2,920	14·6	7·55

the two curves termed the optimistic and pessimistic curves, while the single-phase load curves approach very closely to the pessimistic curve.

The data of Fig. 13 are represented in Table IV., which, after what has been said, requires little comment. It has been demonstrated by the large number of tests described in this Paper that the "ampere-turn" method does not give satisfactory results in determining the regulation of an alternating-current machine. The method is inherently wrong, as it neglects the extremely important inductive effect of local fields in the armature. It has also been

FIG. 10.

FIG. 11.

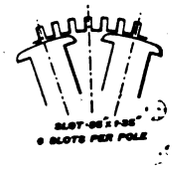

FIG. 12.

shown that the E.M.F. method gives entirely misleading results. Therefore, it is proved conclusively that it is not possible to obtain the regulation of an alternating-current machine by using no other characteristic than the saturation and short-circuit curves.

Another element is required in order to enable us to resolve all the effects of the armature current into two components, one component representing the demagnetising effect of the armature and

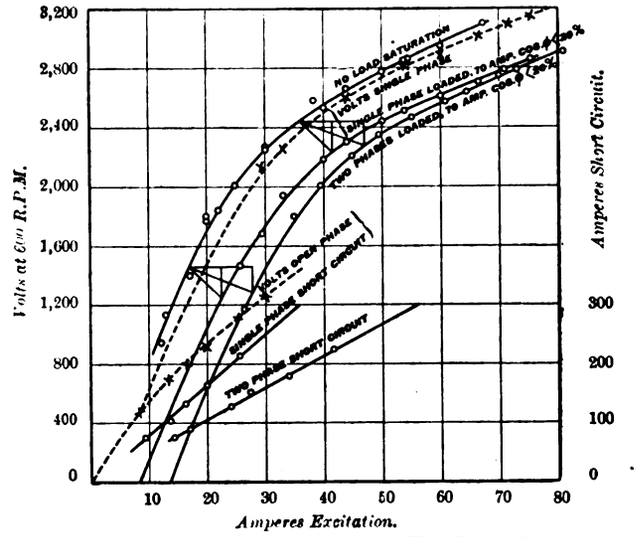

FIG. 13.—REGULATION CURVES OF A 350KW. TWO-PHAS GENERATOR.

the other component representing the inductive drop produced by local armature fields. Any theory which aims at a complete explanation of the phenomena produced by a load in the armature of alternating-current machines must conform to actual observation and fact. Therefore, the two methods which have been criticised in this Paper stand condemned. They should not be used for the quantitative determination of the regulation, because they do not explain nor express the facts. We must frankly admit the existing predicament that there is no simple method which explains all the facts observed. It is entirely a matter of skilful designing to reduce the inductive drop in a machine. It is plain that it is necessary to

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avoid any leakage from pole to pole, and for that reason it is essential to use large pole-pitches—in other words, to place the poles far apart from one another. This matter of field leakage is well brought out by a comparison of the regulation curves of the inductor generator in Fig. 1 with the regulation curves represented in the other figures. The poor regulation of the inductor generator is due to the field leakage between two inductor horns producing a counter E.M.F. Speaking from a large experience in the designing and testing of this type, I venture to assert that it is impossible to make these machines so that the load regulation curve lies very much above the pessimistic curve. While it is perfectly possible to build inductor generators with good regulation, this can only be done at the expense of a great deal of material.

In looking at Figs. 7, 8, 9, and 13, in which the drop in the armature has been resolved into its two components, it is seen at a glance that if we want to take advantage of the high saturation it is essential to reduce to a minimum the local fields in the armature, as this reduces the side of our triangle parallel to the ordinate. As a matter of design, this can be accomplished by using a large pole-pitch, a narrow armature, and, to some extent, a large number of slots per pole and per phase. The large pole-pitch which thus proves so useful has the further advantage of improving the ventilation of the machine, thus leading to cool operation. A large pole-pitch makes a machine easily accessible, and increases the radiating surfaces, as the most effective part of the radiating surface of the machine lies in the armature faces.

If, for a given excitation, we have determined the drop of a machine for a given current and zero power-factor, we can determine the regulation for any power-factor for the same current, by using the vector diagram. The most elegant method is that represented in Fig. 14, originated by Mr. G. Kapp. After resolving the inductive drop into its two components, the armature reaction and the local fields, we can compose the ampere turns on the fields OA', with the ampere turns on the armature OA, finding the resultant ampere turns OC. Next, applying the same process to the local fields, we can draw another diagram, making OB equal to the

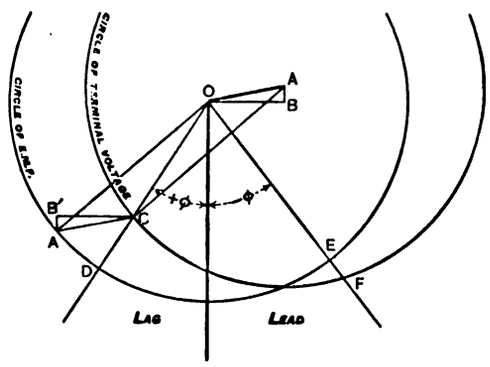

FIG. 14.—KAPP'S DIAGRAM FOR THE DETERMINATION OF THE REGULATION AT DIFFERENT POWER-FACTORS

E.M.F. produced by these local fields, BA equal to the ohmic drop in the armature, and OA equal to the E.M.F. of the machine produced by the resultant ampere-turns. We thus obtain OC, the terminal voltage of the machine. It can readily be seen that, by describing the two circles with OA' as radius, about O and A as centres, the radii vectors drawn from O as centre at an angle $+\phi$ or $-\phi$ will intersect the circle of terminal voltage in points C and F, so that OC and OF represent the terminal pressures at the two different power-factors. The quadrant on the left represents a lag of the current, and, therefore, a drop in pressure, while the quadrant on the right represents a lead. If the lead increases beyond the point of intersection of the two circles, the terminal pressure rises above the E.M.F. of the machine. For most practical purposes it is not necessary to use this diagram twice for the ampere-turns on the armature and for the local fields, but it is sufficiently accurate to consider the inductive drop as an apparent impedance and to make OA equal to this impedance.

It should not be overlooked that the apparent impedance is not only dependent upon the field excitation, but it is also dependent upon the armature current. This can easily be seen by working out a few values for the apparent impedance in Fig. 4. It will thus be found that the impedance, while a constant at low saturation, increases rapidly with the increase of the armature current at the same field excitation.

It is interesting to study the curves giving the pressure on the open phase while taking out single-phase current, as this has important bearing on the question of regulation of two-phase and three-phase machines when operating on a lighting load. It can be seen from Figs. 6 and 9, which represent three-phase machines, two phases in series loaded, the third phase open, that for high saturation the curve for the pressure on the open phase between the terminal of the open phase and either of the terminals of the loaded phases lies considerably higher than the curve for the pressure on the loaded phases. The same is true to almost the same extent of the two-phase machine, the curves of which are represented in Fig. 13. This shows conclusively that there is little preference in favour of either type of machine as far as regulation is concerned.

PATENTS EXPIRING IN 1904.

The following is a list of the patents of interest to electrical engineers which (unless specially extended by recommendation of the Judicial Committee of the Privy Council) will expire during the present year. The list includes only those patents of 1890 which have been kept in force up to date by payment of the renewal fees:—

Date (1890).	No.	Name of patentee.	Subject of patent.
Jan. 8	350	Ludwig Epstein	Electrodes for primary and secondary batteries.
Jan. 17	911	James B. Atherton ...	Apparatus for winding ribbons or tapes of insulating material around electric conductors.
Jan. 21	1,110	Charles A. Hitchcock	Galvanic batteries.
Jan. 22	1,142	William Chadburn ...	Electrical transmission of orders, &c., on board ship.
Jan. 22	1,143	William Chadburn ...	Telegraphic apparatus for vessels.
Jan. 24	1,306	William L. F. Hellesen	Dry galvanic elements.
Feb. 11	2,219	Henry O. Rudolph ...	Telegraph-printing apparatus.
Feb. 18	2,653	S. Z. de Ferranti	Electricity meters.
Feb. 24	2,945	A. M. F. Laurent Cely & Illius Timmis	Secondary cells.
Feb. 26	3,082	Rudolf Langhans.....	Filaments of incandescent lamps.
Feb. 26	3,096	S. Z. de Ferranti.....	Improvements in elec. meters.
Apr. 9	5,420	Carl Kellner.....	Manufacture of cellulose by electricity.
Apr. 10	5,474	H. Lyon and H. J. Leslie	Regulating and controlling electric currents.
Apr. 18	5,928	Edward Tyer	Electric signalling on single lines of railway.
Apr. 29	6,569	Edward Weston	Electric measuring instruments.
May 22	7,932	F. E. Elmore	Mandrils for electrolytically-deposited tubes.
May 27	8,242	Hermann Lemp	Electric welding.
June 2	8,534	Nicholas de Benardos and J. Howard and J. H. Lloyd	Accumulators.
June 10	8,959	Sir William Thomson (Lord Kelvin)	Mariner's compass.
June 10	8,988	C. M. Ball and S. Norton	Devices for separating magnetic and non-magnetic substances.
June 12	9,084	A. M. Thomson	Electric control system on single-line railways.
June 17	9,361	T. L. Willson	Electric smelting and reduction.
July 1	10,134	John H. Cheever.....	Insulating compound for electric cables.
July 8	10,595	Elihu Thom on	Electricity meters.
July 29	11,862	W. E. Ayrton and T. Mather	Electrostatic measuring instruments.
Aug. 1	12,094	Richard Morris	Electric firing of guns.
Aug. 5	12,221	Edward Weston	Elec. measuring instruments.
Aug. 19	13,042	Chas. Jos. Van Depoele	Electric railways.
Aug. 21	13,123	George Hookham ...	Electricity meters.
Aug. 22	13,260	M. von Dolivo-Dobrowolsky and Paul Mamroth	Distribution of electricity.
Sept. 8	14,077	Thomas Jas. Wilmot	Automatic transmitter for submarine cables or long telegraph lines.
Sept. 16	14,603	The Hall Signal Co.	Signalling apparatus.
Nov. 1	17,560	J. A. Iliffe and Henry Barton	Locked switches for electric current circuits.
Nov. 11	18,186	Edward Weston	Elec. measuring instruments.
Nov. 13	18,292	B. M. Drake and J. M. Gorham	Electric switches.
Nov. 18	18,576	R. H. C. Nevile	Elec. current control apparatus.
Nov. 18	18,625	Hermann Lemp	Electric welding apparatus.
Nov. 21	18,896	A. S. Elmore	Electrolytic manufacture of copper tubes, sheets, strips, &c.
Nov. 24	19,076	W. M. Mordey.....	Electric safety fuses.
Dec. 3	19,740	F. H. W. Higgins ...	Column-printing telegraph receivers.
Dec. 9	20,089	Western Electric Co.	Telephone exchange apparatus.
Dec. 15	20,425	M. von Dolivo-Dobrowolsky & the A.E.G.	Speed and power regulation of alternating-current motors.
Dec. 24	21,045	Frederick Walton ...	Apparatus for armouring insulated electrical conductors.

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1903.

In reviewing the events of the past year so far as they have affected the position of electrical science and the electrical engineering industry, one is struck with the unusual influence which political matters have had upon them. Statesmen and politicians who have been recommending tariff reform during the latter half of the year have been at considerable pains to show that our industries are declining, or, at all events, are not advancing at the pace which should be expected of them. Among these industries is, of course, electrical engineering; other statesmen and politicians, desirous of demonstrating the incorrectness of these views, have exerted themselves to make it evident that each individual industry is improving and that there are no signs of retrogression; but the very facts and figures which they adduce in support of their cause, suggest weak points which are capable of improvement to those intimately connected—either as producers or buyers—with the industries in question. A third party, while allowing that our industrial supremacy is being threatened denies that the reason for it is the Free Trade policy of the past, and seeks other reasons to confound alike the radical Conservatives and the conservative Liberals. Attention has thus been drawn most forcibly to the want of organisation and the general incompleteness of our methods of technical education, to the exaggerated deference to trade unions, to the errors arising from an over-indulgence in municipal trading, to the restrictive legislation which has crippled or impeded the growth of many industries, to the lack of enterprise frequently displayed by the British trader and manufacturer, and to a score of other real or imaginary evils, all of which have been exposed before, but seldom displayed from such an effective platform. The PRINCE OF WALES' appeal that we should "Wake up" is thus being repeated on all sides, in various keys and with all manner of variations. We are now fully awake, and are already setting to work to improve our position: the outcry against the so-called "fair" labour clause and the purchase of Belgian rails by the London County Council has already had effect, a scheme is on foot for the provision of a college in London for the better technical education of leaders of our industries, and the campaign against "municipal socialism" started in *The Times* has not been allowed to sleep. We cannot, of course, attribute all this to the tariff reform movement and the opposition to it; but doubtless the better "tone" which has been brought about by this development in party politics has contributed to its realisation.

Having thus briefly alluded to the general position and tendencies, we will, in accordance with our annual custom, review briefly the year's electrical progress under the various headings. The revival of trade, which was welcomed by manufacturers in 1902 and the early months of 1903, was succeeded by a duller time, in which orders came in less rapidly, but towards the end of the year again the outlook has become slightly better, and a large amount of electrical machinery and plant is now in hand for colonial as well as for English cus-

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tomers. Undoubtedly the colonial market will continue to improve. Large orders may be expected from the Admiralty, as one and a-half millions has been voted for the electrical equipment of the Government dockyards in various parts of the world. The appointment of Mr. C. H. WORDINGHAM as electrical adviser to the Admiralty was received with approbation in the electrical community. Further attention has also been drawn to the use of electricity in mines by the deliberations of a Departmental Committee on the question, and by several Papers read before the Institution of Mining Engineers. The completion of the British Westinghouse Company's works, and the opening of dynamo and carbon factories by the General Electric Company occurred early in the year, and other owners of works have been making provision for an increased output and improved methods of manufacture. Engine makers have been somewhat unsettled by the invasion of foreign steam turbines and gas engines of large output, but some firms at home have already made arrangements to manufacture this class of plant, and if the present feeling in favour of it is more than a passing fashion, we may rely upon our own makers being able to supply the demand. It must not be forgotten that England was the home of the original steam turbine and gas-engine industries. Dynamo design is getting more and more standardised, the only new development of importance during the year relating to the "compensated" machines of HEYLAND and BLONDEL, which have found, at any rate, one active champion in this country. The manufacture of three and two-phase plant is extending in Great Britain, and the adoption of this type of plant is no longer being looked upon as an un-English tendency. Much attention has been directed to single-phase motors during the year, and there are now several new designs for which high power-factor and good starting properties are claimed. Manufacturers have welcomed the formation of the Engineering Standards Committee, which has nominated several sub committees for the standardisation of various classes of electrical plant. Standard specifications for tramrails and a set of electrical pressures and frequencies have already been issued.

We have referred above to the employment of steam turbines and gas engines for driving large units. Otherwise, electricity supply engineers are paying more attention to increasing their load and keeping down their works costs with existing systems than to trying new classes of machinery. Motor loads are growing, as are also the relative number of combined lighting and tramway stations, and the tendency towards large units of plant is increasing as the day loads increase. As a means of employing large units at light loads when generating both alternating and continuous current, the use of double-current generators at the electricity works of the Willesden Urban District Council has proved very successful. The former will be the first works to be transferred from a local authority to a company. The North Metropolitan Power Distribution Company which has agreed to take them over, will have a wide area for its operations with a good tramway load, and it has, therefore, been able to offer a supply "in bulk" in Willesden at a cheaper price than that at which the District Council could generate its own current. Several smaller towns have also wisely transferred their provisional orders to power companies or are taking power "in bulk" from them, and in other cases large municipal works have greatly extended their areas by the inclusion of outside districts. Manchester, for instance, will soon supply electrical energy in no less than six neighbouring urban districts.

Electric traction has continued to make fast progress, and encouragement to those contemplating the "electrification" of railways was gained during the Institution of Electrical Engineers' visit to Italy in the spring. Both three-phase and continuous-current systems have been employed in that country with success. The electrification of the Lancashire and Yorkshire and the North-Eastern Railway has commenced in this country, and by the Railways (Electrical Power) Act last session all existing steam railway companies which had not previously obtained powers are authorised to equip their lines electrically after obtaining a Provisional Order directly from the Board of Trade. A section of the "electrified" Metropolitan-District Railway was opened during the year, and the equipment of the remainder of this company's lines, as well as of the Metropolitan Railway, is proceeding. The Great Western Railway is also letting contracts to the extent of 10,000 H.P. for the electrical equipment of a portion of its lines. The transformed Mersey Railway was opened last spring, and this line, as well as the Metropolitan-District, employs multiple unit systems with considerable success. The vibration trouble on the Central London Railway has been overcome by the employment of a motor car at each end of the train (run on the multiple unit system) in place of a locomotive, but there has been a series of unfortunate incidents owing to middle coaches being derailed at cross-overs. This is due to the two motor cars acting simultaneously, but doubtless a cure will soon be found. Otherwise, there have been remarkably few accidents either on electric railways or tramways during the year in this country, but in France the disaster on the Metropolitain has given warning that fire-risks must be borne in mind in designing tunnel lines. In England we had already profited by the lesson of the fire in the tunnel of the Liverpool Overhead Railway in 1901, and such a misfortune is not likely to occur again. Experiments with single-phase systems of electric traction are being made on the Continent and in America, but not on the lines of the Ward Leonard system as was predicted by some advocates, but rather by a return to the neglected repulsion and series single-phase motors. The renewed experiments in high-speed railways in Germany, in which speeds up to 130 miles an hour were reached, have been valuable. The Behr monorail system between Liverpool and Manchester, however, is still far from realisation, an unsuccessful endeavour to obtain the capital for a company having been made in August.

Tramway development has proceeded chiefly on standard lines, and the mileage of trolley lines in the United Kingdom has increased enormously. In London, several miles of the London County Council's conduit lines are now in operation, and large extensions are being made; some of the remaining lines belonging to the Council will be on the trolley system, however. After considerable vacillation, the Wolverhampton Corporation has decided to continue its surface contact tramways, and to equip new lines on the same system; but these are still the only surface contact lines in this country, and the system has not extended at all abroad during the year. An experiment with a regenerative system of control is being made in Devonport, a hilly town. The details have been ingeniously worked out by Mr. RAWORTH, and the results of a year's working will be awaited with interest. Electric automobiles are now much in use in London, but for long-distance work and in hilly districts they have been unable to compete seriously with petrol and benzine cars. Those interested in motor cars, however, should not fail to read Lieut.-Col. CROMPTON'S spirited advocacy of the electric motor car at the Engineering Conference last summer. Except for this Paper, and an excellent discussion on the electrical equipment of railways, this biennial conference was rather a disappointment so far as electrical matters were concerned.

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Additional details as to the construction of the Edison secondary battery and trials made with it have been published, but its effect on the motor-car industry cannot yet be considered revolutionary.

Coming now to the oldest branch of electrical engineering, an important addition has been made to the world's telegraph cables by the completion of the American Pacific cable, and the all-British Pacific cable continues to work uninterruptedly, although at a financial loss. Two new cable steamers, designed primarily as cable-repairing ships for stations abroad, were completed by the Eastern Extension Telegraph Co. early in the year; the Commercial Pacific Cable Co. have purchased the Telegraph Construction and Maintenance Co.'s "Scotia"; the Eastern Telegraph Co. have just completed the "Levant"; and the West India and Panama Co. have launched the "Henry Holmes" to replace the ill-fated "Grappler." We may also mention an important article by Mr. ELTON YOUNG upon the "Core Ratio" (ratio of resistance to capacity) of submarine cables, published in *The Electrician* in March. The London telegraph world had the honour of entertaining the delegates to the International Telegraph Conference this year. Underground telegraph cables are being extended in England slowly and surely by the Post Office. Some new type-printing telegraphs and also an improvement of the Pollak-Virág writing telegraph have been brought before the public during the year, but we believe that the Post Office is still content with its present methods of employing the Morse system.

The year 1901 ended with the announcement that the signal SSS had been transmitted across the Atlantic by wireless telegraphy, and 1902 ended with congratulatory messages transmitted from America to England by the same means. On March 30th, 1903, it was announced that such progress had been made that *The Times* had arranged for a day-by-day transmission of news from New York by wireless telegraphy. This announcement should have been made two days later; *The Times* is still without its day-by-day "Marconigrams." A complete system of wireless telegraphy, which, it was announced, would be in operation by the end of the summer, has also not been realised, and there has been no successful practical development of long-distance wireless telegraphy. Many short-distance installations have been erected, however, and a wireless telegraph equipment is now supplied to almost every large new ship that is built, while English and foreign navies, as well as the larger passenger ships, are employing it. Some important improvements in apparatus have been made by various workers in England, America and Germany, including the invention of an electrolytic coherer, a better appreciation of the theoretical and practical considerations governing resonance, and the evolution of a simple instrument to measure wave-lengths. The preliminary Wireless Telegraph Conference held in August showed that the majority of the States represented desired to prevent a wireless telegraph monopoly, and to submit wireless telegraphy to international control; and the majority of our Crown Colonies, following the example of some European countries, have declared wireless telegraphy and the erection of wireless telegraph stations to be a Government monopoly.

In telephony the central battery exchange system is extending, but a Paper read before the Institution of Electrical Engineers advocating a central battery system applied to a divided multiple switchboard met with little sympathy. The Post Office telephone system in London is increasing in magnitude, and two new exchanges have been opened—in Mayfair and at Chiswick. The metropolitan system of the National Telephone Company continues side by side with that of the Post Office, and the arrangements for intercommunication between the two systems work satisfactorily. Small municipal exchanges have been opened in Portsmouth, Swansea and Brighton. Hull has commenced the erection of a municipal telephone exchange, but is rather late, as its telephone licence expires in 1911; in order to compete successfully with the National Company the Corporation gave notice to terminate the agreement under which the Company had been permitted to lay its underground lines, and this led to a lawsuit resulting, however, in favour of the Corporation. The accounts of the Glasgow municipal telephone department were severely criticised on all sides, it being contended that the undertaking was being run at a considerable loss, and fault being found with the allocation of certain expenses (such as canvassing) to capital account. In addition to the municipal exchanges already mentioned, and the Tunbridge Wells exchange which has been transferred to the National Telephone Company, seven other municipal telephone licences have been granted; but we believe that no progress has yet been made towards building the actual exchanges, although some of these licences expire in 1911. A telephone service between England and Belgium is now in operation, and the Telephone Convention between this country and France was ratified by the Senate on December 30th. Mention may also be made of successful experiments in Germany and America with distributed inductance in long telephone lines.

There is some progress to record in electro-chemistry and electro-metallurgy. The production of nitrates by electric spark discharges, foreshadowed by CROOKES, is still in operation at Niagara, and other processes on the same principle have been announced by GRUSZKIEWITZ and by FRANK in Germany. KELLER and GOLDSCHMIDT have published interesting Papers relating to the electric reduction of iron ores, progress is recorded in the electrolytic production of antimony, and the electrolytic reduction of lead ores has been started on a practical scale at Niagara. SWINBURNE and ASHCROFT'S process for smelting complex sulphide ores, described before the Faraday Society, has good commercial possibilities.

A few important legal decisions have been made during the year. Chief among these is the award in the arbitration between the Marylebone Borough Council and the Metropolitan Electric Supply Company, with its interesting appendix of legal difficulties which have been raised in order to postpone or evade payment by the Council of the large sum awarded as the purchase price of the Company's electric lighting undertaking in Marylebone. An important Appeal decision was given in the Finchley overhead wire case, and there was a House of Lords decision that two of the famous City of London electric lighting contracts were invalid. The last of a long series of meter patent cases was decided in the House of Lords. Little general interest was taken in the case, as the patent had expired since it began its journey through the Law Courts. A similar instance was a case brought on a "magnetic blow-out" patent of 1889, although this has not proceeded further than the court of first instance. An appeal with regard to a dry battery patent which expires this year has still to be heard, and a successful action by Mr. GEIPEL against the Manchester Corporation for infringement of his steam-trap patent may possibly also be appealed against.

We summarised in our issue of August 21st the results of the Parliamentary Session of 1903, and, in our issue of December 11th, the contents of the Bills deposited for the coming session were also commented upon in a leading article. The Joint Committee on Municipal Trading issued its report in July. This did not deal with the whole wide question of municipal trading, but merely with that relating to the auditing of accounts, with regard to which useful recommendations were made which will doubtless form the

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subject of legislation next session. The Royal Commission on London Traffic has been sitting since March, and has also visited America; but the hearing of evidence has not yet concluded, and it is stated that no report will be issued until next December. Such a delay would be regrettable. New traction schemes for London which were deferred last session and have not been brought forward for next session pending the report of the Commission; and, if it is not issued until December, this will prevent the proper preparation of private bills for the 1905 session, and will delay the much-needed improvement in London traffic facilities yet another year.

In electrical science, radium and radio-active bodies have offered an exceedingly interesting field for research and much good work has been done, notably by RUTHERFORD, RAMSAY and SODDY. Their investigations, following the important researches of M. and Mdme. CURIE, have enabled them to evolve a working hypothesis as to the cause of radio-active phenomena which was approved by the majority of leading physicists at the British Association meeting, and have also pointed to a connection between radium and helium. Their views have, moreover, received considerable confirmation by more recent experiments. Other investigators have traced radio-activity in waterfalls, tap water, snow, and a host of other bodies, and good research work is being continued in England, France and Germany. CROOKES' "spinthariscope" has helped further to popularise radium research. BLONDLOT, in France, has discovered a new radiation, N-rays, many of whose peculiar properties have still to be explained, and he has also succeeded in rotating the plane of polarisation of X-rays. Electro-therapeutics has also had some successes, but precise information as to the relative value of radium, X-rays, and high-frequency discharges as a cure for cancer is still desired; medical men are naturally cautious in making announcements with regard to a prevalent disease that has hitherto been regarded as incurable.

It is our sad duty to recall the names of those several members of the electrical profession who have been taken from us during the year. The list of deaths includes JAMES WIMSHURST, Sir GEORGE STOKES, JAMES HOOKEY and Sir FREDERICK BRAMWELL, and *The Electrician* has suffered the loss of EDWARD TREMLETT CARTER, who had occupied the editorial chair for five years, JAMES LAISTER, who had been connected with the journal almost from its start, and G. H. ROBERTSON, an old and valued contributor.

Among miscellaneous events during 1903, we may refer to the celebration of the Gilbert tercentenary; the acquisition by the Institution of Electrical Engineers of a site for a building of its own; the opening of a new Local Section of the Institution at Leeds; an extension of the work and scope of the National Physical Laboratory; and the establishment of a London University and the granting of charters to several universities in the North of England.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electrical Engineering. By T. SEWELL. 2nd edition, revised. (London: Crosby, Lockwood & Son.) 7s. 6d.

Although it is little more than 12 months since the appearance of the first edition of this book, a second edition has already been published. Three additional chapters, dealing with alternating currents, have been incorporated, together with an appendix of questions on the contents of the entire volume. The author is remarkably well-versed in the art of imparting information to others, and this in the simple possible manner. His explanation in the first of the three additional chapters, by means of a vector diagram, of the method of measuring true power in an alternating-current circuit is simplicity itself, and all the terrors of the "cosine of the angle of lag" disappear. The second chapter deals with transformers, alternators and synchronous motors, while the third is devoted to polyphase working. All are excellently illustrated and admirably suited to the purpose for which they were written. The student is thus enabled to obtain sound and practical elementary information upon a subject often avoided owing to the difficulties which it possesses when presented in an advanced form.

Electricity and Magnetism. By R. T. GLAZEBROOK, F.R.S. (London: C. J. Clay & Sons.) 7s. 6d.

In the wilderness of elementary text-books, Dr. Glazebrook's effort proves a veritable oasis. The author explains, in the preface, that the book is really a series of lectures delivered to students at the famous Cavendish laboratory at Cambridge. But whatever the origin of the book, it is distinctly refreshing to find the subject dealt with in such a masterly fashion. Misleading analogies and faulty elaborations do not find a place; the point of the matter is arrived at without delay, and although obviously the work of a brilliant physicist, yet it is never "above the heads" of elementary students. It is taken for granted that the reader is fairly conversant with algebra and trigonometry, and numerical examples are set at the end of each chapter. This question of mathematics Dr. Glazebrook has undoubtedly met in the right way. It seems to be the fashion nowadays for authors of elementary text-books to either leave out the mathematical side of the subject or make a lame apology for its insignificant appearance. They apparently think that a student can learn elementary electricity and magnetism quite well without any calculations, and that when he comes to the "practical" work there will be still less necessity to know anything of such matters. But they surely forget that, at some time or other, the work must be done, and that no man can expect to be a good engineer unless he has a sound knowledge of mathematics. So much is being said just now about engineers' neglect of mathematics that one begins to wonder whether the teacher is not as much, if not more, to blame than the student.

The illustrations in the book under review are excellent, but we fancy that many of them have appeared in other text-books on the same subject; however, they are none the worse for that. The portion dealing with galvanometers and, in fact, with all kinds of electrical measurements, is particularly explicit, and will prove of considerable value to students who experience difficulty in this direction.

Electrical Influence Machines: Their Historical Development and Modern Form, with Instructions for Making them. By JOHN GRAY, B.Sc. 293 pages. 2nd edition. (London: Whittaker & Co.) 5s.

This is one of those happy books which need not fear comparisons, since it treats of a subject in which there are very few rivals. It embodies the author's attempt to bring together all that is useful and of interest with regard to influence machines, and therefore embraces the origin, development and theory as well as the constructional detail of the various types of instrument. We have little but praise for the work, for it is carried through luminously and with scientific accuracy. The diagrams are numerous and for the most part very clear, though in one or two cases the use of reference letters too be-suffixed and be-indexed is somewhat exasperating. We do not think the elementary discussion of general electrical theory which takes up the first 40 pages of the little book really necessary, however. Probably most readers will, justifiably, skip those pages; while those who have not before met with the rudiments of electrostatics cannot, we are afraid, gather here sufficient knowledge and experience to carry them intelligently through the rest of the book. The space might have been utilised rather for the inclusion of some of the merely curious and less useful influence machines, ancient and modern, which the author has chosen to omit, but which would have added to the value of the work for the purposes of reference. As a whole the book is of sterling merit and sure to be useful.

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CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Emission of N-rays by Strained Bodies.—R. Blondlot has found that N-rays are emitted by bodies in a state of strain, such as a bent rod; or bodies in a state of molecular strain, such as tempered steel and glass. On compressing pieces of wood, glass or indiarubber in a press and bringing them near a calcium sulphide screen, they increase its luminosity. A simple experiment is the following: The shutters of a room are closed so as to let in only sufficient light to render the face of a clock situated at 4yds. or 5yds. from the observer faintly visible. A stick is then held in front of the eyes and bent. The clock face is then seen to brighten up, and to become faint again shortly after the force is released. Instead of the rod a piece of glass may by used, bent either by hand or in the apparatus used for demonstrating double refraction by strained glass. Tempered steel exerts a similar action without being bent at all, but only as long as it is tempered. On annealing it it loses the property. The rays emitted traverse without difficulty a plate of aluminium 1·5cm. thick, a plate of wood 3cm. thick, black paper and similar bodies. Steel articles retain the property of emitting N-rays for almost incredible periods of time. Thus a knife found in a Gallo-Roman sepulchre of the Merovingian epoch shows them unmistakeably. The author suggests that the mechanism of their emission may be closely connected with that of radium rays. A plate of iron which is permanently bent emits N-rays for a few minutes only, and a block of aluminium shows an even more transitory effect. Torsion produces the same effects as bending.

[R. BLONDLOT, *Comptes Rendus*, December 7, 1903.]

Efficiency of the Nernst Lamp.—L. R. Ingersoll has re-determined the efficiency of the Nernst lamp by Angström's method, in which the total spectrum of the light is dispersed in order to separate out the visible spectrum, and the visible rays are then re-combined by means of a cylindrical lens and thrown upon a bolometer or thermopile. The glowers were burnt freely in air, without heaters, on a 100-volt alternating current. A voltmeter and wattmeter across the terminals of the glowers and a rheostat in series enabled the author to keep the voltage or power consumption constant at any desired value. The principal factors in the determination of the efficiency of any glower are its age and the power it consumes. The experiments showed that Nernst glowers are by no means uniform. New glowers show an efficiency of from 4·35 to 4·70 per cent. The efficiency falls rapidly for about the first 20 hours, decreasing to a mean of 4·3 per cent., and varies only slowly after this. Tests of glowers of 40 hours' age and upwards gave a mean efficiency of 4·17 per cent. Some very old glowers gave only 3·6 per cent. It is noticeable that after a glower has been burned upwards of 20 hours it develops a marked crystalline appearance, and it is probable that the fall in efficiency is due to the greater radiating surface and consequent lower temperature afforded by the crystalline structure. The author adds that if, as is now proposed, the glowers are aged before they are sent out, the deterioration with time may no longer be observable. As regards Hartman's observation, that old glowers show an increase in luminous intensity, the author points out that Hartman kept the current constant rather than the power consumption. As the resistance of the glower increases with age a constant current means an increased power consumption, and hence a greater emission.

[L. R. INGERSOLL, *Phys. Review*, November, 1903.]

Luminous Efficiency of Vacuum Tubes.—When Wood measured the temperature of the positive light column directly by means of a bolometer mounted in the tube itself, he found that the luminous gas was only a few degrees above the temperature of the room. Angström found that the light emitted by nitrogen at 0·15mm. pressure has the extraordinary luminous efficiency of 90 per cent. These facts have led E. R. Drew to undertake a careful study of the temperature and luminous efficiency of glowing vacuum tubes, on the general lines of Angström's experiments, but using a radiometer instead of a bolometer or thermo-couple on account of its freedom from magnetic disturbance. Owing to the great variation of the efficiency with the diameter of the tube, the author first made a comparison of two tubes of different diameters under identical conditions. He found that a tube 18mm. in diameter has about half the efficiency possessed by a tube 9mm. in diameter, and the efficiency is always a little less for alternate currents than for direct currents. The luminous efficiency of vacuum tube radiation from air at the pressure of 1mm. is approximately 20 per cent. A considerable proportion of this radiation is due to a single line, or narrow group of lines, at wave-length 4·75μ. The author discusses the results from the point of view of the electron theory. The theory that the radiation is due to collisions between charged particles and neutral gas molecules, and that the proportion of high-frequency radiation increases with the energy of these collisions, is sufficient to account for the observed facts in all cases where the conditions are well enough known to warrant its application. The temperature of the glowing gas was found to range from 50 to 100 deg. above the ordinary temperature.

[E. R. DREW, *Phys. Review*, November, 1903.]

Chemical Effects of Röntgen Rays.—R. Luther and W. A. Uschkoff have discovered a hitherto unsuspected difference in the behaviour of light and of X-rays in their action upon a photographic plate. Röntgen rays, even after a very short action upon gelatino-bromide paper, alter its sensitiveness to light, either increasing or diminishing it, whereas a previous exposure to ordinary light does not affect the sensitiveness of the paper for X-rays. In one experiment, the authors exposed a paper to an X-ray object for such a short time that, under ordinary conditions, no image would have appeared on development. They then exposed it to diffuse daylight until the paper turned grey, and then the Röntgen ray image appeared on development black on a grey background. This result led them to try whether under-exposed pictures taken by ordinary light could be brought out by a subsequent treatment with Röntgen rays. In this they were, however, disappointed. When a sensitive plate is exposed first to light and then to X-rays, the effects of the two agents are simply added to each other; but, when the X-rays act first, the final outcome is complicated by something resembling solarisation. The density of the final product may then be represented by the formula, $D = R + \frac{L}{1+aR}$ where R is the density of the Röntgen-ray image taken by itself, L that of the light image and a a constant. It is evident that D may be either greater or smaller than R. The authors confine themselves for the present to a statement of the facts, but hope shortly to furnish an explanation.

[LUTHER and USCHKOFF, *Phys. Zeitschr.*, December 15, 1903.]

N-Rays.—H. Zahn has vainly endeavoured to observe the N-rays discovered by Blondlot. He says that the latter's experiments as described by him have been repeated in several quarters, but so far without success. He himself employed a method which he claims to be more sensitive, as well as more objective, than that of Blondlot. He allowed a small sensitive flame to illuminate a selenium cell, hoping to find the existence of N-rays indicated by a change in its resistance. An Auer burner was surrounded by sheet-iron as in Blondlot's arrangement, and its light was concentrated upon a small gas jet placed in front of a selenium cell of 6,000 ohms normal resistance. An alteration in the resistance, amounting to 5 per cent., could have been determined with certainty, and as Blondlot's results lead one to expect a change in the brightness of the flame, amounting to at least 100 per cent., the experiment ought to have been successful. But the result was entirely negative. So it was when the author operated with a small spark worked with a string interrupter with terminals of various shapes and materials. The author does not go so far as to deny the existence of the N-rays, but points out that their discoverer has not described his experiments with sufficient detail, and that the rays can certainly not be so easily observed as he alleges.

[H. ZAHN, *Phys. Zeitschr.*, December 15, 1903.]

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ELECTRIC TRACTION WITH ALTERNATING CURRENTS.

The following is an abstract of the discussion which took place at the Manchester Local Section of the Institution of Electrical Engineers on Tuesday, December 15th, in connection with Mr. Eborall's Paper on the above subject. The Paper itself was published in our last two issues.

The CHAIRMAN (Mr. Cowan) said that the most striking thing about the Paper was its evidence of the rapid advance made in the use of alternating-current motors. He remembered that when the author last gave a Paper on electric traction before them, he had regarded the use of alternating-current motors for traction work as a hopeless problem. He (Mr. Cowan) and Mr. W. Atkinson, five years ago, spent much time on a single-phase series alternating-current motor. A model was made and tested, but the difficulties of commutation were enormous, and sparking defects caused them to cease their investigations on these lines.

Mr. PORTHEIM did not approve of single-phase repulsion motors, and he drew attention and maintained that Fig. 9 of the Paper, showing results of tests made by the Union Company on an experimental coach fitted with motors of Messrs. Winter and Eichberg's design, was misleading. He also read extracts from a letter from Herr Bláthy comparing three-phase and single-phase motors for economy and efficiency, to the credit of three-phase. The losses were greater in single-phase, more expensive gear was required for regulation, and they were restricted to a low-pressure system. Regulation with three-phase was effected by the half-speed cascade arrangement. The capital outlay for three-phase and single-phase was the same. He considered it no disadvantage that three-phase motors had to take the worst grades at full speed, and thought sub-stations ought to stand the overload. To obtain the same acceleration the cost of three-phase was only equal to continuous-current equipment. Regeneration of three-phase on the down grades was an advantage. He remembered making arrangements to supply three-phase traction current to a colliery, and when the line came to be operated with empty trains going up and full ones coming down from the colliery, they found that instead of supplying current to the colliery they were supplying current to the supply company. This was quite true. Comparing the double trolley with the single he drew attention to the fact that the same power could be transmitted through the double trolley at a lower voltage, and, any way, the cost of the line could be only 7 per cent. of the locomotive equipment. He believed it was only 1½ per cent. on the Valtellina Railway. The three-phase motor was as simple as any other motor, and in heavy main-line work the pressure would have to be greater for single-phase than for two-wire three-phase line.

Mr. RITCHIE said he had experienced serious trouble with alternating-current series motors in factory work, and asked if those described by Mr. Eborall were quite satisfactory in this respect.

Mr. S. L. PEARCE disagreed with the author when he advocated different systems for main line and suburban railways. Main line considerations would mainly determine the systems for use on the other lines, and, speaking as one having had some experience of a composite system, he could put it forward as the most satisfactory. The figure 106 watt-hours per ton-mile on the Valtellina Railway was very high, and he quoted 45 watt-hours per ton-mile for the Central London Railway by way of comparison. The cost of using a rail return was 20 times as great with alternating currents.

Mr. FRITH asked for information on the Zossen Railway. He wanted to know if the track had been broken up by their 90-ton car, and if they had transformers on the car and three-phase induction motors.

Dr. BOWMAN was gratified to realise the rapid progress made in single-phase working.

Mr. ANDREWS commented on Mr. Eborall's statement that electric traction was not so reliable as steam traction, and asked him to locate the trouble. Speaking of the tandem arrangement, he did not clearly understand why the motors ran at half-speed—he could understand them running below synchronous speed—but why half-speed?

Mr. HUTCHINS suggested the use of a variable speed gear, instead of dissipating energy in the present regulating arrangements.

Dr. RHODES spoke of compounding the generators themselves, and pointed out that wattless currents prevented a generator from doing its work. He commented briefly on the figures 83½ and 66 per cent. energy current for full load and half load mentioned on p. 328, giving an analogy in amperes. There was a want of proper speed control; the tandem control system was not satisfactory. The usual way of connecting the primary of the first to the stator of the second restricted the arrangement to low pressure. He commented on the theory of the arrangement, but admitted that, if his explanation were correct, he failed to see how power was returned to the line. Perhaps the author would enlighten them. He did not believe in single phase with commutators. The great point about alternating-current motors would have to be the absence of a commutator and freedom from repairs to minor details. The preference was given to three-phase motors in big power plants because they would stand most ill-treatment.

The CHAIRMAN regretted that they had not heard anything from the Westinghouse men present about the Washington–Baltimore single-phase railway.

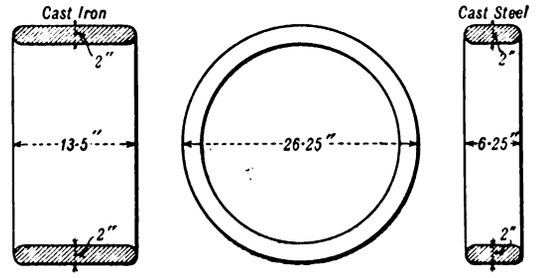
Mr. EBORALL, in reply, said that there was no hope for single-phase motors starting with phase splitting arrangements beyond ordinary industrial application. He defended commutators in low frequency single-phase motors, but said that in any case a series motor was hopeless over 25 cycles. He gave a further explanation of the diagram, Fig. 9, and the limiting transformer ratios 24 : 1 and 8·3 : 1 with the aid of the blackboard. In answer to Mr. Pearce, the figure 106 watt-hours per ton-mile was quoted from Mr. Kapp's report and was correct; it related only to the period of acceleration and retardation. Taken over the whole line the value would come down very much, and would compare more favourably with Mr. Pearce's figure of 45 watt-hours per ton-mile on the Central London Railway, where, however, it must be remembered that artificial gradients are provided. Impedance of the rail return had been dealt with in a footnote, where references to investigations on the subject had been given; for the rest, for 80lb. bonded rails the apparent resistance at 25 cycles was about 10 times that with direct current. In answer to Mr. Frith, he said that they had reached a limiting speed of 120 miles at Zossen. At higher speeds than that, the trains swayed and rocked dangerously. In answer to Mr. Andrews he pointed out that a steam locomotive had fewer weak links, such as transmission line, sub-stations, &c. Dr. Rhodes was right about the working of the tandem arrangement, but if he considered that by this arrangement he got virtually a single motor with twice the number of poles, he would arrive at the solution of the problem much more quickly.

EXPERIMENTS ON EDDY CURRENTS.*

BY W. M. THORNTON, D.SC.

§ 1.—Experiments on Massive Cast-Iron and Steel Rings.

Eddy currents are induced in solid masses of metal by any variation of a magnetic field traversing them. The loss of efficiency of dynamo-electric machines from this cause can be approximately determined from the fact that while other losses caused by hysteresis and mechanical friction vary directly with speed, eddy-current losses are proportional to its square. The usual way of conducting the separation test is to run the machine light, at the same excitation but at different speeds, as a separately-excited motor, and to plot the current taken by the armature vertically, the brush voltage or speed horizontally. A line is obtained which cuts the vertical axis, and the current required to overcome the



Area, 26·14 sq. in.
1,000 turns, 13·16 per in.
Weight, 6 cwt.

Area, 11·64 sq. in.
777 turns, 10·22 per in.
Weight, 3 cwt.

Fig. 1.—Yoke Rings for Magnetic Tests.

eddy-current loss is the height of the line above a horizontal through this point of intersection. Measured in this way eddy loss is found to account for 25 to 50 per cent. of the loss of efficiency at light load. (Hawkins and Wallis, "The Dynamo," 3rd edition, p. 689.) The increased loss at full loads depends very much on the construction of the machine. It is greater with poles and pole-faces of high electrical conductivity than with cast iron, because the circulation of the local eddies varies not only inversely with the specific resistance, but as the square of the permeability. It is for this reason that they are much greater in iron than in copper, for the ratio μ^2/ρ is 500,000 times greater for the former than the latter at ordinary flux densities. A comparatively small variation of magetisation will, therefore, give rise to strong currents when they are permitted to flow.

Before examining in detail the losses in a machine, it is well to know how eddy-current loss is related to hysteresis and copper losses in the most perfect case—that is, of a massive closed iron ring covered with a uniform winding and excited by an alternating current. For this purpose it is only necessary to measure the current taken and watts absorbed by the coil under different conditions of excitation and at different frequencies. Tests were made on two yoke rings (Fig. 1), kindly lent by Messrs. W. H. Allen & Co., the hysteresis loops of which have been determined by a special method independent of the influence of eddy currents in the core. Each ring was connected in turn first to the supply mains at a frequency of 83, and then to experimental alternators giving either 18 or 87 periods per second. The results are recorded in Table I.

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers on Monday, December 14th. Slightly abridged.

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Table I.—*Cast-steel Ring.*

Volts.	Amp.	Watts.	cos ϕ.	~	ri^2.	Hyst. watts.	Eddy watts.	Eddy hysteresis.	V/A ohms.
31·8	0·71	22·6	1·0	83·5	0·96	15·4	6·2	0·4	44·7
42·0	1·0	41·5	0·99	83·5	1·9	27·3	12·25	0·45	42·0
60·7	1·5	84·2	0·93	83·5	4·27	39·0	41·0	1·05	40·5
81·5	2·0	148·0	0·91	83·5	7·6	40·4	100·0	2·47	40·7
100·0	2·8	254·0	0·90	83·5	14·9	43·0	196·0	4·55	30·6
25·0	1·1	27·5	1·0	13·3	2·3	5·6	19·6	3·5	22·7
76·5	4·2	289·0	0·9	15·8	14·2	14·2	241·3	17·0	18·1
80·5	5·39	392·0	0·9	19·0	19·7	19·75	317·0	16·0	14·9
89·0	6·25	502 0	0·9	18·8	20·2	20·2	407·3	20·3	14·2
				Cast-iron Ring.					
100·0	0·67	60·5	0·9	83·5	1·3	21·0	38·0	1·8	149·0
37·0	0·39	13·0	0·9	37·0	0·44	8·6	4·3	0·5	95·0
45·2	0·534	21·4	0·89	37·0	0·83	12·5	8·0	0·64	85·0
102·5	0·782	68·4	0·84	37·0	1·78	49·6	17·0	0·34	132·0

When the frequency is high, it is impossible to work out the hysteresis loss from loops obtained by a slow cyclic process, but when the magnetisation is less than saturation the eddy-current and hysteresis losses can be separated by considering the latter to be proportional to the rate of change of the induction—that is, for low values to the exciting current—and the former to its square. Thus, if w represents the total watts less the copper loss, it can be written $w=ai+bi^2$, where a is the watts lost by hysteresis per ampere and b those lost by eddy currents per (ampere)^2. a and b can be found from two readings—$w_1=ai_1+bi_1^2$, $w_2=ai_2+bi_2^2$; so that $a=\frac{w_2i_1^2-w_1i_2^2}{i_1i_2(i_1-i_2)}$, and $b=\frac{w_1i_2-w_2i_1}{i_1i_2(i_1-i_2)}$.

At the higher frequency the greatest value of b for the steel ring is *25* watts per (ampere)^2, and of a 31·6 watts per ampere, but these co-efficients vary with the saturation, and should be determined

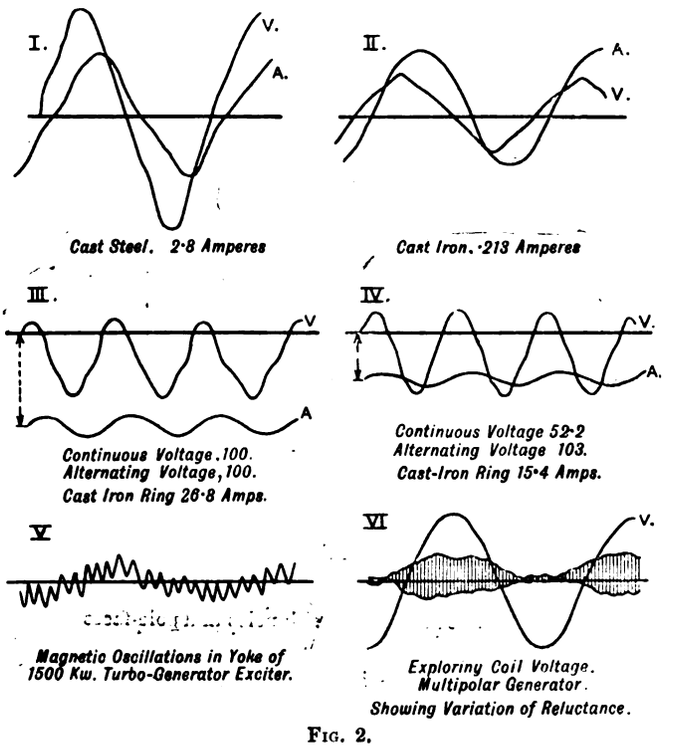

FIG. 2.

from adjacent values for the whole range of exitation. Thus, for the lowest current b is *12·25*. In this way the eddy current and hysteresis losses have been calculated. At the lower frequency it has been assumed that the shielding effect is not sufficient to lower the magnetisation reached at the inner parts of the core, because the long thin cross-section is very much less favourable to the flow of eddy currents than a circular area. The values of the hysteresis watts have in these cases first been found from the loops and the eddy loss deduced, but the results were also checked by the above method with an agreement within a few per cent. For example, the calculated values in column 8 corresponding to 241·3 and 407·3 are respectively 240 and 402.

Much difficulty was experienced with the cast-iron ring in getting consistent readings. This was found to be due to the retentiveness of the iron. The highest alternating voltage available in the laboratory is 100, and not having a suitable transformer the greatest current reached at the highest frequencies was 0·67 ampere. The power-factor was found by the oscillograph and the watts calculated, but there is little practical interest in these very low magnetisations. Typical oscillograms are given in Curves I. and II. (Fig. 2). By an inspection of the tables it will be seen that as losses increase the power-factor decreases. This cannot be due to the increase in permeability, for that is higher at the lower magnetisations. It means that with small coil currents, the eddies are sufficiently great on account of the high values of μ to prevent waves of any strength entering the core. When the whole core is magnetised by the large coil currents, the loss by eddy currents is increased, not because of their greater intensity, but of the larger area of the core brought into activity.

It is interesting to compare the behaviour of the two rings. The area of the iron ring is 2·25 times that of the steel. Its permeability is about one-half; the ratio of the turns on the windings are as 1·285 to 1. The inductance of a coil with a laminated core being $L=4\pi T^2A\mu/l$, where T is the total turns, A the cross-sectional area of the core, μ its permeability, and l its mean length, the corresponding inductance of the iron ring is 2·84 henrys, which is 1·44 times that of the steel. The resistance of the "iron" coil is 2·9 ohms, that of the steel 1·9. These are too low to affect the impedance, and the inductances would, with laminated cores, be in the ratio 1·44 to 1. They are actually 5 to 1.

Table II. shows how the cores are affected and their magnetic properties inverted by the action of the eddy currents.

Table II.

——	Cast iron.	Cast steel.
Mean permeability from loops	$\mu_1=260$	*520·0*
Calculated inductance	2·84	1·98
Observed impedance	149·0	30·58
Resistances of windings	2·9	1·9
Frequency	83·5	83·5
Observed inductance	0·445	0 058
Actual permeability of cores as a whole	$\mu_2=40$	*19·8*
Ratio μ_1/μ_2	6·5	26·3
Frequency	37·0	13·3
Observed impedance	132·0	18·1
Observed inductance	0·57	0·034
μ_2	51·5	11·7
Ratio μ_1/μ_2	5·05	44·5

Cases of solid cores exposed to alternations of this kind are rarely met in practice, but it is common to find a solid framework carrying a flux-density less than saturation exposed to alternations of rapid frequency and considerable amplitude, as, for example, in the magnetic circuits of alternating-current machines. Some effects of these oscillations have been given in a former Paper, and the tests made on the Hastings plant show that they are present under the best conditions of practical working. To imitate such cases, I placed an alternator in series with a continuous-current generator across the coil windings of the experimental rings, obtaining Curves III. and IV. (Fig. 2). In the larger of the two with 100 volts alternating superposed upon 100 volts continuous, the effect of the core in distorting the voltage wave is seen as a third harmonic. The current variation has an amplitude of about *12* per cent. of the mean reading and *17* per cent. when the continuous voltage is reduced to *50*. The maximum disturbances of field currents observed in practical working were *22* per cent. of the steady value in single-phase, *15* per cent. in three-phase machines, the average being about 10 per cent.* The ring experiments (Table III.), therefore, closely approximate to the conditions of practice, and it may with reason be inferred that the losses will be in much the same ratio and of the same order of magnitude in similar yoke rings and magnet cores.

Table III.

Continuous voltage.	Alternating voltage.	Combined voltage.	~	Amperes.	Watts.	Cos ϕ.
52·2	103	112	86	15·4	853·4	0·485
100·0	100	138	86	26·8	2,410·0	0·65

H continuous.	H alternating.	Hysteresis watts.	ri^2.	Watts eddy current	Per cent.	Eddy current watts per cub. cm. of core.
89·6	10·4	3·5	690	180	12·1	0·055
156·2	26·6	0·0	2,080	330	13·6	0·101

To separate the continuous from the alternating-current components, the oscillograph records were necessary. The ammeter reads $\sqrt{(I+i\sin\theta)^2}$, and by knowing the relative values of i and from the curves, their average values can be separated. Thus when the ammeter read *26·8*, 24 was continuous and 4·08 alternating. The combined voltage was taken with an electrostatic instrument. It

* Vide *The Electrician*, September 4, 1903.

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is seen that the intensity of the continuous magnetisation is so great that the hysteresis loop is closed for the range of alternating-current employed. There is, nevertheless, a wave of magnetisation accompanying each reversal of the alternating component, which, though the permeability is comparatively small, still entails a certain loss in the core, amounting in the second case of Table III. to *330* watts, or 13·65 per cent. of the whole energy dissipated, and in the second case, when the permeability is slightly greater, to 21 per cent.

§ 2. Tests of Continuous and Alternating-current Machines.

From these results it can be concluded that if in any machine the field current shows a synchronous variation, caused by armature reaction, of about 10 per cent., there will be a loss in the core by eddy currents, which will be a large fraction of the total losses in the machine.

In the experimental machine tested the total volume of the two magnet cores and yoke is 30,000 cubic cm., all of which is exposed to varying magnetisation, though not of the same amplitude. Running it as a shunt motor, light and varying the speed, the eddy-current loss at *1,150* revs. per min. is found to be *480* watts. Now, the energy lost in an iron core varies as the square of the alternating ampere-turns applied to it; but the secondary voltage in an exploring coil about the core is proportional to the primary ampere-turns. By measuring the exploring coil voltage under various conditions of working, the magnetic movements producing eddy currents within the core can be gauged. Table IV. gives a few results obtained in this way, the deflections being those of a hot-wire galvanometer placed across the series turns. When the brushes were central, very little deflection was observed. They were, therefore, moved backwards until commutation took place in the fringe from the trailing tip and slight sparking was visible. They were fixed in this position during the tests. The disturbing influence of the armature current is seen by the great increase in the square in column 6 with load when the fields are weakened. Why there is any deflection at all is a question which will be answered in section 3. The deflection obtained when the machine was running light as a motor with the brushes forwards to the same angle that they were previously backward was $\theta_0 = 8{\cdot}2$, with an armature current of 9 amperes. The figures in the last column give the relative eddy-current losses in a loaded generator to those in a motor running light, which are given above.

Table IV.—*Continuous-current Generator. Speed, 1,120 revs. per min.*

Field current.	Flux density in gap.	Voltage.	Current.	Deflection θ.	Square of ratios of θ.	$\left(\frac{\theta}{\theta_0}\right)^2$
			0	6·25	1·0	0·59
3·7	5,100	128	30	8·5	1·85	1·07
			51	13·0	4·3	2·5
			72	18·0	8·3	4·8
			0	1·55	1·0	0·03
2·7	4,475	110	30	4·5	8·4	0·3
			50	8·0	26·5	0·95
			71	12·0	60·0	2·15
			0	0·65	1·0	0·006
1·7	2,980	75	30	3·2	24·2	0·15
			51	6·0	85·0	0·53

It is difficult to imagine a loss of 2,300 watts by eddy currents in a 10kw. machine, even with the brushes far backward. The last column of figures must stand for what it is worth as a test of the method, but it was thought well to devise another, and the method finally adopted was to pass an alternating current through the series windings and to measure the power at different currents or frequencies, vide Table V.

Applying the previous method of separating hysteresis and eddy-current loss, the three components have been worked out. It is reasonable to suppose that, in this case, practically all the eddy currents circulate in the solid frame, for it is certain that those in the laminated armature are exceedingly small compared with the circulation in the solid core around which the magnetising coil is placed. According to this table, it takes about *2,000* ampere-turns applied to the coil at a frequency of 83 to produce eddy-current loss comparable with that observed in a motor running light, but since the loss varies as the square of the frequency, it would take only *13·8* ampere-turns to produce the same effect at a frequency of *1,000*, which is that of commutation. It may be pointed out that the loss in the solid frame—viz., 480/30,000, or *0·016* watt per cubic centimetre—is not widely different from that obtained in Table III. from experiments with alternating currents on cores already saturated.

Before proceeding to consider the causes of eddy-current trouble it may be of interest to show by Table VI. the behaviour of the same machine as an alternating-current generator. The internal disturbance when working single-phase is greater than in continuous-current generators, but with three-phase currents much less, and it is known that the efficiency of the machines is greater in the latter case. If the greater part of the eddy-current loss takes place in the armature, why should three-phase working be so much better than single? To show that it does not, a single-phase current was passed through the armature by way of the slip-rings, and the losses separated by the method given in the appendix. The magnitude of the hysteresis loss in ordinary working can be found with accuracy, and is 10 per cent. or more of the total losses, so that the eddy-current loss in the armature may be taken from the table in the appendix at about 3 per cent. But the total eddy-current loss for a continuous-current machine is about 30 per cent. of the whole. The remaining 27 per cent., or practically all, must, therefore, take place in the solid magnet frame.

Table V.

Volts	Amps.	Watts.	Cos ϕ.	IT.	ri^2.	Eddy-current watts.	Hyst. watt.	Ratio eddy /hysteresis.
86·0	41·4	2,300	0·64	4,554	69·8	1,975	255·0	7·7
56·8	26·2	900	0·60	2,882	28·0	790·0	82·0	9·6
43·0	17·75	468	0 61	1,952	12·8	303·0	92·2	3·9
25·5	11 9	220	0·72	1,310	5·6	163·0	51·4	3·18
18·25	8·05	115·5	0·78	885·5	2·6	74·5	38·4	1·94
12·1	5·27	50·2	0 78	579·7	1·1	31·9	17·2	1·85

Table VI.—*Alternating-current Generators. Speed, 1,120 revs. per min.*

——	Field current.	Volts.	Line current.	Watts.	Cos ϕ.	θ.
	3·7	81	0	0	—	0
	3·7	75	33·5	2,460	1·0	4·85
	3·7	71	52·0	3,700	1·0	14·0
Single-phase..	3·7	69	60 0	4,050	0·98	19·5
	2·7	52	335·0	1,740	1 0	6·0
	2·7	47	47·0	2,260	1·0	13·1
	1·7	35	33·0	1,160	1 0	4·7
	2·0	44	25·0	1,640	0·75	0·5
Three-phase..	2·0	40	37·0	2,220	0·75	0·5
	2·0	37	55·0	3,040	0·75	0·85

§ 3. Oscillograms of Magnetic Field Disturbance by Variation of Armature Reaction and Reluctance.

It has been shown that large eddy-current loss can take place in the magnet frames of both continuous and alternating-current machines. In the latter class the chief source of the loss is, no doubt, variation of armature reaction; but in the former the conditions have been generally thought to reach a steady state, or one in which the magnetic movement is confined to the armature teeth or pole-faces.

There are in continuous-current machines four possible sources of disturbance; the first and most important at light load being imperfect centreing of the armature or adjustment of the air-gaps. The second is the variation of reluctance caused by the teeth of the armature moving across the pole-face. The third is the slight peripheral shift of the cross magnetising belt to and fro during commutation; and the last the variation of reaction set up by a rise and fall of armature current, caused by phase swinging or uneven turning moment of the engine.

In my last year's Paper it was shown that imperfect centreing caused double-frequency waves of magnetisation in the solid cores when the armature was revolved mechanically with no current of any kind in its windings. During some experiments at Neptune Bank station it occurred to me that the magnetic circuit of the exciter of the recently-installed 1,500kw. turbo-generator might show signs of internal movement. An exploring coil of 10 turns was, therefore, wound around the yoke of the machine, which is bipolar, mounted on the end of the turbine shaft, and itself separately excited from the main exciter 'bus bars. The remarkable result is shown in curve V., Fig. 2. There are two effects present, one synchronising with the three-phase current generated in the main circuit, the other with commutation in the exciter. The generator has four poles and a revolving field. The oscillograph motor was driven from the main supply, and the cause of the wave in the curve must be looked for in something which goes through a cycle in half a revolution of the shaft. The current leaving the exciter showed no such wave, but only a small irregular ripple evidently set up by the three-phase reaction. The disturbance must, therefore, arise within the exciter, and it is not difficult to see that such an effect can only be produced by a slight eccentricity of the armature on its shaft, so that when the hump is opposite either pole the reluctance of the exciter circuit is least, and when between them greatest, causing a reaction at double the speed of the exciter—that is, synchronising with the main supply. The superposed ripple has 15 periods to that of the wave, and, therefore, coincides with the frequency of commutation, for the exciter has 30 segments. The machine delivers 210 amperes at 30 volts, and the demagnetising ampere-turns vary by about *125* during each short-circuit. For let the angle covered by one brush be θ, then when commutation is perfect there is a change of current from a

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positive to a negative maximum in that space. By unfastening one of the connections to the commutator and joining the ends to two slip-rings, the brushes of which are then connected by a low resistance, this change of current can be observed in an oscillograph. Fig. 3 is a typical curve from a machine with wide carbon brushes. The current falls rapidly to zero and grows slowly to its opposite maximum.

Let the point of passing through zero be after 0·06 of the brush angle has been traversed, then the entering current will be rapidly falling while the leaving current is rising, the effect in cross ampere-turns being the same as if the former persisted at its full value for an angle $0{\cdot}03\,\theta$, then suddenly ceased, and the latter reached and maintained it about $0{\cdot}7\,\theta$ before release. There is, therefore, a resultant peripheral shift of the cross ampere-turns equal to the mean of these effects, or about $0{\cdot}36\ \theta\ i_a C/360$, where C is the total number of conductors on the armature. Taking $\theta = 20$deg., there is for the exciter an oscillating peripheral variation of about $0{\cdot}36 \times 20 \times 105 \times 60/360$, or 123 ampere-turns. This may not appear

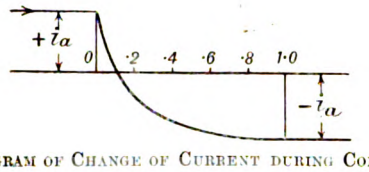


Fig. 3.—Oscillogram of Change of Current during Commutation with Wide Carbon Brushes.

great, but in a low-voltage machine it may be an appreciable fraction of the total winding ampere-turns. In this case it is sufficient to disturb the whole magnetic circuit to the extent shown. The section of the yoke is 8in. by 14·5in., and it is of cast iron, in which, as we have seen, there is comparatively small damping by eddy currents. The effect is not likely to cause much loss by core heating, but it is this further evidence of disturbances in the magnetic circuits of large commercial machines constructed with great accuracy which leads me to regard them as universal, and as a general source of loss of efficiency.

To illustrate the extent to which these oscillations set up in commutation affect the magnetic circuit, I connected the series coils of a Pallion six-pole generator, which has a steel frame and poles and cast-iron shoes, to the hot-wire galvanometer and, keeping the load constant, varied the brush position. (There is a slight permanent reaction caused by the armature running out of centre by an amount too small to be observed. This variation of reluctance can be seen in Curve VI., Fig. 2, where the voltage in an exploring coil placed about the bobbins varies between the limits of the shaded area in time with the speed of the machine, the oscillograph motor running at three times the speed. This is a confirmation of the cause

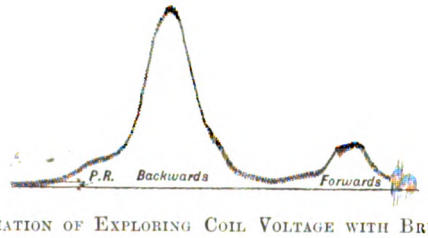
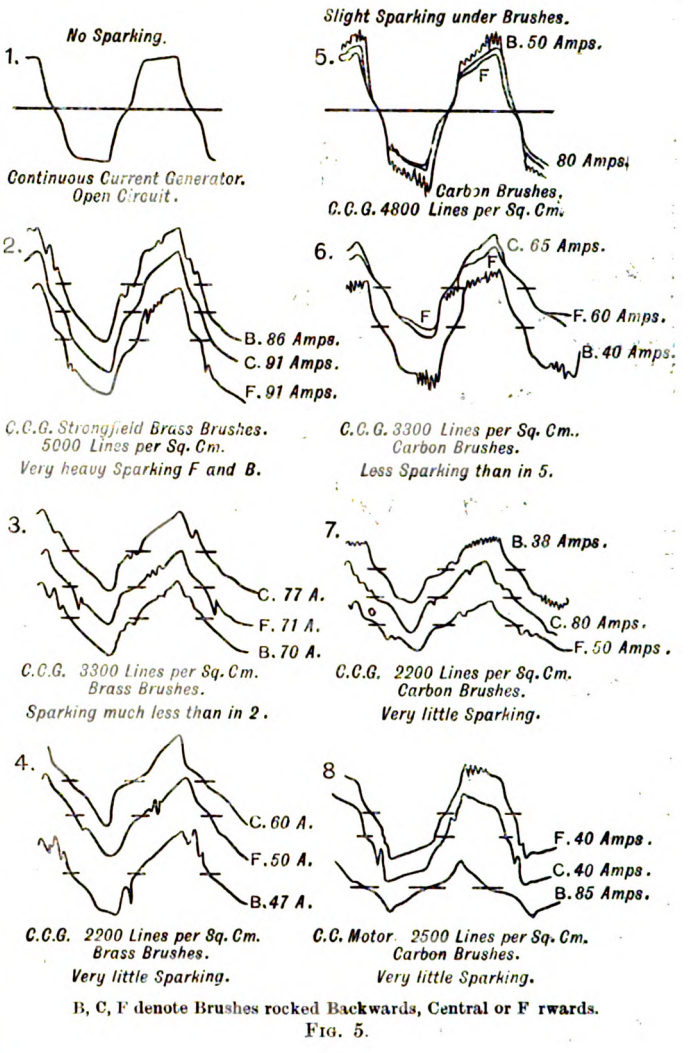


Fig. 4.—Variation of Exploring Coil Voltage with Brush Position in Continuous-current Generator.

of the wave in the Wallsend curve, though it was in that case stationary on the screen, the speeds being identical.) Any increase of voltage can then only be due to the change in the magnetising ampere-turns during commutation, for this is the only thing which is varying. It is seen from Fig. 4 that when the brushes are rocked backward until there is sparking there is an active movement within the core, which when they are forward is much less. Both curves show signs of rapid changes of considerable amplitude. To investigate this further, the resistance connecting the experimental slip-ring brushes was removed and the two adjacent commutator segments short-circuited by a copper bridge One coil of the armature then acts as an exploring coil, the voltage in which is at every instant proportional to the strength of the field through which it is passing. The rings were then connected to the oscillograph, and a few of the results are recorded in Fig. 5.

These curves are of interest as being, I believe, the first to show the instantaneous distribution of polar magnetism in dynamo-electric machines. Their full consideration must be reserved for another occasion. It is seen, however, that when the brushes of a generator under load are moved backwards, the magnetism in the gap is caused to oscillate at a speed much higher than that of the machine and in ripples. These are in a state of oscillation, the amplitude of which is greater with strong fields and for brush positions which correspond to commutation taking place in a strong field. The effect does not depend upon sparking at all, for in the fifth curve there was scarcely any, while in the second, with brass brushes, it was very heavy both in the forward and backward positions. These brushes were narrower than the carbon, and the peripheral shift is therefore less. In generators or motors, the ripples are strongest at the pole tips with the most stray field.



B, C, F denote Brushes rocked Backwards, Central or Forwards.

Fig. 5.

It may, therefore, be concluded that of the four causes given, the first and third are active in producing eddies. The second is known to be by the heating of pole-faces with slotted armatures. It remains to examine the effect of the last.

(To be concluded.)

FERRANTI ALTERNATING-CURRENT INTEGRATING WATTMETER.

A new alternating-current wattmeter possessing certain novel features has recently been introduced by Messrs. Ferranti Limited. The meter is of the induction-motor type, measuring accurately the energy consumed on an alternating-current circuit, whether the load is inductive or non-inductive; and it is essentially a practical, commercial instrument, the energy being recorded directly in Board of Trade units, and no multiplier or constant is necessary. The accompanying illustrations show clearly the construction of the meter, and indicate the simplicity of its parts.

The aluminium rotatable disc D, mounted on the spindle S and geared to the train of wheels CT actuating the index hands, serves the double purpose of an armature receiving the driving torque of the meter coils and also the retarding torque of the permanent magnets PM. One shunt coil, ShC, placed round the coil C of a special tubular electromagnet, TM, constitutes the shunt system. The core of this magnet has three outward radial poles, P^2, alternating with four inward radial poles, P^1, from the shell or tube of the shunt magnet, the plane of these poles being horizontal and parallel to the disc; this tubular magnet is placed below the disc. It is well known that, in the case of the induction-motor type of

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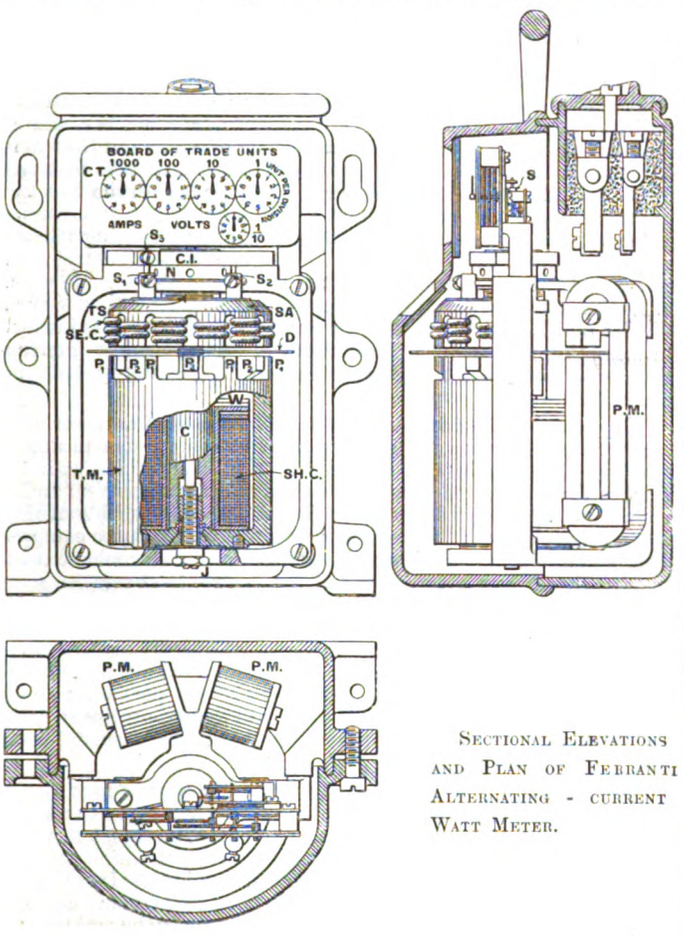
meter, it is necessary that the shunt circuit should be very inductive, and in this connection a special tubular magnet is found most suitable, no choking coils, secondary circuits, resistances or compensating coils being required. The number of electrical connections is thus reduced to a minimum, and the possibility of trouble therefrom considerably reduced. The series system consists of a slotted armature, SA, above the disc, the series coils SeC being wound in these slots. A wave-form of winding is used, somewhat similar to the winding adopted by Mr. Ferranti for his alternators in 1884; it will be noted that the slots of the series armature are almost directly above the poles of the tubular magnets.

If the shunt circuit be sufficiently inductive, the eddy currents produced in the disc by the shunt field will be in phase with the impressed E.M.F. These eddy currents are acted on by the series field, which is in phase with the load current, giving a driving torque on the disc proportional to the E.M.F. of the circuit multiplied by the amperes and by the cosine of the angle of lag of the main current behind the E.M.F., this being the true watts supplied to the circuit through the meter. The retarding torque due to the permanent magnets is proportional to the speed, and the disc therefore revolves with a speed which is proportional to the watts. If the series and shunt magnetic systems could be made exactly symmetrical and placed relatively to one another in a symmetrical position—*i.e.*, the slots of the series magnet exactly above the shunt poles—then the disc would not revolve when the shunt coil alone is energised, and the meter would read low at the small loads owing to the friction of the train and spindle bearings. For the purpose of compensating for any dissymmetry in the magnetic system due to small irregularities in material, workmanship and pivot friction, it is necessary to have some adjustment which gives a driving torque when no current passes through the series coil, this driving torque being insufficient in itself to cause rotation of the disc and train. In many other meters, special grooves, pole extensions or coils are required, but it is an important feature in the Ferranti design that no additional windings or parts are necessary, as the series magnet is simply turned about the axis of rotation of the disc to the necessary extent to effect the required compensation; for if the series magnet is displaced clockwise, the disc will tend to revolve anti-clockwise. But if, on the other hand, the series magnet is put to the other side, the disc will tend to revolve clockwise. Hence it will be seen that it is possible to leave the series magnet slightly out of centre in the direction which gives a slight torque on the shunt alone, and this can be very accurately adjusted to compensate for pivot friction or for any dissymmetry in the magnetic circuit met with in manufacture.



SECTIONAL ELEVATIONS AND PLAN OF FERRANTI ALTERNATING-CURRENT WATT METER.

The adjustment can be most accurately made, and the meter can be calibrated or adjusted by the simple action of slightly altering the relative positions of the shunt and series magnets, and this is done by means of the two screws S^1 and S^2. The driving torque with the shunt alone, even with the maximum possible displacement of the series armature, is extremely small, and as it will be noted that the armature is fixed by a powerful clamp, Cl, and the two screws S^1 and S^2, the possibility of the meter developing any tendency to creep on the shunt is very remote. The constant of the meter is also readily adjusted by lowering or raising the series armature by means of the nut N on the threaded spindle TS, the effect of this being to strengthen or weaken the action of the coils, and after adjustment the series magnet is securely fixed by means of the strong clamp Cl and the screw S^3. On all conditions of circuit, inductive or non-inductive, on overloads up to 50 per cent., and under variations of voltage to 50 per cent. above or below the normal, the meter is very accurate, and it is also practically independent of variations in frequency, wave form or temperature. Every meter is calibrated to the following limits of accuracy:—1½ per cent. from one-tenth to full load, and 2½ per cent. from one-twentieth to one-tenth load. The accuracy is not affected by short-circuit through a fuse of double the capacity of the meter. It is said that a 10-ampere meter starts well with 0·05 ampere, and can be relied upon to register with a 250-volt 8 c.p. lamp. The losses in the meter are very small, and the efficiency is consequently high; in a 10 ampere 200 volts 100 periods instrument it is claimed that the losses in the shunt circuit are not above 1·7 watts, and the series loss at full load does not exceed 0·8 watt. Only 0·015 ampere is required in the shunt. All Ferranti alternating meters are tested to withstand a pressure of 1,000 volts alternating, applied between windings and case. For convenience in testing, all meters are calibrated to run at a standard speed of 40 revs. per min. at full load, the standard voltages for calibration being 100, 110, 120, 200, 220 and 240. For intermediate voltages the nearest standard is adopted, this making no difference in the accuracy of the meter.

The terminal box is specially designed to facilitate testing, the shunt being connected to a fourth terminal, which can readily be disconnected from the main terminal, allowing the shunts of several meters to be placed in parallel on the voltmeter leads, and avoiding unnecessary opening of the cases. All meters are fitted with a one-tenth unit train on front dial for facility in testing. The meters are fitted with removable jewelled brass settings, J, which enables a defective jewel to be easily replaced by a new one at any time without altering the calibration of the meter, all parts being interchangeable.

SELECTION AND INSTALLATION OF HIGH-TENSION SWITCHING APPARATUS.*

BY L. L. ELDEN.

The development of alternating-current generating and transmitting apparatus has been so rapid that since the year 1897 almost every branch of the electrical equipment has become specialised, and none more so than switchboard apparatus. To-day the switchboard of a prospective central station in any of the large cities receives more serious consideration than any other part of the station; and justly so, for upon this particular unit largely depends the reliable and continuous supply of service from the station, it being at this point that most of the emergencies are cared for by the operator. When considering the construction of a switchboard there are several points to be carefully considered before proceeding with the selection of the switching apparatus. The operating requirements should largely govern this selection, and on this point it is necessary to decide whether a considerable amount of the responsibility be allowed to rest with the operators, or whether a certain amount of special apparatus be installed with the end in view of rendering the entire installation automatic. The former course is without question the proper one to pursue, as the special apparatus devised to care for unusual occurrences is at times very erratic and unreliable in action, and, under some conditions, inoperative.

When the reliability of the generating and transforming apparatus now furnished by the manufacturers and the freedom from burn-outs which it enjoys are given full allowance, there is no good reason for complicating the switchboard to avoid an occasional emergency which may momentarily cause use of the apparatus in excess of its rating.

The emergencies that occur in a well-controlled station which cannot be cared for safely and properly by a vigilant operator are few and far between, and in general fewer interruptions to the service occur in stations where the switchboards are arranged with simplicity in view, and reliable attendants are employed. I can scarcely place too much stress on the term "simplicity" when applied to a central-station switchboard, for that is the key upon which its success as a part of the station depends.

* Paper read at a convention of the Association of Edison Illuminating Companies.

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The types of switches which have been developed to meet the requirements of the last few years have become standardised to a certain degree, and for ordinary requirements there are certain types of oil switches available whose capabilities are now well known. For small capacities there is the hand-operated tank switch, having all breaks in a common oil tank, each pole being separated by barriers. This switch can safely be relied upon to perform its duties up to 2,500kw., but above that capacity recourse should be had to a modification of this switch, which is largely used. This modified switch comprises separate oil tanks for each pole of the circuit, all mechanism for operating the switches being attached to a common hand lever to operate all. The use of this switch is fairly satisfactory up to 4,000kw. to 5,000kw. where there is not too great a capacity, which can be concentrated at a fault in the system, as, for example, 10,000kw. to 15,000kw. For very heavy duty above these capacities there is available the motor or magnet-operated cell-type of oil switch now commonly in use in nearly all large stations, which, seemingly, has unlimited ability to successfully rupture tremendous amounts of energy. The construction of this switch in brick compartments makes it one of the safest features of the entire switchboard construction, inasmuch as it practically confines any trouble that may occur to the switch itself. The use of oil switches should have the preference over all others for alternating-current work, where the voltage conditions do not exceed the known ability of the oil switch.

Considering the location of the switching apparatus, it is very desirable that all of this material be installed in a room or building entirely isolated from the generating room, particularly if it be a steam-driven station under consideration. This is of prime importance where continuous and uninterrupted service is desired, as the operator and switching apparatus are protected from any trouble that may occur in the generating room, and many times the operator is able to make such connections and arrangements as will prevent a complete shut-down, whereas if exposed in the engine room, as was the practice in the past, he was not able to operate at his highest efficiency, and, as has been frequently the case, much of the switchboard apparatus would be damaged to such an extent as to prevent an early resumption of current supply. The fact that a majority of the interruptions of service in the large modern plants arise primarily from troubles which occur in connection with the steam side of the plants is an argument in support of the above recommendation, and engineers of such plants who have installed their switchboard in separate buildings or rooms express the greatest satisfaction with the arrangement.

The arrangement of 'bus bars for a station is one that should receive the most serious attention before a final scheme is settled upon, for the successful operation of the system depends a great deal upon the flexibility and ease with which the various units are handled. The preferable arrangement is a complete double set of bars arranged for sectionalising for the purpose of facilitating inspection, repairs and testing. In very large stations, the amounts of energy which can be concentrated at a given point make it absolutely essential that provision be made to separate any given section of 'bus bar in the event of a switch or other apparatus failing, thereby interrupting only a small part of the system. Each feeder or generator of the system can, under this plan, be isolated for any purpose whatever, and a station which has not had many cases each year when it was very desirable to do this would be hard to find. Of course, there are exceptions to the rule, and doubtless there are some stations where there would be no great advantage derived from the above arrangement when compared with a single 'bus bar installation.

There have been some advocates of a single set of 'bus bars, having in turn radiating from them a number of sub-'bus bars, thereby forming certain divisions of the system. Aside from the lower first cost, there is nothing to say in favour of this plan, and it has been advocated largely by those who did not fully realise the serious side of operating a plant when completed. The restrictions placed upon the operator as to the possible ways out of trouble in emergencies are many when compared with the double 'bus bar system, and additional cost should not be a bar to installing the proper apparatus. In some moderate-sized stations it has been the practice when arranging a double 'bus bar system, to specify double-throw switches or circuit breakers as a part of the completed switchboard. This, I think, is a serious mistake, as a much safer and preferable arrangement is two single-throw switches in place of each proposed double-throw switch, particularly at such points as it is possible to concentrate energy in excess of the capacity of the switch if a fault should occur in the switch. This last statement does not, however, apply to small lighting feeders for local distribution where the expense is prohibitive and the risk slight.

Taking up the question of the proper switching equipment for generators, it is very generally conceded that no automatic devices are required for this work in the majority of stations, as it is rarely that anything happens to damage modern generators with the liberal momentary overload factor provided in their construction. For generators of 1,500kw. and over, the switching equipment should provide suitable single-throw hand-operated non-automatic selector switches for connecting the generator to either set of 'bus bars, and in addition to these, in the case of generating units of 2,500kw. or over, an additional emergency switch should be provided and installed in series with the selector switches. If any automatic switch is to be used in connection with the generator this additional or emergency switch is the proper one to equip with the necessary tripping devices.

Tripping apparatus is available for protection from two sources of trouble—namely, overload and reverse current. Overload devices are reliable and satisfactory, and while their use may be desirable in some plants, particularly where belted apparatus or generators of small capacity are in use, the reverse is true of the larger machines generally in use in large stations. Concerning reverse-current devices, there is yet considerable room for improvement in their design, as those at present on the market have not been entirely satisfactory to those who have had them in use. With reference to their use, it is suggested that the best use for them in connection with generator circuits is to indicate to the operator, by means of a signal of some sort, upon occurrence of a reversal of current, leaving it to his discretion as to what course to take to meet the existing emergency. In such systems as it is deemed advisable to use tripping devices for overload or reverse-current protection for the generator, these devices should be capable of being adjusted as to the time which will elapse before the switch will operate after the occurrence of the trouble.

The switches to be employed for feeders should provide selector switches arranged to connect the feeder to either 'bus bar, and all switches should be equipped with automatic overload and time-limit devices. When equipping a lighting system it is advisable that each feeder should have its own individual connections with the 'bus bars in preference to the group method. This ensures less interruption to the service, as there is no possibility of other feeders being affected, as is sometimes the case where the selector switch controlling a group of feeders is tripped, due to the severity of the trouble which affected a single feeder in the group. This method will, of course, involve a higher first cost than the group method, but it is justified in a lighting system by the additional insurance against interruptions to the service, which in a system not having storage batteries as auxiliaries is a serious matter.

The method of operating large switches by means of motor or large magnets seems to be the simplest and most desirable means to employ. The use of bell cranks and pipe connections with the smaller types of switches, when installed at a distance from and in connection with panel boards, affords a simple and reliable method of operation by hand, but when such switches are to be equipped with automatic tripping devices, some improvements could be made to advantage over the mechanical arrangements shown in some comparatively recent installations. It would be of considerable advantage to the operators to have the tripping coils on such switches brought to the panel and operate directly in connection with the operating handle, instead of being located out of sight and operating to trip and disconnect a portion of the mechanism only. The indicating devices at present used with remote-control switches to indicate the position of a switch can hardly be improved upon, and need no comment here.

When a prospective purchaser of switching apparatus states his requirements to the manufacturers, he is sometimes offered a number of special devices which will accomplish various results, but which, if purchased and installed, usually require more attention than all the rest of the switchboard to keep in good condition. It is imperative in the majority of large stations where switches are operated by means of relays that a separate source of energy be employed to operate the switches, which shall not in any way be subject to fluctuations in the generating system, as, for example, a storage battery.

Two general forms of construction have been exclusively used in arranging controlling panels for switchboards where the switches are remote control, namely, the bench-board and individual-panel systems. The panel system seems to be the more preferable of the two, because all of the instruments and other controlling apparatus belonging to the particular unit which the panel represents is confined to one panel, and a glance is all that is necessary to learn the condition of the machine, or feeder, controlled by a particular panel. With the bench-board system, having only the switch controls on the bench, it is necessary to have an additional board on which to erect the necessary instruments for each unit's control, and the task of looking from one to the other is a bar to rapid work by the operator. Another objection to the bench-board construction is the concentration of such an amount of control wiring in a small space, making that a danger point easily destroyed in event of a fire starting, due to the failure of some part of the controlling apparatus. The present forms of bench-board construction are very inconvenient and inaccessible as constructed, and leave much to be desired in the way of improvement.

Wherever additional expense is not too great a burden, isolate all switchboards and switching apparatus in a separate room

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or building, apart from the generating or transforming apparatus. Instal 'bus bars in duplicate and provide for sectionalising same. In large lighting systems, particularly, arrange 'bus bars and switching apparatus for operating the main generating plant in unit groups not exceeding 20,000kw., and, preferably, as small as 10,000kw. At sub-stations operate feeders separately—that is, do not connect them in multiple, as by this means much of the switching apparatus is relieved from excessive strain. If, however, a station of 40,000kw. to 50,000kw. is to be operated as a single unit, delivering current to heavy feeders, connected in multiple at the receiving end, the introduction of suitable reactances, limiting the current that can flow in each feeder to a reasonable amount, would be very desirable.

Wherever the conditions are proper do not use automatic switches on generators, but in some cases provide for reverse-current indication. Equip all feeders with automatic time-limit and overload protective devices. Make the whole installation simple and accessible, and, above all, take plenty of room. Avoid grouping cables as much as possible, and use cable and wire about the board possessing slow-burning qualities and having ample insulating qualities to make it safe to handle. Use brick cell construction and oil switches when capacities and voltages are high, and avoid air-break switches wherever possible. Instal auxiliary breaks in series with all switches or any other apparatus which requires inspection or test, after board is in operation; in other words, make it possible to work on any part of the completed board with perfect safety and without interrupting the service.

Bearing in mind that the completed installation will be operated by men entirely distinct from those designing and installing the switchboard apparatus in large stations, do not fail to give careful consideration and weight to the ideas of competent operators, who have had experience in similar plants already in operation.

CORRESPONDENCE.

DYNAMO DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg to bring to your notice a formula which I have devised for determining the lengths of the poles of field-magnets by a more direct method than is at present adopted. Since the length of the pole depends entirely on the length of the bobbin to be put on it, the method now used is to assume a trial value, then make a drawing of the machine and from this calculate the mean magnetic paths, from which are deduced the total number of ampere-turns required per pole. Assuming a suitable magnetising current, it is now possible to find the number of turns and hence to design the bobbin. This gives a new and final value for the pole length which necessitates a new drawing, and alters the mean magnetic path in the pole cores and yoke. The schedule has now to be altered and the current changed to suit the new number of ampere-turns.

The formula which I give below does away with the necessity for any ampere-turn schedules or preliminary drawing:—

Let D = the depth of wire on the bobbin.
d_c = diameter in inches of the wire DCC.
n = number of turns of the wire per linear inch.
L = length of one layer of wire; and
S = number of turns of wire per bobbin.

Obviously number of turns per layer = $L \times n$, and number of layers = $D \times n$. Therefore, $S = (L \times n) \times (D \times n) = LDn^2$. But since $n = 1/d_c$, $S = LD/d^2_c$.

Multiply each side of the last equation by C = the magnetising current. We have $CS = LD/d^2_c \times C$. But if C_d = the current density in the wire, and d = the diameter of the wire bare, then $C = \pi d^2/4 \times C_d$.

Subs. for C, we have $CS = \frac{LD}{d^2_c} \times \frac{\pi d^2}{4} C_d$. Re-arranging, we have, $L = \frac{4}{\pi} \cdot \frac{CS}{D \cdot C_d} \times \left(\frac{d_c}{d}\right)^2$. Hence the formula is $L = 1{\cdot}49$ to $1{\cdot}91\ CS/D \cdot C_d$.

The constant is arrived at thus:—Assuming C_d to be 700, the most suitable wire for every current can be found, then knowing both d_c and d, $(d_c/d)^2$ is easily calculated, which multiplied by $4/\pi$ gives the necessary constant. I give a list of these constants for currents varying from 1 to 10 amperes, though I think it would be sufficient to bear in mind that it is 2 for 1 ampere and 1·5 for 10 amperes.

Current.	No. of S.W.G. wire.	$\frac{4}{\pi}\left(\frac{d_c}{d}\right)^2$	Current.	No. of S.W.G. wire.	$\frac{4}{\pi}\left(\frac{d_c}{d}\right)^2$
1	18	1·9	6	12	1·58
2	16	1·79	7	11	1·55
3	15	1·72	8	11	1·525
4	14	1·67	9	10	1·505
5	13	1·62	10	9	1·49

Current density taken as about 700 $\frac{\text{amperes}}{\text{sq. in.}}$

The method of using the formula is as follows:—Make a drawing of the armature as before, and from it calculate the number of ampere-turns required for the gap, teeth and armature body. This will give you the CS required for the formula. It will be noticed that these are not the total CS for one pole, but the modern practice is to make the gap fairly long and to keep the flux-density in the teeth high, so that the extra ampere-turns required for field-magnets do not, as a rule, exceed one-tenth of the CS for the rest of the machine. These are amply allowed for by low current density chosen in calculating the constants. The depth to which the wire may be wound is governed by the permissible heating, and is, therefore, dependent on the specifications and the designer's experience; the usual depth is about 3in. The constant chosen depends on the magnetising current and, therefore, on the output of the machine. It only remains now to put in the values for the quantities in the formula to find L, the length of one on the bobbin; to this must be added the thickness of the two bobbin ends and the insulation between the wire and the bobbin to obtain the true length of the pole. The field-magnets can now be added to the drawing of the armature, and having found the total CS, the bobbin may be designed and the extra ampere-turns allowed for, either by making the depth of the bobbin slightly larger, which, since both D and C are arbitrary numbers, is of little importance. If the quantities are assumed to be 3 and 750 respectively, the formula is reduced to $L = 86$ to $85\ CS/10^5$.

This formula is most applicable to alternator or shunt machines if a rheostat is to be used, as it does not make any allowance for the resistance of the wire, but it can be used for any shunt machines if the current can be approximated beforehand so as to get a suitable constant.—Yours, &c.,

London, Dec. 26. GEOFFREY H. COOKE.

PROTECTION AND TRAMWAY ENTERPRISE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Atherley-Jones' recent Paper upon the Fiscal Question (as abstracted in your issue of December 18th) occurs a very serious case of "Russian scandal," which I crave permission to point out. In your issue of November 27th, Mr. W. Pollard Digby, in a statistical article, states, "As to the exact extent to which foreign generators have entered our central stations, it is not easy to say. . . . Of electricity supply works in operation it can be stated that in 95 per cent. dynamos or alternators of *Continental* manufacture are unknown," the italics being mine. In quoting from this Paper Mr. Atherley-Jones renders the above (according to your abstract): "It was worthy of note that in 95 per cent. of the electrical supply works in this country dynamos or alternators of *foreign* origin were unknown"—*i.e.*, "Continental" has been extended to "foreign," and the imports from the United States are entirely overlooked, although the competition from America has, till the last year or two, been much more severe than from the Continent.—Yours, &c.,

Brinton Hill, Dec. 30. EDWARD V. CLARK.

Tramcar Roof Covers—In addition to Mr. Macedo's roof cover, which is being tried on the Leeds Corporation tramways, there is under probation a cover with glass windows and open platforms at the ends, an invention by the staff of the tramways department. Two other patterns will be tried shortly.

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ELECTRICAL JOINT STOCK COMPANIES OF 1903.

The following are the more important limited liability companies connected with the electrical and allied industries registered during the past year, with their capital:—

A. B. P. Accumulator Co.	£20,000
Aerozone	12,000
Alert Electric Co.	2,000
Alley and Maclellan	130,000
Anglo-American Motor Co.	20,000
Anglo-Iberian Elec. Light and Power Co.	10,000
Auto-Electric Rifle and Target Co.	60,000
Automatic Telephone Co.	100,000
J. Bakewell & Co.	15,000
Bath and District Light Railway Co.	225,000
Bath Electric Mfg. Co.	15,000
Blake-Morscher Elec. Ore Separator Synd.	10,000
British Accumulator Co.	5,000
British Electric Calibrated Fuse Co.	3,000
British Elec. Separating Co.	6,000
British Electric Signs Co.	20,000
British Elec. Transformer Co.	125,000
British L. M. Ericcson Mfg. Co.	200,000
British Tramways & General Construction Co.	300,000
Brooker and Goss	5,000
Bruce Peebles & Co.	200,000
Calvert & Co.	15,000
Chichester and District Electric Supply Co.	20,000
City and Suburban Electric Carriage Co. (1903)	152,000
Codd Arc Lamp Co.	2,000
Column Printing Co.	10,000
Consolidated Electrical Co.	125,000
Cooper & Co.	100,000
Craigpark Elec. Cable Co.	150,000
Cross Electric Engineering and Mfg. Co.	4,000
Delagoa Bay Development Corporation	300,000
Durham and District Elec. Traction Co.	30,000
Dynamic Gas Power Co.	155,000
East India Construction Syndicate	300,000
Edison Mfg. Co.	100
Ekstromer Accumulator Co.	25,000
Elec. and General Insurance	10,000
Elec. Indicator Syndicate	5,000
Elec. Lamp Renovating Co.	20,000
Electric Danite Syndicate	5,000
Electrical Name and Numerical Sign Co.	4,000
Electrical Post Railway Co.	1,500,000
Electrical Turnery	2,000
Electrophone	15,000
Fenner, James & Co.	3,000
Gell Telegraphic Appliances	30,000
Gen. Elec. Inspection Co.	10,000
Gent & Co.	50,000
George M. Callender & Co.	75,000
Glamorgan Engineering Co.	16,000
Glasgow Electric Crane and Hoist Co.	100,000
Hammersmith, City and N.E. London Railway	30,000
Havana Electricity Co.	300,000
Headley Limited	10,000
Hele-Shaw Patent Clutch Co.	50,000
Hemsworth Electricity Supply Co.	6,000
Henley's (South Africa) Telegraph Works Co.	2,000
High-Speed Braiding Machine Co.	60,000
Hodge & Co.	25,000
W. D. Houghton & Co.	50,000
J. E. Hutton	50,000
Hyde Electrical Mfg. Co.	5,000
Imperial Engineering Co.	1,000,000
Incandescent Lighting and Electric Fittings Co.	2,000
India Rubber Mfg. Co.	20,000
Industrial Storage Battery Syndicate	100,000
Jarrard's Automatic Track Cleaner	£5,000
Johnson Economiser and Smoke Consumer	8,000
Kingswood Elec. Supply Co.	1,000
Kola Mines Power Station.	30,000
Korting Bros.	50,000
Krieger Electric Carriage Syndicate	30,000
Lacy-Hulbert & Co.	10,000
Lamp Mfg. Co.	10,000
Lancashire Power Construction Co.	300,000
Light Cure and Electro-Therapeutic Institute	12,000
Ljungstrom Engine Boiler and Condenser Co.	36,500
Lond. Gen. Automobile Co.	10,750
London Telegraph & Steam Gauge Electric Co.	1,000
Lord and Shand	3,000
Lyon Patent Refrigerator.	12,000
Mersey Elec. Supply Synd.	3,000
Metals Deposition and Recovery Co.	6,000
Metals Extraction Synd.	5,500
Metropolitan Engineering Association	10,000
Mfg. Electric Co.	6,000
Thomas Middleton & Co.	30,000
Milford-on-Sea Electric Supply Co.	8,000
Miller Signal Syndicate for India	2,500
Miller Signal Syndicate (Foreign Patents)	5,000
M.I.P. Electrical Syndicate	10,000
Mono-Rail Construction Co.	60,000
Mullineux	50,000
Municipal Foundry and Engineering Co.	5,000
Nat. Prov. Electricity Corp.	30,000
New Automobile Co.	10,000
North Wales Power and Traction Co.	270,000
North Western Electricity and Power Gas Synd.	10,000
Nottingham Electrical Co.	1,000
Ozone Generators	6,000
Pearson Fire Alarm	250,000
Penarth Tramway Synd.	3,000
Phœnix Dynamo Mfg. Co.	60,000
Piscicilli Electric Post Parent Syndicate	150,000
Portpatrick Elec. Supply Co.	2,000
Prested Minera' Gas Indicating Elec. Lamp Co.	12,500
Private Wire and Telephone Installation Co.	3,000
Van Raden & Co.	10,000
Ramsgate and District Elec. Supply Co.	30,000
Rapid Magneting Machine Co.	3,000
Reliance Electric Co.	1,000
Lionel Robinson & Co.	50,000
St. Albans and District Electric Supply Co.	25,000
Seale, Austen and Barnes.	15,000
Scottish Central Electric Power Co.	30,000
Simplified Underground Conductor Co.	20,000
South London Tram. Co.	293,000
South-Western Electrical Co	5,000
Steam Generators	12,000
W. & E. Sumner & Clementson	5,000
Sunderland District Electric Tramways	270,000
Syro Switch Co.	3,000
Tasker, Sons & Co.	50,000
Taunton Elec. Traction Co.	50,000
Transporter Co.	20,000
Tokio Construction Co.	150,000
Tonyrefail and Gilfach Goch Electric Light Co.	3,000
Uddington District Electric Lighting Co.	£1,000
Ulster Elec. Power Distribution Co.	10,000
Universal Insulator	10,000
T. H. Wathes & Co.	3,000
Wave Power Co.	12,000
Wells, Rayner & Co.	20,000
Werner Frères	120,000
Western Elec. Distributing Corporation	10,000
West Surrey Light Ry. Co.	1,000
World's New Accumulator Co.	£7,500
Worthington Pump Co.	500,000
Archibald J. Wright	3,000
York Electrical Co.	5,000
Yorkshire Elec. Tramways Construction Syndicate.	230,000
Yorkshire Private Telephone Co.	6,000
Zone Dynamo and Motor Patents Co.	2,700

PUBLIC COMPANIES WOUND UP, DISSOLVED, &c., IN 1903.

The following are the principal electrical and engineering limited liability and statutory companies which have been wound up (either voluntarily or compulsory) or dissolved during the past year. An asterisk denotes that the company was wound up by order or under the supervision of the Court, and † that the company has been struck off the register of joint-stock companies:—

Automatic Electric Railway Signal.
Automatic Fog Signalling and Railway Appliances Syndicate.
Automobile Supply Co.
Berend (O.) & Co.
Bland Bros.
†Brianne Electric Lamp Co.
British Electric Car Co.
British Electric Street Tramways.
†British Motor Traction Co.
British Schuckert Electric Co. (for amalgamation with Siemens Brothers & Co.) [Co.
†British Volta Electric Glow Lamp
*Carbon (New) Syndicate—Supervision Order.
City and Suburban Electric Carriage Co. (for reconstruction).
†Collier-Marr Telephone and Elec. Mfg. Co.
†Collier's Patents Syndicate.
Column Printing Telegraph Synd.
Cons. Telephone Construction and Mfg. Co. (for reconstruction).
Easton & Co.
Elec. and General Contract Corp.
†Electric Arms and Ammunition Syndicate.
Electric Installation Co.
*Electric Lighting Boards (for reconstruction).
Electric Lighting & Fittings Corp.
†Electric Propulsion.
Electric Royalties Syndicate.
*Electric Tramways Trust.
†Electrical Guarantee and Trust.
Electrical Luminiscriptor Co.
†Electrical Transport and Power Co
†Electrical Undertakings.
†Electro-Ceramic Syndicate.
Electro-Magnetic Traction Co.
Electro-Neurotone Co. (for reconstruction).
Electrophone Limited (for reconstruction).
†Ferrolite Electric Syndicate.
French Victoria Accumulator Co.
†General Traction Co.
*Hands Limited.
†Haulage and Traction Co.
†Herne Bay and Canterbury Light Railway Syndicate
†Hire-Purchase Electric Wiring Co.
†I.E.S. Accumulator Co.
†International Electric Storage
†Lancashire and Grand Trunk Electric Tramways.
†Lancashire United Elec. Tramways.
†Leeds Electrical Supply Co.
Lithanode Electric Storage.
†London Electrical Cab Co.
London Motor Omnibus Syndicate.
London & Prov. Electrical Const. Co.
M'Alpines Electrical Co.
Marquand Accumulator Co.
†Merthyr Tramway Co.
Milnes (Geo. F.) & Co.
†Monte Video Tramways Co.
Morley-Fletcher Wave Power System
†Nalder and Harrison Construction Syndicate.
*New Imperial Electric Lamp Co.
†New-Mayne Electric Rudder Motor Syndicate.
North British Electrical Co.
Northern Counties Traction Co.
Norwich Electricity Co.
Paisley Tramways Co.
Patent Exploitation.
Railway Construction Co.
Renewable Electric Lamp Co.
†Road and Tram Car Electric Traction Co.
Rosling and Fynn.
†Ryde Electric Light and Power Co.
*S. M. Van Hinden Electrical Co.
†St. Martin's Electrical Mfg. Co.
*Salmony (H. M.) & Co.
Schischkar & Co.
Stewart Electrical Syndicate.
Surprise Arc Lamp Syndicate.
*Telescriptor Syndicate.
United Elec. Wire and Telegraph Works Co.
†Universal Electric Lighting Co.
Vaughan and Brown.
*Warrington and District Electric Light and Power Co.
Woolwich District Elec. Light Co.
Yorkshire Electric Power Synd.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

"Detailed Proposals for a Tariff Bill." (London: Bolton's, Knightsbridge). 1d.

"Die Dissozierung und Umwandlung Chemischer Atome." By Dr. J. Stark. (Brunswick: F. Vieweg & Son.) 1.50m.

"Elektrisch betriebene Strassenbahnen." Edited by S. Herzog. (Munich and Berlin: R. Oldenbourg.) 8m.

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MUNICIPAL, FOREIGN, & GENERAL NOTES

APPOINTMENTS VACANT AND FILLED.

An assistant electrical engineer is wanted by the Bengal-Nagpur Railway Co. (Ltd.), with thorough mechanical and electrical training. Further particulars are given in an advertisement. Applications to the company, 132, Gresham House, Old Broad-street, E.C., by Jan. 15.

An electrical engineer with good commercial knowledge and experience in estimating costs and preparing tenders is required by Messrs. Vickers, Sons and Maxim (electrical department), Sheffield. See advertisement.

An electrical engineer is also wanted to take charge of dynamos, motors and other electrical plant in steel works. Applications to Messrs. Vickers, Sons and Maxim (Ltd.), Sheffield. See advertisement.

Another assistant, with factory experience, competent to give instruction in the theory and practice of electric machine design, construction and testing, is wanted in the department of electrical engineering of the City and Guilds Central Technical College, Exhibition-road, S.W. Salary £150 per annum. Applications to Prof. Ayrton. See advertisement.

Electrical mechanics, with good experience in any branches of electrical work (except telegraphs and telephones), are wanted at once in electrical department of Devonport Dockyard. Applications to the electrical engineer, H.M. Dockyard, Devonport. See advertisement.

An assistant is wanted for the testing department of an electricity works. Must have had technical training and experience in testing and calibration of electricity meters. Applications to city electrical engineer (Mr. Victor A. H. M'Cowen), Belfast, by Jan. 13. See advertisement.

Birmingham Asylums committee require a resident working engineer in connection with the new Hollymoor Asylum, to take charge of electric lighting and laundry machinery, &c. Wages 50s. per week, with house, coal and gas. Also an electrical assistant to work under the resident working engineer. Applications to Mr. Wm. Hutton, Council House, Birmingham, by Jan. 4.

St. George's (Hanover Square) Guardians require a clerk of works in connection with the electric light installation at Fulham-road Workhouse. Applications to clerk, Mr. T. Worlock, St. George's Hall, Mount-street, London, W., by Jan. 11.

The Southend-on-Sea Light Railways and Electric Lighting committee require two tramway inspectors with previous experience. Applications to borough electrical engineer and general manager (Mr. W. E. J. Heenan) by noon Jan. 18.

Birkenhead Corporation require a tramways manager. Salary £450 per annum. Applications by 8th inst.

Wellington (N.Z.) Technical Education Board require a director for their technical school. Salary £500. Further particulars from the Agent-General, 13, Victoria-street, London, S.W.

We regret that the note in regard to the changes made in the staff of Bradford Corporation tramways department which appeared in our last issue was not accurate. Mr. G. R. Blackburn, A.M.Inst.C.E., A.M.Inst.E.E. (who is hon. secretary of the Leeds section of the Institution of Electrical Engineers), was not an electrical engineer in the workshop, but was deputy and chief assistant to Mr. Edwards, who has been appointed to Gloucester. On the departure of Mr. Edwards, Mr. Blackburn took up his duties. Mr. Foster, the depôt foreman, has been appointed superintendent of rolling stock, responsible to Mr. Blackburn, who has entire control, under the general manager, of all engineering and technical work in the department.

Mr. H. B. Knowles, M.A., principal of the technical college at Swindon, has been appointed principal of Salford Royal Technical Institute at £450 per annum.

Portsmouth Telephone sub-committee have appointed Mr. Teasdale, of Lancaster, chief clerk and accountant of the telephone department.

EDUCATIONAL NOTICES.

Birkbeck College.—The new term begins on Jan. 4. Systematic courses of instruction (lectures and laboratory work) are given in experimental physics, chemistry, mathematics, assaying, metallurgy, &c. The courses include practical work in well-equipped laboratories to meet the requirements of the University of London degrees. Evening classes are also held in practical geometry, building and machine construction, steam, theoretical and applied mechanics, &c. Further information from the principal. See also advertisement.

Sir John Cass Technical Institute.—Evening classes in chemistry, metallurgy, physics and mathematics, designed to meet the requirements of those engaged in the chemical, metallurgical and electrical industries and in trades associated therewith, are held at this Institute, and every facility for special and advanced practical work is afforded in well-equipped laboratories. Two courses of instruction in glass-blowing will be given during the Lent term by Mr. A. C. Cossor. The new term begins on Monday. Further particulars may be obtained at the Institute, or by letter to the principal, Jewry-street, Aldgate, London, E.C.

Argentina.—The *Review of the River Plate* states that the question of establishing electricity works is under consideration by the mayor of Corrientes.

Lincoln (Buenos Ayres) new electricity works were recently started.

It is stated that Government approves of the Municipal Council having control of the service and tariffs of all the telephone companies in the Federal capital.

A *Financial Times* correspondent states that Buenos Ayres Municipal Council are discussing a proposal to limit the period of the current concessions of the various tramway undertakers to 30 years. The Council have refused consent to the City of Buenos Ayres Tramway Co.'s proposed conversion from horse to electric traction. The gas companies have been directed to reduce their charges, and the Compania Alemana Transatlanticade Electricidad to fix their tariffs in paper currency instead of gold. The undertakers in each case will resist the designs of the Corporation, and the Senate have temporarily shelved the application of the Corporation for a law authorising the borrowing of $20,000,000 for street-making, and the imposition of a special tax upon the property of the electric lighting and tramway companies to liquidate the loan.

Specifications, plans and conditions have been approved by the Government of Argentina for the electrical installations on the defence works of the Puerto Militar. The total cost of these installations is estimated at $24,387 gold, and the work is to be carried out by the Coast Artillery force. A decree in the "Boletin Oficial" of Nov. 26 indicates that the plant and apparatus for these installations will be purchased either in Europe or America. The "Boletin" can be seen at the Commercial Intelligence Brach of the Board of Trade, 50, Parliament-street, London, S.W.

Aston.—The official inspection of the Aston tramway route took place on Tuesday, and the line will be opened for traffic on Monday.

Australian Federal Patents Act.—This act was assented to on Oct. 22 last and probably comes into force to-day (Jan. 1), although this period may be extended. The principal provisions are :—

One patent will now cover all the Australian States.

(1) *Who may apply:* (*a*) The actual inventor, (*b*) his assignee, agent, attorney or nominee; (*c*) the actual inventor or his nominee jointly with the assignee of a joint interest in the invention; (*d*) the legal representative of a deceased actual inventor or of his assignees; (*e*) any person to whom the invention has been communicated by the actual inventor, his legal representative or assignee (if the actual inventor, his legal representative or assignee is not resident in the Commonwealth).

(2) *Novelty:* Complete specifications only are subject to an examination as to novelty.

(3) *Conversion of State Rights:* Existing State patents may be converted into Commonwealth privileges for the unexpired period, but if the invention (*a*) is not novel, (*b*) has been published, (*c*) has been made the subject of a pending application in any other state than the state in which the existing patent was granted, then any such state may be excepted.

(4) *Grounds of Opposition:* Same as Great Britain, with addition of ground of want of novelty. Appeal lies to Supreme Court.

(5) *Amendments:* Are allowed by way of disclaimer, correction or explanation.

(6) *Extensions and Revocations:* Are provided for similarly as in Great Britain.

(7) *Patents of Addition:* Are granted for unexpired term of original patent at half fees.

(8) *Manufacture:* In the Commonwealth is *not* compulsory.

(9) *Compulsory Licences:* May be granted after two years to any person proving that the reasonable requirements of the public have not been satisfied.

(10) *Non-conformity:* A patent cannot be assailed on the ground of non-conformity between the provisional and complete specifications.

(11) *Prior Patents:* A patent granted more than 50 years ago shall not be a bar to validity, if there has been no user in the Commonwealth within that period.

(12) *Fees:* The Government fees up to sealing are £8, and there is a renewal fee at the expiration of the seventh year of the period of the patent.

Barking.—The Empire Electric Light and Power Co. recently offered to take a lease of the electricity supply and tramway undertakings for 21 years. The Council have declined the offer.

Beeston (Notts.).—The Council are considering a report upon certain proposals of the Derbyshire and Nottinghamshire Electric Power Co. to supply electricity in bulk in this district, the Council undertaking the distribution for public and private lighting. On this basis, the cost of sub-station equipment, distributor cables,

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house services, meters, &c , is estimated at £4,250. The company offer to supply current in bulk at 1½d. per unit if a minimum of 100,000 units is taken per annum, the Council distributing at 4½d. per unit for private lighting and 2d. or 2½d. per unit for power.

Belfast.—At the last meeting of the Corporation the city electrical engineer (Mr. Victor A. H. M'Cowen) submitted a report on the progress made by the electricity undertaking during the past year. There was the equivalent of 160,371 8 c.p. lamps connected to the mains, compared with 115,671 at the end of last year, an increase of 44,700 for the year, practically double the increase of any former year. The output also showed a satisfactory increase, the estimated units sold being 1,989,000, compared with 1,491,841 for the previous year—increase 33 per cent.

Board of Trade Returns —Considerable interest is taken in the Board of Trade returns, as is evidenced by the fact that the principal trade journals devote considerable space to these details. It is, therefore, satisfactory to learn that the Board of Trade is about to give effect to a very reasonable demand from representatives of important organisations of British traders that an attempt should be made to specify in every item of the returns the country of origin of goods imported into and re-exported from the United Kingdom (in addition to the place of actual shipment). Only a misleading idea of the volume of trade can be gleaned from the present returns, as, from various causes, the country of origin of a large proportion of our imports is not now stated. For instance, goods manufactured in Switzerland are credited to whatever shipping port they may be ultimately despatched. In consequence, France is credited with very much larger exports to this country than she is actually entitled to. This applies also to several German and Belgian ports. The change effected by the Board of Trade comes into force on Jan. 1.

Bristol.—A special meeting of the Electrical committee was held on Tuesday when the report of the city electrical engineer (Mr. H. Faraday Proctor) upon the fire which occurred at Temple Back electricity works on Wednesday last week was presented. This report is set out in another column.

Mr. Faraday Proctor was in attendance and, in reply to a question, he stated that there was ample current at Avonbank to supply private lighting, and in fact, 25 per cent. to spare. There were two steam alternators and two steam turbine sets, any three of which were sufficient to supply all required current. Continuous current for power was still supplied from Temple Back.

Mr. Henry Williams was appointed assessor to act on behalf of the Corporation in connection with the insurance claim.

Great appreciation was expressed of the assistance rendered by a number of gentlemen, including representatives of various firms, who at great personal inconvenience came specially into the city to supply stores, &c., required for the repair work. Acknowledgments were also made of the splendid labours of the electrical engineer (Mr. Faraday Proctor), the secretary of the committee (Mr. F. W. Prosser) and the members of their respective staffs.

Cambois.—The miners have sent a deputation to the Northern Counties Electricity Supply Co. urging them to give a supply of electricity for lighting the cottages of the Island Colliery.

Cromer.—The Council have sanctioned the payment of £7,345 to Edmundson's Electricity Corporation on account of their contract for the erection of electricity works. The Highways committee are making experiments in public lighting with Nernst lamps. Extensions of the electric lighting mains to Suffield Park have been authorised at £1,700.

Dinner.—At West Hartlepool on Monday last week, the first annual dinner of the Teeside and District Electrical Contractors' Association was held, Mr. Watson, of Middlesbrough, presiding.

Responding to the toast of "The Governing Bodies," Councillor J. W. Boanson said that the fact that the electrical contractors in West Hartlepool had plenty of trade showed that the Corporation undertaking was a success. They were determined that everything should be done to make it so, as it was the only undertaking which was remunerative. A capable committee, with Ald. Macfarlane as chairman, and with Mr. H. F. Friederichs as chief of the electrical staff, assured them that the electric lighting of the town would be put upon a paying basis.

Mr. J. Spence, speaking to the toast of "The Teeside Electrical Contractors' Association," said the object of the Association was to band themselves together to push forward electrical work of all kinds, and to abolish that class of work called "jerry wiring." He wished the Association every success, and assured them that the manufacturers would endeavour to work harmoniously with them.

Mr. Watson responded, and said that, although the Association had not yet been quite a year in existence, they had now as members half the electrical contractors in the district. They had been assisted very greatly by the Corporation and manufacturers, and the National Association had recently signed agreements which would greatly benefit the trade in the future.

Mr. G. H. Prescott (West Hartlepool), proposing the toast of "The Visitors," said the object of the Association was not to run up prices or to fight the workmen, but to further the cause of the electrical industry and to ensure the turning out of better work.

Mr. Friederichs replied, and commended the contractors for combining to prevent bad work, which he had noticed in other towns where he had been. He supported Mr. Boanson's remarks with regard to the education of apprentices and men. If they did that they would be helping along the industry perhaps more than they thought.

Durban (Natal).—The incomes from tramways, telephones and electric light appear in the Corporation's annual estimates as £79,000, £13,000 and £63,000 respectively, and amongst the largest items of expenditure are tramways £77,000 and electric light £56,000. The revenue from electricity, tramways and water supply combined has increased during three years from £76,669 to £172,179. It is not proposed to undertake any new works during 1904.

East Ham.—An inquiry was held here last week into the application of the District Council to borrow £15,000 for extensions of the electricity undertaking.

The clerk (Mr. C. E. Wilson) and the electrical engineer (Mr. W. C. Ullman) gave evidence. Mr. Ullman said the works were opened on June 22, 1901, and on Dec. 1 last there were 611 private consumers and 169 arc and 140 incandescent lamps used for public lighting. 30 miles of distribution cables were laid. The revenue for year ended March was £7,858, and for the six months ended September, £4,646. In order to meet next winter's load it was necessary to make considerable additions to the generating plant, and the Council had decided to erect a 750kw. dynamo and a 1,200 H.P. direct-coupled set, a motor-generator-balancer set; also two more boilers and condensing plant, a 3,000 gallon capacity heater and detartariser, with piping, &c. Certain alterations to the switchboard would also be necessary.

There was no opposition.

Edinburgh.—At the meeting of the Council last week the convener (Mr. Mackenzie) in presenting the minutes of the Electric Lighting committee, which recommended the amendment of the wiring rules, said that if the Council approved the rules they would have to be submitted to the Board of Trade for sanction.

Mr. Mackenzie also said that certain paragraphs had appeared in the papers lately which stated that the risk of fire from electric lighting was much greater than it really was, and he desired to say that the greatest risks were what they were trying to prevent in recommending the amended rules. One of the rules recommended that wires should be in closely jointed iron pipes. He wished to warn the public against the use of certain pipes which were, in the opinion of experts, very unsuitable for the purpose. That tubing was not welded, but the edges were brought together, and not screwed at the ends, the one end being simply pushed inside the end of the next pipe. They were thus not in close electrical contact, and if the insulation of the wires broke down, the current could not get along the pipe to a point where it could be bonded to earth, but found a path in some other way. It perhaps got on a bell wire, and if that bell wire happened to cross a gaspipe an opening might be made for the escape of gas, which the electric current might set on fire. The object of that particular rule was to give the engineer power to refuse to connect where those unsuitable tubes were used. If electric wiring were properly done there was less risk with electric lighting than with either oil or gas lighting.

The minutes were approved.

Electric Lighting Provisional Order —The Urban Electric Supply Co. (Ltd) have asked the Board of Trade to substitute the County of Durham Electrical Power Distribution Co. (Ltd.) as undertakers under the Bishop Auckland Electric Lighting Order, 1900.

Electricity Supply in Ireland.—Dalkey District Council and several other local authorities have received communications from Mr. T. H. Walker, Redan House, Dalkey, stating that influential persons in London, whom he represents, desire to invest from £1,000 to £1,000,000 in electricity supply undertakings in Ireland.

Ely.—An agreement has been entered into between the District Council and the Southern District Electricity Corporation giving the former's consent to an application by the company for a provisional electric lighting order.

Fulham.—The borough electrical engineer (Mr. A. J. Fuller) has prepared a special report dealing with the conversion of the whole of the side streets from gas to electric incandescent lighting. This report is now before the committee, and an early trial with some 200 or 300 lamps is probable. Mr. Fuller has also reported to the Council that the Granville Theatre of Varieties is now connected to the Corporation mains. Owing to the failure of the plant installed by the owners of the theatre, temporary connection to the Corporation mains had to be given. The weekly output of the works for Christmas week, 1903, was more than double that for the corresponding period last year, and since March last (when Mr. Fuller commenced his engagement at Fulham) the number of consumers has increased from 650 to 1,020. Dust destructor statistics show that the largest quantity of refuse ever burnt in a single week at Fulham was accomplished last week, when 766 tons were consumed

Ghent (Belgium).—The municipal authorities of this city have disposed of their tramway system to a syndicate chiefly representing the Tramways de Gand Co. (Belgian), the Union Electrique (Belgian) and the A.E.G. (Berlin) the main condition being that the line shall be promptly converted to electric traction.

Glasgow.—The proposed tramway provisional order of the Corporation for extending the tramway system is threatened with opposition from the railway companies likely to be affected.

Institution of Civil Engineers.—The complete pass list of the October, 1903, examinations at home and abroad to the student-

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ship and associate membership of the Institution of Civil Engineers has just been issued.

Ipswich.—The new Spring-road and Derby-road tramway routes were officially inspected on Monday last, and the Bramford-road section was opened for traffic on the same day. The Bishop's-hill route is not to be put in operation pending the Board of Trade's decision on the inspector's report.

Kashmir (British India).—We refer elsewhere to a contract about to be let for an electric power installation at Srinagar, Kashmir. *Indian Engineering* contains the following additional particulars:—

1. A canal taking out of the Sind River and passing along the hill sides to near Ganderbal at the mouth of the Sind Valley. At this point a fall of about 200ft. can be obtained. The water supply in the Sind River is ample at all times of the year except in the winter, and even then will probably be sufficient for the lighting scheme or for the production of about 300 H.P.

2. A series of turbines, with the necessary pipe lines to bring water down to them, electric generating plant and the necessary transformers, &c. All these will be situated in suitable buildings at the foot of the hill along which the canal runs near Ganderbal.

3. Overhead bare copper wire mains to transmit the power generated to Srinagar, a distance of about 12 miles.

4. A central transformer station outside the city of Srinagar to reduce the voltage to not higher than 2,000 volts. From this point the power will be transmitted to four or more sub-transformer stations situated in different parts of the city, and all within a radius of about 2 miles, at which points the voltage must be arranged to meet the requirements of power machines and electric lighting.

Kashmir Durbar propose themselves to construct the canal (1). Tenders are invited for all the other works, including the necessary buildings. The total cost of the scheme is estimated roughly at about 6 lakhs of rupees (£40,000). Firms proposing to undertake the work will be expected to supply detailed estimates and specifications stating exactly the works proposed, the systems to be adopted and the cost. The amount of power to be delivered in Srinagar is about 700 H.P., but the works must be so arranged that in case of future extensions 1,000 H.P. can be delivered in Srinagar. The maintenance and up-keep of the whole plant for at least one year after completion of the works must be included in the tenders.

Kilmalcolm (N.B.)—In May last the Kilmalcolm Electric Lighting Co. obtained a provisional order, and the necessary works were promptly undertaken. The generating station is situated adjoining the railway station, and in its construction and equipment space has been left for extensions. Contracts for plant were let to Babcock and Wilcox (boiler), Belliss and Morcom (steam engine), Laurence, Scott & Co. (dynamos), Lancashire Dynamo and Motor Co. (booster), Tudor Accumulator Co. (storage battery), Callender's Co. (cables), and Chamberlain and Hookham and Bastian Meter Co. (meters). Already 40 consumers are taking, or have promised to take, current, and about 3 miles of cable have, up to the present, been laid. This work has proved to be of a very arduous nature, owing to the rock which has had to be blasted to enable cable channels to be formed. On Christmas Eve current was switched on to St. James's Church for the first time. The charge for current is 6d. per unit. The work has been carried out under the superintendence of Mr. A. W. Stewart, consulting engineer, of Glasgow, and Mr. J. Brown, A.M.I.E.E., is resident electrical engineer.

Lancaster.—Last week the Council decided to construct a new electric tramway route from Dalton-square to the London and North-Western Railway station at a cost of about £8,000.

Leeds.—The proposals of the tramways manager (Mr. J. B. Hamilton) to adopt the "split-turn" system of duties with regard to their tramway employés were adopted by the Tramways committee at a special meeting on Tuesday.

Light Railway.—The Ripon and District Light Railways Order has been submitted to the Board of Trade for confirmation. Objections by Jan. 14.

Liquidation of Companies.—The annual report of the Inspector-General, issued by the Board of Trade under sec. 29 of the Companies Winding-up Act, 1890, shows that winding-up proceedings were commenced during last year in 1,629 cases. The report points out the manner in which private companies, as exemplified by the Johnston Die Press Co. and similar companies, may still evade the law, and how the wily promoters of companies, originally of the one-man or private-class type, can still manipulate affairs to the great loss of the public, as the formation of these companies would not be affected by the provisions of the Companies Act, 1900, relating to the disclosure of material facts, seeing that they do not issue a prospectus.

Liversedge.—The Board of Trade have decided to defer for 12 months the question of the revocation of the Council's electric lighting order, 1900.

Llandudno.—Notice of objection has been given by the Council to the assessment of their electric lighting undertaking.

London County Council and Foreign Labour.—We recently announced that the London County Council had decided to make an inquiry as to the number of hours per week worked by men employed by foreign contractors in making rails for the Council, certain provincial corporations, &c. The inquiry is to be limited in the first instance to Belgian and German practice, and Mr. James Cox, J.P., Darlington, secretary of the National Ironworkers' Association and operative secretary of the Manufactured Iron and Steel Trades' Board of Conciliation, has been nominated to conduct the inquiry.

London County Council Tramways.—The conversion to electric traction of the Council's tramways from the Thames bridges to Greenwich, via New and Old Kent-roads and to New Cross via Walworth-road and Camberwell, has been completed. Trial trips have been run and the routes will be opened shortly, and horse traction will thus be abolished on the whole of the system acquired from the London Tramways Co.

Maidstone.—In addition to the present system of charging, the Council have decided to introduce the following scale for the supply of electricity during the day hours:—

Consumers not requiring supply during October and February between 5:30 p.m. and 8 p.m., November and January 5 p.m. and 8 p.m., and December 4:30 p.m. and 8 p.m., will be supplied at 1d. per unit, providing they are prepared to pay £1 per annum for rental and winding of a time switch. Consumers requiring 50 H.P. or over will be dealt with separately by the committee, with a view to a special price being given.

Manchester.—During the past year the consumers of the electricity department have increased from 4,423 to 4,959. For the year ended March 31, 1902, the number of units sold was 10,502,000; for 1903 17,400,000, and for 1904 27,500,000 is the estimated figure.

During the year considerable progress has also been made with the tramway undertaking, several additional routes having been opened, including the whole of the lines formerly worked by the Manchester Carriage and Tramways Co. in the Manchester area. The total length of the lines now worked by the department is 131 miles (single track), and of these 84 miles were owned by the Corporation and 47 by the neighbouring local authorities, the latter being worked by the Corporation under lease. Considerable extensions, especially on the southern side of the city, are projected.

The Waterworks committee are considering a scheme for utilising the water power at the city waterworks at Longdendale for the generation of electric current. It is proposed to light and drive the workshop, and to work the private railway running by the reservoirs on the Corporation estate (on the overhead trolley system) by this means.

Marylebone.—The mayor (the Rev. H. Russell Wakefield) has convened a public meeting of the parochial electors, to be held at Queen's Hall, Langham-place, London, W., at 8 p.m. on 19th inst., to consider the question of promoting a bill in Parliament to enable the Borough Council to raise a loan for the completion of the purchase of the Marylebone undertaking of the Metropoliton Electric Supply Co.

Mr. H. Birchenough's Report.—A correspondent calls attention to a statement in the report of Mr. Henry Birchenough (the special commissioner appointed by the Board of Trade to inquire into and report upon the present and future prospects of British trade in South Africa) on the subject of "Mill Engines." The extract is as follows:—

MILL ENGINES.—I consider the modern type of the "Hick Hargreave" (English), the most modern "Robey" (English), and the genuine "Sulzer" (Swiss), to be beyond compare the best on the fields. The German-made "Sulzer" type are good engines, but steam valves and stems get loose, and the design and material are not by any means perfect in this respect.

It is interesting to note from the above that English engineers hold their own in steam engine design and manufacture.

Newquay.—The Southern Counties Electricity Corporation propose to establish electricity works in this town. The share capital of the undertaking is to be £9,000. The company will undertake "free" wiring, and will supply current to public lamps not more than 75yds. from an existing main on a three years' agreement. Dowson gas plant will be employed in the generation of electrical energy. The Council have resolved to consent to the company's application. The charge for current is not to exceed 4d. per unit for public and 6d. for private lighting.

Nottingham.—On Monday the City Council will consider a recommendation to apply for sanction to a loan of £100,000 for extending the plant at St. Ann's electricity station and also the distribution system.

Paris.—It is stated that the Municipal Council will issue early next year 170 million francs (£6,750,000) in 2½ per cent. bonds, with annual drawings of prizes to the amount of 700,000fr., in order to promote the construction of tube railways in the city. The Metropolitan Co. is also about to raise £2,000,000. Notwithstanding the calamity in August last (estimated to cost about £80,000) the same dividend as last year (15fr. per share) is expected to be paid.

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Potchefstroom (Transvaal).—There was only one tender submitted for the electric lighting of this town—viz, from the Potchefstroom Consumers' Electric Light and Power Co., which was not, however, accepted. The matter remains in abeyance, to be dealt with by the newly-elected Municipal Council.

Presentation.—The staff of Crompton & Co. at Chemsford have presented a matchbox and cigarette case to Mr. F. G. Smith, chief inspector, on his departure for Inverness.

Railway Station Lighting.—By the installation of arc lighting in the station, goods yard, &c., at Woking Junction, which is being carried out by the London and South-Western Railway Co.'s own employés, under the supervision of Mr. Bircham, the company's electrical engineer, the use of gas will be entirely superseded. Current is to be taken from the Woking Electric Supply Co. Salisbury is at present the only station on the company's system lighted entirely by electricity.

Railways and Tramways Competition.—The Great Northern Railway Co. have closed one of the booking offices at Stanningley station (near Leeds) as a result of decrease of traffic consequent upon tramway competition.

School Lighting.—Bradford Grammar School is being wired for the electric light. Arc lamps will be used in the gymnasium and art room, 12 220 c.p. Nernsts in the hall, and incandescent lamps in other parts of the building.

Sheffield.—The electric light and power department has made considerable progress during the past year, especially in regard to the use of electric current for motors. The aggregate horse-power in motors connected is now about 2,300, compared with 841 in 1902; the number of motor power users increased from 143 to 350 in the same period, and motors let on hire from 167 to 200. Extensions of the mains have also been made, including two trunk cables to the new power house at Neepsend, and two-phase distributing mains of large capacity connected up with many parts of the east end. The length of cable now laid represents 54 miles of high-tension feeder cable and 60 miles of low-tension distribution mains. At the end of 1902 there were 2,000 customers, and there are over 2,550 at present, representing an equivalent of 300,000 8 c.p. lamps connected to the mains. The units sold during the year ended March last were 2,912,722, compared with 2,487,564 in the previous 12 months, but it is anticipated that the total will approach 4,000,000 before the end of March next. The average price obtained for supply, including motors, is 3·56d., the reduction being due to the large number of motors now connected and the low charges made for them.

The receipts of the Corporation electric tramways department for the past quarters were £57,774. 12s. 3½d., compared with £52,501. 2s. 5d. in 1902.

Southend-on-Sea.—During the year a deficit of £1,687 was incurred on the electric tramway system and £993 on electric lighting.

Stepney.—After discussion, the Borough Council on Wednesday last decided to refer back the recommendations of the Electric Lighting committee as to extensions of plant at the electricity station and to the distribution system to enable the committee to submit further financial particulars.

The Council have acquiesced in the proposals of the London County Council for the reconstruction of the tramways in East London on the conduit system.

Stourbridge.—The proposals of the Dudley, Stourbridge and District Electric Traction Co. in regard to doubling the track along the Kinver route from Coalbournbrook to the Ridge have been referred to a committee.

Tariff Commission.—The far-reaching investigations of the Tariff Commission which has been selected to inquire into the fiscal question are to be presided over by Sir Robert Herbert, G.C.B., chairman of the Telegraph Construction and Maintenance Co. (Ltd.), and a director of the Eastern and South African Telegraph Co. (Ltd.). The following are also members of the Commission as at present constituted:—

Mr. F. Baynes (director of the London and North-Western Railway Co.), Mr. H. Bostock (director of Edwin Bostock & Co., Ltd., Stafford), Mr. C. Eckersley (director of the Fine Cotton Spinners' and Doublers' Association), Sir J. A. Coburn, K.C.M.G. (late Premier of South Australia, and for many years Agent-General for the Colony), Mr. F. Elgar, F.R.S. (managing director of the Fairfield Shipbuilding and Engineering Co.), Mr. L. Evans (John Dickinson & Co., Ltd.), Mr. T. Gallaher (Gallaher Limited), Mr. A. Gilbey (W. and A. Gilbey, Ltd.), Mr. W. Harrison (Harrison, MacGregor & Co.), Mr. J. J. Keswick (chairman Rio Tinto Co.), Mr. C. Lyle (Abram Lyle & Sons, Ltd.), Mr. H. D. Marshall (Marshall, Sons & Co.), Mr. J. Rank (Joseph Rank, Ltd.), Sir G. Ryder, K.C.B. (late chairman of the Customs Commission), Sir C. C. Smith (late Governor of the Straits Settlements), and Mr. W. B. Webb (chairman Baltic Mercantile and Shipping Exchange).

Thames Valley.—The statement recently made at Kingston-on-Thames that "electric light, comparatively safe and more luxurious, is not within the financial reach of the majority of the public," has drawn from Edmundson's Electricity Corporation an interesting printed statement:—

The company point out that at Twickenham, Teddington, Surbiton and Weybridge, in all of which supply undertakings the company are interested, facts all point to the inaccuracy of such a statement, as it is shown that the bulk of the consumers in these districts own or occupy small houses, and are supplied with current by the company on very advantageous terms to the consumer. The circular goes into details, and proves conclusively that tenants of small houses in the districts named are in a favourable position for obtaining the electric light on terms which bring the light within the reach of the masses.

The Pacific Cable.—At the last meeting of shareholders of the Eastern Extension Telegraph Co, the chairman, Sir John Wolfe Barry (whose remarks were fully reported in *The Electrician* for Nov. 20, 1903) referred to the competition of the Pacific cable, and contended that the Pacific line was being worked for the current year at a loss of nearly £100,000, which would have to be borne by the taxpayers of this country and by those of Canada, Australia and New Zealand. In *The Times* for Dec. 26 Sir E. Sassoon lengthily challenges Sir John Wolfe Barry's figures, and in fact claims for the Pacific cable that, so far from being worked at a loss for the current year of £100,000, it is "making money." This statement Sir E. Sassoon makes on the authority of Sir H. Tozer. Sir Edward further takes the Australian Government to task for exacting a share of 5d per word out of the present message rate from London to Australia of 3s. per word.

In *The Times* of Dec. 31st Sir John Wolfe Barry replies to Sir Edward Sassoon, and gives chapter and verse for his estimate of a total loss of £100,000 for the year This estimate (Sir John points out) is based upon the official statement presented to Parliament on Aug. 12, dealing with the period of working of the Pacific cable up to Mar. 31, 1903 (4 months), and Sir John more particularly refers to the statement published in *The Times* of Nov. 18, 1903, wherein the loss for the year ending Mar., 1904, is officially estimated at £92,100, this loss being apportioned amongst the various contracting Governments as under:—

United Kingdom	£25,409	New South Wales.....	£10,172
Canada	25,409	Queensland	10,172
Victoria	10,172	New Zealand.....	10,172

Sir John Wolfe Barry urges that his calculation of a loss of £100,000 per annum for the period to March, 1903, is obviously not far from being correct, the figures upon which the 1904 estimated loss is calculated allowing for a total traffic for the year of £73,400, against £19,579 for the four months working' to March 31, 1903. It was upon these latter figures that Sir John's original estimate of £100,000 per annum was based.

Transvaal Imports—For the nine months ended September, 1903, the value of the imports into the Transvaal of electric cables, wires and fittings amounted to £53,000, compared with £31,000 for the corresponding period of 1902. Tramway material was valued at £62,000, compared with £18,000. For the month of September, 1903, these values were respectively £4,000 and £5,000, compared with £2,000 and £6,000 for the same month in 1902. These figures do not include free importations for various Government departments, &c., imported as "public stores."

Tunstall.—The Council have rejected the proposals of the Sir Hiram Maxim Electrical and Engineering Co. for erecting electricity supply works, on the ground that it is "inadvisable for them to enter into any such arrangement."

Vancouver (British Columbia).—The British Columbia Electric Railway Co. announce that electric current for public lighting was supplied on 19th ult. from the power plant at Trout Lake.

Walsall.—The local tramways of the South Staffordshire Tramways (Lessee) Co. were taken over by the Corporation yesterday (Thursday).

West Ham.—On Tuesday a successful trial trip was made on the Corporation electric tramway between Plaistow-road and Church-street.

Widnes.—The Town Council last week formally decided to proceed with their application for a provisional order to extend the area of supply.

Wood Green.—The Board of Trade have formally sanctioned the proposed system of electricity supply. At Wednesday's meeting of the Council an unsuccessful attempt was made to rescind the resolution passed on Oct. 28 to apply for sanction to a loan of £43,200 for electricity works.

Concert.—The annual Christmas concert of the employés and staff of the Robertson Electric Lamp Works, Hammersmith, London, was held in the factory on Dec. 19, a company of over 800 being present, under the presidency of the manager, Mr. C. Wilson. A lengthy programme was carried through to the end, many of the turns evoking enthusiastic encores.

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TRADE NOTES AND NOTICES.

[Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.]

TENDERS INVITED.

The Guardians of *St. George's* (Hanover-square) Union invite tenders for the electric wiring and mains required at their Fulham-road workhouse. Specifications, &c., from the consulting engineers, Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster, S.W. Tenders to the clerk, Mr. Thos. Worlock, St. George's (Hanover-square) Hall, Mount-street, Grosvenor-square, London, W., by 10.30 a.m. Jan. 13. See advertisement.

Kettering Urban District Council invite tenders for supply and delivery of electricity meters. Specifications can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to the clerk (Mr. John Bond), Council offices, Kettering, by Jan. 9. See also advertisement.

Belfast Gas and Electric committee invite tenders for electricity meters. Specifications from the city electrical engineer, Mr. Victor A. H. M'Cowen. Tenders to the town clerk (Sir Samuel Black), Town Hall, Belfast, by noon Jan. 15. See also advertisement.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring installations of May-Oatway fire alarms to direct connections with the fire brigade headquarters of Edinburgh and Glasgow, as set out in an advertisement. Particulars from the managing director, 49, Queen-street, Glasgow. Tenders by Jan. 6.

Pontypridd Urban District Council invite tenders for pipe work and meters. Specifications, &c., from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, London, S.W. An advertisement contains further particulars. Tenders to the chairman of Electric Lighting and Tramways committee, Council offices, Pontypridd, by noon Jan. 15.

Glasgow Corporation invite tenders for providing and erecting at their generating stations two 3,000kw. 6,500-volt three-phase turbo-alternators and condensing plant; one 2,200 H.P. engine coupled to a double-current generator and transformers; and six 500kw. motor generators and rotary converters. Specifications, &c., from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow. Tenders (addressed to Mr. James G. Monro, interim town clerk, City-chambers, Glasgow) by Jan. 11. See also advertisement.

Glasgow Corporation also require tenders, by Jan. 11 for the supply of mild-steel angle racks for new stores at Port Dundas electricity works.

Erith Urban District Council invite tenders for the supply and erection of two Lancashire boilers, with fittings, brickwork settings and steam feed pump; steam, &c., pipes; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam engine of 500kw.; and extensions to main switchboard and cable connections. Tenders to the clerk (Mr. Charles H. Fry) by noon Jan 18.

Wallasey Urban District Council invite tenders for about 7,100 yds. of concentric armoured cable, with joint boxes and section boxes. Tenders to Mr. H. W. Cook, Public offices, Egremont, Cheshire, by Jan. 16.

Manchester Paving, Sewering and Highways committee require tenders by Jan. 11 for laying underground telephone pipes, &c.

Messrs. Preece and Cardew are authorised by the Municipal Council of *Sydney* (N.S.W.) to invite tenders for the supply, delivery and erection of one or two 600kw., or one 1,200kw., steam alternators (three phase), with condenser, pipework, motor generators, static transformers, switchboards, &c. Tenders to Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W., by noon Jan. 12.

According to *Indian Engineering*, tenders are invited by the Public Works Department of the State of *Kashmir and Jammu* (British India) for an electric power installation in the neighbourhood of Srinigar, Kashmir. Further particulars can be obtained from the State engineer, Kashmir Durbar, Srinigar. (We refer to this contract on a previous page.)

The *Great Indian Peninsula Railway Co.* invite tenders for supply of galvanised iron telegraph wire, spring steel, steel work and iron work for carriages and vans, &c. Tenders to secretary, 48, Copthall-avenue, London, E.C., by 11 a.m. of Jan. 14.

Buenos Ayres (Argentina) Corporation are inviting tenders for constructing and working an electric tramway from Plaza Mayor to Villas Devoto, Ortiza and Urquiza.

Copenhagen Municipal Electricity Works invite tenders by noon Jan. 5 for two electric centrifugal pumps with a capacity of about 500 to 600 cubic metres per hour. Specification, &c, from the works, 30, Gothersgade, Copenhagen (deposit 20 kroner = £1. 1s.). Tenders to Copenhagen Public Lighting Department, 22, Vestre Boulevard, Copenhagen.

TENDERS RECEIVED AND ACCEPTED.

In our issue of Nov. 6, 1903 (p. xxii.), appeared an invitation from the Great Western Railway Co. for tenders for engines, three-phase generators, and condensing and auxiliary plant for the company's new electricity generating station at Park Royal. The aggregate of this plant is about 10,000 H.P., and the contract has, we are informed, been secured by the Electric Construction Co. of London and Wolverhampton.

Bristol Electrical committee have accepted the following tenders:—
McDowall, Steven & Co., arc lamp standards, £2,850.
John Spencer (Ltd.), pipe work at Avonbank, £1,270. 7s. 6d.
Ferranti Limited, power switchboard at Temple Back, £715. 10s.
Babcock and Wilcox, coal conveyor extension at Avonbank, £656.
Indestructible Paint Co., painting arc lamp posts, £141.

Walsall Corporation have accepted the tender of Bumsted and Chandler for a 500 H.P. steam engine at £1,430, and that of Thomas Parker Limited for dynamo at £740.

Messrs. Rowland Carr & Co., 6 and 8, Lime Street-square, have received a further large repeat order for troughing and roadway frames and covers for Oporto.

The contract for the new pumping engines and plant for Deptford station of the London County Council has been secured by Yates and Thom at £22,700.

BUSINESS NOTICES.

The sales administration of the meter department of Ferranti Limited will be conducted, as from Jan. 1, from Donington House, Norfolk-street, Strand, London, W.C., by Mr. F. Barnes Spencer, as representing this branch of the company's manufactures. Both continuous and alternating-current types of meter are now entirely standardised for all sizes, and are manufactured throughout at the company's works at Hollinwood. The company takes all responsibility for accuracy, following each consignment by a competent tester, so that any defect or injury in transit may be at once detected and the client assured of the quality and accuracy of the apparatus.

We are informed that the British Accumulator Co., late of Parliament-mansions, Victoria-street, London, S.W., has now been converted into a registered limited company, and that the future address will be 15, Victoria-street, London, S.W. Mr. F. von Gerson is managing director, and Mr. E. W. Dunton is engineer and manager of the company.

Messrs. F. A. Robinson & Co., 54, Old Broad-street, London, E.C., have taken into partnership as from Jan. 1 Mr. Malcolm H. Butcher, M.Inst.Mech.E., A.M.I.E.E., and Mr. Arthur E. T. Lees, M.Inst.C.E. Both gentlemen have been connected with the business for many years.

The British Mica Co. (Ltd.), have removed their offices at 23, Great St. Helens, E.C., to the works, Lebanon-road, Wandsworth, London, S.W. The company's telegraphic address is now "Micamina London," telephone No. 405 P.O. Putney.

We are informed that Mr. Thos. Browett has resigned his position as joint managing director of Browett, Lindley & Co. (Ltd.), Patricroft, and no longer holds a seat on the board. Mr. Browett's present address is 6, Old Queen-street, Westminster.

Messrs. Palmer and Taylor, 50, Wellington-street, Glasgow, are now the sole representatives for Scotland of the Union Cable Co. for their electric cables and wires, and will hold considerable stocks.

Mr. E. D. Chester, M.I.M.E., will as from 1st inst. carry on business as consulting and mining engineer at 20, Copthall-avenue, London, E.C.

Mr. W. Stamm, 25, College-hill, Cannon-street, London, E.C., informs us that he has taken over the business of Messrs. Otto Weiss & Co. of Berlin, for machinery and apparatus for the manufacture of electric cables, hemp, wire, rope, &c. Mr. Stamm has a pamphlet ready listing these machines, of which copies can be obtained on application.

The Electrical Standardising, Testing and Training Institution, of Faraday House, 8 and 10, Charing Cross-road, London, W.C., will, towards the end of 1904, be removing to a home of its own, and the board of control have just accepted the tender of Messrs. Perry & Co. (at £14,155) for the erection of a new building at Southampton-row, London, W.C., in direct line of the new County Council thoroughfare from the Strand to Holborn. There were 13 tenders sent in, the highest being nearly £15,500.

LIQUIDATIONS, BANKRUPTCIES, &c.

In the failure of John Webster Michelson Starr, electrical engineer, 29, Grange-road, Dudley, the gross liabilities are returned at £319. 10s. 1d., assets nil. Alleged causes of failure, bad debts, losses on contracts, &c.:—

The official receiver reported that bankrupt commenced business about 10 years ago as an electrical engineer, under the style of Webster, Nicholson & Co., at Dudley, with a capital of £90, which he saved. In 1902 he disposed of his business to a limited liability company, and had since been engaged as traveller for the company. He received no cash payment for his interest in the business, but 1,000 £1 shares, now valued at £50.

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Another meeting of the creditors of Max Margowski, financial agent, &c., took place last week at the Bankruptcy Court, London. The amended statement of affairs showed liabilities £13,507, of which £1,607 was unsecured, and assets £1 in cash and £650 in shares. Debtor, who has been managing director of the Automatic Telephone Co., stated that since Nov., 1901, he had lost £5,300 on shares in several companies, and also large sums in the promotion of companies.

At London Bankruptcy Court recently the public examination took place of Capt. Francis Lane-Fox. Debtor was a director of the West Riding Tramway Co. (Ltd.), which was promoted for constructing a tramway from Knottingley to Leeds. The gross liabilities were £15,931 (£10,027 unsecured), assets £1,201.

Debtor stated that he had been a private secretary for some years. He was connected with various mining and other companies, including the Veterinary Radiant Heat Syndicate and the West Riding Tramway Co. He took 5,000 shares in the syndicate which promoted the latter company, for which he paid £5,000, and had charged those shares to three creditors. About £30,000 was subscribed to the syndicate, but owing to depressed financial conditions the tramway company was not floated. Examination concluded.

The public examination of Cecil Wray, electrical and mechanical engineer, took place at Bradford last week. Deficiency £1,364. 6s. 7d.

Debtor traded in partnership with C. B. Crawshaw as the Wray Electrical Engineering Co. from 1892 until 1895 and with Mr. C. W. Baxter as Baxter and Wray until 1898 when he bought out Mr. Baxter's interest, afterwards trading as Cecil Wray & Co. until 1899. In the latter year the concern was sold to a limited company, debtor receiving £1,500 in cash and £1,500 in shares. Debtor acted as managing director until October, 1901, when the company went into liquidation. He then resumed business on his own account in Simes-street and settled for £100 an action brought by the purchaser of the undertaking of the former limited company to restrain him from trading in Bradford. Examination closed.

The first meeting of creditors of A E. Hodgson, motor car manufacturer, &c., 94, Victoria-street, Westminster, was held at the London Bankruptcy Court last week, when the meeting was adjourned until 4th inst. for appointing a trustee and committee of inspection.

The Northern Counties Traction Co. (Ltd.) is to be wound up voluntarily. Mr. W. C. Spencer, Central-buildings, Liverpool, is liquidator.

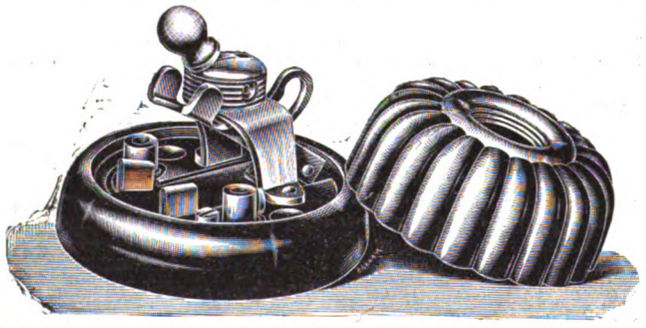
Plant for Sale.—Messrs. Bottone & Son, Wallington, Surrey, have for sale a 1 H.P. Tangye dynamo gas engine, a ½ H.P. gas engine and accumulator-charging dynamo, a ¾ H.P. high-speed vertical steam engine, X-ray coil, 4in. spark, 1 H.P. direct-current series motor, and ¼ H.P. 200-volt direct-current motor, a 3 H.P. petrol engine, &c. Further particulars in advertisement.

Three 20 N.H.P. Marshall horizontal compound engines and three 20 H.P. Marshall multitubular high-pressure boilers, with feed-water heater, two Worthington pumps, &c., are for sale. Applications to inspect the plant (in working order) to the clerk to the Governors, People's Palace, Mile End-road, E. See advertisement.

Works, &c., for Sale.—Some modern well-equipped car-building works, occupying a covered area of 8¾ acres, with 25 acres available for future extensions, are advertised for sale in another column. Applications to Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C.

Some manufacturing premises are advertised for sale or letting on lease, without restriction and with or without steam power. The premises adjoin Laindon station, Essex, 22 miles from London. Particulars from Messrs. I. Levy & Son, 62, Albany-road, Old Kent-road, London, S.E.

Quadrant Tumbler Switch.—A special feature of this switch, which is being placed on the market by the General Electric Co., is its long break (½in.). Special precautions have been taken



against breakage of the tongue piece, which in this switch is made of one solid metal stamping. Another improvement consists in the provision of conical holes in the base, through which to thread the insulated leads. The annexed illustration gives a good idea of the general construction of the switch, which appears to be of simple and reliable design.

Patent Switches.—Mr. A. P. Lundberg asks us to call attention to a matter which he considers has a direct trade interest. It would appear from a statement Mr. Lundberg has placed before us that he was, as far back as September, 1901, threatened with proceedings in connection with an alleged infringement of J. H. Tucker's patent No. 18,019 (1893), by reason of the manufacture and sale of Mr. Lundberg's patent "Pivot" and "Century" types of tumbler switches. Mr. Lundberg's reply to these threatened proceedings was that his manufactures were in no way an infringement of the said patent. Mr. Lundberg assures us that no further steps were taken in the matter until March, 1903, when a solicitor's letter threatening proceedings was received and a similar reply returned. On March 28, 1903, a writ was issued claiming an injunction and damages. A statement of claim was duly lodged, and Mr. Lundberg's defence was delivered on June 15. As no further proceedings were taken by the plaintiff in the action, Mr. Lundberg's solicitors (Messrs. Headley and Roberts) gave notice that an application would be made to have the action dismissed for want of prosecution, and on Nov. 26 an order of the court was duly made dismissing the action for want of prosecution, and directing that the plaintiff should pay Mr. Lundberg's costs.

Small Arc Lamps.—The Electrical Co., 121-125, Charing Cross-road, London, W.C., are making a special feature of the "Rignon" small arc lamp for continuous current. The arc in this lamp is enclosed, and one pair of carbons burn for about 15 hours. These carbons are specially prepared of very small diameter (4·2mm.), enabling a 200 c.p. light to be obtained for a current consumption of 2 amperes. The Rignon lamp may be burnt singly on 100 to 110-volt circuits or two in series on 200 to 220-volt circuits, a small steadying resistance being used. It is claimed that the current consumption of the lamp, including resistance losses, does not exceed from 1 to 1·1 watts per candle-power, and that the violet colouring of the arc, often a serious drawback in lamps of the long-burning type, has been almost entirely obviated. By the arrangement of using the stump of the upper carbon as a lower carbon great economy in carbon consumption is secured. The company recommend these lamps especially for theatre, restaurant, factory and shop-window lighting, and for all places where the larger type of lamps are in excess of lighting requirements.

Calendars, &c.—The British Electric Transformer Co. have adopted a novel method of advertising their manufactures in the form of a copy of the indispensable "Whitaker," bound up with padded leather covers and containing lists of the company's clients and views of installations of the company's transformer equipments.

Mr. James Hendry, 252, Main-street, Bridgeton, Glasgow, issues a well-got-up desk calendar for 1904. Mr. Hendry has also ready a new price list of his well-known laminated leather beltings.

Messrs. W. T. Glover & Co., who have usually something uncommon to present to their customers and friends, issue this year a pad calendar quite out of the regular run of these useful memory aids. This pad is occupied by a series of portraits of leaders in the electrical profession and excerpts from Papers read or speeches made at the meetings of electrical associations. The pad would be improved by wiring, as it has a tendency to break off in small blocks.

From the May-Oatway Fire Appliances Limited we have to acknowledge the receipt of a card calendar for 1904.

Messrs. John Knox & Co., 210, Upper Thames-street, London, E.C., have issued their annual hanging calendar, and the trade will be supplied with copies on application. Some of the tools and plant manufactured by this firm are illustrated.

Messrs. Nalder Bros. and Thompson are sending out a pad calendar which is small enough to find a place on the desk without losing any of its usefulness from this cause.

From the Brush Co. we have to acknowledge the receipt of a very neat desk calendar showing excellent views of the company's manufactures.

An effective advertising device is to hand in the form of a paper-weight showing in a graphic manner a section of cable manufactured by the Britsh Insulated and Helsby Cables Limited. There have been various designs of transparent glass paper-weights issued, but this is the most effective of any that have yet come before us.

Catalogues.—Mr. A. H. Hunt, 115-117, Cannon-street, London, E.C. (as representative for Great Britain of Messrs. Geoffroy and Delore), forwards a price list of wires and cables manufactured by that firm. Mr. Hunt is stocking these goods.

A new price list has been issued by Electric Lighting Boards, Limited, 80, York, London, N., in which several additions have been made. The company state that their system is meeting with con-

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siderable success, and that during the past 18 months a large number of temporary electric lighting installation contracts for exhibition and other purposes up to 5,000 lights have been carried through. The company are making a speciality of electric signs in various forms. The new price list gives particulars of complete temporary electric installations on hire.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Dec. 23 to 30, with the ports of destination:—

Africa—Alexandria, £18; Cape Town, £171; Delagoa Bay, £141 (telegraph material); Durban, £1,357 (including £14 telegraph material); East London, £828; Port Elizabeth, £133. *Australasia*—Adelaide, £85; Fremantle, £148; Lyttelton, £425; Melbourne, £23; Otago, £50; Perth, £62; Sydney, £442; Wellington, £91. *Austria*—Trieste, £15. *Canada*—St. John (N.B.), £121. *Ceylon*—Colombo, £113. *Germany*—Bremen, £65; Hamburgh, £250 (telegraph material). *Gibraltar*, £280. *Holland*—Amsterdam, £72. *Hong Kong*, £85. *India*—Calcutta, £188. *Japan*—Kobe, £73 (telegraph material); Yokohama, £370. *Perim*, £21,243 (telegraph cable). Total (for eight days), £26,849, against £49,078 for 11 days last year (Dec. 20 to 30).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

October 6, 1903.

21,458 B. ROBERTS. Apparatus for laying, raising or destroying submarine cables.

21,466 F. JEANNOT and F. DE ZEA BERMUDEZ. Arc lamps. (Date applied for, Sept. 12, 1903; date of application in France.)*

21,491. F. M. LEWIS. Electro-motors of the induction type.

21,493 SIEMENS BROS. & Co. Apparatus for perforating type bands for automatic telegraph transmitting apparatus. (Siemens and Halske, A. G., Germany.)*

21,504 SOCIÉTÉ ANONYME DES ATELIERS DE MÉCANIQUE DE PRÉCISION DE TERRITET. Electric meters. (Date applied for Oct. 15, 1902, date of application in Switzerland.)*

October 7, 1903.

21,511 L. B. MOLLAN and A. MILLIN. Belfast. Temporarily holding electric lamps by magnet.

21,520 T. D. TAYLOR. Penzance. Telegraphic apparatus for transmitting cable messages.

21,551 K. QUANEY and W. C. KIRWAN. Dublin. Switches for electric lighting and power.

21,574 N. J. TUBBS, R. H. SMITH and J. S. HARTLEY. Disinfecting telephones.*

21,582 G. SCHAULI. Primary batteries.

21,592 SIEMENS BROS. & Co. Electromagnetic signalling apparatus. (Siemens and Halske A.G., Germany.)*

21,596 M. SHORT. Rheostat.

October 8, 1903.

21,593 F. PETMEKY. Manchester. Self-replacement intercommunication telephones.

21,609 J. CRESWICK and H. SHAW. Sheffield. Electro-deposition of metals upon aluminium.

21,628 W. H. TAYLOR. Manchester. Lifeguards for electric vehicles.

21,632 F. HÜLSMANN. Berlin. Electric ignition petards.

21,636 K. J. LENDER and F. BROD. Berlin. Electric safety and alarm devices for doors.

21,637 H. PETERS. Berlin. Electrical alarm clock.*

21,652 J. M. DE LA CROIX. Secondary battery.

21,653 T. E. CLARK and the THOS. E. CLARK WIRELESS TELEGRAPH-TELEPHONE CO. Coherers for wireless signalling.*

21,700 C. BEEZ. Electrical measuring instruments.*

October 9, 1903.

21,711 A. J. BEAUMONT. York. Jablochkoff candle lamps.

21,717 J. I. HALL. Trolley line apparatus.

21,728 J. M. MOSS. Liverpool. Magnetic separators for ores.

21,742 T. C. WALTERS. Ship's telegraphs.

21,759 E. G. BRADNAM. Telephones, metallic-circuit automatic secret intercommunication instruments.

21,779 T. HEFFERNAN. Electric cells.

21,791 J. R. CRAWFORD. Filaments for incandescent lamps.

21,793 T. C. FUTERS. Valve and brake controlling mechanism for electric hoisting engines.

21,801 J. SAYERS and F. B. HOLT. Simultaneous telegraphy and telephony.

October 10, 1903.

21,830 E. W. LEWIS. Coventry. Electric ignition apparatus.

21,846 J. N. DAUNCEY. Trolleys for tramways.

21,851 W. S. HADLOCK. Telephone attachments.*

21,858 J. A. KENNEDY-MCGREGOR and H. WREN. Birmingham. Switches.

21,886 J. HEALEY and O. H. WHITE. Cheshire. The Dome sparking plug.

21,875 G. VARLEY. Halifax. Trolley heads.

21,882 W. L. KING. Motor and gearing for electric cranes.

21,885 L. H. WALTER. Manufacture of electric lamps.

21,898 W. P. MILES. Operating valves, cocks, taps, electric switches and the like at predetermined intervals.

21,909 G. M. LANE and E. H. ADAMS. Arc lamps.*

21,921 W. KRON. Electrical fire-alarms.

21,930 M. MCDERMOTT. Preventing the fusing of wires.

21,939 O. J. LODGE and A. MUIRHEAD. Signalling through submarine and like cables.

21,963 J. H. LEE. Wireless telegraphy.

21,972 J. H. ST. H. MAWDSLEY. Dynamo-electric machinery.

21,980 R. HULSART and E. H. ADAMS. Arc lamps.*

October 13, 1903.

21,983 J. J. CARTER. Dublin. Trolley head.

21,984 T. E. WEAVER. Manchester. Starting switches for motors.

21,987 F. MITCHELL. Clockwork electrical stopping and starting apparatus.

21,996 C. J. CASSÉ and H. H. CASSÉ. Bradford. Electro-motor starters.

22,008 T. L. BOYDEN. Wolverhampton. Multipolar electric generators and motors.

22,013 E. G. RIVERS. Richmond. Electric radiator.

22,016 J. B. TANNAHILL. Electrical circuit-breaker.

22,044 H. EDENBOROUGH. Dynamo machines.

22,053 W. C. MARTIN, J. LOWSON and W. B. SAYERS. Dynamo-electric machines.

22,087 L. DESPAADELS. Apparatus for electrical correspondence.*

22,090 G. CORNARO. Manufacture of electrodes and resistances.

22,097 A. B. UPHAM. Liverpool. Current collectors for electric traction

22,101 T. E. DANIELS, jun. Circuit breakers. (Date applied for, Jan. 2, 1903, date of application in U.S.)*

October 14, 1903.

22,133 A. JOHNSTON and C. A. BOWEN. Swansea. Automatically controlling trolley pole after leaving trolley wire.

22,181 G. G. M. HARDINGHAM. Transforming alternating currents. (L. Magrini, Italy.)

22,182 J. R. DICK. Electrical switching apparatus.

22,185 J. B. ALEXANDER. Manufacture of insulating material.

22,190 L. G. HUNT and SANDYCROFT FOUNDRY CO. Liverpool. Alternating-current induction meters.

October 15, 1903.

22,210 P. DEWHIRST. Blackpool. Rectifying transformer for alternating currents.

22,216 A. E. TANNER and E. A. CLAREMONT. Manchester. Laying conductors.

22,265 J. HARMATTA. Electric welding.

22,269 G. M. GIBSON. Brushes for electrical machines.

22,287 W. J. DAVY. Arc lamps.

22,291 J. W. P. SCOTT, J. COGHLAN and E. S. MOULDEN. Electric generating machines and motors for continuous current.

October 16, 1903.

22,324 J. H COX. Glasgow. Machine for developing electromotive force.

22,356 S. COWPER-COLES. Apparatus for electro-deposition of metals.

22,365 W. BAXTER, jun. Electromagnets. (Date applied for, Nov. 21, 1902, date of application in U.S.)*

22,371 T. BLANEY. Liverpool. Overhead trolleys for vehicles.

22,374 L. C. H. MENSING. Arc lamps.

22,388 F. W. HOWORTH. Apparatus for transmitting telephonic and telegraphic messages over the same line wire. (C. Turchi and E. Bruné, Italy.)*

October 17, 1903.

22,423 J. H. HINDLE. Lancashire. Electric generators and motors.

22,432 C. M. DORMAN and R. A. SMITH. Salford. Ceiling fittings.*

22,439 F. J. TURQUAND and J. F. WAKELIN. Electrical connection for electrochemical apparatus.

22,440 W. C. FAIRWEATHER. Telephone systems and apparatus. (Kellogg Switchboard and Supply Co., U.S.)*

22,443 D. H. WILSON. Winding inductive and non-inductive coils.

22,456 G. B. BOWELL and PEARSON FIRE ALARM (LTD.) Fire alarm apparatus.*

22,465 B. T.-H. Co., R. C. CLINKER, E. B. WEDMORE and J. WHITCHER Safety devices for alternating current distribution systems.

22,470 R. S. PILCHER. Liverpool. Turn-over or alternative switches.

22,475 T. E. ELMORE. Collecting currents from unipolar dynamos.

22,481 G. WEINMANN. Distance operated gas igniters.*

22,486 H. SHOEMAKER. Electric range finders. (Date applied for, Jan. 10 1903, date of application in U.S.)

October 19, 1903.

22,497 J. MAKIN. Sheffield. Electrical numerical switch.

22,507 J. A. STEVEN. Glasgow. Electric hoists.

22,532 J. O. GIRDLESTONE and C. F. G. THORKELIN. Arc lamps.*

22,538 F. EASTERFORD. Ilford. Automatic fire alarm.*

25,551 J. S. RAWORTH. Electric motors and controlling devices for vehicles.

22,556 E. HUGHES, J. C. JONES and A. G. MACKIE. Electrically operating fire alarms, burglar alarms and the like.

22,572 SIEMENS BROS. & Co. Working electric winding engines. (Siemens and Halske A.G., Germany.)*

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22,573 Siemens Bros. & Co. Safety fuse device for electrical installations. (Siemens and Halske A.G., Germany.)*
22,584 G. B. Bowell. Thermostats.

October 20, 1903.

21,601 F. H. Hall & C. Hall. Birmingham. Electric ignition for engines.
22,602 T. H. Hall and C. Hall. Birmingham. Contact breakers for electric ignition of internal explosion engines.
22,606 T. W. S. Hutchins. Manchester. Electric lighting of trains.
22,634 F. H. de Veulle. Birmingham. Terminals for stranded wires.
22,639 S. Robinson. Covers and frames for junction boxes.*
22,643 M. E. Thompson. Brushholders for dynamo electric machines.*
22,654 T. H. Walker. Clip for suspending electric cables.
22,658 F. Punga. Induction electric motors.
22,664 E. Imray. Contact apparatus for electric relay master clocks. (Siemens-Schuckertwerke, G.m.b.H., Germany).*
22,668 J. E. Spagnoletti. Insulators.
22,673 A. R. Müller. Liverpool. Current regulator for electric machines.*
22,674 P. Hardegen. Liverpool. Telephone systems.*
22,680 L. Dorman. Coherers for wireless telegraphy.*
22,694 P. R. Allen. Indicating stoppage of distant machines.
22,696 C. S. Whitney. Electrical vibratory motor.*
22,698 J. Prince. Telephone transmitters.*

October 21, 1903.

22,742 H. F. Joel. Dynamo electric machines and motors.
22,751 J. Dalziel. Voltage regulated electric lighting for vehicles.
22,778 C. Smart. Commuting currents passing through combined arc and incandescent lamp circuits.
22,785 E. W. Smith. Storage battery plates. (Date applied for, September 10, 1903, date of application in U.S.)*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1902.

19,647 Bremner. Electric elevators.
21,969 Halsey. Electricity meter. (Date applied for, March 13, 1902.)
22,024 Munro, Brecknell and Rogers. Life-guards for vehicles.
22,135 Gilmour. Electrolytic decomposition of alkaline chlorides.
24,148 and 24,149 Esson. Electric fuses.
24,192 Rowlands. Trolley collectors for electrical traction.
24,205 Hewett. Switch lampholders for incandescent lamps.
24,235 Bronn. Heating by means of electricity.
24,325 Wilson and Hardingham. Apparatus for testing electric lamps.
24,328 Bowen. Incandescent lamps.
24,517 Harkin. Resistances for heating or other purposes.
24,576 Oppenheimer (A.G. Mix and Genest). Telephone party-line system on exchanges working on central battery system.
24,643 de Ferranti. Detection of faults in the conductors of electric traction systems.
24,709 and 27,761 Carolan (G.E. Co., U.S.). Cut-outs.
24,744 Lodge and Saunders. Lightning guards for submarine telegraphy.
24,772 Berry and British Electric Transformer Mfg. Co. Transformers.
25,085 Quaney and Kirwan. Switches for electric lighting.
25,216 Leitner and Lucas. Cut-outs and regulators and their application.
26,039 Carolan (G.E. Co., U.S.). Electric train control systems.
26,051 Carolan (G.E. Co., U.S.). Trolley poles.
26,647 Carolan (G.E. Co., U.S.). Electric recording instruments.
26,818 Cleminson. Incandescent lamps and collars for same.
26,905 Foster. Junction frog-plates for overhead electric tramways.
26,917 Byng and Anders. Switching mechanism for intercommunication telephone systems.
27,133 Reclus Petitdidier Schmitt. Enclosed arc lamps.
27,272 Lake (Stone). Selective electric signalling.
27,373 Pearson and Fiedler. Galvanic cell.
27,375 Pearson and Fiedler. Electrode for galvanic cells, and a method or process for producing same.
27,476 Boult and Boult. Electric traction on surface-contact system.
27,574 Peebles and Pickstone. Reversible boosters.
27,619 Siemens Bros. & Co., Lydall and Duke. Control of electromotors on electric railway cars.
27,755 Carolan (G.E. Co., U.S.). Electric furnaces or muffles.
27,758 Carolan (G.E. Co., U.S.). Machines for cutting micanite and the like.
27,762 Carolan (G.E. Co., U.S.). Electric regulators.
27,765 Carolan (G.E. Co., U.S.). Electric phase-indicating instruments.
27,769 Carolan (G.E. Co., U.S.). Rheostat switches.
27,771 Carolan (G.E. Co., U.S.). Electromagnetic locks for automatic circuit-breakers.
27,858 Eckstein and Krause. Electric light switches.
28,193 Harding and Harding. Wire-winding machines.
28,304 Thomas and Thomas. Automatic circuit-breakers.
28,486 Leitner and Lucas. Switches.
28,487 Leitner and Lucas. Means for controlling variable-speed dynamos.
28,510 Hommel and Hommel. Trolley poles.
28,552 Lake (Stone). Oscillators for wireless telegraphy.
28,643 Kennington and Fawcett. Supporting trolleys for overhead traction.
28,828 Duddell and Sparks. Protecting cables or other apparatus from effects of current surgings.

1903.

10 Stevenson. Automatic suspension and contact appliance for arc lamps.
273 Müller. Manufacture of electrodes for secondary batteries.
517 Naylor. Miners' lamps ignited by electricity.
518 Davidson. Back-gearing appliances for electric motors and dynamos and for steam and water-driven turbines.
778 Siemens Bros. & Co. (Siemens and Halske A.G.). Indicating condition of the electric circuit controlling air-brake valves on a train.
1,088 Roderbourg. Manufacture of positive electrodes.
2,687 Birnbaum (Telephon Fabrik A.G., vorm. J. Berliner). Transmitting motion to or from mechanism contained in a case.
2,874 Terry. Switches for controlling an electric circuit from several points.
3,083 Bahrfeldt. Roller bearing for suspended lamp lustres.
3,420 Chaplin. Chemical rectifiers for converting alternating into direct current.
7,831 Hoffelt. Electrodes for arc lamps.
8,679 Hubert. Apparatus for electro-plating.
11,427 Blondel. Radiator systems for wireless telegraphy. (Date applied for May 28, 1902.)
14,688 Winton. Ignition mechanism for explosion engines. (Date applied for, June 4, 1903.)
16,487 Schutz. Telegraph pole.
16,988 Steenlet. Partitions or diaphragms for electrolytic purposes.
19,288 Lake. Submarine communication.
19,399 White and Waldron. Pipe couplings for facilitating inspection.
19,453 Boldt and Marquardt. Fixing plugs in walls.
19,521 Scott. Alternating-current distribution for railways. (Date applied for, Sept. 13, 1902.)
19,524 Gest. Manhole terminals for conduit sections.
19,836 Page (Weber Railway Joint Mfg. Co.) Insulated joints.
19,877 Siemens Bros. & Co. (Siemens and Halske A.G.). Electromagnetic relay apparatus.
19,886 Lamme. Electromotive force regulators. (Date applied for, Oct. 2, 1902.)
19,896 Evans (Gesellschaft zur Einfuhrung von Erfindungen, m.b.H.). Driving of dynamos by steam turbines.
20,061 Morin. Receivers for wireless communication.
20,102 Gray. Bracket attachments for telegraph and like posts.
20,401 Hunter and Warren. Switches.
20,497 Kowalski and Moscicki. Electric plant for synthetical production of nitric products.
20,655 Evans (Elektrochemische Werke G.m.b.H.). Electrolytic production of metals of the earthy alkalies, more especially metallic calcium.
21,304 Siemens Bros. & Co. (Siemens and Halske A.G.). Driving electrical machines by steam turbines.
21,574 Tubbs, Smith and Hartley. Disinfecting telephones.
21,851 Haddock. Telephone attachments.
22,639 Robinson. Covers and frames for junction boxes.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

COPPER CO. (LTD.)—Reg. Dec. 23, capital £100,000 in £1 shares (30,000 15 per cent. cumulative preference), to acquire certain patents granted or to be granted in respect of inventions relating to improvements in the electro-deposition of metals for the manufacture of compound wire bars and the like, and in apparatus therefor, and to enter into an agreement with F. H. Medhurst, and to carry on the business of manufacturers of compound wire bars, &c., and of apparatus therefor, and any other business usually or conveniently carried on in connection with same. The subscribers are H. Francis, G. Graham, engineer, J. Cheal, W. Henderson, electrical engineer, E. F. G. Truefitt, C. D. McMillin and W. C. Williams. Reg. office, 13, Victoria-street, Westminster, London.

ELECTRIC AND GENERAL ASSURANCE (LTD.)—Reg. Dec. 22, capital £10,000 in £1 shares, to insure against loss or damage arising from electric or other tramway, light railway, omnibus, motor car and similar accidents, to carry on any accident, indemnity, fire, marine and general insurance and guarantee business (except life assurance), &c. The subscribers are P. G. H. Carvill, M.P., J. F. Albright, G. Cornwallis-West, J.P., M. Smee, E. A. White, J. Devonshire and A. W. Johanning. First directors, P. G. H. Carvill (chairman and managing director), J. F. Albright, J. Devonshire and G. Cornwallis-West. A. E. Johanning is assistant manager and secretary.

EMPRESS MFG. CO. (LTD.)—Reg. Dec. 8, capital £7,500 in £1 shares, to adopt an agreement with R. K. Evans, and to carry on the business of manufacturers, electricians, mechanical engineers, machinists, motor car builders, &c. First directors, Commander G. P. Heath, R.N., G. R. Spencer and R. K. Evans. Reg. office, 3, Church-court, Old Jewry, London, E.C.

ETHERIDGE RAILWAY CO. (LTD.)—Reg. Dec. 8, capital £30,003 in 300 ordinary shares of £100 each and 60 B shares of 1s. each, to acquire concessions and privileges for constructing railways and tramways in Queensland or any part of the world, and to carry on the business of carriers of passengers and goods, engineers, contractors, manufacturers of and dealers in railway, tramway, electric and other apparatus, transmitters, users and suppliers of electricity, &c.

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GENERAL RUBBER CO. (LTD.)—Reg. Dec. 19, capital £500 in £1 shares, to carry on the business of manufacturers of rubber and rubber goods, cable makers, dealers in electric light requisites, &c.

GLOVER'S WATER-TUBE BOILER CO. (LTD.)—Reg. Dec. 2, capital £10,000 in £1 shares, to adopt agreement with L. G. C. Glover and D. Crowther for acquiring benefit of certain existing inventions in relation to water-tube boilers, and the conversion of existing boilers into water-tube boilers, and to carry on the business of mechanical engineers, tool makers, boiler makers, machinists, &c. No initial public issue. First directors, L. Glover, C. Glover, W. Deighton, B. Talbot, H. A. Watson, T. Sheffield, R. S. Dower, J. H. Clough and P. G. Wright. Reg. office, 17, East-parade, Leeds.

MONARCH MOTOR SYNDICATE (LTD.)—Reg. Dec. 18, capital £500 in 8s. shares, to manufacture and deal in electrical and other motors, machines and engines of all kinds, and to carry on the business of electricians, electrical engineers, mechanicians, &c. Reg. office, 59, Moorgate-street, London, E.C.

RAMSGATE AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Reg. Dec. 21, capital £30,000 in £5 shares, to carry on business of electrical, mechanical and chemical engineers, electricians, practical engineers and contractors, manufacturers of electrical apparatus, suppliers of electricity, &c. Subscribers are F. E. Gripper, engineer, W. T. Pressland, electrical engineer, J. C. Wigham, engineer, A. J. Fippard, electrical engineer, C. H. Jones, A. Anderson, engineer, and W. T. Belf, engineer.

THOMAS MIDDLETON & CO. (LTD.)—Reg. Dec. 23, capital £30,000 in £1 shares, to acquire business of Thomas Middleton & Co., and to carry on business of electrical and mechanical engineers, metal workers, boiler makers, manufacturers of and dealers in apparatus of all kinds used in connection with the production, storage, application and distribution of electrical energy, &c. P. Otto de Clermont is permanent Government director (special qualification £10,000) with power to appoint other directors. Reg. office, Loman-street, London, S.E.

ZONE DYNAMO AND MOTOR PATENTS CO. (LTD.)—Reg. Dec. 24, capital £2,700 in £1 shares, to execute contracts for works involving the supply, application or use of dynamos, motors and dynamo-electric machinery, and to carry on the business of electrical engineers and experts, technical advisers, consulting, mechanical and general engineers, manufacturers of dynamos, electric motors, motor-generators and transformers, magnets, machines, electric regulators, &c. First directors, H. Edmunds, L. W. Holmes, H. F. Joel and J. H. St. H. Mawdsley. Reg. office, 10, Serjeants Inn, London, E.C.

MORTGAGES AND CHARGES.

CORK ELECTRIC TRAMWAY AND LIGHTING CO. (LTD.)—Lien reg. Dec. 21 for £2,000, part of £110,000; amount previously issued, £105,000; charged on certain property situate in city of Cork.

ELECTRICAL TESTING LABORATORIES (LTD.)—£400 debentures, created Dec. 14, 1903, charged on company's undertaking and property, present and future, have been registered. No trustees.

GENT & CO. (LTD.)—£17,000 debentures, created and dated Dec. 14, 1903, have been registered. Property charged: Company's undertaking and property, present and future, including uncalled and unpaid capital. No trustees.

MEDICAL ELECTRO-THERMIC GENERATOR CO. (LTD.)—£1,000 first mortgage debentures, created and dated Dec. 5, 1903, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

PHŒNIX DYNAMO MFG. CO. (LTD.)—A postponing deed dated Dec. 2, 1903, extending time for payment of £14,700 debentures, part of series created July 23, 1903, to secure £15,000, has been registered. Property charged: All company's property, present and future, including uncalled capital. Parties to agreement C. B. Crawshaw, J. Sellars, and company.

STATUTORY RETURNS.

MIDLAND ELECTRIC LIGHT AND POWER CO. (LTD)—The annual return to Nov. 13 gives the capital as £50,000 in £10 shares. 3,139 shares taken up. £70 paid. 31,320 considered as paid. No mortgages or charges.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26½d. per oz. (Dec. 31). Consols 88—88⅛ for money, 88 1/16—88 3/16 for account; 2½ per cent. annuities 87⅞—88 (Dec. 31). Consols Pay Day, Jan. 6; Stocks and Shares Continuation Days, Jan. 12 and 26; Ticket Days, Jan. 13 and 27; Pay Days, Jan. 14 and 28; Mining Share Carry-over Days, Jan. 11 and 25.

EDMUNDSONS' ELECTRICITY CORPORATION (LTD.)—An interim dividend of 5 per cent. per annum on the ordinary shares has been declared payable 15th inst.) for the half-year ended Sept. 30.

QUEENSTOWN (TASMANIA).—The Town Board are raising a loan for lectricity supply amongst other purposes.

SOUTH STAFFORDSHIRE TRAMWAYS CO.—At the annual meeting on Wednesday the chairman informed the shareholders that during the past year the directors had been in constant communication with the authorities through whose districts the company's lines ran. In Walsall the company had 6 miles 6 furlongs of line, which had now been transferred by purchase to Walsall Corporation for £18,500. In West Bromwich the undertaking (9 miles 6 furlongs) had been sold for £32,000. This £50,500 had been devoted to paying off debentures. Negotiations were being carried on with regard to their undertaking at Wednesbury. An offer had been made for the company's tramways at Dudley, but the terms were not possible. Negotiations had also been carried on with the local authorities at Tipton and Coseley, but without success. The company had many points in common with the British Electric Traction and the South Staffordshire Lessee Companies, but there were also many points on which they were distinctly at issue with those companies. If the agreements which they had with those companies were carried out fairly, the board were prepared to negotiate. A resolution to pay a dividend of 5s. 2d. per share, tax free, on the preference shares was approved.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have ordered 50,000 fully-paid 7 per cent. £1 cumulative preference shares of the *Blackheath and Greenwich District Electric Light Co. (Ltd)* to be quoted and have been asked to allow 150,000 cumulative 6 per cent. preferred £1 fully-paid shares of the *Kalgoorlie Electric Power and Lighting Corporation (Ltd.)* and 109,251 ordinary £1 shares of the *Consolidated Electrical Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Dec. 26	1,175	+ 274	50	87,147	+ 6,560
Ayr Corporation	,, 26	173	+ 2	33	10,132	+ 81
Barnsley	,, 18	141	- 10	50½	8,988	- 12
Bexley District Council	,, 25	177	...	12	1,977	...
Birkenhead	...	...	...	...	...	...
*Birmingham Tramways	,, 26	4,970	- 157	25	128,513	+ 3,304
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 24	287	- 18	§38	87,603	- 159
Blackpool and Fleetwood	,, 26	226	- 1	26	20,754	- 101
Blackp'l, St. Anne's & Lytham	,, 24	144	+ 121	§8	1,144	+ 668
Bolton Corporation	,, 27	1,884	+ 206	39	71,701	+ 8,495
Bournemouth Corporation	,, 23	873	...	39	40,166	...
*Bradford Corporation	,, 27	4,055	+ 211	87	147,601	+ 19,889
Brighton Corporation	,, 27	872	- 91	39	86,281	+ 2,633
Brisbane Tramways	Nov. 11	2,510	- 11	19	44,596	+ 432
*Bristol Trams & Carriage	Dec. 25	5,314	- 49	5	22,671	+ 880
*Buenos Ayres & Belgrano	Nov. 29	3,079	+ 125	6	19,105	+ 618
Burnley Corporation	Dec. 26	1,018	+ 220	39	39,365	+ 6,865
Burton Corporation	,, 27	350	...	21	7,541	...
Calcutta Tramways Co.	,, 26	R10,455	+R8,259	26	R875,075	+R153,715
Camborne-Redruth	,, 28	164	...	8	7,079	...
Cardiff Corporation	,, 26	2,133	+ 304	26	76,926	+ 20,453
Carlisle Tramways Co.	,, 26	205	- 7	¶51	9,562	+ 854
Central London Railway	,, 26	6,412	+ 277	26	166,820	- 6,782
Chatham & Dist. Lt. Rys.	,, 17	518	+ 159	} 51	27,611	...
	,, 24	620	+ 172			
City & South London Rly.	,, 27	2,979	- 164	26	70,694	- 10,302
Cork Electric Trams Co.	,, 24	482	- 5	41	26,281	- 3,375
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 18	460	+ 82	50½	23,253	+ 1,675
Dover Corporation	,, 26	177	- 27	†39	8,998	+ 73
Dublin & Lucan Railway	...	...	...	...	...	...
Dublin Southern District	,, 25	839	+ 2	¶25	26,234	+ 8,521
Dublin United	,, 25	4,300	+ 117	¶25	100,950	
Dudley—Stourbridge	,, 18	728	+ 33	50½	41,877	+ 3,869
Dundee Corporation	...	...	...	...	...	...
East Ham Council	,, 26	643	+ 57	†39	26,190	+ 7,508
Gateshead & Dist. Trams	,, 18	858	+ 23	50½	44,204	+ 5,438
Glasgow Corporation	,, 26	18,497	+ 924	30	409,720	+ 42,313
Gravesend—Northfleet	,, 18	203	+ 49	50½	12,087	+ 1,842
Greenock & Port Glasgow	,, 18	431	+ 50	50½	27,371	+ 2,288
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 18	241	+ 34	50½	13,580	+ 927
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 26	2,318	+ 261	†39	78,554	+ 4,645
Ilkeston Corporation	...	...	...	...	...	...
Ipswich Corporation	...	...	...	...	...	...
Isle of Thanet Co.	,, 26	275	- 78	26	22,955	- 1,062
Kidderminster & District	,, 18	96	+ 4	50½	6,865	+ 187
Kirkcaldy Corporation	,, 23	202	...	43	7,578	...
Lanarkshire Trams Co.	,, 24	532	...	§19	13,844	...
*Leeds Corporation	,, 26	5,625	+ 42	39	215,459	+ 13,051
Liverpool Corporation	,, 19	9,753	+ 154	51	512,053	+ 17,275
*Liverpool Overhead Rly.	,, 27	1,561	+ 159	26	42,912	+ 2,833
London County Council	,, 19	9,843	+ 1,264	‡38	375,303	+ 69,606
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 26	11,605	+ 3,121	28	328,383	+ 165,691
Mersey Railway	,, 26	1,707	+ 619	26	34,952	+ 7,138
Merthyr	,, 18	178	+ 16	50½	9,995	+ 46
Middleton	,, 18	238	+ 34	50½	15,795	+ 1,925
Newcastle-on-Tyne Corp.	,, 26	3,997	+ 585	26	91,298	- 925
*Newport (Mon.)	,, 26	533	+ 310	12	5,807	+ 2,711
Oldham, Ashton & Hyde	,, 18	498	+ 15	50½	28,473	+ 1,624
Perth (W. A.) Elec. Trams.	,, 25	1,630	+ 255	§51	60,725	+ 7,158
Peterborough	,, 18	106	...	47	7,811	...
Poole and District	,, 18	209	+ 12	50½	15,045	+ 2,147
Portsmouth Corporation	,, 26	1,269	- 25	†39	70,011	+ 4,593
*Potteries	,, 18	1,670	+ 116	50½	80,103	+ 3,756
Reading Corporation	...	..	...	...	...	...
Rothesay	,, 18	82	- 1	50½	6,951	1,601
Salford Corporation	,, 28	4,084	+ 888	39	149,582	+ 43,309
Sheerness	,, 16	50	...	36	2,998	...
Sheffield Corporation	,, 27	4,770	+ 42	2§	118,990	+ 9,202
*Southampton Corporat'n	,, 24	977	+ 113	...	...	...
Southend Corporation	...	...	...	...	...	...
Southport Tramways	,, 18	221	+ 16	50½	15,618	+ 2,701
S. Staffordshire Trams.	,, 18	955	+ 330	50½	45,891	+ 8,730
*Sunderland Corporation	,, 27	1,208	- 30	39	48,061	+ 2,190
*Swansea Trams	,, 18	462	+ 18	50½	26,039	+ 2,182
Taunton Trams	,, 18	46	- 1	50½	3,013	- 194
Tynemouth and District	,, 18	180	- 18	50½	15,307	+ 743
Tyneside Trams Co.	,, 23	273	+ 44	51	16,844	...
Wallasey District Council	,, 26	639	+ 43	†39	27,448	+ 3,441
Weston-super-Mare	,, 16	21	- 2	50	5,712	- 516
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 18	323	- 18	50½	19,493	+ 7,695
Wrexham	,, 18	105	...	37	5,123	...
Yorkshire Woollen District	,, 18	435	...	48½	17,084	...

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Dec. 30.	Rate per Cent. Yielded.	Dividend Due	Business, 8 days to Dec. 30	
				£ s. d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine 8h(1to260,007)5%Cm.Pf.	4¾–5	4 17 6	April, Oct	..	..
St.	6%	† Do. Permanent 6% Deb. Stock	125 –130	4 12 4	..	..	..
10	10	Barcelona Tramways Ord.	7½–8½	5 17 8	..	..	..
10	5/0	† Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 –102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 –3	..	..	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	3¾–4½	5 17 8	..	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Prov. Certs.	97 –102	4 8 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 –21	3 10 10	Feb, Aug	..	..
10	4%	† Do. Cum. Pref. (fully paid)	10½–10¾	3 15 11	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	105 –107	3 14 9	Feb, Aug	..	..
St.	6	British Columbia Elec. Rlwy. Def. Ord.	79 –82	3 12 9	..	80½	..
St.	5%	Do. Pref. Ord. Stock	91 –94	5 6 2	..	94¾	..
10	4/2½	Do. 5% Cum. Perp. Pref.	10 –10¼	4 15 3	..	..	..
4	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅞–104⅞	4 6 7	..	102⅞	..
10	6/0	British Electric Traction Ord.	11¼–11⅝	6 16 2	..	11⅝	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼–11⅝	5 2 2	Feb, Aug	11⅝	11½
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –123	4 1 4	..	121½	..
5	..	Buenos Ayres and Belgrano Ord.	2¾–3¼	..	..	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼–5¾	5 4 0	..	5⅝	5 1/16
5	3/0	Do. "B"	4¾–5¼	5 14 3	..	5¼	..
St.	5%	† Do. 5 per Cent. Debs.	104 –107	4 13 6	..	..	..
St.	5%	† Do. 5% 2nd Deb. Stock Prov. Certs.	97 –100	5 0 0	..	..	..
5	2 6	Calcutta Tramways	6¾–7¼	3 2 1	..	6⅞	..
100	4½%	† Do. 4½% 1st Deb. Stock (red.)	104 –107	4 4 2	..	..	..
1	1/2½	Cape Electric Tramways Shares	1¾–2	7 10 0	..	..	..
St.	4%	Central London Ordinary Stock	93 – 96	4 4 9	June, Dec	95	94
St.	4%	Do. 4 per Cent. Pref. Stock	99 –102	3 18 10	..	..	..
St.	4%	Do. Deferred Stock	93 –96	4 3 4	..	..	..
100	4%	Do. 4 per Cent. Debs.	115 –118	3 7 11	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 – 5½	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con Ord.	47 –50	6 5 0	Feb, Aug	50	49
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 –129	3 18 7	Feb, Aug	..	..
St.	5%	Do. (1896)	123 –126	4 0 4	..	..	..
St.	5%	Do. (1901)	120 –125	4 1 1	..	122	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 –112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101 –104	4 16 9	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord	12 –13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3¾–4¼	6 13 4	..	..	..
.	5%	† Do. 5 per Cent. Deb. Stock (red.)	92 –97	5 3 1	..	..	..
0	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 –8	3 15 0	..	..	..
0	..	Gt. Northern, Piccadilly & Brompton Ord., 6peyer Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	‡Imperial Tramways Ord	20 –21	4 13 0	Mar, Sept	..	..
10	6%	††Do. 6 per Cent. Pref.	14 –14½	4 2 10	Mar, Sept	..	..
St.	4½%	††Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½ –4	6 5 0	..	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	..	..	..
10	11%	Liverpool Overhead Railway Ord.	5 –5½	2 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼–10⅝	4 13 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –101	4 1 0	Jan, July	..	..
10	5,0	†London United Trams. 5% Cum. Pref.	11 –11¼	4 6 11	..	..	..
St.	4%	† Do. 4% 1st Mort. Deb. Stock	102 –104	3 16 11	..	..	..
St.	..	Mersey Con. Ord. Stock	8 –11	..	..	8¾	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	7/8–15/16	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	1 1/16–1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 –104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 –107	4 4 1	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½–2½	..	May	..	..
St.	5%	†Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 –102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½–9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 –10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 –105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 –94	3 9 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 –103	3 18 0	Jan, July	..	..
10	..	Amazon Telegraph	2½–3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	49 –52	6 1 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	92 –94	6 8 3	F,My,Ag,N	93½	93⅜
St.	1/0	Do. Deferred	7⅜–8½	0 12 5	F,My Ag,N	7 1/16	7⅛
100	$2	†Commercial Cable Capital Stock	160 –170	4 14 2	Jn,Ap,Jy,O	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	88 –92	4 7 0	Jn Ap,Jy,O	..	..
10	7,0	Cuba Submarine Ord.	7 –8	10 0 0	Feb, Aug	7 1/16	..
10	10/0	Do. Preference 10 per Cent.	16 –17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	7⅜	7
50	4½%	Do. 4½ per Cent. Deb.	100⅝–103⅞	4 9 4	Jan, July	102	101
20	3/	Direct United States Cable	10 –10½	6 3 10	Ja,Ap,Jy,O	10½	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	100 –103	4 8 10	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	121 –126	5 11 1	Ja,Ap,Jy,O	123	122
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 –89	3 19 4	Ja,Ap,Jy,O	87	..
St	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –108	3 14 1	May, Nov	..	..
10	2/6	Eastern Extension	11 –11½	6 1 9	Jn,Ap,Jy,O	11⅜	11½
St.	4%	Do. 4 per Cent. Deb. Stock	106 –109	3 14 4	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 –102	3 18 10	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝–102⅝	3 18 11	May, Nov	100⅜	100
10	5/0	Great Northern of Copenhagen	25 –26	4 16 2	Jan, July	..	..
10	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	100 –103	4 9 4	June, Dec	..	..
25	12.6	Indo-European	37 –40	6 5 0	May, Nov	38½	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 –102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	98 –101	4 0 9	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 –6	3 6 8	..	..	..
2½	..	West Coast of America	¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	96 –99	4 2 6	Jan, July	..	..
10	..	West India and Panama	⅜–½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 –8½	9 4 8	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 –104	4 17 7	Jan, July	..	..
10	3/0	†Western Telegraph	11¾–12½	5 14 3	Mr,Jn,O,D	12½	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –104	4 18 6	June, Dec	..	..
St.	4%	† Do. 4% Deb. Stock (red.)	98 –101	3 19 3	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	8	Elec. & Gen. Investment 6% Cum. Pref.	4¾–5½	5 14 3	..	..	..
10	2/0	Globe Telegraph and Trust	8¼–8¾	4 11 5	Ja Ap Jy O	8⅝	..
10	3/0	Do. 6 per Cent. Pref.	12½–13	4 12 4	Ja Ap,Jy,O	12⅝	..
5	4/0	Reuter's	6⅞–7⅛	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 –122	4 19 3	April, Oct	119½	..

Share.	Last Dividend	Name.	Price Wed., Dec. 30.	Rate per Cent. Yielded.	Dividend Due	Business 8 days to Dec. 30	
				£ s. d.		high-est.	Low-est.
		TELEPHONES.					
5	6/0	Chili Telephone (fully paid)	4¾–5½	5 14 3	August	..	..
St.	6%	National Co. Pref. Stock	101 –103	5 18 9	..	103	101¾
St.	5%	Do. Def. Stock	77 –80	6 2 10	..	78½	77½
10	6·0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 5 9	Feb, Aug	..	..
10	6.0	Do. 6 per Cent Cum. 2nd Pref.	13 –14	4 5 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¾–6⅜	4 13 0	Feb, Aug	..	..
St.	3¼%	*†Do. Deb. Stock 3¼ per Cent. (red.)	94 –96	3 12 11	June, Dec	..	..
St.	4%	† Do 4 per Cent. Deb. Stock (red.)	100 –102	3 18 5	..	101¼	..
1	0/7½	Oriental	¾–1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 –1⅛	..	..	..	..
5	3 0	†United River Plate	5¼–6	5 16 8	July	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	4¾–5⅛	4 15 3	June, Dec	..	..
St.	5%	*†Do. 5 per Cent. Deb. Stock (red.)	102 – 105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝–¾	..	..	..	..
1	..	Do. 7 Cum. Pref.	1⅛–1⅜	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	114 –117	3 17 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½–13½	5 18 6	..	..	..
10	4/8	Do. 4½ per Cent. Cum. Pref	10 –11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	101 –104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. &Power 1stDebs.	100 –103	4 7 5	..	..	..
5	4/8	Brompton & Kensington Elec. Sup. Ord.	10¼–10⅝	4 3 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	9⅜–10¼	3 8 4	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	6¾–7⅛	4 6 8	..	..	..
St.	4%	Central Elec. Sup.Co.4% Guar.Db.Stock	105 – 108	3 13 11	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8¾–9⅛	5 8 1	Feb, Aug	9⅛	9⅛
5	2/3	Do. 4½ per Cent. Pref.	5¼–5¾	3 18 3	Feb, Aug	5⅝	..
†	Do.	City Undertaking 4½% Cm. Pref.	4¾–5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –105	3 16 3	..	..	..
5	2.0	Chelsea Electric Supply Ord.	5½–6	4 3 4	March	..	..
St.	4½%	*†Do. 4½ per Cent. Deb Stock (red.)	105 –108	4 3 8	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10 –11	6 16 4	Feb, Aug	10 1/16	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	..	..
St.	5%	*†Do. 5 per Cent. Deb. Stock (red.)	121 –126	3 19 4	Jn, Dec	..	..
St.	4½%	† Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7½–8½	4 14 2	..	8 1/16	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Mar, Sept	..	..
St.	4½%	† Do. 4½% Deb. Stock (all paid) (red.)	106 – 109	4 2 7	..	109½	..
St.	27,6½	Do. Second Deb. Stock Prov. Certs.	99 –102	..	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5¼–6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 –103	4 7 5	..	..	..
10	..	Havana Electricity Co. Shares (£8 paid)	7½–8½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10¾–11½	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾–7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station, 4% Deb. Stck. (red.)	101 –104	3 16 11	..	103	..
3	..	London Electric Supply Ord.	1¾–2¼	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	5 –5½	5 9 1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 –100	4 0 0	Mr,Jn,S,D	..	..
10	8 0	Metropolitan Electric Sup. Ord.	17–18	4 6 1	April, Oct	17⅜	17⅛
5	..	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅜	..	..	5⅛	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	3 19 6	Jn, Dec	..	..
St.	3¾%	† Do. 3¾ per Cent. Mrt. Db. Stock (red.)	95 – 98	3 11 4	..	97⅛	96½
10	6.0	Notting Hill Electric Ord.	12½–13½	4 8 11	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5½–5¾	4 15 8	March	..	..
St.	4%	Do. 4% Deb. Stock	98 –101	4 0 6	..	..	..
1	..	Rand Electric	⅞–1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 –102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½–15½	4 13 9	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	7½–8½	4 2 4	Feb, Aug	..	..
St.	3½%	† Do. 3½ per Cent. Deb. Stock (red.)	97 –101	3 10 4	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3 –3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	86½	86
5	1/9	South London Electric Supply Ord.	3½–3⅝	4 13 4	..	3⅝	..
5	2,6	Urban Electric Supply Ord.	4⅜–5⅛	4 17 7	..	..	..
5	2/6	Do. 5% Cum. Pref.	4¾–5¼	4 17 7	..	..	..
5	6/6	Westminster Electric Supply Ord.	12 –13	5 0 0	Mar, Sept	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½–⅝	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	5/16–⅜	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 –6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5¼–5½	5 4 4	Jan, July	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	105 –107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	103 –105	4 5 8	..	104	..
5	3/0	British Westinghouse 6% Pref.	4½–5	5 0 0	..	4 1/16	4½
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock	94 –97	4 2 6	..	..	..
½	..	Brush Electrical Engineering	¾–1½	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼–1⅝	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –100	4 10 0	Mar, Sept	..	..
St.	4½%	† Do. Perpetual 2nd Deb. Stock	75 – 80	5 12 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	11 –12	6 5 0	Jan, July	11½	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5¼–5½	4 6 11	Jan, July	5⅜	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 –108	4 3 8	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝–¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	90 –95	4 15 3	..	..	..
1	0 7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅞–2⅛	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	99%–103⅝	4 19 4	Jan, July	..	..
5	..	Edison & Swan United("A"Sh.) (£3 pd.)	¼	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½–1½	..	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Mort. Deb.Stock (rd.)	71 –76	5 5 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 –81	6 3 5	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6 –6½	5 7 8	H'lf-yearly	6½	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6½	4 12 4	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 –107	4 5 4	..	..	..
2	1/2½	Electric Construction Co.	1⅝–1¾	6 8 0	Jan, July	..	..
2	2 9½	Do. 7 per Cent. Cum. Pref.	2½–3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 –101	4 0 9	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	½–¾	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾–1	..	..	..	..
St.	5%	†Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	†General Electric (1900) 5% Cum. Pref.	9¾–10¼	4 17 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 – 98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	13½–14½	6 17 11	Feb, Aug	14	..
5	2/3	Do. 4½ per Cent. Pref.	5 – 5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 – 112	4 0 9	Feb, Aug	..	..
10	15/0	†India Rubber, Gutta Percha, &c., Wrks.	18 –19	5 5 3	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 – 103	3 17 3	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾–11½	4 8 11	Mar, Sept	..	..
1	12/0	Telegraph Construction & Mainten'ce.	34 – 37	6 9 8	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 –105	3 17 3	Jan, July	..	..
5	3 0	Williams and Robinson Ord.	4½–5½	5 18 2	Apr, Oct	4⅝	4½
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6½	4 12 4	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –102	3 18 5	May, Nov	..	..

In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend ‡ The London Stock Exchange Committee have refused to quote these.

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BOILERS. No.	Type.	Total Actual Evaporative Capacity in lbs. per hour	Class	PRICE PER UNIT. Small figs. (1) indicate first hour, (2) first two hours, &c. Lighting.	Power.	TARIFF SYSTEM. W. indicates the WRIGHT system of charging. D. indicates Discounts.	Price of Gas in District.	Gasworks owned by L.A. = Local Auth. Co. = Company.	—	REMARKS.
3	B. & W.	8,000	Local sla	7d.(1)—4d.	4d.(1)-1½d.	W.	3/5	Co.	174	96-tube Green econ. B. & W. chain grate stoker. Nat. draught. Weir differential steam pumps, hot or cold. Free wiring. Motors, heating, &c., hire or purchase.
2	Lancs.	10,000	Slack	5d.	3d. & 2d.	D.	3/6	Co.	175	Station to be worked in conjunction with Meldrum refuse destructor. No economisers. Hand firing. Worthington feed pumps. Two Royles feed heaters.
4	Lancs. 30′ × 8′ 6″	32,000	Unscr slac	6d.(1-1)—2d.	2d.(2)—1d.	W.	2/6	L.A.	176	96-tube Green economiser. Natural draught. Bennis stokers. One compound steam and two 3-throw electric feed pumps. No free wiring. Motors on hire-purchase.
3	Cornish (Hill) (2), Davey-Paxman Loco. type (1)	3,000 4,500	South W steam Forest Dean	6d.	3d.	...	3/6	Co.	177	No economisers. Natural draught. Engines only auxiliary in cases of floods and dry seasons. All street lighting electric. Hand stoking.
3	B. & W.	12,000	Scotc co	6d.(1)—4d. and 5½d.	4d(1)-1½d	W.	4/10	Co.	178	No econ. Nat. draught. Hand firing. Duplicate Worthington feed pumps. Rented wiring at 1/- per lamp per ann. or ½d. per unit, or through prepayment meters at 5½d, incl. Motors: rent 10% of their value.
4	Water-tube (2) Danks Lancs. (2)	34,000	Rd. Ha Hard	5d.	3d.	D.	3/9	L.A.	179	192-tube Green economiser. Natural draught. Worthington pumps feed into ring main: town water. Boosters, 15 and 20kw. Arcs 25 in series. Transformers worked automatically from generating station.
3	Lancs. (Houldsw'th)	14,000	Slack	4½d.	3d. & 2d.	D.	2/9	L.A.	180	192-tube Green economiser. Natural draught. Bennis stoker driven by Greenwood and Batley motor. Worthington and Weir feed pump and injector. Town water. Steam raised at station for heating Corporation baths.
4	Lancs. Sinclair (2) Marshall (1) B & W. (1)	31,500	Wash single	3½d.	1½d. to 1d.	None	2/11	Co.	181	No economisers. Natural draught. Feed heater. Carruthers steam-driven vertical pumps. Hand and mechanical stoking.
3	Lancs. (8) Stirling (5)	...	Nuts sm	4½d.	2½d.—1d.	D. 5% to 35%	1/10	Co.	182	Green economiser.
4	Loco.(2) Econ.(2)	...	Hard Yorl	7d.(1)—4d.	4d.(1)-1½d.	W.	3/8	Co.	183	Chevalet and Boby feed heater. Town water and well. Hand stoking. Worthington and Hall feed pumps Free wiring by Company. Prepayment meters.
3	B. & W.	12,400	Bitum slac	7d.(1)—4d.	4d.(1)—1½d.	W.	3/10	Co.	184	No econ'rs. B. & W. chain grate stokers. Duplicate Hall feed pump Well water. Free wiring at 1/- per lamp per ann. Motors and arcs on hire.
7	Lancs.	46,000	Collie sma	5½d. to 2d.	2d. & 1d.	W. & D.	3/6	Co.	185	192-tube Green economiser. Natural draught. Procter and Bennis stokers. Pearn and Worthington feed. Water overflow from condensers. Flat, and sliding scale rates.
2	B. & W.	6,500	...	7d. & 4d.	4d. & 1½d.	W.	3/6	Co.	186	No economisers. Natural draught. Hand firing. Two Hall pumps. Free wiring, 4½d per lamp per quarter, 10 per cent. on motors, &c.
2	Economic(1) Gall way (1)	6,000	Durh coal	6d.	4d. to 2d sliding scale	D.	3/6	Co.	187	Worked without Provisional Order under agreement with Urban District Council. Town water. Free wiring. Wiring all done by the Company. Motors on hire Sturtevant induced draft fan (45in.) electrically drive.. Overhead mains gradually being substituted by solid system underground.
4	Lancs.(2) B.&W.(2)	40,000	Midla small co	6d(1)—3d.	2d.	W. & D.	2/5 less 10%	Co.	188	Bennis stokers on all boilers. Green economisers. Superheaters. Nat. draught. Own well water, water softener. Motors on hire.
ie	...	...	Mond ga	6d.(1)—4d.	2d.—1d.	W.	3/9	Co.	189	"Mond" producer gas used. Free wiring.
	B. & W. (7) Dryback marine (4)	76,000	Welsh H'rd st	5d.	See remarks	...	3/3	Co.	190	Motors 3d. for first 500 units a quarter, 2d. for second 500 and 1½d. beyond. Green econ'rs, 328-tubes. Hand firing. Blake-Knowles and Mumford steam feed pumps. River water. Crompton boosters. Free wiring and motors hired. Stanhope water softener.
2	Lancs.(8) Multi(14)	...	Local	5d.(1-1)—1½d.	1¼d.	W.	2/10	L.A.	191	First price for lighting is for first 100 hours per quarter. Green economisers with Berryman heaters. Natural draught. Hand-firing. Pearn and Weir feed-pumps.
3	B & W.	18,000	Fine sla Exhall	6d.(1)—3d. 5d.	3d.(1)—1d. 2½d.	W. and flat rate	3/6	Co.	192	Green economiser. Hand stoking. Pearn feed pump and injector. River water. Natural draught. Churches 4d. per unit.
2	B. & W. Water tube	10,000	Dry screene nuts	6d.	3d.	...	7/6	Co.	193	96-tube Green economiser. Natural draught. Hand stoking. Hall feed pump and Sirius injectors.
4	Undertype loco. (2) B. & W. (2)	6,000	Rubbl coal	8d.—6d.	Not supplied	No discounts	No gas	None	194	One station. No economisers. Natural draught. Injector. No balancer or booster. Supply night and morning only from Nov. 1 to Feb. 28.
1	Lancs. (8) Climax (3) Marine (5)	...	Slack	4d.(2)—1½d.	2d(2)—1½d.	W. & D.	2/4 net	L.A.	195	96 and 132-tube Green econ'rs. Nat. draught. Hand stoking. Two stations. Worthington & Weir feed pumps. 2 Berryman feed-water heater. Power also 2d. 1st 500 units per qr.; 1½d. 2nd 500 units per qr.; 1½d. after.
	Multi. (2) B.&W.(2)	...	Slack	7d.(2)—3½d.	...	W.	3/1½	Co.	196	Water heater. Natural draught. Worthington pumps and injector. Well water. Batteries take day load.
	Loco.(5) Econ.(2)	40,000	Welsh steam	6d.	4d.	None	3/2	Co.	197	Green economiser. Natural draught. Hand stoking. Feed pumps direct driven from each marine type engine. One Weir and two Worthington feed pumps.
	B. & W.	30,000	Lanark wa-he sing	4d.	2½d.	...	2/8	L.A.	198	Street lighting by 15 ampere arcs from rectifiers. 288-pipes Green economiser. Natural draught. Vicars stokers. Steam-driven Cameron feed pumps. 1 Weir feed pump. B. & W. superheaters fitted.
	B. & W.	24,000	Doubl Nuts	3½d.	1d.	...	2/1	Glasgow Corp'n	199	Economiser of 200 tubes. Weir feed pumps. Town water. Dust destructor (Manlove-Alliot) combined.
	Lancs.	5,000	Pember slack	3d.	1½d.	D.	3/0	Wigan Corp'n.	200	192-tube Green economiser. Duplicate feed arrangements. Natural draught. Hand stoking. Pump and injectors.
	Lancs.	13,500	Scotch slac	4½d.	3d.	Flat rate	3/10	Co.	201	96-tube Green economiser. Natural draught. Bennis stokers. Green and Worthington feed-pumps, Holden & Brooke injector. Schmidt superheaters by Easton & Co.
	B. & W.		Mix	7d.(1)—3d. or 4½d.	4½d.(1)—1½d.	W.	3/0	Co.	202	No econ'rs. Nat. draught. Hand firing. Berryman exhaust steam feed heater. Free wiring with 8d.(1)—3d. for current. Superheaters.

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—	Name o (Figures estim	TOTAL. 8 c.p. lamps or equivalent.	TOTAL. In Kilowatts.	No., type & size of Public Lamps. Arc.	No., type & size of Public Lamps. Incandescent.	Charge per Street Lamp per annum.	Net Area of District (square miles.)	No. of Consumers.	Miles of Conductors in Mains, including feeders but not including pilotwires	MAINS. Types and Makes of Cables.	MAINS. How laid; Types and Makes of Conduits.	
174	Melto [7,45	1,500	383	5 10-amp. open type	4 50 c.p. 145 25 c.p.	£344 10s. the whole service.	...	420	About 11	Callender lead covered and armoured. *Feeders*—Triple concentric. *Distributors*—3-core	Direct in ground	17
175	Mexb [10,7	7,320	235	15 encl. 5 amp.	175 32 c.p. 51 50 c.p.	Arcs, £15 Inc. £8	...	82	10	Callender V.B. insulated	Solid system	17
176	Middl [91,3	2,700	1,281	None	None	...	4¼	380	13	B.I.W. and Callender lead-covered triple concentric	Pot. and wooden troughing filled with bit. c mp.	17
177	Monm [5,095	4,955	165	2 open 15 amp.	274 16 c.p.	£437 aggre.	...	103	4 11 1	*H.T.*—Armoured concentric ..... *L.T.*—Rubber covered (Siemens) ..... *L.T.*—Overhead bare	Direct in ground 4-in. stoneware pipe.	17
178	Montr [12,85	1,500	383	20 open 10 amp.	19 32 c.p. 107 16 c.p.	Arc £10 per 1000 hr. Inc £1 per 16c.p. 1000 hr.	...	250	...	Callender's lead-covered and steel-taped. Triple-concentric feeders and 3-core distributors	Direct in ground	17
179	Morec [11,79	5,798	473	101 open 10 amp.	20 32 c.p. 80 16 c.p.	Arcs, £19 15s. 6d Inc., 4½ per unit	...	325	20	H.T. feeders concentric. H.T. distributing (arc circuits) and L.T. cables single. All Callenders. Arcs part concentric.	Bitumen casing solid, and direct in ground	17
180	Morle [23,63	1,194	336	16 15 amp.	33 32 c.p.	£22	...	160	10	Callender concen. lead-covered cables Glover concen. lead, armoured	Doulton ...	18
181	Mothe [35,00	0,032	900	60 open 10 amp.	371 32 c.p. 125 16 c.p.	Arc £13 32 c.p. 56/-	2	224	40	Callender solid system and armoured ...	Earthnwre, wooden troughs & direct in ground	18
182	Newca [214,8	4,400	3,132	None	None	...	2	840	...	Rubber cables	Pipes & culverts filled with bitumen	18
183	Newm [10,68	6,500	550	None	None	...	...	150	12½	Lead-covered, steel-armoured. Triple-concentric feeders. 3-core distributors. (All Callender)	Direct in ground	18
184	Newpo [10,91	6,000	533	30 10amp.	...	...	...	450	...	Callender lead-sheathed and steel-taped	Direct in ground	18
185	Newpo [67,290	3,134	1,830	76	11	£20	2	725	41	*H.T.*—Lead-covered diatrine ..... India rubber concentric cable ..... *L.T.*—Armoured cables ..... Lead-covered diatrine ..... } Paper and lead { Troughs Iron pipes Direct in ground Troughs		185
186	Newto [12,518	4,500	150	20	300	...	...	...	100	Callender's V.B. cables	Solid in wood troughs	186
187	Northa [4,009]	5,405	162	23 5 amp. enclosed, 8 10 amp. open	80 32 c.p.	13s. per 100 hours arcs, 3s.9d., 8s.6d. and 3s.1ucd.	3½	111	8	Callender's L.S.S.T. ..... British Aluminium Co. and Bolton's copper cables	Direct in ground Steel poles & underg'd	187
188	Northa [87,021	0,600	1,220	None	None	...	...	700	13⅓	B.I.W. and Glover's twin and concentric lead-covered .. Callender's V. B... ..... Bare copper.....	In wood troughing .... Solid in bitumen .... Wood troughs ..... Culverts ...	188
189	Northw [31,500	6,670	500	...	28 25 c.p.	...	...	355	20½	Callender and B.I.W. triple-concentric... B.I.W. and Glover paper-insulated, concentric, triple-concentric and armoured	Doulton and solid Direct in ground	189
190	Norwic [111,728	4,966	3,448	None	None	...	22½	3,000	19 distrib.	Bare copper..... B.I.W..... Do. armoured ..... St. Helen's Dialite	Culverts & Stoneware In pipes Direct in ground In pipes	190
191	Notting [239,75	2,406	7,437	156	None	...	...	2,503	...	Callender bitumen cables	Albion Clay Co. Bitumen	191
192	Nuneat Coto	2,300	369	20. open, 10 amp.	43 16 c.p.	£3 per arc lamp per ann.	...	146	5	Callender cables (armoured) ..... Johnson and Phillips paper insulated ..... Callenders ..... St. Helen's Dialite	Direct in ground. Doulton and c.i. pipes	192
193	Oban... [5,374]	5,567	167	30 open, 10 amp., 1 enc.	68 16 c.p.	£20 per arc £5 10s. and £2 10s. per incan.	...	70	5	*Distributors* ..... St. Helens Cable Co.	Laid direct..... Stoneware	193
194	Ogmore [15,000]	2,100	45	None	200 16 c.p.	£3	1½	300	30	Two and three-wire cables ..... B.I.W. & Helsby underground armoured concentric cable	Dir. in ground	194
195	Oldham [137,239	7,000	1,710	20 enc. 6 amp.	None	2½d. per unit	...	638	...	Overhead bare copper, London Electric Wire and Callender	Direct	195
196	Oswestr [9,579]	5,300	160	...	...	...	...	189	9	Bare copper in culverts, india-rubber and paper cables in pipes, paper cables arm'd, bit. water-proof & cables, Callender solid system, connecting stations together *Distributors*—Bitumen insulated	Culvert pipes and solid system Laid solid. Doulton.....	196
197	Oxford [49,513]	5,700	1,771	32, open, 10 amp.	40 16 c. p.	...	...	790	55	*Feeders*—Lead-covered and armoured ... *L.T.*—Double steel-armoured, lead-covered	Direct in ground	197
198	Paisley [80,000]	1,651	1,630	66 15 amp. open	None	£30	6¾	406	36	*H.T.*—India rubber ..... Diatrine lead-covered ..... Conc., insulated with vulc. bitumen. Conc. fibre and bit., lead sheathed and armoured. Twin vulc. bit. for arcs. Diatrine con. steel armd. (special)	Direct in ground Iron pipes Stoneware conduit Bitumen in C.I. troughs & direct in ground and covered with tiles	198
199	Partick [60,000]	8,000	840	76 open 12½ amps	None	£17 15s.	3·5	425	40	B.I.W., triple conc. lead covered	Solid and Doulton ducts	199
200	Pember 21,664	0,586	315	14 encl. 5 amp.	510 16 c.p.	2½d per unit	2	380	5	B.I.W., St. Helens, Johnson & Phillips dist. Feeders	Solid system C.I. pipes	200
201	Pembro	9,000	270	18 open 10 amp., 6 encl.	80 32 c.p. 10 04 c.p. 2 200 watt Nernst	Arc £20, Inc. £6 10s. and £3 10s.	...	190	20	Callender lead-covered	Wood troughs on solid system	201
202	Penarth [14,227]	4,588	160	None	None	None	0·7	83	0·5	Western Electric lead-covered	Solid in wood	202

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UNIVERSITY OF CALIFORNIA

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NOTES.

SIR OLIVER LODGE, in his lecture on Radium at Birmingham on Tuesday, took the view that the whole phenomenon, contrary to the general opinion, is intelligible and simple, on the theory that radio-activity is due to an atomic disintegration. Sir OLIVER advanced arguments in favour of the disintegration hypothesis from the mathematical theory that the atom is constituted of electrons in motion, which requires—(1) an atomic radiation, (2) the expulsion of electrons, (3) an occasional disintegration of the atom. These three phenomena LODGE associated with the γ, β and α-rays of radio-activity respectively. The disintegration theory is acceptable as the most probable explanation of radio-active phenomena so far as our present knowledge goes, but this additional proposition put forward by Sir OLIVER will hardly receive general endorsement. The lecturer also contended that theoretical physics had kept pace with the new facts, and each one as discovered fitted its particular niche in the electrical theory of matter; but it is difficult to part with the opinion that the pure scientist was for a time fairly beaten.

IN concluding his lecture, Sir OLIVER LODGE pointed out the important consequences of the discovery—viz., the belief in the mutability of matter and the transmutation of the elements. The atoms are crumbling and decaying. Must they not also be forming and coming to birth? Decay only, without birth and cumulation, cannot be the last word!

AN improvement in the treatment of radiferous ores and the separation of radium is announced from Paris, whereby the time of the preliminary operations before treatment on a laboratory scale is shortened from three months to one month. This is effected by employing the bromides instead of the chlorides in the fractionation of the radium from the barium. But the process is by no means new. It was discovered by GIESEL two years ago and has been in constant use ever since at the Chinin-Fabrik in Brunswick. Two new sources of radium have also been announced during the week, the mines in Cornwall and the deposits from the hot-water springs at Bath, but neither is likely to prove of any practical importance. With regard to the latter it is known from the work of H. S. ALLEN (*The Electrician*, Vol. LI., p. 690) that the gas from the springs contains minute traces of what behaves like the radium emanation, and STRUTT now announces that he has found "appreciable quantities" of radium in the deposit from the pipes, but "not enough to repay extraction." It has to be borne in mind that a hundred-thousand-millionth of a grain of radium is an appreciable quantity. With regard to the Cornish ore, there is no evidence at present that any better source of radium has been obtained than that tried and rejected by M. CURIE some years ago. Doubtless the day is not far distant when radium will be discovered in everything. This is, however, on account of the extreme delicacy of our methods of looking for it, and the general public would do well to remember the fact.

IN another part of this issue we publish an illustrated description of the Stepney Borough Council's electricity works, which is of more than ordinary interest for several reasons. Owing to the fact that nearly all the consumers are of the Jewish persuasion, the Friday, Saturday and Sunday load-curves are quite different to those of any other undertaking in this country. Most consumers, too, are shopkeepers who live over their shops, and the maximum demand system has been rigidly adhered to. In these circumstances it is natural to expect a somewhat high load-factor, but few engineers would be so optimistic as to expect an average load-factor of 23 throughout the year. Yet this is the figure actually obtained. On an ordinary day, November 28th, for instance, the load-

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factor was no less than 51 per cent., and this is of quite frequent occurrence. Doubtless, the maximum demand system has been largely instrumental in bringing about this pleasing state of affairs, but it must not be imagined that the system has been introduced and worked without trouble. The task of explaining its intricacies to a layman, who understands English thoroughly, is by no means an easy one, but when the same thing has to be done with imperfectly educated aliens the state of affairs can be better imagined than described.

As may be gathered from our article, the station is now fully loaded, the top load being 1,270kw., and extensions are to be commenced immediately, failing which it will be necessary to refuse further applications for connections. But in the near future it is proposed to build a large three-phase station on the river bank, and it is expected that the low average price of 2·75d. per unit sold for private lighting will be still further reduced. Great developments in dock and crane work along the 2½ miles of river frontage included in the Council's area are to be expected, and we shall watch the development of the scheme in this direction with considerable interest.

In connection with the recent calamity at Chicago it is interesting to learn that the origin of the fire is attributed to sparks from an arc lamp falling upon inflammable draperies, and hence, the opponents of electric lighting are arguing that if some other system had been employed the catastrophe would not have happened at all. But, as a matter of fact, if ordinary gas lime-lights had been used the result would have been precisely the same, and further, it is absolutely certain that if all the arc lamps at present employed in theatres were replaced by oxy-hydrogen limes the hazard would be increased tenfold. If the origin was really as has been alleged, then the fault was not due to the use of electricity, but to gross negligence, whereby it was possible for such inflammable material as drapery to get so close to a source of heat. It is further stated that the "explosion" was due to a large set piece, containing 150 incandescent electric lamps, falling on the stage.

It is not a usual occurrence that two business men, when reviewing the prospects of a commercial undertaking, should differ so much in their estimates, that, while one sees indications of a loss of £100,000 a year, the other foretells a profit. Still more remarkable is this when the accounts of the first four months' working of the undertaking are available, together with detailed statements of the capital expenditure, and expert opinion as to the working expenses and maintenance charges over a period of years. This has happened, however, in the case of the Pacific cable laid by the Government in 1902. Sir John Wolfe Barry has expressed it as his opinion, based upon official returns, that the result of the first year's working of the Pacific cable would be a deficit of £100,000. Sir Edward Sassoon, on the other hand, has advanced the opposite view to which we have alluded, and in support of it he cites a few figures, which, even if they might be taken to show that Sir John Wolfe Barry had over-estimated the loss by a few hundred pounds, certainly do not prove in any way that the Pacific cable will be a profitable undertaking. Sir John's statement is clear, however: The traffic receipts on the Pacific cable up to March 31, 1903 (a period rather less than four months) have been returned as £19,579—say, therefore, £60,000 per annum. The original official estimates provided for a capital of £1,800,000, and a yearly expenditure—including interest at 2½ per cent., sinking fund, working expenses, maintenance, &c.—of £155,000. As a matter of fact, the capital expenditure has been actually £2,000,000; adding 2½ per cent. of the £200,000 difference brings the yearly expenditure to £160,000; and £60,000 receipts less £160,000 expenditure equals £100,000 net loss—the sum estimated by Sir John Wolfe Barry. Another method of arriving at a similar figure is from an estimate made by the responsible manager of the Pacific cable, and published in *The Times* of November 18th, to the effect that, with a revenue of £73,400, there would be a loss of £92,100 for the year ending March 31, 1904. Moreover, it must be remembered that up to the present the cable has suffered no break. As there is no duplicate cable, each interruption will cause a considerable drop in the traffic receipts; and although the best engineering skill has been employed for the manufacture and laying of the cable, which is a fine piece of workmanship throughout, occasional faults are inseparable from a cable of such length.

In effect, the Pacific cable will be worked at a loss which will be made good by the Government, that is practically under a Government subsidy. "Surely it will not be disputed," Sir Edward Sassoon poetically remarks in *The Times*, "that one of the most potent means of bringing the far-sundered portions of our Empire into community of thought and idea, is the network of telegraph lines, almost purely British in its extent, which spans every ocean, and which enables nearly every British possession, however small or remote, to respond almost instantaneously to each pulse-beat from the heart of the Empire." By all means then let every British cable be subsidised, whether worked by a company or by the Pacific Cable Board. But the chairman of the company which may suffer by the competition of the Pacific cable has surely a right to complain, if the subsidy required to make good the loss on that cable is excessive and subjects his company to unfair competition.

Dr. W. M. Thornton's Paper on "Experiments on Eddy Currents" is a most valuable contribution to our knowledge regarding dynamo losses, for it touches upon some fine points in dynamo design which are often either not sufficiently taken into account or totally overlooked. It happens occasionally, in fact, that, owing to this neglect on the part of the dynamo designer, the losses due to eddy currents assume surprisingly large values. Many designers, lacking opportunity or inclination for carrying out the necessary experiments, have no clear conception of the magnitude that these currents may actually attain in different parts of commercial machines. From Dr. Thornton's investigations it can be concluded that the variations of the magnetic flux are of considerable extent, even in those solid parts of the machine which are comparatively distant from the disturbing effects of the armature; and in designing machines it might well be worth while to

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consider whether, in given cases, a more complete lamination of the magnetic path would not produce a machine, the increased cost of which would be more than set off by a superior efficiency and an increased output per unit weight. The value of laminating the pole-pieces of traction motors is made evident by Dr. THORNTON'S Paper. The load on a motor of this class is necessarily of a rapidly fluctuating nature, and since the eddy losses increase approximately with the square of the flux-density and the motor is series-wound, the loss from this cause alone may be considerable.

DR. THORNTON'S measurements regarding the increase in eddy-currents—and the consequent decrease in efficiency—with the increase in the cyclic irregularity of the driving engine are also of considerable value. As the author himself remarks, his figures represent extremes, and it need not be emphasised that in only isolated cases in this country will a single cylinder double-acting steam engine be the prime mover. Gas engines, too, are being built with more than one cylinder, and with suitable governing and adequate flywheels the newer patterns have a far more even turning moment than the older ones.

WE have occasionally been accused of unreasonable hostility to the London County Council and all its works, but if we have been sharply critical on some occasions it has not been without cause. It is true that the electrical industry has profited by the Council's having built electrical tramways, but the London tramways would certainly have been "electrified" whoever the owners. A Parliamentary return published yesterday shows how much money the London County Council has spent, not in promoting, but actually in impeding the progress of the electrical industry. During the 14 years from 1889 to 1902 (the figures for 1903 are not given) £78,500 has been spent by the Council in opposing Bills in Parliament, and of this £13,500 has been for opposing "tube" electric railways, £10,400 for opposing Bills relating to "electric lighting, gas, hydraulic power and telephones" (of which electric lighting is the most important item), £2,700 for opposition to tramway Bills, and several hundreds in opposition to Bills for the electrification of railways other than tubes. In 1901 and 1902 nearly £800 was expended on opposition to the Metropolitan District Railway, and £2,370 on opposing "London underground railways (generally)," in addition to items for each of the tube lines, aggregating several thousands; and in 1902 alone about £750 was wasted in opposing electric tramways, with the only result that a few hundred yards of one of the tramway schemes had to be abandoned by its promotors.

Technical Education.—The report of the Education Committee of the North-East Coast Institution of Engineers and Shipbuilders, reproduced in abridged form in our issue of December 25th last, was submitted to and approved by the general meeting of that institution at Newcastle on December 18th.

Electrical Smelting of Iron Ores.—The *Daily Telegraph* states that a commission has been appointed by the Canadian Government to go to Europe to inspect the various plants for the smelting of iron ores and the making of steel by the thermo-electric process. Our contemporary adds that there are five establishments in Europe where this process is commercially used, situated respectively in Paris, at St. Etienne, La Praz (France), Turin and Gysinge (Sweden).

Electro-Pneumatic Signalling.—It is announced that the Great Central Railway Co. has decided to adopt a low-pressure pneumatic system of signalling combined with an electric track circuit. A start will be made from Ardwick Junction, near Manchester, to Newton station, a distance of 6 miles on a very busy section of line.

A New Lighthouse.—The Berlin correspondent of the *Standard* states that a new lighthouse has been erected at Cape Arkona, on the island of Rügen, and that it has been fitted with rapidly-revolving electric lights. The new lighthouse stands about 30ft. higher than the old one, which was only provided with a fixed petroleum lamp of antiquated pattern. Power for the lamps of the new lighthouse is supplied by three small dynamos of 12 H.P. each.

Subway for Electric Cables.—According to the *Aberdeen Gazette*, a short subway from the Aberdeen electricity station at Dee Village is to be extended a distance of 687yds. The subway, built of concrete and lined with brickwork, and protected from damp by bituminous sheeting, is 6ft. 6in. high and 4ft. 6in. broad. It will contain at present 52 cables, used for street lighting and as tramway feeders, but more may be accommodated if required. These cables are to rest on cast-iron racks, spaced 6ft. apart. Two manholes, placed at suitable points in the foot path, give access to the subway. A disconnecting chamber will be constructed at both these points to facilitate a future extension. The subway will be ventilated by an electrically-driven fan, placed at one end. It is stated that the total cost is estimated at £9,800, and that the work will probably be completed by the end of May next.

Cable Interruptions.

	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Anjer—Kalianda	Aug. 2, 1902
Cayenne—Pinheiros	Aug. 13, 1902
St. Lucia—St. Vincent	Sept. 19, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
Paramaribo—Cayenne	Feb. 27, 1903
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Cape St. Jacques—Haiphong	Dec. 15, 1903
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903
St. Kitts—San Thomé	Dec. 22, 1903
St. Vincent—Grenada	Dec. 29, 1903

The cable between England and the Channel Islands is interrupted, and telegraphic messages are being sent by the mail boats from Southampton and Weymouth, or are being despatched via France at the increased tariff.

Obituary.—It is with deep regret that we record the death yesterday, by apoplectic stroke, of Dr. Friedrich von Hefner-Alteneck, one of Germany's most distinguished electrical engineers. Dr. von Hefner-Alteneck was born in 1845, and was, therefore, 58 years of age. At the age of 22 he entered the firm of Siemens and Halske, having previously received scientific training at the Zurich and Munich polytechnics, and worked his way up into the position of manager of the electrical engineering department, remaining with that firm until 1889. In 1872 he invented the drum armature, one of the most important developments in the design of dynamo-electric machinery. He also invented one of the first, if not the first, differential arc lamps, the transmission dynamometer which bears his name, and (in 1883) the famous "Hefner" amyl-acetate standard of light.

Failure of Turbo-generators at Portsmouth.—Two new 750kw. turbo-generators have been installed at the Portsmouth generating station, but are not yet out of the contractors' hands, although it appears that they have been running on load. Last Friday the armature on one of these machines became short-circuited, and shortly afterwards that of the other machine also broke down in a similar manner. To make matters worse, the armature of a third Parsons generator, which had been working satisfactorily since the end of 1902, also developed a short-circuit. A similar accident happened to the latter last December, but a new armature was put in and no further trouble was experienced until all three machines collapsed practically at the same time. Fortunately, there was no cessation of supply in any part of the district, but consumers were requested to use only 75 per cent. of their usual nnmber of lamps until the damage was repaired. A gang of

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men was despatched from Messrs. Parson's works at Newcastle and arriving in Portsmouth the same day, work upon the injured machines was commenced immediately.

Bath Electric Tramways.—As mentioned in our issue of January 1st, the Bath electric tramways were opened last week. There are 12½ miles of route, consisting of 9 miles of single and 3½ miles of double track. The rails are of the 95lb. girder type. The central trolley system is adopted, the trolley wire being of hard-drawn copper wire suspended mostly on side poles, with some span wires and rosettes. The feeders were supplied by the British Insulated and Helsby Cables and are of 0·6, 0·3, 0·25 and 0·2 sq. in. section, laid for the most part under the footpaths. They are laid on the solid system. The return is by the rails and four return feeders. There are 26 double-deck cars and four single deck. Hand and Newell magnetic track brakes are fitted. The schedule speed is 7 miles per hour. A special power house has been erected containing three Babcock and Wilcox boilers with a total evaporative capacity of 30,000lb. per hour; three Yates and Thom horizontal compound condensing engines, and one Westinghouse single-acting engine direct coupled to four Westinghouse compound generators, the aggregate capacity being 675kw. The average distance between stopping places on the line is 400 yds., the maximum gradient being 1 in 10, and the sharpest curve 35ft. There are numerous curves on all the routes, and the line is very hilly in places. As stated last week, the British Westinghouse Company had the contract for the power house and electrical equipment, and Mr. C. Chadwell that for the permanent way. Mr. W. D. Hardy is resident engineer, and Mr. R. D. McCarter manager. Messrs. Harper Bros. and Messrs. J. Hopkins & Son were the consulting engineers.

Electrical Contractors' Association.—At the meeting of this Association on Tuesday, a Paper was read by Mr. R. B. Johnson on "The Necessity for the Standardisation of Wiring Rules." He considered which of the already existing regulations would best meet the requirements of electrical contractors. On account of their diversity, the regulations issued by the various supply companies could not be considered, neither could those enforced by the fire insurance offices because of their ambiguity. But the rules of the Institution of Electrical Engineers, although based on broad principles and therefore applicable, as they stood, only to general cases, might, he thought, well form a basis for contractors to work upon. Rules for special cases might be framed by the Association and submitted to the Institution for inclusion in their rules or for approval. In the discussion which followed, these views were generally accepted, one speaker mentioning that he used at his office a rubber stamp with an inscription to the effect that the wiring had been carried out in accordance with the rules of the Institution of Electrical Engineers, and that, instead of filling in every detail of the sheets submitted to him by the insurance companies, he used this stamp, and had never experienced trouble on that account. Other speakers drew attention to the diversity of the regulations of the various supply companies regarding the relative positions of the meter, fuse and main switch; and the final outcome of the discussion was a proposal, which was accepted, to the effect that some standard rule concerning this particular point be drawn up and submitted to the authorities in question for consideration. The drafting of this is to be left to the president, and if he is no more energetic in the matter than the committee appointed by the same Association to consider the municipal "free wiring" question, it may be concluded that the matter will not be proceeded with.

The Bristol Fire.—At a meeting of the Bristol City Council last Friday, Alderman Pearson read a statement, prepared by Mr. H. Faraday Proctor, giving details relating to the recent unfortunate fire at the electricity works. He first moved the adoption of a report in which it was stated that the committee had entered into certain contracts, among them being one with Ferranti Limited for a new switchboard at the Temple Back station; the report was approved. He mentioned the names of those persons who had been of valuable service in the time of distress, and to whom the thanks of the Council were due. It appears that the offer of the Tramways Company to supply current could only be accepted for arc lighting, but by the aid of five lamps supplied from this source, the work of reconstruction in the engine room was commenced. The first feeder which supplied the current for printing the newspapers was switched on at 1:55 a.m. One of the largest of the power and arc lighting machines at the Temple Back station was dried out and got into working order soon afterwards, and while this was going on the arc lighting switchboards and the resistances in connection therewith received attention. The damage to the switchboards and resistances of the remainder being much more serious, they could not be got going before Thursday evening. According to the report, no individual can be blamed for the accident, since no operation was going on at the time of the occurrence. The hour being shortly after five o'clock, top load had been reached some time previously, consequently machines were neither being put on nor taken off. The charge engineers had just completed going round the whole of the fuses and ascertained that their temperature was normal, and the occurrence can, therefore, only be attributed to some actual weakness in a portion of the switchboard or cable work. The burn-out is too complete to say at which point the trouble actually arose, although the bulk of the damage undoubtedly arose from the switchboard. In connection with the switchboard, oil fuses as well as oil switches are used, and through these smashing one after another the oil was scattered about the place, and this, presumably, was the cause of the flames reaching to such a considerable height as to destroy the roof.

Generating Station Flooded.—During a flood the generating plant of the Cudahy Packing Co. at Kansas City, U.S.A., was completely submerged, but is now said to be running as well as ever, with no indications of the damp experiences it has passed through. The engines and boilers were naturally well adapted to withstand the effects of a soaking, and after the accumulations of mud and rust had been removed they were easily restored to running conditions. The generators, however, being less protected, required more rigorous treatment before they were ready to be operated. The plant is a comparatively modern one, having been installed but a little over three years ago. The engine room accommodates two large steam-driven ammonia compressors, used in connection with the refrigerating system, and two directly-connected units, each consisting of a horizontal engine and a continuous-current generator. One set has a capacity of 350kw., and the other is similar but smaller, having a capacity of 200kw. Starting on a level with the lower field coils on May 31st, the water rose very rapidly until it reached a height of about 12½ft. It remained at this level for 48 hours, and then fell very gradually, taking 10 days to reach the floor line. As the water subsided the engineer and his assistants made their way about the engine room on a raft, and with a force-pump washed the mud off from the exposed parts of the machinery. Finally, when it became possible to stand on the bottom with high rubber boots on, the mud, which was about 2½ft. deep on the floor, was removed from around the engines and generators and the washing process continued until the water level was well below the floor and the lowest parts of the machines. After the water and mud had been removed, housings of double thickness matched flooring were built over the generators and steam coils placed under them along the bottom at each side. They were then left for a week with live steam turned on day and night, after which, while still enclosed, the generators were slowly revolved for a time. The housings were then taken down, the generators thoroughly cleaned and the brush yokes and studs taken apart and brightened up, especially at all points of electrical contact. For the first trial the machines were brought up to full voltage very gradually and the load applied by degrees as different parts of the plant were started up. From the outset no difficulties of any sort were experienced, and the machines have been running satisfactorily ever since. Besides the generators, there were 22 motors, ranging in sizes from 1½ H.P. to 75 H.P., which were in the water for about the same period. These were either taken apart and carried to the engine room to be baked out in one of the housings there, or in the case of the larger sizes (two of 50 H.P. and one of 75 H.P.) were

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housed where they stood and treated in the same manner as the generators. These also are all running at the present time and doing their regular work, apparently none the worse for their recent drenching. Probably the most remarkable feature of all is that neither the generators nor motors have suffered even so much as an increase in their maximum heating temperatures or a loss of efficiency.

Design and Construction of the Electric Tramway Car.—A Paper on this subject was read by Mr. R. H. Simpson before the Rugby Engineering Society last night. In the course of his remarks, the author said that if rolling stock were not subjected to definite periodic inspections—the consumption of power increases some 25 per cent. (this has been deduced from actual experiment); it has therefore been found that generous maintenance pays best, besides, the exact state of the stock is then known, and it can be relied on accordingly. The type of car body most generally adopted in this country is the double decker, mounted on either a single four-wheel truck or on a pair of bogies; this type can be further amplified by changes in interior seating accommodation, the design of staircase or by the addition of vestibuled ends The single-deck car, which does not obtain such favour, is built in various types on both single and double trucks. In deciding the type and size of car, the first consideration is the gauge, and this should be the standard (4ft. 8½in.) if at all possible, so as to get the advantage of as great a carrying capacity as can be obtained. If possible, it is of advantage to obtain 9ft. 6in. between rail head and the kerb, to prevent standing traffic from stopping the service. The wheel base is dependent on the curves with single-truck cars, and is generally 6ft., and 4ft. for bogie trucks. The length of car is settled by the wheel base in the case of single-truck cars, and has devolved on a standard length of 16ft. over the body and 26ft. 6in. over platforms. Bogie cars should not be less than 22ft. over the body, which is also a standard length, otherwise the inner pair of wheels would practically touch one another and no advantage would be gained in carrying capacity by the extra length of body obtainable when supporting same on a pair of trucks. There should be at least 6ft. 4in. standing room on the top of car when passing under bridges, and if this cannot be obtained the road must be lowered; this is sometimes impossible, due to sewers, &c., and in this case the single-deck car must be resorted to, but it must be a last resort on account of its low carrying capacity. The total weight complete, ready for service, of a 16ft. body single-truck car is approximately 8½ tons, and of a 22ft. body bogie car 10½ tons. No pitch pine whatever should be permitted in the underframe. No countersunk-headed bolts are to be let into wood that may have to take an end strain, otherwise they will work loose. Collision fenders should extend far enough to protect projecting parts on the ends of the cars when butted together on the straight or on a curve. Platforms are now provided with a step on one side which folds up when not in use, so as not to strike a person when knocked down under the car before being caught by the pick-up guard. Trucks are designed in three types, viz.:—The single four-wheel truck, which does not swivel under the body; the maximum traction bogie; and the equal wheel bogie truck. The first mentioned is used under car bodies from 14ft. to 18ft. over the body, or from 24ft. 6in. to 28ft. 6in. over the platforms. The 16ft. body with reversed stairs should not have a truck under it with a less wheel base than 6ft., otherwise pitching will result. The maximum traction truck is so called by reason of it being arranged for about 75 per cent. of the load being taken by the driving wheels, the remaining two pony or trailing wheels being of smaller diameter— viz., 20in. or 22in.—so that they may clear the underframe of the car when the truck swings over, and at the same time allow of the car being carried lower. The shortest car that can be used with these trucks is 18ft. over body. The last type of truck has four equal wheels, and is generally used for four motor equipments, two motors per truck; this type can also be used as a maximum traction truck by shifting the bolster over from the centre towards one pair of wheels, if one motor per truck only is required. Truck side frames should be perfectly square one with the other and remain so in service, besides being well braced and stayed, otherwise the truck, and especially the wheel flanges, will suffer. Frames should consist of as few parts as possible, and all bolts provided with a locking device. The spring base must be long to ensure easy riding, and two types of springs preferably used—viz., elliptical between body and frame and coil between frame and axle boxes. The axle boxes should drop out of the horns without dismembering the truck and must ride easily in the guides. The brasses, which should easily be brought out at the front of the box, must be long and have ample lubrication as well as be dust-tight; a collar should be provided for taking up end thrust. The horns should have renewable wearing strips on one side at least. In England the diameter of the wheels is usually 30in., this dimension being a relic of horse traction, and an effort to keep the step as low as possible. With 30in. wheels there is a clearance between the motor and top of rail of about 2¾in., but this clearance is not maintained in the centre of the track, owing to the crowning of the paving. With chilled wheels it is not possible to wear them down to a less diameter than 28¾in. or 28¼in. on account of getting beneath the chill. With steel-tyred wheels the diameter should be greater as the tyres are 2½in. thick and allow a wear of 1½in. to 1¾in. radially; if a 30in. wheel is used the motor will be down on the track before the full life of the tyre has been obtained. The guaranteed life of a chilled iron wheel is 30,000 miles, but there are records of 40,000 and even close on 60,000 miles with these wheels. The weight of a 30in. chilled wheel is from 300lb. to 325lb. The guaranteed mileage of a steel-tyred wheel is usually 60,000 miles, but there are records up to 100,000 in some districts. The weight of a 31¾in. diameter steel-tyred wheel is 330lb. to 370lb. The motors are of the four-pole enclosed type, hung on the axle by two bearings, and from the truck by a bar supported by draw and recoil springs; the gearing is single reduction. The trolley earthing has generally been effected by connecting the non current-carrying part to earth through two 250-volt red lamps, which will, therefore, light up when a ground is on the standard, thus drawing the attention of the driver or conductor to the fact. A later method, much in favour by the Board of Trade, is to earth the standard direct through a switch which is closed by the blowing of a light fuse, a connection at the same time being made so that the battery current actuates the driver's bell, which again causes attention to be directed to the earth on the car.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, January 11th.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION.

7:30 p.m. Meeting at Storey's Gate. Paper to be read: "Electric Passenger Lifts," by S. H. Stevens.

TUESDAY, January 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "The Electrical Reconstruction of the South London Tramways on the Conduit System," by Alexander Millar.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street. Adjourned discussion on Prof. Baily's Paper, "The Education of an Electrical Engineer," and a demonstration by the British Westinghouse Company of the Cooper-Hewitt Mercury Vapour Lamp.

WEDNESDAY, January 13th.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. Meeting at the Royal Institution, Liverpool. Paper to be read: "Motor Vehicles," by W. Norris.

THURSDAY, January 14th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Adjourned discussion on Mr. P. V. McMahon's Paper, "The City and South London Railway: Working Results of the Three-wire System applied to Traction, &c." If time permits the following Paper will also be read: "On Magnetic Dispersion in Induction Motors and its Influence on the Design of these Machines," by Dr. Hans Behn-Eschenburg.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting at the Royal College of Science. Paper to be read: "Three-phase Working with Special Reference to the Dublin System," by W. Brew.

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3,000KW. TURBO-ALTERNATORS AND 1,400KW. DOUBLE-CURRENT GENERATOR FOR GLASGOW.

As advertised in our last issue, tenders have been invited by the Electricity Department of the Glasgow Corporation for two 3,000kw. turbo-alternators for their Port Dundas generating station, and a double-current generator of 1,400kw. capacity for the generating station at St. Andrew's Cross. The following particulars with regard to the plant that is required are not without interest:—

It is left to the option of the tenderer whether the steam turbines be vertical or horizontal, provided that they are arranged for direct coupling to the three-phase alternators. Superheated steam at a pressure of 190lb. per square inch and superheated to 550°F. will be supplied at the engine stop valve, and the engines are to run condensing with a 27½in. vacuum. Capacity to carry an overload of 25 per cent. for two hours and 50 per cent. for 30 minutes at normal speed is specified. The speed of the combination may be fixed by the makers, however, and is to be stated in the tender. Easy accessibility to the blades and bearings of the machine is made a point of. As the turbo-generators will be run in parallel with the existing reciprocating engines, an even turning moment is required, ¼ per cent. being the maximum permissible variation in angular velocity during a revolution under constant load. They are to govern within 1½ per cent. above and 1½ per cent below the normal speed, from no load to maximum overload; but the contractors are requested to state within what percentage they will guarantee to keep the speed constant, both as to momentary and permanent variation. A speeding gear is also to be fitted, and an emergency valve capable of being worked both automatically and by hand if from any cause the speed exceeds a prescribed limit. Forced lubrication is suggested, and strainers are to be provided to ensure the absence of dirt from the oil; the latter are to be removable to allow of cleaning while the turbines are in motion. Some satisfactory means of flushing the bearings before starting up is also required, and special precautions are to be taken to avoid air or oil being sucked through the shaft glands and so getting into the condensers. A preference is expressed for engine piping of lap-welded steel, excepting the cooling service pipes, which must be of copper. No copper pipes are to be used for high-pressure or high temperature steam work, however. Provision is to be made, by an adjustable collar thrust bearing, for adjustment of the working parts, and all the main shaft bearings must be water cooled.

No steam consumption is specified, but contractors are requested to state in their tender the steam consumption in pounds per kilowatt hour which they will guarantee at 25 per cent. overload, full load, three-quarter load, half load, and quarter load, both condensing and non-condensing. They are also asked what percentage they are willing to have deducted from the contract price for each 1 per cent. increase in the steam consumption beyond that specified. Each turbine is to have its own condenser, preferably situated beneath it, and both the circulating pump and the air pumps will be driven by shunt motors off the continuous-current 'bus bars.

The three-phase generators are to be of the revolving field type, generating 3,000kw. at 6,700 volts and 25 ∼ per second. At full load and 93 per cent. power-factor they are to be capable of running continuously for 36 hours, with a rise of temperature not exceeding 70 F. The overload specification has already been referred to in connection with the steam turbines. The load on them will consist of synchronous and asynchronous motor-generators and rotary converters running in sub-stations at varying distances from the works. The neutral point will not be earthed. Exciting current will be provided from the station 'bus bars at 520 volts, and the contractors are to specify, when tendering, the percentage loss in the field coils, and the percentage increase in exciting current required between full load at 93 per cent. power-factor and at unity power-factor. Cast-steel slip-rings and former-wound armature coils in micanite tubes are specified, and the whole of the high-tension winding is to be enclosed, so as to exclude danger of shock to the attendants. The inherent regulation is to be such that the rise in pressure does not exceed 8 per cent. when full load is thrown off. The following information is also to be supplied by the contractors in their tenders:—Dimensions of shaft, size of air-gap, nature of insulating material employed, current density in the armature and field windings at full load and 93 per cent. power-factor, efficiency at quarter load, half load, three-quarter load, full load and 25 per cent. overload (these figures to take account of the exciting current), and method of access to rotating parts for inspection and repair.

The double-current generator is to be capable of giving its total output of 1,400kw. from the alternating or from the continuous-current side, or part from each, and, if necessary, for 36 hours at a stretch. It will be excited from the station 'bus bars at 520 volts, and is to supply continuous current at from 520 to 600 volts, and three-phase alternating current at from 318 to 367 volts with a frequency of 25 ∼ per sec.

Its engine will be of the vertical enclosed pattern, either single or double-acting, and is to run at a speed of 187·5 revs. per min. It is also left to the contractor as to whether he will specify a compound or triple expansion engine, but the engine is to have three cranks in either case. Steam at 190lb. per square inch superheated to 500°F. will be employed. The armature of the generator may serve at the same time as flywheel, but a separate flywheel is preferred, so connected with the armature that in the event of a short-circuit occurring there shall be no extra strain brought upon the shaft, tending to shear it off. The size and weight of the flywheel must be such that the angular velocity does not vary by more than ¼ per cent. during a revolution at constant load, as it is intended that this set shall run in parallel with steam turbines in another station, and also with the reciprocating engines already installed. The engine is to govern within 1½ per cent. from full to no load, and the contractors are asked to specify in their tender what percentage they will guarantee to keep the speed constant both as to momentary and permanent variation. The governor is to be fitted with a speeding gear by means of which the speed can be varied to the extent of 10 per cent. whilst running, and there is also to be an emergency valve capable of being worked both automatically and by hand, if from any cause the speed exceeds a prescribed limit. The cylinders are to be so proportioned that the engine gives its most economical load at 2,200 H.P. when running on a Körting ejector condenser, with a vacuum of 22in. of mercury. It must, however, be capable of giving 3,000 I.H.P., though at a sacrifice of economy, for two hours at a stretch. Arrangements are also to be provided to enable the engine to be run satisfactorily non-condensing. The steam parts of the engine are to be lubricated by means of Rochester piston lubricators, with separate sight feeds for each of the separate valve chests or other important parts. Special precautions are to be taken to avoid oil being sucked into the low-pressure cylinders from the piston rods, &c., and the same rule is given as to engine piping as that in the tender for steam turbines above. Contractors are asked to give in their tender the steam consumptions per indicated horse-power and the efficiencies which they will guarantee at overload, full load, three-quarter load, half load, and quarter load, both condensing (22in. vacuum) and non-condensing.

The normal output of the generator has been stated above. As regards its overload output, it is to be capable of giving the maximum overload output of the engine at 520 or 600 volts continuous or from the alternating-current side for two hours without undue heating. The alternating-current load will be rotaries and synchronous and asynchronous motor-generators in sub-stations. The neutral point will not be earthed.

The contractors are to state the loss in the field coils and rheostat at full alternating-current load (93 per cent. power-factor) as a percentage of the full-load output of the generator, and must also specify the percentage increase in pressure when full non-inductive load is thrown off the alternating-current side, the field current and speed remaining constant; also the percentage increase in field current required when the generator is delivering normal full load at 93 per cent. power-factor over that required when delivering normal full output to a

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non-inductive load. Equalising rings are to be fitted on the machine. The commutator bars are to be insulated with mica, and to have sufficient depth to allow at least one radial inch of wear without renewing.

Both armature and magnet coils are to be former-wound. The temperature at any part of the dynamo must not exceed 70°F. rise above that of the surrounding atmosphere after a run of 36 hours at full load. Contractors are requested to state what percentage drop in voltage they will undertake not to exceed during a 36 hours' run at full continuous-current load, the terminal pressure being 600 volts, with the speed and shunt resistance remaining unaltered during this time; and they are also to give the following information:—Dimensions of shaft; insulating material used in armature and field windings; current density in the armature and field windings at normal full load (93 per cent. power-factor, alternating-current voltage 367); efficiencies as direct-current generator at quarter load, half load, three-quarter load, full load and maximum overload; efficiencies as alternator at the same loads; method of access to rotating parts for inspection and repair.

A set of three oil-cooled 500kw. transformers are also required. They are to be used in a three-phase system for transforming the energy from 320 volts per phase on the primary to 6,500 volts per phase on the secondary. They must be capable of carrying the maximum overload output of the generator for two hours without undue heating. An induction regulator of approved construction is to be installed on the secondary sides of the transformers to allow of pressure regulation from 6,500 to 7,000 volts independently of the exciting circuit of the generator, the hand-wheel or switch of the induction regulator being brought to a convenient position on the switchboard gallery. The contractors are to state the maximum percentage drop in voltage at no load and full non-inductive load. A test at 15,000 volts for five minutes is to be made between primary and secondary windings and between the primary winding and case. The temperature of any part of the transformers is not to exceed 70°F. above that of the surrounding atmosphere after a run of 36 hours at the ordinary full load.

The contractors are also to give the following additional particulars when tendering:—Thickness and magnetic properties of material used in core; insulating material used; current density in the primary and secondary windings; efficiencies at: Quarter load, half load, three-quarter load, full load, maximum overload; open circuit loss in watts.

STEPNEY BOROUGH COUNCIL ELECTRICITY WORKS.

The provisional order for the original undertaking was obtained by the Whitechapel Board of Works in 1892, but nothing was done towards carrying the order into effect until 1899, when Mr. Arthur Wright was instructed to prepare a scheme and draw out the necessary specifications. At that time the area was confined solely to the district of Whitechapel, but in 1900 provisional orders were obtained authorising the undertaking to supply in Limehouse, Mile End and St. George's. On the conversion of the various "vestries" to Metropolitan Borough Councils, the control of the undertaking passed from the hands of the Whitechapel District Board of Works into those of the Stepney Borough Council. Up to March 31, 1903, sanction had been obtained to borrow £213,774, but only £136,950 had actually been borrowed, so that there still remains £76,824 available, and this amount the Council intends to take up almost immediately, in order to carry out further extensions, which are now urgently needed.

At Easter, in 1899, Mr. Wm. C. P. Tapper, who had a considerable share in getting out the details of the scheme under Mr. Wright, was appointed resident engineer, and the laying of the cables was commenced immediately. At the same time, steps were taken to instal temporary plant, and by December 16th of the same year supply was commenced. Thus, in less than nine months from the opening of the ground for the first cables, the system was in actual operation, and this may, therefore, be very properly considered a record, at any rate for Great Britain. The temporary plant consisted of two Babcock and Wilcox boilers and one 200 H.P. Willans engine directly connected to two 60kw. Mather and Platt dynamos, the armatures of which were coupled together on one shaft, and connected in series to supply on the three-wire system. Regulation was assisted by a Tudor battery of 260 cells, which at first was sufficient for the night and part of the day load. The load curve increased very rapidly, however, and it was found necessary to put in a second set consisting of a Willans engine directly coupled to a 480-volt 275kw. Mather and Platt generator. With this increment the temporary engine room, in reality little more than a shed, could accommodate no more plant of any description, and it therefore became necessary to erect a galvanised iron structure. At this period the building operations for the new station adjoining were in progress, and the foundations of the old premises had to be more or less undermined so that excavations for the new coal bunkers could be made. Struts were employed to prevent the temporary buildings collapsing, but it was known that the situation was not unattended by danger, and these suspicions were amply confirmed by subsequent events. Meanwhile, another temporary set of 275kw. was installed, and actually continued to run for several months under a partial covering of galvanised iron and tarpaulin. This state of affairs existed until April, 1901, when the temporary station collapsed entirely and fell into the excavations for the new coal bunkers. Fortunately, some plant had been got into the new building, and although there was a total shut down, only two hours elapsed before the network was once more alive. The accident occurred at daylight, and very few consumers were aware that anything untoward had happened. No steam was available from the station boilers at the time, but that from the refuse destructor was employed, as had been done since the plant commenced running. No lives were lost nor was any person injured, but considerable inconvenience was caused in many ways. Balancing was quite out of the question, and the voltmeter on the temporary switchbourd had to be read at a distance of about 20ft. with a chasm 30ft. in depth intervening. It is little short of extraordinary that under such conditions as have been described above only one cessation of supply for two daylight hours has taken place in a period of over four years.

The refuse destructor is by Messrs. Manlove, Alliott & Co, and the boilers by Messrs. Babcock and Wilcox, who also supplied the four water-tube boilers in the new station. These latter have an evaporative capacity of 11,000lb. of steam per hour each, and work at a pressure of 200lb. per square inch. The new station is situated between Osborn-street and George-yard, and the offices face Osborn-street. Coal is brought in carts from the railway, Welsh smokeless at 20s. 11d. per ton being used. It is tipped into bunkers below the ground level, gravitates to the firing floor below water level, and is then fed by hand to the boiler furnaces. Water, obtained from the mains of the East London Water Co., is first softened in two large tanks by the Archbutt-Deeley process, and, after being heated by passing through a Row indented tube feed-water heater, capable of raising 48,000lb. of water per hour through 100°F. by an equal weight of exhaust steam, is passed into the boilers by two Weir feed pumps, one having a capacity of 2,000 gallons and the other 10,000 gallons per hour. Each boiler is also fitted with an injector as stand-by. Additional water-softening plant of the Reisert pattern, manufactured by Messrs. Royle, is now being installed. It will be capable of softening 2,000 gallons per hour, from 20 to 3deg. This plant will be working almost continuously, and softened water will be stored in tanks having a capacity of 50,000 gallons. Economisers are to be employed after further extensions are completed. In the steam pipe duct are two 7in. steel mains fitted with lap-welded flanges. One of these mains conveys steam from the refuse destructor and the other from the works boilers. It is possible to put any of the engines, except the 800 H.P. one, on to either destructor or works steam, but the steam is never mixed. It is owing to the fact that the destructor is unable to supply more than sufficient steam for 400 H.P. that the 800 H.P. engine has not been connected to the destructor steam main. All the pipe work was carried out by Messrs. Babcock and

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Wilcox. In the boiler house are two centrifugal pumps which keep water out of the stokehole. One of these is by Messrs. Gwynne and is driven by a Phœnix motor, and the other set is by Messrs. Mather and Platt. The latter is rated at 10 H.P. and is capable of lifting 100 gallons of water per minute through a height of 180ft. The water so pumped is stored in tanks on the roof and used for engine-cooling purposes.

The new engine room is a lofty and well-designed structure measuring 70ft. in length, 40ft. in width and 36ft. to the eaves.

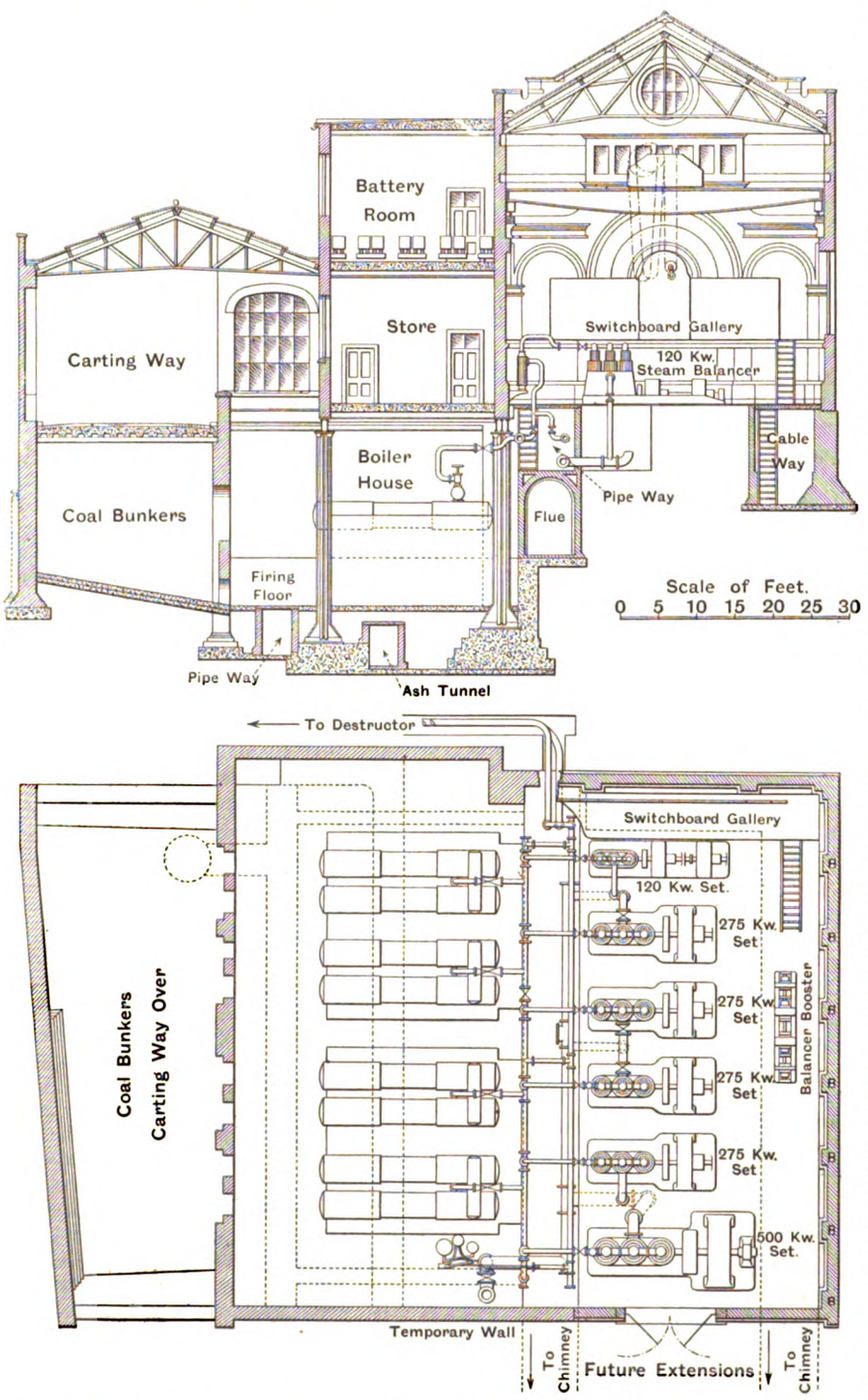

FIG. 1.—CROSS SECTION AND PLAN OF GENERATING STATION SHOWING GENERAL ARRANGEMENT OF PLANT, &C.

A 20-ton hand-driven travelling crane, built by the Chatteris Engineering Co., runs throughout its length, at a height of 25ft. The building itself is built up of steel framework, bricked in, and the floor is tiled. The wooden roof is well glazed and supported by iron principals. As may be seen from the drawings of the station, which we reproduce, there is a capacious cable subway under one side of the engine room and a pipe way under the other. The present generating plant consists of the small steam balancer formerly in the temporary station, four 275kw. Willans-Mather and Platt sets, the generators of which are four-pole and run at 350 revs. per min., and one 500kw. Willans-Dick, Kerr six-pole set running at 270 revs. per min. It will be seen from the plan of the engine room that there is now no more room for fresh plant, and as the station is already fully loaded, an interesting problem presents itself. However, the end wall is to be pulled down at once, and additional plant installed. In the engine room there is also a combined balancer booster, consisting of four machines all coupled together in tandem on one bed-plate. Two of the machines, each of 30kw. capacity, act as a balancer on the three-wire system, and at the same time drive the battery booster, regulation being effected by hand on the switchboard. The regulating resistances for the main generator fields are mounted upon the yokes of the machines themselves, and much complication on the switchboard is thereby avoided.

The exhaust steam main is of steel, and has a diameter of 20in. It is taken through the feed-water heater previously described, but by means of a by-pass this operation may be omitted if desired. A vertical exhaust pipe 44ft. above the roof carries the steam to the atmosphere, no condensing plant being installed. At first considerable trouble was experienced with this atmospheric exhaust, owing to condensation of the steam and consequent perpetual artificial rain. When it threatened to involve the Council in legal proceedings, steps were taken to provide a remedy, and this was found in a Sturtevant exhaust head, which, we are informed, has proved very effectual, and now the rain has ceased.

One of the most admirable features of the station is the arrangement of the switchboard, which is simplicity itself, and there is no sign of the familiar forest of wires which one is accustomed to see at the rear of the average switchboard. Where possible, all connections are quite permanent, and the few loose insulated wires are all labelled. Small conductors, such as voltmeter leads, are all enclosed in screwed steel barrel, from which they emerge through circular junction boxes fixed at convenient points. The board itself was built by the Edison and Swan Company, and is divided into two sections, one of which is situated on a spacious gallery at the end of the engine room and the other immediately underneath, on the ground floor. It is built up of 2in. slate panels carried by angle irons, and that portion on the gallery is divided vertically into three, the positive being on the right, the negative on the left and the neutral in the middle. The positive and negative panels are each provided with four main 'bus bars, as shown in Fig. 2. By means of short bars at right angles to these, and suitable plugs and sockets, any feeder can be plugged on to any 'bus bar. Similarly, separate 'bus bars may be employed for separate generators, or they may all be plugged together. This arrangement permits of feeders which supply distant points being raised to a higher potential than those supplying points close to the station. The dynamo cables come up through the gallery floor to the back of the board and are connected to their respective panels, but the feeder cables are carried upward and over the intervening space of about 4ft. to the wall of the building and thence to the cable subway. Thus, dynamo and feeder cables never

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come into contact, and until the latter enter the street all positives are kept on one side of the subway and all negatives on the other, the neutrals being suspended from the roof. The subway itself is perfectly straight and the cables are supported by iron racks. In one cable of each dynamo there is a Cowan non-return cut-out and an Aron wattmeter and on the other a main switch and an ammeter. The field switch is interlocked with the main switch in the usual manner and the field magnets may be excited at any voltage from 480 to 530, depending upon the voltage of the 'bus bar from which exciting current is obtained. There are eleven feeders in all, each of which is provided with a knife switch and ammeter.

Referring to Fig. 2, it will be seen that there are two smaller 'bus bars immediately under the main 'bus bars, the top one supplying the exciting current, and the lower one is called the "discharging" bar. Instead of employing a separate coil for each dynamo for damping the rises of potential due to self-induction obtained when breaking the field, only two coils are used for all the machines in the station. According to the direction in which the fields are wound, they are connected up as shown in the diagram, and the result is a considerable simplification and reduction in the number of switchboard connections. On the neutral panel of the board are three voltmeters for indicating 'bus bar and feeding point voltages, and a multi-way switch is mounted on the gallery rail in front of this panel. The gallery floor is of glass.

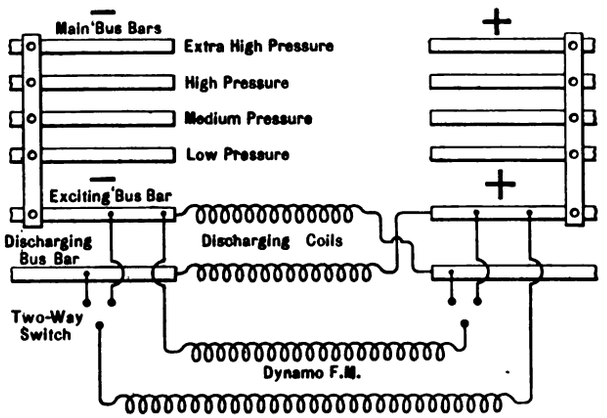

FIG. 2.

Of the distributing network there is not much to say, as it is very much on standard lines. The original installation of single cables, paper-insulated and lead-covered, was carried out by the British Insulated Wire Co. These cables were laid solid with pitch and granite siftings in earthenware troughing, and did not extend beyond the old Whitechapel area. Since the acquisition of the new orders, a three-phase high-tension three-core cable of 0·15 sq. in. section, by the St. Helens Cable Co., has been laid down the Mile End-road. It is about 2 miles in length, and is at present used as a low-tension feeder; after being laid it was successfully tested with 20,000 volts. A similar cable by the British Insulated and Helsby Cables (Ltd.) has also been laid in the Commercial-road. Both cables are paper-insulated, and the latter was successfully tested to 10,000 volts. Henley distributing mains and St. Helens and British Insulated single feeders and triple concentric distributors have been laid at various times throughout the district. Five glazed brick underground chambers, measuring 6ft. across by 9ft. or 10ft. in depth were built at different points in the original area. These were equipped with slate panels by the Edison and Swan Company, and were used as feeding points. Owing, however, to their excessive prime cost and the difficulty of keeping moisture out, it has been decided to build no more, but to employ distributing boxes sunk in the footpath. These boxes are only one-fifth of the price of the chambers, and there is no difficulty in keeping them dry. They are manufactured by the Reason Company. Another box, also manufactured by the same firm, is used for triple-concentric cables. Fig. 3 shows a plan and section of this box. Trouble is frequently experienced by distributing engineers owing to the blowing of a fuse in such a box, causing one or both of the other fuses to go, and in order to prevent these occurrences Mr. Tapper has decided to place a "cap" over each fuse. The cap consists of a box of insulating material having neither lid nor bottom. On the blowing of a fuse, the resulting arc is confined to that fuse, and the device effectually prevents damage to either of the other fuses. It will be seen from the section of the box across EF that the bosses, through which the concentric cable runs, do not possess flanges as might be imagined from the other views given, but that four teeth project from the outer edge of each. The wires of the outer and middle conductors are wound and sweated on the outside of the bosses, and the teeth prevent them from coming off. The inner conductor is sweated into the thimble provided for it in the third terminal, in the usual manner.

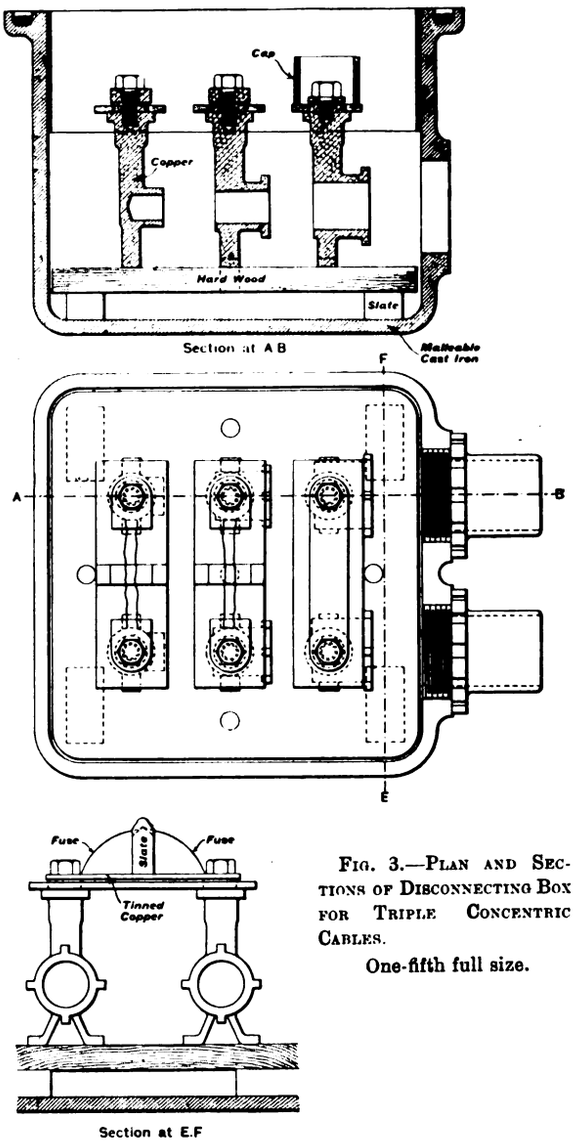

FIG. 3.—PLAN AND SECTIONS OF DISCONNECTING BOX FOR TRIPLE CONCENTRIC CABLES.

One-fifth full size.

The public arc lamps, by Messrs. Crompton & Co. and the New Century Arc Lamp Co., are supplied at the same rate as private consumers—viz., 8d. per unit for the first hour of maximum demand per day and 1d. afterwards, and, owing to the long-hour consumption, the average price works out at 1·6d. per unit. Nernst lamps are employed in station and office lighting. Reason electrolytic and ordinary wattmeters are installed in consumers' houses, and the Wright maximum demand indicator and time switch are also employed. A test room is being fitted up above the offices, one of the first instruments of accuracy obtained being a very fine Elliott potentiometer complete with shunts, &c.

We have to express our thanks to Mr. Wm. C. P. Tapper, chief engineer and manager, for his courtesy in conducting us round the works and giving us the necessary information for this description.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 403.)

Rate of Decay of the Thorium Emanation.—If the emanation is blown away from the thorium by a blast of air into a metal cylinder, which can be closed air-tight, provided with a central insulated wire, the duration of its radio-activity can be investigated by measuring the ionisation current between the central wire and the cylinder, after the air stream is stopped and the cylinder closed. In this way Rutherford showed that the radio-activity of the emanation after separation from the thorium compound decays in a geometrical progression with the time, and falls to half-value in about one minute. This is expressed by the equation (p. 378) $I_t\ I_0 = e^{-\lambda t}$, in which the radio-active constant λ has a value of $1/86$, or $1{\cdot}16 \times 10^{-2}$. In 10 minutes after the removal of the emanation from the thorium the radio-activity falls to one-thousandth of its original value, a quantity generally too small to be detected.

A convenient apparatus for the study of the thorium emanation is shown in Fig. 26. A known weight of the thorium compound to be tested is placed in C, and a steady current of air from a gas bag passed over it. The cotton wool in D removes from the air the ions caused by the action of the direct radiation. The emanation passes through the plug and causes the ionisation in the cylinder. With a uranium compound in C no current would be observed with this apparatus, for all the ions present in the gas would be removed on passing through D. With 10 grammes of ordinary thorium oxide in C,

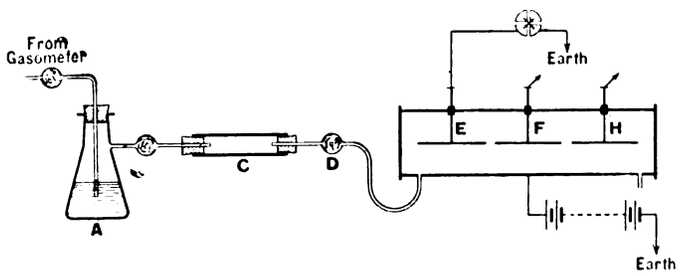

Fig. 26.

and a fairly rapid stream of air, a current between 10^{-10} and 10^{-11} ampere passes between the cylinder and the electrodes. The central electrode is divided into three separate parts, E, F, H, for the purpose of determining therate of decay of the emanation. If the velocity of the gas stream is known, the ionisation currents respectively measured by connecting the three electrodes successively with the electrometer will afford a measure of the decay of activity suffered by the emanation in the time taken for the gas stream to pass from E to F and from F to H. If the gas stream is kept constant, the rates of decay of the activity of the emanations from different compounds of thorium, and from the preparations of thorium X, can be compared together. It is found that the rate of decay, and therefore the radio-active constant λ, is the same in all cases, although, as we shall see later, the "emanating power," or amount of emanation produced per second by a definite weight of thorium compound, varies very widely for different substances and with different chemical and physical conditions.

The thorium emanation was the first type of matter possessing temporary radio-activity to be recognised, and its nature had been studied pretty completely before thorium X was discovered. In this work (Rutherford and Soddy, *Phil. Mag.*, 1902, VI., 4, p. 569), the conclusion was drawn that it was a specific type of radio-active matter of a gaseous character in infinitesimal quantity. The latter presents no drawback, for its radio-activity affords adequate and convenient methods for its experimental study. Various experiments were performed on the action of temperature and chemical re-agents on the emanation. The general result showed that it was completely unaffected by any of the means employed. It is not altered by passage through a tube of platinum raised to the temperature of bright white heat. It may be bubbled unchanged through any acid or reagent. It is not absorbed by passing through red-hot lead chromate, magnesium powder, zinc dust, &c., and in this respect it shows the same chemical inertness as the members of the argon family of gases. The latter and the emanations of thorium and radium are the only known gases which resist absorption by these reagents. The apparatus employed in these experiments was that already described (Fig. 26), the tubes containing the reagents used being placed in the gas stream between D and the testing cylinder. A steady stream of gas was maintained and the ionisation current measured with the tubes hot and cold. Since the value of the ionisation current was not altered by this treatment, it not only proves that the emanation is not absorbed, but also that the rate of decay of the activity of the emanation is the same throughout and is not affected either by temperature or by chemical reagents.

Some experiments were performed by the author with a view to determine if the presence of the air were necessary for the production of the emanation by thorium. An apparatus for producing hydrogen and oxygen by the electrolysis of dilute sulphuric acid was constructed, and the gas passed over a thorium compound. All the joints were of sealed glass, so that there was no possibility of air leaking into the apparatus. Over a thousand litres of hydrogen were passed over the thorium compound, without opening the apparatus to the air, in an uninterrupted stream lasting for three months. At the end of this period the amount of emanation carried over by the gas stream was no less than at the beginning. Hence there is no escape from the conclusion that the emanation is a specific type of matter of a new kind derived from the element thorium, and is not, for example, one of the inert constituents of the atmosphere rendered radio active by contact with thorium. This conclusion was confirmed by an investigation of the behaviour of the emanations of thorium and radium at the low temperatures attainable by the use of liquid air (Rutherford and Soddy, *Phil. Mag.*, 1903, VI., 5, p. 561). It was found that the emanations of both thorium and radium were completely condensed if passed through a tube cooled with liquid air. The gas stream used to convey it passes on completely freed from the emanation. If the tube is allowed to warm up, the condensed emanation again volatilises unchanged.

Now the experiments already recorded on thorium X show that the emanation is not produced by thorium directly, for when freed from thorium X the thorium possesses no emanating power at all at first, but gradually recovers it. The thorium X, on the other hand, possesses the full emanating power of the original substance from which it was separated, and gradually loses its power as the thorium recovers it.

Without, at the present stage, considering more fully the nature of these phenomena, a simple explanation may be developed on the lines laid down in the discussion of thorium X. It is clear that just as thorium X must be considered as the product of the radio-active change of thorium, so the emanation in turn must be regarded as the product of a second change of a similar kind suffered by thorium X. A chemical separation is necessary to effect the removal of thorium X from thorium, because both types of matter are non-volatile. But to remove the emanation no such operation is needed, because in this case the matter is gaseous in character, and separates itself from the matter producing it by ordinary gaseous diffusion.

Imparted Radio-activity.—The most remarkable property of the emanation is its power to impart temporary radio-activity of a specific kind to solid bodies with which it comes into contact (Rutherford, *Phil. Mag.*, 1900, V., 49, p. 161).

If a thorium compound is kept in a closed vessel for several hours, so that the emanation is retained and prevented from diffusing away, it is found that the interior of the vessel after removal of the thorium, is itself strongly radio-active. The character of the rays from this imparted radio-activity is distinct from that of the thorium itself, being more penetrating (compare Fig. 18, p. 296). The decay of this imparted radio-

* These articles are based on a series of 12 lectures which Mr. Soddy is now delivering at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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activity follows the usual law, decreasing in a G. P. with the time, and reaches half-value after 11 hours. λ, the radio-active constant for this case is, therefore, $1{\cdot}7 \times 10^{-5}$. All objects become radio active in this manner independent of their nature, and the imparted radio-activity is of the same character. Moreover, if the surface of the body made active is scrubbed with sand paper, the activity is to a large extent removed and transferred to the sandpaper. Rutherford found that certain acids were capable of dissolving off the matter causing the radio-activity from a platinum wire rendered active by the thorium emanation. Hydrochloric acid and sulphuric acid especially possessed this power, whereas nitric acid and alkalies showed very little effect. The activity of the matter removed is in no case destroyed. Thus, if the hydrochloric acid used be evaporated in a platinum dish, the activity removed from the wire is left behind on the dish after the evaporation of the acid. By evaporating aliquot portions of the acid at definite intervals of time, Rutherford proved that the activity of the matter causing the phenomenon decayed at the same rate when dissolved in the acid as it does when kept on the wire on which it was originally deposited. An interesting feature experimentally distinguishing the type of active matter causing the imparted radio-activity of thorium from the other types produced by this element is that it carries a positive charge and travels in the electric field to the negative electrode. In this way it is possible to concentrate the whole of the imparted activity on a fine wire, so that the latter is, weight for weight, many hundred times more active than the original thorium compound. The action of the field does not in any way affect the total amount of radio-activity imparted by the emanation, but merely alters the distribution. For a fuller consideration of this phenomenon, see Rutherford, *Phil. Mag.*, 1903, VI., 5, p. 95.

The interpretation of the foregoing facts follows without difficulty on the explanation adopted in the other cases. The deposition of a film of matter by the emanation on solids, the imparted matter again possessing a specific kind of temporary radio-activity, obviously points to a third radio-active change, the gaseous emanation changing in turn into a non-volatile type of matter which settles down out of the gas upon whatever provides it a resting-place. Being positively charged at the moment of production, it will move in a field and be directed to the negative electrode exclusively. The possession of this charge, no doubt, assists its deposition, even when no field is acting, by causing it to be attracted to uncharged objects.

Analysis of the radio-activity of the element thorium has thus shown that it is made up of at least four parts, due to four specifically distinct types of matter—the parent thorium and three new types continuously being produced from it by successive change—

Thorium
↓
Thorium X
↓
Emanation
↓
Matter causing the imparted radio-activity.

It must be admitted that a series of changes of this kind would be extremely remarkable if they were considered to be due to ordinary molecular or chemical change. The absolute dissimilarity of the successive products in chemical and physical nature, the matter in question passing from a non-volatile state to the gaseous condition and again back into the non volatile form, is, however, what is to be expected of a sub-atomic transformation. If radio-active change consisted in the successive degradations of a heavy atom into lighter ones, unless it happened that all the products were members of the same family of elements in the periodic table, it is to be expected that the successive elements resulting would exhibit the widest variation in their nature. The fact that some families of elements increase in volatility with increasing atomic mass (for example, the series lithium caesium, magnesium-mercury), while others (oxygen tellurium, fluorine-iodine) follow the opposite course, together with the existence of very light elements which are extremely non volatile—for example, carbon and silicon—shows that nothing can be predicted of the physical nature of the products resulting from the break-up of a heavy atom unless they chance to belong to the same family in the periodic table.

(To be continued.)

CONDUCTIVITY OF MERCURY VAPOUR.

BY PETER COOPER HEWITT.

The electrical conductivity of gases and vapours and its relation to the conditions under which the electrical current is maintained has occupied my attention for many years. A large number of experimental data accumulated during the progress of my work, which, when properly arranged and co-ordinated, furnish a theory of electrical conduction through gases which seems to account satifactorily for the phenomena observed. It was thought desirable to perform additional experiments for the purpose of obtaining exact quantitative measurements upon some particular gas, and for this purpose mercury vapour was selected. The results of these experiments are given in the following brief summary. I was fortunate to secure, during the progress of this work, the assistance of Dr. A. P. Wills, who expects to publish in the near future a detailed account of the methods and apparatus employed in this experimental study.

A gas or vapour forming part of an electric circuit exhibits three distinct sources of electrical reactions—namely, one at the junction

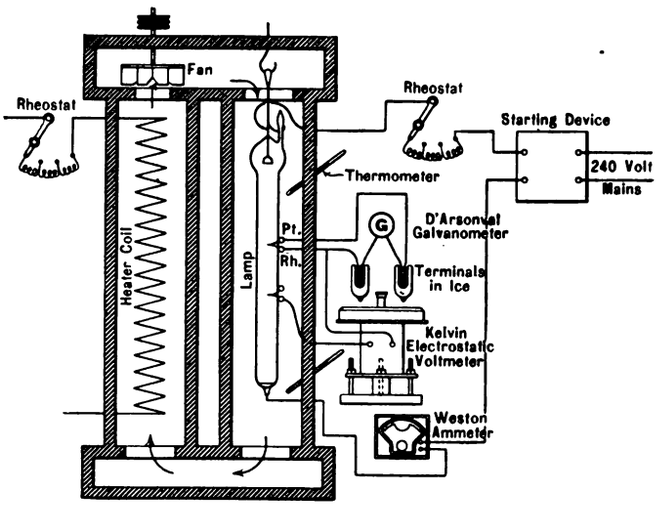

FIG. 1.—Diagram of Measuring Apparatus.

of the positive electrode of the conductor with the gas or vapour, one in the gas or vapour uninfluenced by the electrode effects, and one at the junction of the gas or vapour with the negative electrode. Difficulty was experienced in obtaining electrical measurements upon the conducting gas or vapour independent of these electrode effects; the measuring instruments require the use of terminals or electrodes in contact with the gas or vapour with the electrode resistances accompanying them; difficulty was also met with in obtaining the gas or vapour in a state of purity. The results given in the diagrams are not vitiated by terminal or electrode effects. The measurements were taken in such a way as to be subject to but little variation from the effects of the current during the time of observation.

Fig. 1 is a diagrammatic view of the apparatus. Two upright chambers of insulating material were connected together at the top and bottom, thus forming one continuous air chamber. One chamber contained an electric heating coil, the current supply of which could be regulated externally; a centrifugal fan over this chamber produced a rapid circulation of the air contained by the two chambers for the purpose of bringing the whole to a uniform temperature, which was regulated by the heating coil. In the other chamber was placed the vessel containing the gas or vapour marked "lamp" with the necessary electric connections. Thermometers were inserted at both ends, as shown, for determining the external temperature. Two platinum-rhodium couples were sealed in the walls of the lamp at a measured distance apart, and extended to the centre. The external terminals of the couples were immersed in ice and connected to a d'Arsonval galvanometer. The internal temperature was measured by means of these couples by observing the deflection of the galvanometer. It was possible to ascertain accurately when the internal and the external temperatures were the same. The drop

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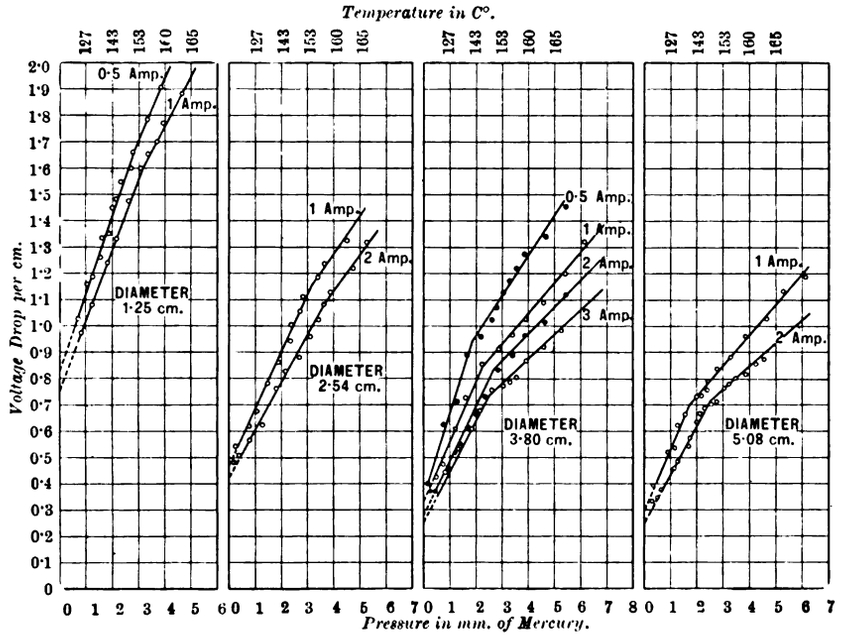
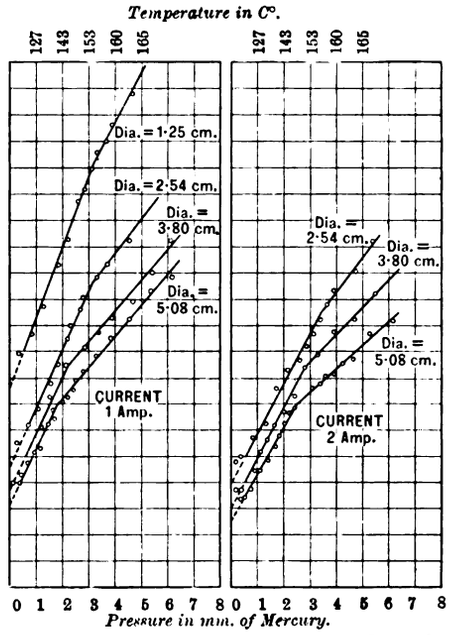
in volts between the platinum-rhodium points was taken by a Kelvin electrostatic voltmeter; the couples thus served a double purpose. It was possible to obtain voltage measurements at the temperatures desired. When a required temperature was obtained internally and externally, the current was started through the lamp by the starting device, and was controlled by an external resistance and measured by a Weston ammeter. Immediately after starting the current the reading of the Kelvin voltmeter was taken. There was sufficient time to obtain these readings accurately before the current materially altered the vapour density.

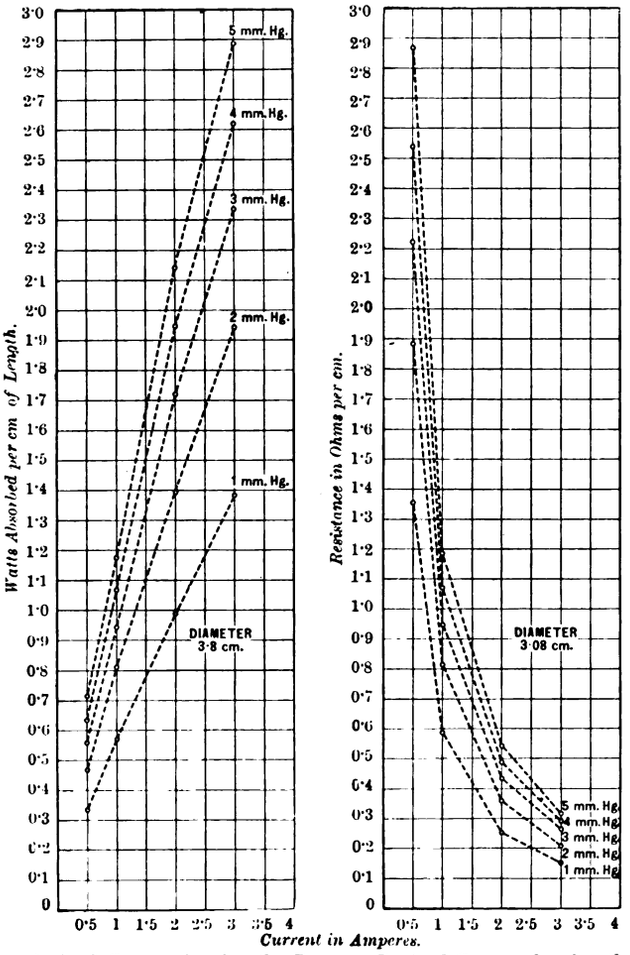
The lamps contained some mercury, and were exhausted with great care until nothing but mercury and its vapour were present. The size of the tube used for the lamp limited the diameter of the conducting vapour column, and its diameter is the diameter given in the diagram. The relation of the pressure of the saturated vapour to the temperature was deducted from the observations of Ramsay and Young; the density is proportional to the pressure.



Diagrams showing the Relation of Drop in Volts per cm. of Length to the Pressure in mm. of Mercury for Different Currents in Lamps of given Diameter.

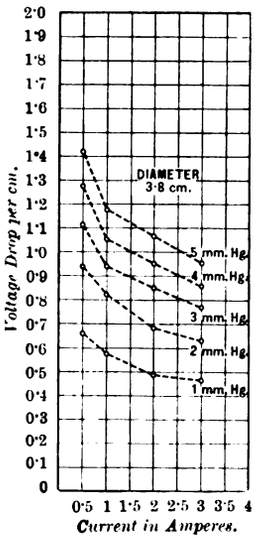


Diagrams showing the Relation of Drop in Volts per cm. of Length to the Pressure in mm. of Mercury for Lamps of Different Diameters at Constant Current.

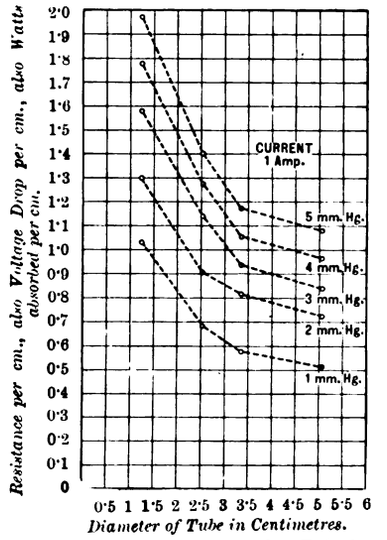


Derived Curves showing the Relation between Watts Absorbed per cm. of Length to Current in Amperes for Different Pressures of Mercury Vapour.

Derived Curves showing the Relation of Current in Amperes to the Resistance in Ohms per cm. of Length for Different Pressures of Mercury Vapour.



Derived Curves showing the Relation between Voltage Drop per cm. to the Current in Amperes for Different Pressures of Mercury Vapour.



Derived Curves showing the Relation of Resistances per cm.; Voltage Drop per cm.; and Watts Absorbed per cm. to the Diameter of Tube in cm. for Different Pressures of Mercury Vapour.

The walls of the lamps being covered by small globules of mercury and a large amount of mercury being present at the bottom of the lamp, the vapour was considered to be in a state of saturation. The points on the curves indicate actual readings; the drop in volts and temperature were observed. In most cases the experiments were repeated many times with different lamps, and with the same lamps re-exhausted, in order to be certain that only mercury vapour was present in the lamp, since the presence of a small amount of another gas will cause considerable variation in the measurements. For instance, on admitting a different gas into a lamp containing a pure gas, the effect may be observed by the measuring instruments. The diagrams show the influence of density, diameter and current on

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the drop in volts per unit length. From them can be deduced the resistance, as a function of the density current and diameter. They show that the voltage required to maintain an electric current in a gas or vapour is directly proportional to the density, and that it decreases as the diameter of the lamp increases. The resistance decreases with increase of current. From the diagrams, relations among the diameter, density and current may be established. The current assumes a definite cross-section for a given density and current when not restricted by the lamp; this cross-section increases with increase of current and decreases with increase of density. The angles in the curves shown may be due to these effects, but this point needs further investigation. The light efficiency of mercury vapour varies with the density; there is a density of maximum light efficiency. On passing a current at very low density, practically no light is visible, and the drop in volts for the same current is less than at greater densities. At densities greater than a certain limit the light efficiency decreases. If another gas is present with mercury vapour, the current is usually selective, and gives the spectrum of mercury vapour, but the resistance is materially altered. The effect of magnetic force transversely applied at low densities is very marked, and is that of increasing the resistance in an extraordinary degree, while at higher densities it increases the resistance but little. Magnetic force alters the spectrum, particularly at low densities.

The experimental curves speak for themselves. The conclusions which may be drawn with respect to the relation of the conductivity of mercury vapour to the physical conditions under which the electrical current through the vapour is maintained appear to be, broadly speaking, generally true for all gases and vapours. It is not necessary to enumerate here all these conclusions, for they are sufficiently evident on the face of the curves. Some curves are given which have been deduced from the curves obtained by direct experiment. They are marked in the diagrams as "derived" curves. There is one conclusion, however, which from a purely technical point of view deserves special attention. It is this:—

When a given vessel containing mercury vapour is to be employed as a source of light—that is, as an electric lamp—the highest light efficiency will be obtained when the vapour density and the current employed have a definite and fixed relation.

EXPERIMENTS ON EDDY CURRENTS.*

BY W. M. THORNTON, D.SC.

Concluded from page 422.)

4. Influence of Periodic Irregularity of Armature Rotation and of Unequal Turning Moment in Prime Movers.

The first three may be regarded as internal in their origin, the armature swinging as external. It is peculiar to certain classes of alternating-current machines. Synchronous motors and rotary converters, even when provided with damping devices, have free periods of oscillation, so that a sudden change of load or a synchronous engine speed will start the system swinging about some position of stability. This phase swinging, as it is called, is known to set the field ammeters fluctuating in time with the disturbance. There are, therefore, waves of magnetisation of low frequency, but great intensity, sent into the poles from the armature, and the consequent loss of energy there is material in reducing the oscillation. Since the armature currents are changing at a high frequency at the same time as they are fluctuating, there is a two-fold effect on the field while the swing persists, the more important of which is not that caused by the slow hunting swing itself, but by the increased armature reaction. To examine this, the hot-wire instrument was connected to an exploring coil on a converter field delivering single-phase current to a second converter, and through it to a non-inductive resistance. This load was suddenly thrown on and off, with the result that both machines started a phase swing, which by reason of the eddy currents induced in the magnet frames was reduced to zero in half a minute. The relative magnitudes of the two reactions is shown in Fig. 6, which is a photograph of the induced exploring coil voltage. The swing frequency is 120 per minute, sufficiently removed from the speed of the engine, 74 a minute, to show that it is a true phase-swing effect. The ordinates of the curve are a measure of the coil voltage which sets up eddies, though these are proportional to the square of this, which explains the rapidity of the damping. Loss from this cause is not in any case persistent, and is in a sense a direct advantage, but it is closely allied with one which is the most serious cause of eddy currents of all which have to be considered.

Irregularity of turning moment in an engine driving either continuous or alternating-current generators causes the armature currents to vary in time with the period of the engine, and the whole distribution system may be set swinging together, entailing a loss in the magnetic circuits of every synchronous motor or converter connected to the mains, and only differing from that of Fig. 6 in its persistence. In other words, it is a forced vibration started and maintained by the engine. Fluctuations of current in time with the engine can be seen in any large alternating-current supply system; even turbines are not quite free from this source of loss, unless the puffs of steam admitted by the governor are too rapid for the machines to follow. With the old throttle type of governor this does not occur.

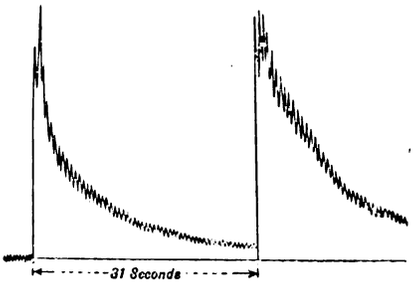

Fig. 6.—Exploring Coil Voltage during Phase Swinging.

Some experiments made last year may be of interest in showing that the efficiency of a transmission system supplied from turbo-generators may be several per cent. higher than from reciprocating engines. The two converters in the laboratory were connected single-phase, as in the former experiments. They were then driven by continuous current—first, from a turbo-generator, and afterwards from a single-cylinder double-acting engine with a heavy flywheel. Measuring the input and output by carefully calibrated wattmeters, it was found that in the former case the output was higher than in the second, as shown by Table VII. and Fig. 7.

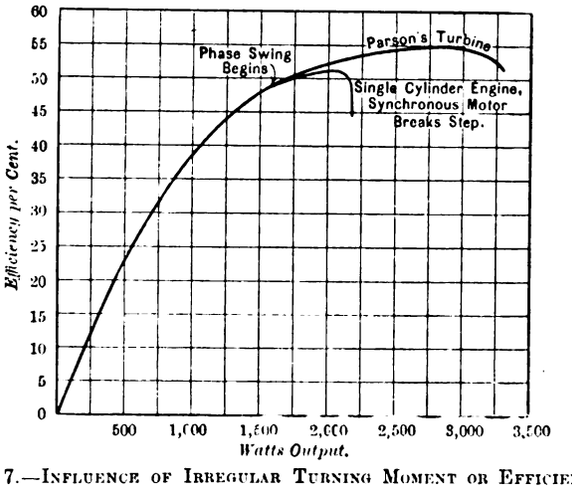

Fig. 7.—Influence of Irregular Turning Moment or Efficiency of Transmission Plant.

There can be no question of error of instruments, for the tests were purely comparative, and under exactly the same conditions of excitation and speed, but by applying the oscillograph to the fields of the machine in each case, a difference in the amplitudes of the exploring coil voltage was observed. The ratio of the root mean square values at full load is 1·03. Since eddy losses are proportional to the square of this, the difference is explained as caused by extra eddy currents in the magnet frames set up by the swinging

Table VII.—*Turbo-Generator.*

Volts input.	Amperes input.	Amperes output.	Watts input.	Watts output.	Efficiency per cent.
80·0	30·0	9·0	2,400	800	33·0
80·0	44·0	23·5	3,465	1,720	49·7
72·0	58·0	35·0	4,360	2,330	53·4
85·0	72·0	44·0	5,770	3,135	54·4
82·0	84·0	50·5	6,400	3,300	51·6
		Single-Cylinder Engine.			
72·5	32·0	12·0	2,480	940	37·9
71·0	45·0	23·5	3,190	1,560	48·9
71·0	59·0	32·0	4,150	2,140	51·6
65·0	71·0	39·0	4,550	2,150	47·6
64·0	76·5	43·7	4,950	2,220	44·9
63·5	86·0	42·0	4,960	2,150	43·3

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers on Monday, December 14th. Slightly abridged.

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of the armature currents in each of the motors when driven off the single-cylinder set. This disturbance was so great that the second machine broke step at loads corresponding to the sudden droop in the efficiency curve; whereas, when driven from the turbo-generator, very little fall is to be seen at loads 50 per cent. greater. The case no doubt represents the two extremes of engine regularity; but many large gas-engine plants show much more fluctuation on load than does our 75 H.P. single-cylinder engine. It is fitting that these results should conclude this Paper. I am now sure that, if one had the time and opportunity to conduct a series of experiments on widely different types of machines, by building them first with solid then with laminated poles and yokes, the same result would be reached—viz., that it is in the large solid iron masses of any machine that the greatest dissipation of energy takes place.

APPENDIX.

The Separation of Eddy-Current and Hysteresis Loss in Armatures.

The armatures being removed from the magnets, alternating current is passed through the windings, and measurements are made of the frequency, power and current. The current can be led into alternating stators by the ordinary terminals, and into continuous ring armatures by temporary brushes set about half one pole-pitch apart. The reason for

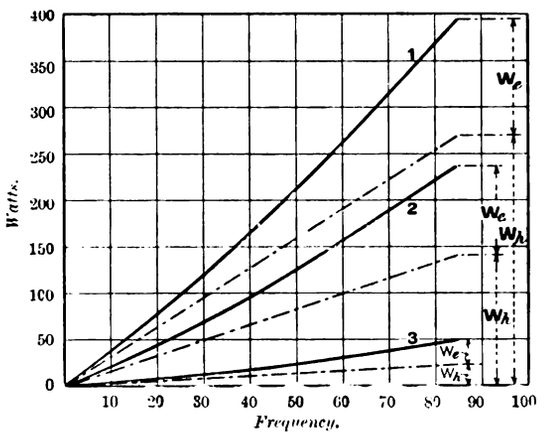

FIG. 1A.

this in the latter case is to cause differential magnetisation and ensure an oscillatory circulation of magnetism. With drum armatures there is no necessity for this, and two of the ordinary brushes can be used. The current should be as large as possible, though if the heating is excessive it is difficult to get steady readings simultaneously. Dead-beat direct-reading instruments should be employed. On account of the comparatively low flux densities reached when the core is magnetised in this way,

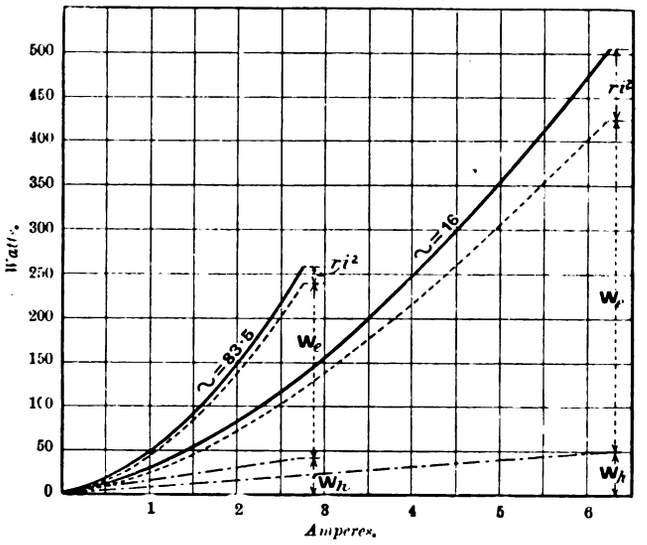

FIG. 2A.—CAST STEEL RING.

the greater part of the power is absorbed in heating the windings. Of the remaining iron loss the hysteresis component is proportional to the frequency, the eddy-current loss to its square. The iron loss may then be written

$$w = anB^{1.55} + \beta n^2 B^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which, by using the same current at all frequencies, reduces to the form

$$w = an + bn^2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Using two frequencies n_1 and n_2, the ratio of the hysteresis loss to the eddy loss is

$$\frac{W_h}{W_e} = \frac{w_2 n_1^2 - w_1 n_2^2}{n(w_2 n_1 - w_1 n_2)},$$

and

$$W_h = an = \frac{(w_2 n_1^2 - w_1 n_2^2)}{n_1 n_2 (n_1 - n_2)} n.$$

$$W_e = bn^2 = \frac{(w_2 n_1 - w_1 n_2)}{n_1 n_2 (n_1 - n_2)} n^2.$$

But the separation can be more easily and accurately made by a graphical method. Plotting power as ordinate and frequency as abscissa, it is seen from (2) that the total height of the curve is the sum of the ordinate of a straight line $W_h = an$, and a parabola $W_e = bn^2$, both of which pass through zero. A tangent to the plotted curve at this point divides all ordinates into two parts, the upper giving the eddy current, the lower hysteresis loss.

The following table gives the results of tests on a 10kw. ring armature having an iron volume of 9,050 cubic cm. and on a smaller one of 1,000 cubic cm.

—	Curve.	Amps.	Watts.	~	ri^2.	Iron loss.	W_h.	W_e.	$\frac{W_h}{W_e}$.
10kw. ring armature.	1	61·0	180	7·5	165	15	13·5	1·5	9·0
		61·0	200	14·7	165	35	27·0	8·0	3·37
		61·0	400	84·0	165	235	140·0	95·5	1·46
	2	81·0	360	11·5	310	50	42·0	8·0	5·25
		81·0	706	85·2	310	396	270·0	125·0	2·16
5kw. ring.	3	17·48	342	16·7	335	7	5·5	1·5	3·6
		17·48	385	83·5	335	50	25·0	30·0	0·83

In every case the hysteresis loss is greater than the eddy current, even at the highest frequencies, and by comparing Fig. 1A with Fig. 2A, which is for the solid rings of sec. 1, the value of lamination in reducing eddy losses is seen by the smaller curvature near the origin.

THE ALBION SYSTEM OF MAGNETO IGNITION FOR INTERNAL COMBUSTION ENGINES.

This system consists generally of a magneto-electric generator driven directly from the crankshaft of the motor, generating the necessary current for the igniting spark. From the magneto current is led to make and break spark plugs of simple design fixed on the combustion chamber of each cylinder, the make and break being operated by a trip rod and cam mounted on the half-time shaft. The ring-shaped armature of the generator is bolted to the engine casing, and the field magnets are mounted on a spider keyed to the crankshaft; thus it will be seen that there are no moving coils, commutators or brushes, and, therefore, very little to go wrong.

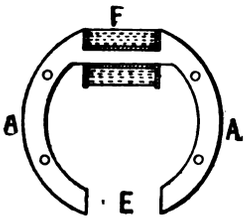

FIG. 1.—ARMATURE.

The armature A (Fig. 1) is built up of ring-shaped iron stampings having a portion, E, on one side entirely cut away, and a portion on the other side, F, reduced to take the winding or induction coil. The field-magnets consist of a couple of suitably-shaped soft steel pole-pieces, which embrace the armature and are bolted to a non-magnetic spider keyed to the crankshaft; across these pole-pieces are bolted the necessary permanent steel magnets to produce the magnetic flux through the armature. It is evident that, as the magnets rotate, the magnetic flux will first pass through the armature coil in the one direction and then in the other. Fig. 2 shows a side elevation and Fig. 3 an end elevation of the complete generator. D is the crank shaft of the motor, or any other shaft, driven positively from the engine at the speed of the half-time shaft, or any multiple of this speed as may be most convenient. To this is keyed a bronze spider, H, to which, in turn, are bolted the soft iron or steel pole-pieces G. The permanent magnets JJ are bolted across these pole-pieces, similar poles being bolted to the same pole-pieces. As the field-magnets rotate, an alternating current is generated in

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the coil F, the maximum E.M.F. occurring just after the pole-pieces have passed the position shown in Fig. 3.

By closing the circuit of the coil while the magnetic flux through it is a maximum, and by breaking the circuit when it is about the minimum, a slightly magnetising effect is obtained which tends to strengthen the magnetism of the field-magnets. This removes the principal objection raised against magneto ignition—viz., that the magnets gradually weaken and require re-magnetising every few months. We are informed that specially weakened magnets have been employed experimentally, and after months of ordinary running it has been found that the magnets increase in strength. The make-and-break mechanism is of the simplest possible description. The ignition plug proper is constructed by allowing the ignition port cover to carry one insulated contact which projects into the combustion chamber, while alongside this is a rotating spindle having at its inner end an arm which bears upon the insulated contact pin; the contacts are provided with platinum tips to prevent corrosion. To the outer end of the spindle is keyed a crosshead or double-ended lever, to one end of which is attached a spring tending to rotate the spindle so as to bring the arm into contact with the insulated pin; the other end of the crosshead receives the blow from the striking spindle, and there is thus caused a sharp rupture of the circuit. This striking spindle is lifted by a simple trip cam on the half-time shaft, and it is made as light as possible so that the lapse of time between the moment that it is freed by the cam and the rupture of the electric circuit and consequent ignition of the charge is reduced to a minimum. This has been experimentally determined, and is said to be less than one-tour-hundredth of a second.

We are further informed that the inventors of the system have made an extended series of brake tests to determine whether it was necessary or advisable to provide a means of varying the time of ignition, and it was found that with a low-speed engine it was quite unnecessary with this type of ignition. By setting the trip gear to

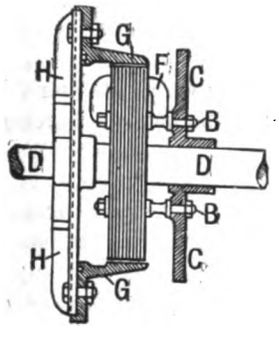

Fig. 2.—Side Elevation.

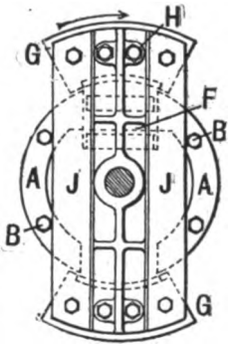

Fig. 3.—End Elevation.

fall when the crank has still 18deg. to rotate before reaching the upper dead centre it was found that the maximum torque and brake horse-power of the engine could be got at a speed of from 550 to 850 revs. per min., and it was also found that with the ignition fixed at this point there was no danger of a back kick in starting, and the engine ran quite steadily and smoothly at as low a speed as 150 to 200 revs. per min. By setting the trip gear 27deg. before the dead centre about 5 per cent. more power could be got at a speed of 950 revs. per min., but the power at 700 was 3 per cent. less than with the previous setting, and with the ignition set thus a slight risk of a back kick at starting was found. Practically, a moderate speed motor does all its work within the range of from 500 to 850 revs. per min., so it is evidently quite unnecessary to provide variable ignition. Indeed, it is a distinct advantage to have a fixed ignition, as the above results indicate, for it is very probable that the driver would rather lose than gain efficiency, on the whole, by having a variable ignition, which might effect a slight saving at the top speed of the engine, but this would probably be more than compensated for by inefficiency at lower speed. It is also obviously desirable to simplify, as far as possible, the mechanism and driving of cars, and by fixing the ignition one lever is eliminated. In ordinary high-tension ignition there is, of course, a considerable time lag between the making of the contact in the primary circuit and the rise of magnetic flux in the coil sufficient to attract the trembler and break the circuit, and it is principally this time lag that makes it necessary to provide a means of varying the time at which the primary circuit is closed, or, in other words, providing a means of compensating for the time lag. It is common knowledge that a careless driver can set up enormous strains on the crankshaft and other parts of the engine by running with the ignition set too early, as many broken crank shafts have testified.

ELECTRIC TROLLEY OMNIBUS.

Some new ideas are embodied in the electric trolley omnibuses which have recently been built and tested in Scranton, Pa., and are described in the *Street Railway Journal*. The design and length of the trolley pole (Fig. 1) are such that the coach can turn out a distance of 15ft. to either side of the overhead construction. As

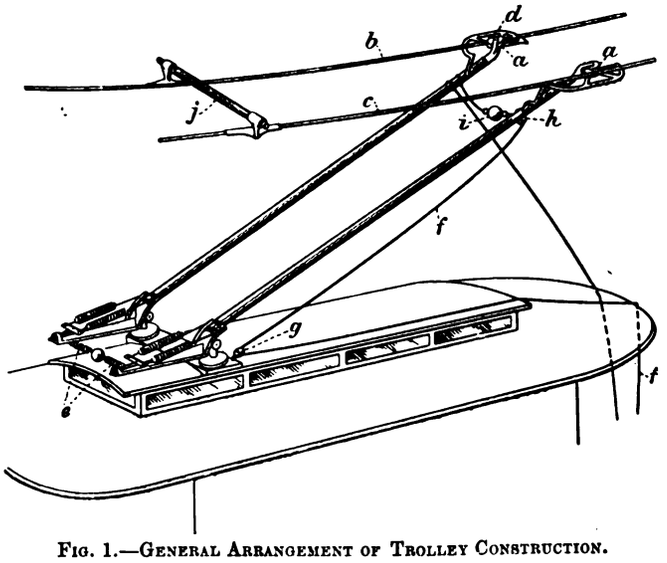

Fig. 1.—General Arrangement of Trolley Construction.

seen in Fig. 2 the current collectors press sideways on the wires, the trolleys being prevented from slipping off by the guards *d*. The latter also serve as a guide for one of the trolley wheels when two cars pass each other (as indicated in Fig. 2), and at crossings and

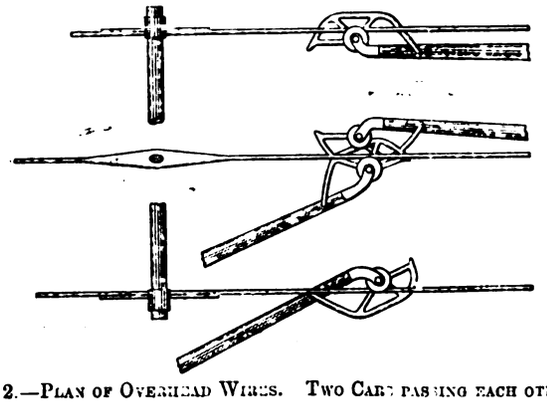

Fig. 2.—Plan of Overhead Wires. Two Cars passing each other.

switch-overs of the overhead wires they are used in conjunction with suitably arranged track blocks to bridge the gap in the conductors into which the trolley wheel would otherwise be pressed. The system is said to be due to Mr. A. B. Upham.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"American Meter Practice." By Lyman C. Reed. (New York: McGraw Publishing Co.) $2.

"Science Abstracts" for December. Section A, Physics. Section B, Electrical Engineering. (London: E. and F. N. Spon.) 1s. 6d. each.

"Annuaire pour l'An 1904." Publié par le Bureau des Longitudes. (Paris: Gauthier Villars). 1fr. 50c.

"Proceedings of the Royal Society," Vol. LXXII., No. 485 (London: Harrison & Sons). 2s.

"Calvert's Mechanics' Almanack and Workshop Companion for 1904." (London: John Heywood.) 4d.

"Annual Report of the Board of Regents of the Smithsonian Institution for the year ending June 30, 1902." (Washington: Government Printing Office.)

"Die für Technik und Praxis wichtigsten Physikalischen Grössen in übersichtlicher und leichtverständlicher Darstellung." By Olaf Linders. (Leipzig: Jäh and Schunke.) 10m.

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ELECTRICITY SUPPLY IN THE UNITED KINGDOM.

With this issue of *The Electrician* we present the first part of our annual supplement of electric lighting stations of the United Kingdom. So many new works are put into operation each year that the number has outgrown the size which it is possible to deal with in a single sheet. We have, therefore, decided to divide the table into two, publishing to-day a table of electricity supply undertakings with no traction load, and next week a table relating to electricity works supplying both lighting and tramways. Many undertakings which formerly supplied energy for lighting only have now a traction load, and, in addition, several new stations, both separate and combined, have come into operation. Last year, particulars of 323 stations actually in operation were given on our first supplement sheet; of these 241 had a lighting load only, and the remaining 82 had a combined lighting and traction load. In the list of schemes which had not commenced operation but were in progress of construction there were 34 entries, 23 of which were intended to supply lighting only and the remaining 11 both lighting and tramways. In addition to these data, however, we published, as usual, a complete list of those undertakings for which Provisional Orders had been obtained and in connection with which active steps had been taken towards carrying the schemes into effect. These numbered 68, and it will be observed that many of them are now under construction, while some have progressed so rapidly as to be now in operation. There were also two other lists, one giving the names of places which had obtained Provisional Orders but which had then only reached the "report" stage, the other setting forth the names of owners of Provisional Orders who had done nothing towards the consummation of the schemes. It is pleasing to observe that, in many cases, steps are being taken to turn Orders into effect and that several undertakings which, last year, were only in the "report" stage have so far progressed as to be classed under "projected" or "in progress" this year. But the facts of greatest importance are those relating to the increase in the number of stations in actual operation over and above the corresponding figure for last year. In the present table it will be seen that there are 264 stations supplying lighting only, as against 241 of last year. To the former figure must be added 99, representing the number of combined stations which will be given in our

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next week's table; this shows a total increase of 40 over the total of 323 for last year, a very considerable number.

Our "stick diagrams," showing the comparative total connections to the various classes of electricity works will appear in our next issue, simultaneously with the publication of our second table. Curves and figures showing the increases in connections to the various metropolitan stations will be found in this issue, however, and are indicative of the progress of electric lighting in London.

There are many other points of interest which may be gleaned from the present supplement, quite apart from statistics. When arc lamps of the Bremer and "flame" type made their appearance there were many people bold enough to say that such lamps would revolutionise electric lighting, but a glance down the column headed "Arc Lamps," unfortunately, shows that these prophetic utterances have not been justified. In the majority of the older and larger undertakings, the number of public arc lamps remains nearly stationsry, and the reason for this is not far to seek. When undertakings first commence they usually instal a large number of arc lamps in the main thoroughfares within their areas, and when once this has been done the quantity remains a fixed one. It is not to be expected that arc lamps will be largely employed for side street lighting, especially in view of the strenuous efforts now being made by gas companies to meet the competition of electric light. Nernst lamps certainly tend to equalise matters, and our supplement sheet shows how extensively they are being adopted, but they are comparatively new, and there is, therefore, all the more reason to hope for much better things of them in the future. For use on continuous-current circuits they have established a good reputation, but there is room for considerable improvement in their behaviour when worked by alternating current.

Another point emphasised by the returns which have come in from the various undertakings in different parts of the country is the steady and, in some places, extremely rapid increase in the motor connections. In spite of the repeated assurances by manufacturers and others that single-phase motors are now a commercial success, and that they are in every respect as good as continuous-current machines, statistics do not show that the increase in the use of this class of motor is so great as that of the continuous-current type. The conversion of single-phase stations to two or three-phase systems so as to obtain a motor load continuous, and those engineers who changed the whole or part of their systems from alternating to continuous current have seen no reason to regret it. Certain undertakings have adopted a tariff whereby energy is supplied for motive power at an extremely low rate, provided the consumer will agree to refrain from taking current during "peak" hours. Stepney and Brighton are cases in point; in these places a time switch is used, and, outside the prohibited hours, energy is supplied at a flat rate of 1d. per unit. This system is, doubtless, very excellent from the point of view of the supply authority, but for obvious reasons, it does not follow that it will meet with such unqualified approval from consumers. There is also the objection that a cheap and reliable time switch has not yet been invented.

Finally, it may be gathered from the accompanying table that the number of undertakings supplied "in bulk" from power companies is largely on the increase. When the electric lighting industry was "in its infancy," many engineers, both great and small, predicted that the success of the future depended upon the establishment of large generating centres from which energy was to be distributed throughout large areas, instead of the installation of comparatively small isolated plants. Years have passed since these suggestions were made, and since Mr. FERRANTI built his famous ex-centric station at Deptford; but it is only comparatively recently that his example has been followed generally. It needed tramways and a large power load to demonstrate the correctness of these views. Now, however, the movement has gathered impetus, and in a few years' time there is no doubt that an enormous increase in distribution "in bulk" will have taken place. The engineering conditions attendant upon such a state of affairs cannot be but favourable; and it is to be hoped that the present trend of events will so stimulate the industry that all its features, financial and otherwise, will be permanently benefited.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Notes on Electric Railway Economics and Preliminary Engineering. By W. C. GOTSHALL. (New York: McGraw Publishing Co.) 1903. 9s.

The book is stated to be an expansion of a series of lectures delivered by the author at Lehigh University, and bears out the promise of its title by putting into strong light the intimate relation between the economics and the preliminary engineering of such a line. Little space is taken up with the routine of surveying, but mention is made of the points to be considered in making the preliminary field survey, and from this and other data definitely locating the track in the office. The business methods and principles to be followed in dealing with promoters, local authorities and others who have to be interviewed, are all laid down clearly and with a steady regard to the permanent commercial interests of the projected road. Many of the details of the procedure recommended are not applicable in this country, but the principles are sound.

From the office location of the track which yields plans and sections, the author proceeds to construct time-tables for a "local" service stopping at all stations, and an express service calling only at the more important stations, each service having its own pair of tracks. The amount of the maximum traffic to be handled and its daily duration are estimated from the population, its occupations, character and habits, and from this estimate of maximum carrying capacity the amount of rolling stock needed is estimated. The schedule speed enters into this estimate, and although the method of determining this is treated in a later chapter, the author makes it clear that such determination with a due regard to economical working is a prime necessity. It is shown that the detail working out of what the author calls "run sheets" affects the whole of the rolling stock, power generating and distributing equipments, and that no useful time-table can be constructed, or average schedule speed reckoned on, until the most economical speed at which the necessary accommodation can be given has been determined.

For this purpose an ingenious graphic method is described and illustrated, substantially a speed time curve is constructed for every section, taking into account the curves and gradients of the line, showing the acceleration, coasting, slacks, and retardation possible, giving directly the time for each run, and indirectly the power consumed and the speed at each instant. To build up these curves the author uses certain standard curves for train resistances, acceleration and retardation on certain grades, and speed distance curves corresponding thereto. The chapters discussing these data, and their application to the formation of run curves are of the greatest value and interest, and form the most distinctive technical feature of the book. It will be noticed that the American measurement of curvature of track in degrees of deflection per unit length lends itself admirably to the valuation of curves as elements of track resistance—always provided that the coefficient is correct.

Outside these wholly admirable chapters, which may be described as an application of simple graphics to high-speed railway problems, technical matters are treated rather generally, and both these and the estimates of earning power are of rather local value.

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Engineering Preliminaries for an Interurban Electric Railway. By Ernest Gonzenbach. (New York: McGraw Publishing Co.) 1903. 4s. 6d.

This book, whilst quite modern in style and matter, is of a very different character to that of Mr. Gotshall. The subject is an interurban line in the West, which is to parallel an existing steam railway giving an infrequent but fast service.

Depending upon a small population, it will have to fight for its bread and butter. The engineering is steadily controlled by these considerations, and is a good example of a study in highest total economy under difficulties. The author does not advocate taking risks or cheeseparing, nor slapdash methods, and while his treatment is much less academic in character than is Mr. Gotshall's, it is just as truly directed to practical commercial ends.

It strikes an English engineer that the economy of power distribution is slightly undervalued in both books, but as neither of them professes to handle all the cognate matters involving general principles, this defect is only noted as a warning. Mr. Gonzenbach's style is colloquial and breezy.

Hoisting Machinery. By Joseph Horner. (London: Crosby Lockwood & Son.)

There is little of electrical interest in this work, but the author is clearly in favour of the adoption of electricity in connection with cranes. He says that electricity has caused vast improvements to be made in the crane industry, and recommends its use for many kinds of hoists and lifts. It is difficult, however, to agree with him that electrically-driven overhead travelling cranes are more easily damaged than those operated by hand. Given a careful attendant, there should be no danger whatever in this direction, and there is no doubt that the economy effected is very considerable. Either continuous or polyphase currents are considered suitable, but for a crane equipped with more than one motor, the author considers that three-phase working is to be preferred, as the variation of speed of the motor is less than that of a series-wound continuous-current machine.

Electricity and Magnetism. By C. E. Ashford, M.A. (London: Edward Arnold.) 3s. 6d.

This publication is intended principally for use in schools and for elementary students. A large number of experiments are described, and the fundamental laws of electricity and magnetism are dealt with in a clear if not very concise manner. At the end of the book are a few numerical examples on the various principles enunciated. There are also the inevitable tables of resistances and mathematical tables.

Fowler's Mechanical Engineer's Pocket Book, 1904. (Manchester: Scientific Publishing Co.) 1s. 6d.

This publication is similar in many respects to those of previous years. Some of the matter has been re-written and enlarged, particularly that section relating to gas engines, which is now very complete and useful.

Der Drehstrommotor. By Julius Heubach. (Berlin: Julius Springer.) 10m.

The author assumes some knowledge of elementary alternating-current theory, and on this basis he builds up the theory of the induction motor. The first chapter is devoted to the ideal motor with sinusoidal fields and without leakage or hysteresis. In the second chapter magnetic leakage is introduced, and the diagram of Heyland explained. Further chapters are devoted to the effects of hysteresis, eddy currents, friction and the actual distribution of magnetism in the field. The ninth chapter deals with the practical calculation of the elements of design. There is a section on the calculation of starting resistances and a chapter on testing motors. The subject throughout is treated in a most systematic manner. To anyone wishing to make a thorough study of the induction motor we can strongly recommend it. The type is good, and the diagrams are drawn with admirable clearness. An excellent feature is the tabulated list of symbols employed—though as these occupy six pages they may have a deterrent effect on the student.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

N-rays emitted by the Human Body.—A. Charpentier has successfully repeated some of Blondlot's experiments on N-rays, and has observed that they are emitted by the muscles and nerves of the human body when in a state of activity. He worked with a barium platino-cyanide screen brought to a state of faint luminosity by means of a piece of radium enclosed in black paper. The luminosity of the screen was enhanced whenever N-rays fell upon it. "I recognised at first," he says, "that the small phosphorescent or fluorescent object became more luminous when brought near the body. Further, this increase is more considerable near a muscle, and is the greater the more strongly the muscle is contracted. It is the same in the neighbourhood of a nerve or a nerve centre, where the effect increases with the degree of activity of the nerve or nerve centre." The effect is transmitted across aluminium and other bodies transparent to N-rays, and stopped by moist paper, and partly by lead. The rays may also be reflected, refracted and condensed. They are not an effect of heat, for they are transmitted through several layers of aluminium separated by air spaces. Neither are they an effect of stored sunlight, since they remain the same after nine hours spent in complete darkness. The author points out the great importance of these physiological actions in view of the fact that we now have a direct external reaction of an excited nerve. He also describes a process for mapping out active muscles in the living subject, notably the heart, which is a muscle in a continuous state of activity.

[A. Charpentier, *Comptes Rendus*, December 14, 1903.]

Electrolytic Treatment of Cancer.—S. Leduc describes a remarkable cure of a cancroid growth after a single introduction of the ion zinc. The growth was in the right wing of the patient's nose, and had existed in a constant state of ulceration for five years. The author applied to its whole surface a plug of hydrophil cotton impregnated with a 1 per cent. solution of zinc chloride. This was connected up with the positive pole of a battery whose negative pole was connected with any other part of the body through a large indifferent electrode. A current of 8 milliamperes was passed for 12 minutes without causing any pain, and boric vaseline alone was subsequently applied. The crusts detached themselves immediately, and 10 days afterwards the ulcer was completely scarred over and of good aspect. Ten weeks afterwards, the scar remained perfect, with the exception of a slight sore at the tip of the nose, which was treated similarly.

[S. Leduc, *Arch. d'Electr, Méd.*, December 15, 1903.]

Magnetic Rotational Dispersion.—J. Disch has tested Wiedemann's law, according to which the Faraday effect is strictly proportional to the natural rotational dispersion of the substance. For this purpose he determined both the natural and the magnetic rotational dispersion for a number of transparent substances showing no absorption within the visible spectrum and requiring no inactive solvent. The substances investigated included oil of turpentine of German, French and American manufacture, paraffin oil, valerianic acid ethyl, diethyltartrate and quartz. The Arons mercury arc was employed as a source of light, the particular line required being sifted out in the polaristrobometer. In the case of quartz, the proportionality appears to be almost perfect. In the case of valerianic acid ethyl, however, there is a distinct lag in the magnetic dispersion in comparison with the natural dispersion as the shorter wave-lengths are approached. Taking the ratio for 656$\mu\mu$ as unity, the natural rotational dispersion becomes 2·573 at 436$\mu\mu$, but the magnetic rotational dispersion becomes only 2·267 for the same wave-length. The other substances show similar discrepancies. The fact that quartz does not show them is attributed by the author to the fact that right-handed quartz is optically homogeneous, and contains no trace of left-handed quartz. The other substances probably contain active aggregates of molecules which modify the natural rotational dispersion. The author tested the equations formulated by Boltzmann, Carvallo and Drude

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to express the dispersion in terms of the wave-length, and found that they apply equally well to the magnetic dispersion.

[J. Disch, *Ann. der Physik*, No. 13, 1903.]

Simple Form of Wehnelt Interrupter.—Referring to Zehnder's simplified form of Wehnelt interrupter—which, by the way, appears to have been already patented by Ernecke—W. van Dam describes a further simplification. The difficulty of mounting the platinum pencil in such a manner that no liquid can pass it is overcome by using indiarubber instead of ebonite. As long as the current does not exceed 0·6 ampere per square millimetre, good Para rubber is consumed exceedingly slowly. The author has only once renewed the rubber in his apparatus within the last two years. In any case, the operation is one of extreme simplicity. The brass rod with the soldered-in platinum wire can be placed directly in the glass tube without using an extra brass tube. Hard solder need not be used, since the joint does not come into contact with acid. The concussions are deadened by the rubber in such a manner that there is practically no danger of breakages. The author uses a tube of 8mm. internal diameter, to one end of which another tube half that width and about 3cm. long is fused. The brass rod with platinum wire 1mm. thick is introduced into the glass tube, and a piece of tubing of the best Para rubber and less than 1mm. in internal diameter is slipped over the projecting platinum wire. It is wetted with water and then pressed into the narrow tubing.

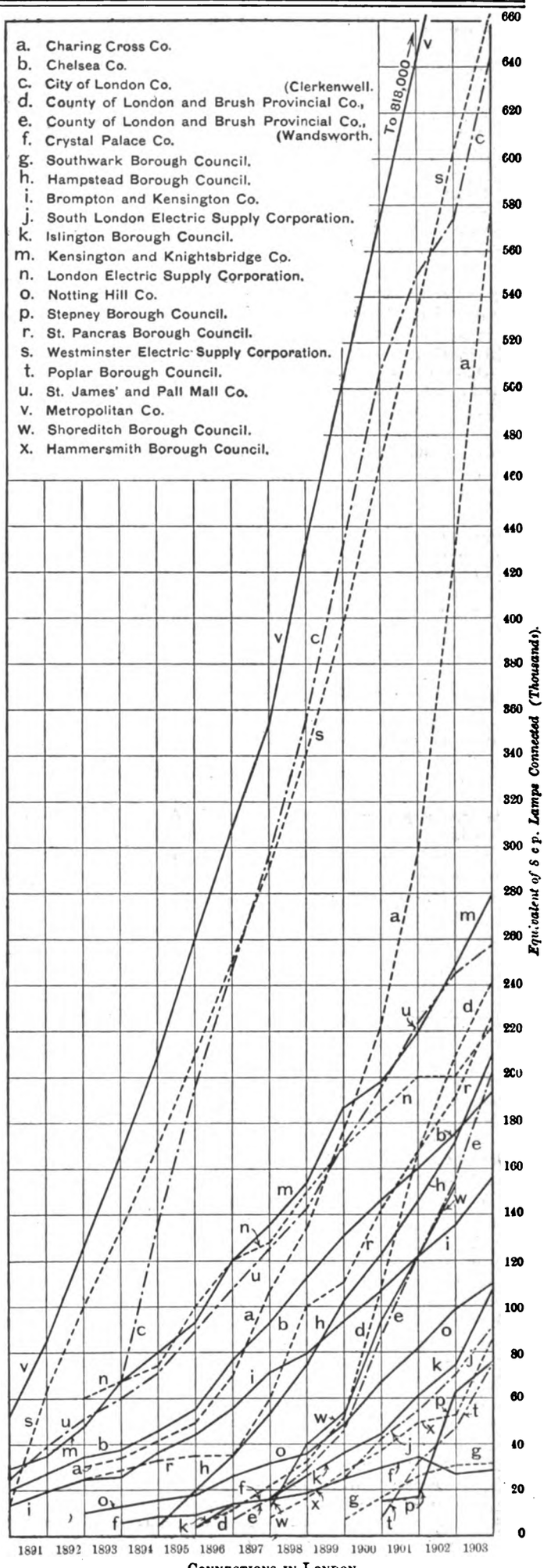
[W. van Dam, *Ann. der Physik*, No. 13, 1903.]

Suppression of Hysteresis.—P. Duhem discusses Maurain's observations of the suppression of hysteresis by a rapidly varying field from the point of view of a theory which he has developed in numerous publications. In this theory, an essential part is played by a line which he calls the "line of natural states." Traced on a diagram, in which the abscissæ are the field strengths H and the ordinates are the intensities of magnetisation M, it passes through the origin and is symmetrical with respect to it. It is this line of natural states which marks out what Maurain would call the "curve of normal magnetisation." One of the results of the author's theory is stated as follows:—"Given a magnetic field undergoing a double and symmetrical oscillation between two finite values positive and negative, what will be the limiting form of the effect produced as the time of oscillation tends towards zero? It is found that this magnetic cycle, described very rapidly between two finite values, is equivalent to a magnetic cycle described slowly between two infinitely small values, which are, of course, incapable of magnetising iron." If a piece of iron is simultaneously subjected to two finite fields, both in the same direction, but one of which is constant while the other oscillates with extreme rapidity between two equal values of opposite sign, the result will be the same as if it had been submitted to the action of a field undergoing very slow, very small and very numerous oscillations about the value of the constant field. Marconi attributed the effects produced in his receiver to the suppression of magnetic viscosity, whereas Tissot was the first to postulate the suppression of magnetic hysteresis. The author's theory takes both these processes into account, but shows that it is just the intervention of the viscosity which leads to the suppression of hysteresis in rapidly oscillating fields.

[P. Duhem, *Comptes Rendus*, December 14, 1903.]

CONNECTIONS TO ELECTRICITY SUPPLY WORKS IN LONDON.

The diagram given herewith represents the progress made by various supply undertakings in London during 1903. By connections is meant the equivalent of all connections, motors included, in 8 c.p. lamps, and the total number connected in London up to December 31, 1903, was over 5½ millions. It will be observed that the Metropolitan Electric Supply Co. still heads the list with 818,000 8 c.p. lamps connected, this being an increase of nearly 100,000 over the corresponding figure for last year. In 1902 this undertaking



Connections in London.

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connected to its mains the equivalent of 83,000 lamps, which was considerably greater than the number connected in 1901. The Westminster Electric Supply Corporation still keeps above the City of London Company, but the curves are now practically parallel, the bend-down of the latter having only been temporary; this shows that the engineer-in-chief of the City Company was well advised in pursuing his policy of adopting continuous-current generation and direct distribution. The increase is largely due to motor load, which has been obtained by energetic canvassing. Once more the Charing Cross Company is to be congratulated on having had more connections to its mains during 1903 than any other undertaking in London. In 1902, its increment was 130,000 8 c.p. lamps, but last year it reached the extraordinary figure of 146,000. This company's total connections now stand at the equivalent of 576,000 8 c.p. lamps.

Up to last year, no station in London under municipal control generated and distributed both alternating and continuous current; but St. Pancras now does this, and has a load of 225,667 8 c.p. lamps. As in former years, the connections to metropolitan stations owned by companies far outnumber those to stations owned by municipalities, and there is, apparently, no likelihood of any change occurring in this order, although the purchase of part of the Metropolitan Electric Supply Co.'s undertaking by the St. Marylebone Borough Council, when it is completed, will make some slight difference.

The following table gives details of connections in 8 c.p. lamps in London :—

	Municipal.	
—	~	—
540,018	454,277	225,667
	Company.	
—	~	—
1,894,448	673,748	1,749,257

A NEW SURFACE-CONTACT SYSTEM FOR ELECTRIC TRAMWAYS.

On Wednesday a demonstration of the "G. B." surface-contact system was given at Ilford. As shown in the illustrations, the bare line conductor, consisting of stranded galvanised iron cable, is drawn through plain butt-jointed 5in. stoneware pipes, and is suspended at convenient intervals by vitrified clay insulators. If found necessary, the electric conductivity of the cable may be raised by including a copper conductor. The galvanised steel pivots of the insulators are carried through one side of the glazed pipe conduit, and are all electrically connected together and with the track rails. This is to ensure a direct path to the rails for any possible leakage current from the cable, thus practically preventing a serious difference in pressure between the studs and the rails due to surface leakage on the clay insulators. Although the total depth of excavation does not exceed 19in. in standard practice, even this depth may be reduced by 6in. or 7in. for special purposes. As seen from Fig. 2, the whole conduit is embedded in concrete. Access boxes, placed at intervals of from 200yds. to 400yds. along the track, consist of cast-iron bodies with manganese covers. The two cable ends, entering a box at opposite sides, are led to terminal bars, mounted on insulators within the box. Drainage pipes, leading from the bottom of these boxes, conduct away any water which may accumulate in the earthenware pipes. Every 7ft. 6in.—corresponding to the distance between studs—a short vertical earthenware tube is cemented to the main horizontal pipe (Fig. 1). Into this vertical portion of the pipe system the laminated stalk of the stud is let, the upper part of the intervening space between it and the tube being subsequently filled up

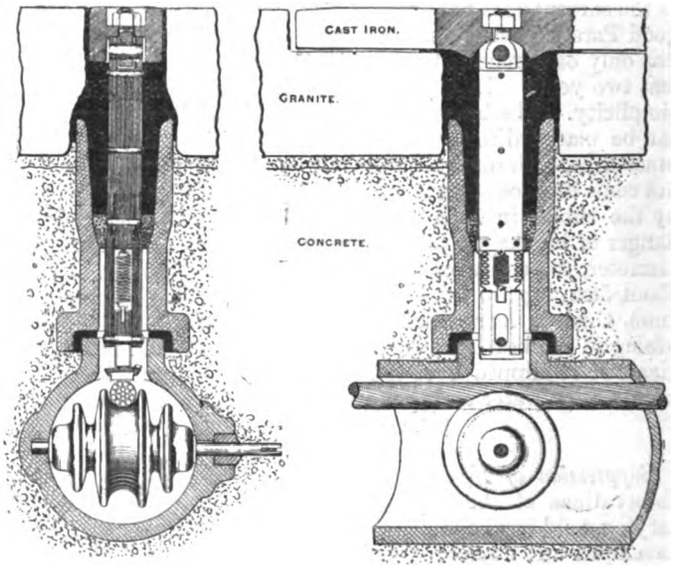

Fig. 1.—Cross-section and Longitudinal Section of Stud.

with bitumen, a packing of jute yarn preventing this material from falling through. A loosely fitting contact plunger, consisting of a laminated body and a carbon contact piece, slides in the brass-lined fork of the stalk, as indicated in Fig. 1. It is electrically connected to the stalk by flexible copper conductors and is held up from the cable against the force of gravity by an insulated phosphor-bronze spring, the separating distance being about $\frac{5}{16}$in. The stalk is connected to the cast-iron stud by a somewhat flexible joint, but this does not prevent it making good electrical and magnetic contact. A recessed granite block receives the stud which is level with the track and whose surface measures $2\frac{1}{2}$in. by 14in. By directing the flame of a blowpipe against the stud, the bitumen beneath is made to melt and the stud as a whole may be withdrawn, this operation occupying, it is said, but seven minutes. In addition to the ordinary standard equipment, each car is provided with a magnet rigidly suspended beneath the car and a battery of accumulators. It may be mentioned that the accumulators serve for starting only, being charged up during ordinary running. One pole of the magnet is in the form of two parallel iron bars, and is suspended at a distance of about 2in. above the centre of the track. Between these two bars are a number of iron tongues (Fig. 2), suspended by springs, but free to move a considerable distance up and down These are all connected at their lower ends by one flat chain belt (not shown in the illustration), about $\frac{5}{8}$in. wide, which is kept parallel to the track at a distance of approximately $\frac{3}{8}$in. by the springs and tongues referred to. In order to have a continuous supply of current, the belt is made longer than the distance between any two studs.

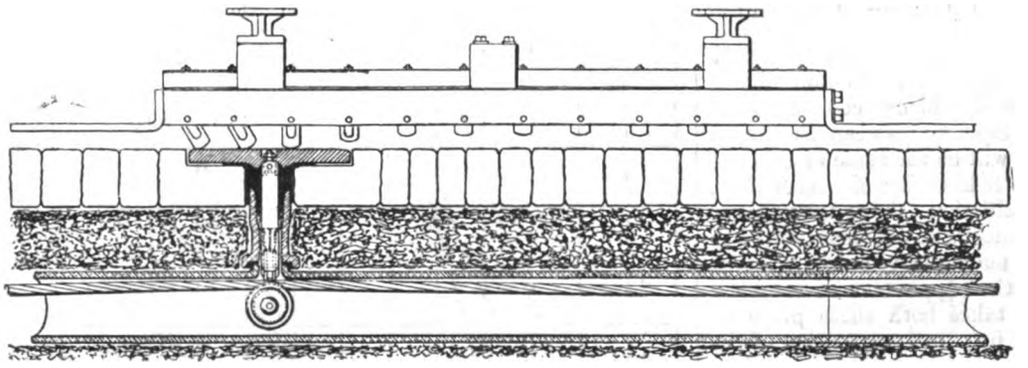

Fig. 2.—Current-collecting Device.

As the car comes over each stud both the flexible chain belt and the sliding plunger are attracted downwards,

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and the former, on coming in contact with the stud, completes the electric circuit. It is stated that the net force with which the plunger, weighing 6½oz, is drawn downwards, is equivalent to the weight of 6oz. at the beginning, increasing to about 16oz. when the carbon contact touches the cable. If a non-magnetic cable is used, the figures are given as 3oz. and 6oz. respectively.

The gauge of the trial track, which was one-fifth mile in length, was 4ft. 8½in., and the paving consisted of granite in bitumen, granite in cement and hard wood. The steepest gradient was 1 in 32, the sharpest curve having a radius of 54ft. A double-deck car, with a total seating for 54 passengers and fitted with two 25 H.P. Walker motors and Dick-Kerr series-parallel controllers had been fitted up with the auxiliary equipment necessary for the new surface-contact system. Its weight, fully equipped, was stated to be 10 tons. When running empty round the track, the current taken by the car varied between 20 and 35 amperes, the latter current corresponding to the steepest incline, the pressure being kept constant at 500 volts. The leakage of the experimental track was measured and found to be 0·05 ampere; and it may be mentioned that the ground upon which the track was laid was very moist. When a bucket of water was thrown on the track, the leakage of current between the rails and a live stud began with 0·5 ampere, and then fell gradually. In order to show the current-carrying capacity of the contacts, the car brakes were applied and the car set in motion. By this means a current of about 95 amperes was taken through the studs.

The energy absorbed for exciting the magnets was measured during the tests, and amounted to 325 watts. On one occasion, a stud was thickly smeared with mud, and the car slowly brought over it; this, however, did not prevent current being successfully picked up. Another stud was covered with a newspaper, and then with a layer of mud. Current was also picked up in this case, that portion of the paper only being torn by the collecting chain which was directly above the stud.

In case a stud should remain alive after the chain belt has passed, the supply is interrupted by means of chains, fixed to the end of the car and trailing on the track, coming in contact with the live stud and causing a maximum cut-out on the car to operate.

We are informed that negotiations have been entered upon with the Folkestone Corporation with the object of laying down about 3 miles of tract on the G.B. system.

ELECTRIC LIGHTING AND TRACTION NOTICES.

During October and November we gave particulars of the notices of intention to apply for or to promote provisional electric lighting or tramway orders or bills during the 1904 session, and, in accordance with custom, we give in the current issue lists of the lighting and tramway orders which have complied with the regulations and in regard to which the necessary deposit of £50 was made with the Board of Trade by December 21st. There is an appreciable increase in the number of applications, there being 74, against 61 last year. On this occasion there are no London orders, there being last year two, and five in 1902. There is, however, quite a "boom" in Scottish applications, of which there are 13. There is not a single Irish order.

Title of Order and Area.	*Promoters.*
Acton	Metropolitan Elec. Supply Co.
Ashford (Kent)	Ashford & Dist. Elec. Supply Co.
Barrhead	Clyde Valley Electrical Power Co.
Barry (Amendment)	District Council.
Bath (Rural District)	District Council.
Beddington, Coulsdon and Sanderstead	Croydon District Council.
Birkenhead (Extension) (Prenton and Upton in Wirral Rural District).	Birkenhead Corporation.
Bishop Auckland (Amendment)	Urban Elec. Supply Co.
Bothwell	Clyde Valley Electrical Power Co.
Brynmawr	District Council.
Caerphilly	District Council.
Cannock and District	Whittaker Bros.
Chippenham	Corporation.
Clevedon, Portishead and Long Ashton	Western Electrical Distn. Corp.
Clitheroe	Corporation.
Crediton	Christy Bros. and Middleton.
Devizes	Corporation.
Eastleigh and Bishopstoke	District Council.
Eastwood and Cathcart	Clyde Valley Co.
Ely	Southern District Elec. Corp.
Epsom (Rural District) (Cheam, Cuddington and Ewell)	County of Surrey Electrical Power Distribution Co.
Gainsborough	District Council.
Glastonbury	Corporation.
Hampton Wick and District (Hampton Wick, Esher and the Dittons, East and West Molesey, and Sunbury; and parishes of Hanworth, Feltham, Ashford, Shepperton, Littleton and Laleham, in Staines Rural District).	Twickenham and Teddington Electric Supply Co.
Hanwell	District Council.
Hexham (parishes of Hexham, Acomb, Sandhoe, Hexham West Quarter and Warden, in Hexham Rural District).	Mr. E. P. Harvey.
Heysham	District Council.
Horley (Reigate Rural District)	Messrs. M. H. Bennett & R. C. Quin
Houghton-le-Spring & District (Houghton-le-Spring, Hetton-le-Hole and Seaham Harbour Urban Districts, and Easington Rural District).	Mr. H. J. Almond.
Huddersfield (Extension to Golcar)	Corporation.
Johnstone (Burgh of Johnstone and portion of parish of Paisley).	Clyde Valley Co.
Keynsham (Somerset)	Keynsham Elec. Light and P. Co.
Kilpatrick (Burgh of Milngavie and portions of parishes of Old and New Kilpatrick).	Clyde Valley Co.
Kingswood	Kingswood Elec. Supply Co.
Kirkby-in-Ashfield	District Council.
Lanark	Clyde Valley Co.
Lichfield (Amendment and Extension of 1901 Order). (Whittington, Shenstone, Swinfen, Packington, Weeford Wall, Longdon, Fisherwick, King's Bromley, Farewell, Cudborough and Elmhurst, Pipe Hill, and portions of parishes of Burntwood and Hammerwich, and of St. Chad and St. Michael, Lichfield, in Lichfield Rural District.)	Corporation.
Maidenhead (Extensions). (Taplow, Hitcham and Burnham, in Eton Rural District; and Cookham and Bray in Cookham Rural District.)	Corporation.
Malden and Coombe	District Council.
Maldens and Coombe and Ham	Twickenham and Teddington Co.
Mansfield Woodhouse	District Council.
Melksham	District Council.
Mid-Shropshire (Bridgnorth and Wenlock, Oakengates and Dawley, and Acton Round, Astley Abbotts, Chetton, Eardington, Morville, Oldbury and Tasley in Bridgnorth Rural District).	Shropshire and Worces. Elec. Power Co.
Milford-on-Sea	Milford-on-Sea Elec. Supply Co.
Musselburgh	Nat. Elec. Constn. Co.
Newquay	Southern District Elec. Corp.
Newton Abbot (Extension). (Portion of Urban District and Kingsteignton in Rural District of Newton Abbot).	Urban Elec. Supply Co.
Northampton (portions of Northampton Borough and of Moulton, Moulton Park, Boughton, Church Brampton, Chapel Brampton, Hardingstone, Wootton, Great Houghton, Little Houghton, Milton, Collingtree, Rothersthorpe, Weston Favell, Great Billing, Little Billing, Dallington, Duston, Upton and Kislingbury, in Rural Districts of Brixworth, Hardingstone and Northampton).	Northampton Elec. Light and Power Co.
North Worcestershire (Bromsgrove and Stourbridge Urban Districts, and Belbroughton, Clent, Frankley, Grafton Manor, Hagley, Hunnington, Pedmore and Romsley in Bromsgrove Rural District).	Shropshire and Worces. Co.
Penzance	Penzance & Dist. Elec. Supply Co.
Portpatrick	Portpatrick Electric Supply Co.
Ramsgate	Ramsgate & Dist. Elec. Supply Co.
Renfrew (Renfrew Burgh and portions of parishes of Renfrew and Govan).	Clyde Valley Co.
Saffron Walden	Corporation
Shettlestone (portions of parishes of Glasgow and Old Monkland).	Clyde Valley Co.
Southgate	District Council.
Stroud, Nailsworth and Dursley	Gloucestershire Elec. Power Co.
Sunderland Districts (Southwick-on-Wear Urban and Sunderland and Houghton-le-Spring Rural Districts).	County of Durham Elec. Power Distn. Co.
Sutton-in-Ashfield	District Council.
Tamworth (Tamworth Borough and portions of Wigginton and Bolehall and Glascote in Tamworth Rural District).	Corporation.

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Title of Order and Areas.	*Promoters.*
Tavistock	Tavistock and District Elec.
Teignmouth (Amendment)	District Council. [Supply Co.
Thornbury	District Council.
Trowbridge Urban, Bradford-on-Avon Urban and Bradford-on-Avon Rural	Western Elec. Dist. Corporation
Uddingston (Bothwell parish)	Uddingston Dist. Elec. Light Co.
Vale of Leven (portions of parishes of Bonhill, Cardoss and Dumbarton)	Clyde Valley Co.
Walmer	District Council.
Walton-le-Dale	District Council.
Walton-upon-Thames	Urban Electric Supply Co.
Watford (portion of Urban District of Watford, and portion of parishes of Watford Rural and Bushey Rural in Watford Rural District).	District Council.
Wickham (Transfer of Powers)	District Council.
Widnes (Amendment)	Corporation.
Wishaw	Corporation.
Yardley	District Council.

TRAMWAY PROVISIONAL ORDERS.

The following is a complete list of the applications deposited with the Board of Trade under the provisions of the Tramways Act, 1870. There are 15 orders, compared with 14 in 1903 and 19 in 1902:—

Altrincham Urban District Council
Bishop Auckland, Shildon and Spennymoor
Calverley Urban District
Crompton Urban District
Dewsbury Corporation
East Ham Urban District Council
Folkestone Corporation
Ossett Corporation
Penarth
Plymouth Corporation
Rochdale Corporation
Royton Urban District
Sunderland Corporation
Wardle Urban District
West Ham Corporation

CORRESPONDENCE.

CUT-OUTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with considerable interest the contributions to the correspondence in your issues of December 18th and 25th *re* the use of return current cut-outs. I entirely agree with both Dr. Garrard and Mr. Quin that the use of an excess current cut-out in each generator circuit could not have prevented the total interruption to the supply that occurred at Westminster a few weeks ago. I also agree with Mr. Quin that the polarised relays suggested by Dr. Garrard would have been equally liable to fail. I cannot, however, allow the statement that "for such accidents as these reverse current cut-outs are useless" to pass unchallenged.

That reverse current cut-outs are not universally used for controlling generators working in parallel is undoubtedly due to the fact that they are not generally considered to be reliable. The construction of a satisfactory cut-out appears at first sight to be a very simple problem, and in the early days of our experience it was treated accordingly. Difficulties have, however, arisen from time to time, showing the error of this, and many engineers have in consequence been tempted to go to the other extreme, treating the difficulties as insurmountable and trusting that, since serious accidents are of rare occurrence, the chances are in favour of the system they are responsible for escaping.

During the past 10 years I have experimented on nearly every conceivable discriminating device, under varied conditions, and have discussed the problems that have arisen with other engineers working in the same direction, both in this country and in the States. I can confidently state that no failure has come to my knowledge that has not been in accord with what a theoretical consideration of the case would lead one to expect, and, further, that all failures might have been prevented by the use of properly-designed cut-outs. I hope to publish at an early date a brief account of some of the investigations made, together with a number of curves showing the behaviour of different types of cut-outs. In the meantime the following notes, briefly summarising the conclusions arrived at, may be of interest:—

1. Zero cut-outs are useless for the reasons given by Mr. Quin.

2. Maximum cut-outs in generator circuits are equally useless, as explained by Dr. Garrard.

3. Polarised cut-outs will work satisfactorily on a small or moderate reverse current, but will almost invariably fail on a short circuit, because the heavy series current entirely wipes out the effect of the permanent magnets.

4. The releasing pull of a reverse-current cut-out should increase as the reverse current increases, as it does in an excess current cut-out. This result can only be obtained by employing the series current to directly operate the cut out. In many types of cut-out the release pull increases with the reverse current up to a certain point. The curve then doubles back and, with a further increase of current, falls to zero and reverses to a holding-in pull, thus causing the cut-out to fail.

5. Compound-wound devices will fail if the E.M.F. winding is coupled directly across the terminals of the generator controlled, as a short across the brushes will cause this E.M.F. to fall to zero. If the shunt winding of the cut-out is connected across a battery in parallel with the generator, the resistance of the battery and generator leads will often serve to maintain sufficient E.M.F. across the shunt to operate the cut-out. This, however, cannot be relied upon.

6. To obtain absolute reliability the shunt windings of the cut-outs should be excited off a small independent battery that will be unaffected by any disturbance on the supply system.

7. Reverse current cut-outs should not operate with a reverse current of less than 25 per cent. of the full load current. Cut-outs can quite well be made to operate on a reverse current of less than 5 per cent. of the full load current, but such cut-outs require fine adjustments and are more liable to give trouble.

The difficulty Mr. Quin refers to, arising from an armature going to earth and generating a low periodicity alternating current, should not prevent a properly designed cut-out from protecting the supply system. It is true that this one generator will—so long as it continues to act as such—generate an alternating current that will not operate the cut-out. The chief source of trouble, however, is due to the faulty machine becoming a short-circuit on the 'bus bars and to other generators feeding current into this short-circuit. This will be a direct current in the reverse direction to normal, and will, in consequence, operate the cut-out, leaving the supply maintained by the remaining healthy generators.—Yours, &c.,

Manchester, Jan. 6. LEONARD ANDREWS.

SINGLE-PHASE MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Mr. Eichberg's letter of December 19th, I will not follow him in the discussion of unimportant details, when essential points should be made clear, and I am sure the readers of *The Electrician* will be astonished at the tone of Mr. Eichberg's letter after reading the following discussion.

Given a sufficient number of interlinked electrical and magnetic circuits, it is generally possible, by the application of Darwin's theories to electrical problems, to point out any and all interesting combinations which may have been invented. But, if we adhere strictly to the original text of the German patent application of Messrs. Winter and Eichberg of November 15, 1901, I claim that it contains absolutely nothing which can be interpreted as a priority of my own work on single-phase compensated motors.

I will now explain to the readers of *The Electrician* the meaning of the single-phase diagrams of the Winter-Eichberg German patent application. Messrs. Winter and Eichberg first proposed to return the energy usually dissipated in the rotor circuits of polyphase motors (external resistances) to the supply network, by the use of a commutator on the rotor and a recuperating transformer with a variable ratio of transformation. (I will not discuss here the novelty of these proposals.)

Wishing to obtain the same results in single-phase motors, Messrs. Winter and Eichberg were led to adopt the following arrangement:—Referring to the figure below, the stator is connected by the main terminals e, f to the single-phase network, AB, the instantaneous voltage of which is $V \sin \omega t$. The brushes c, d, placed in line with terminals e, f, are connected to the recuperating transformer T, the transformation ratio of which is varied with the speed of the rotor. The rotor torque

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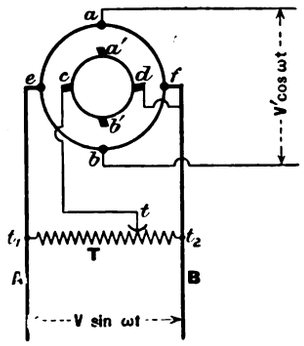
is obtained by connecting the auxiliary stator terminals a, b, placed at 90deg. to the main terminals e, f, to an auxiliary source of current, the instantaneous voltage of which $V' \cos \omega t$ is displaced by 90deg. from the instantaneous voltage of the network AB. In their patent application, Messrs. Winter and Eichberg have stated that, as an alternative, the auxiliary source of current may be applied to the rotor by brushes a', b' placed in line with the auxiliary terminals a, b.



In proposing this alternative, Messrs. Winter and Eichberg have thereby not only not invented the compensated motor, but they have failed to understand the essential phenomena of compensation. Because, if at, or nearly, synchronous speed of the rotor the brushes c, d are short-circuited by bringing the contact t to the terminal t_2 of the recuperating transformer T, while the brushes a, b are connected to the auxiliary source, the rotor and the stator windings will be burned out and the torque of the motor will completely disappear. This will take place owing to the suppression of self-induction in the rotor, which fact I have first discovered and pointed out.

Since Messrs. Winter and Eichberg have become acquainted with my compensated motor they have modified the ideas expressed in the original German patent application, and they now point out the advantage of 0-phase (zero-phase) displacement between the instantaneous voltages of the network AB and the auxiliary source. I claim that the German patent application in its original text cannot be considered a prior disclosure of my compensated single-phase motor under discussion. I claim furthermore that the British *provisional* specification of Messrs. Winter and Eichberg of October 24, 1902, has nothing to do with either the shunt or the series type of compensated single-phase motors.—Yours, &c.,

Paris, Jan. 2. M. LATOUR.

THE "THURY" POWER TRANSMISSION SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an editorial note on the electric power transmission between Lausanne and St. Maurice by the series high-tension direct-current system, you refer to the fact (which later on is emphasised) that for *the same R.M.S. pressure* this system is at a disadvantage on the score of conductor-section when compared with three-phase transmission. I think it would be interesting to inquire why the above criterion should be a fair basis of comparison. No doubt it is some kind of mean voltage which determines leakage both over and through insulating materials, and dielectric losses in cables (if indeed separate from leakage) may also depend on mean voltage. But are these the chief matters which cause difficulty in maintaining a high-tension line? The danger of breakdown of the line-insulation is surely more important still; and most of the writers who have contributed to our knowledge of dielectric strength have assumed that this is determined by *maximum* dielectric stress. Equivalent maximum voltage, however, reverses the case and gives to the direct-current system the *advantage* of some 40 to 80 per cent. of conductor section, according to shape of wave-form and square of power-factor. (The section for direct currents being taken = 100 per cent.)

To those familiar with M. Thury's unique system, its wonderfully simple switch gear and its great adaptability to "point-to-point power transmission" (to which you refer), it seems a pity that it should have been left to one firm only to develop it, especially now that the electric running of our longer railway lines may be coming under consideration. I think it would be unfortunate if the advantages of this system were not fully appreciated.—Yours, &c.,

D. K. MORRIS.

The University, Birmingham, Jan. 4.

STEAM TURBINES v. RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am glad that Mr. Morcom and I are agreed on one point at last, the meaning of load-factor, for I certainly gathered from his last letter that he was mixing the plant capacity with it. I am also sure, if he will discuss the matter with the many consulting engineers who recommend, and station engineers who use his engines, he will appreciate as much as I do its value in reducing the coal bill.

It is unfortunate that he should have selected the Coronation as affording an extra high load at Cambridge; did he know the university town he would remember that the celebration took place in August, when some 75 per cent. of the consumers were away, and that the value of this imaginary maximum would be about half of that on a winter's Saturday night. I cannot speak of Scarborough, but let it be remembered that 19 towns out of 20 have an abnormal load at Christmas, which is denied to both Cambridge and Scarborough.

Now, as to the alleged excess of plant, in all stations when stepping from small units to larger, it must be the case, and I will show that turbine stations are not alone in their excess. I have before me a circular letter and pamphlet, which has been distributed by Messrs. Belliss; if the reciprocating engine needs the circulation of such an effusion it must indeed be in a bad way—but more about this anon. At present I take from a list of stations attached to it (in which are installed Belliss engines) nine of these. I might well ask, Are the engineers so apprehensive of piston valve seizing, or (as has happened before) the whole engine collapsing through water, that they need from two to four times the plant required for their maximum load?

Station.	Max. load. Kw.	Plant. Kw.	Ratio.	Year.
Ayr	460	1,125	1:2·5	6th
Barnes	115	470	1:4·1	2nd
Buxton	180	534	1:2·9	1st
Coventry	526	1,800	1:3·4	7th
Leeds	4,126	8,740	1:2·1	9th
Plymouth	879	2,300	1:2·5	3rd
Taunton	462	1,080	1:2·3	13th
Worcester	510	1,725	1:3·4	8th

I do not wish to question Mr. Morcom's impartiality in compiling his list, but I would ask him to carry his spirit of fair play a little further. Mr. Swinton and I have both drawn his attention to the inclusion of a partly water-driven station, and as yet he has not deigned to reply or withdraw it. Further, non-condensing turbines have been over and over again admitted out of the running with reciprocating engines as regards coal. Why does Mr. Morcom still insist on dragging them in? That non-condensing turbines have scored in another way, I will presently remind your readers.

The average of 160 stations only shows that the bulk is not as good as the sample. I regret, however, that I am not able to follow the turbine bulk figures. Firstly, I cannot call to mind eight turbine stations exclusively; the nearest approach is as follows:—

Name of station.	Coal per unit.	I.H.P. reciprocating.
Blackpool	0·91d.	1,500
Newcastle District	0·52d.	..
Cambridge	0·66d.	..
Scarborough	0·85d.	..
West Bromwich	0·55d.	..
Morecambe	1·28d.	490
Melton Mowbray	0·64d.	..
Whitby	0·95d.	Not in *Electrical Times'* list.
Total	$\frac{6·73}{9}$ = 0·747d. av.	

My list, therefore, gives turbines' average 0·747 against the engines' 0·738, a difference of 0·009, or 1·2 per cent., which is certainly hair splitting; but this is not all. Mr. Morcom will not agree to the inclusion of Newcastle-on-Tyne in his turbine list because there are reciprocating engines as well (Does he include it in the 160?), yet he insists in classing Blackpool and Morecambe, both mixed stations. It is a sad coincidence for

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the reciprocators that the most costly in coal should have the largest ratio of reciprocating plant. Removing the two mixed stations and adding a large allowance to Shipley—viz., 75 per cent.—for steam received from the destructor, the average is only 0·643. This is a similar example of reading figures and facts simultaneously, and is as instructive as the reduction of Cambridge and Leeds to the common basis of smudge and adjusting the railway rate. I well remember the excellent result of the Wallsend Slipway Co.'s engine at the Newcastle station, and Mr. Laing is to be complimented most highly on it; all the same, it only represents one-ninth of the total capacity, and the new station is to have 11,000kw. of turbines. The consulting engineer of this station does not appear to have much doubt as to which type of engine is the better.

My surprise is much greater than my disappointment that Mr. Morcom will not accept the figures I have given him for the value of vacuum. It is not, so far as I know, usual for the members of the great institution to which we both belong to openly doubt the words of each other. I have accepted the figures of the tests made in Mr. Morcom's works: is it too much to ask him to accept those made in the works where I was manager?

Mr. Wilkinson's figures were based on a table, which I have not only demonstrated to be wrong, but have the authority of the makers to say so. If your correspondent had only taken the trouble to calculate the theoretical efficiency of a steam engine under the conditions of the Cambridge tests he would have saved himself being misled by the statement attributed to Mr. Emmet. Unfortunately, I have not the Paper referred to by me, but what Mr. Emmet did say or meant to say was probably that the theoretical value of an inch of vacuum is about 6 per cent.; even this is a high figure. Much as turbines have progressed, their builders have little hope of attaining to the standard of the Rankine cycle.

To come to the pamphlet issued by Mr. Morcom's firm, I am much obliged for the character of great ingenuity, but I cannot hope to aspire to the height of this document. I note that it is copyright, which I trust does not preclude my pointing out its errors. It is indeed surprising that a firm with so deserved a world-wide reputation should lend their name to so misleading a compilation.

The length of this letter prevents me dealing with the full contents, but briefly stated, it is an amplification of the table of seven turbine and reciprocating stations, but instead of seven stations it adds two Metropolitan, making nine turbine stations. The following explanatory note appears: "The nine turbine stations given are the only central stations fitted wholly or mainly with this form of generator which have had any real duty to perform." The first given under turbines is the Metropolitan, with a sale of over 12,000,000 units and a cost in coal of 1·22d. What is the true state of affairs according to a 1904 directory? 22 engines by Willans, five by Hornsby, 19 Parsons turbines, five by Westinghouse (2,500 I.H.P. each) and two Sulzers (5,000 I.H.P. each), a total of 53, and only 19 turbines. Is this wholly or mainly? Four of the reciprocating engines are alone equal to the whole of the turbines. As to Woolwich, the proportion of reciprocating plant is greater than Newcastle-on-Tyne. Why, then, did not Mr. Morcom's impartial spirit allow him to put in this latter station? Salisbury, with its water station, as I expected, also comes in; and, lastly, another note informs us that the examples of reciprocating stations have been selected so as to be as nearly as possible comparable with the others in size, location and load-factor. How far the last portion of this is correct Mr. Swinton and I have already shown. Further comment on this table at present is needless.

Now as to the re-tried engines. The original statement as to these was that the later figures were better than the originals. We are, however, arriving at a modified state of affairs. I fear so ingenious a method of lumping the figures at all loads would not go down with many customers of Messrs. Belliss known to me. I have not yet seen a reply to the increase of the indicated horse-power consumption, which is now 7·96 per cent.

To come back to the Metropolitan, has Mr. Morcom forgotten how turbines came to be used at all? For the benefit of your younger readers it may be worth repeating. In consequence of actual or threatened law proceedings, many thousand pounds were spent in increasing foundations and in carrying out everything that the ingenuity of the best engineers of the day could suggest to prevent the reciprocating engines shaking up the neighbourhood of Manchester-square. Finally, an injunction was obtained ordering the station to be shut down unless the vibration ceased by a certain day. Every engine in the place was turned out, turbines installed, which have run ever since, and the plaintiffs expressed their complete satisfaction with the new plant. In spite of the serious handicap without condensers, turbine builders have no reason to be ashamed of the Metropolitan.

The taunt that turbines figure to so small an extent in the country's total production of engines hardly affects the question. Reciprocating engines have been built for upwards of a century, whilst the first turbine was started less than 20 years ago. Such a start in life goes for a great deal. Turbine builders may, however, be well satisfied with the progress being made. Little more than a year ago there was only one firm in the country building; now there are no less than seven, and, most wonderful to relate, a firm of reciprocating engine builders, whose work and reputation are second to none in the world.

Your correspondent concludes with the usual string of ex parte statements and a list of alleged difficulties and troubles. My turbine experience now extends over nearly 14 years, and I fear my faculties of observation are considerably impaired, as I have not taken any of them seriously to heart; but then I cannot claim to figure amongst the best and most ingenious mechanical engineers.—Yours, &c., JOHN H. BARKER.

Bedford, Jan. 4.

A CORRECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I would be obliged if you would correct an error of a personal nature which you have made in your issue of January 1st. in allocating to me the title of manager of Messrs. Ferranti's switch gear department. I would rather have it known that my connection with Ferranti switch gear design terminated in the year 1900, and that I have not held the permanent position of manager of the switch gear department. My recent employment has been in other directions.—Yours, &c., H. W. CLOTHIER.

Manchester, Jan. 4.

Electricity Stations in Germany.—From the annual list of German electricity stations published by the *Elektrotechnische Zeitschrift* it appears that there are at present in that country 971 such stations, reckoning only those which supply electricity for lighting or power to whole municipalities or to districts of considerable area thereof. Of this number 50 have generating plants equivalent to 2,000kw. or more, at the head being the station at Moabit (Berlin), which, including its sub-stations, has a plant capacity aggregating 26,523kw. Nearly the same capacity—viz., 25,423kw.—is possessed by the station (including sub-stations) situated in Oberspree (Berlin). Of the 50 largest stations mentioned above, 19 generate both continuous and alternating (as a rule, three-phase) current, 16 stations produce alternating current only, while 15 are solely equipped with continuous-current plant. The aggregate capacity of these 50 stations, which supply electricity to 37 towns, amounts to 271,479kw. Worthy of special mention is the electricity station in Brühl, distributing electrical energy to 66 municipalities situated within a circle of about 12½ miles radius, also the Rheinfelden station, supplying 46, and the Neckarwerke, supplying about 40 municipalities with current. Nearly all stations in Germany are provided with a storage battery. The sum total of the capacities of all the German stations approximates 400,000kw. By far the largest number of stations are driven by steam engines, water being the prime mover in 98 cases, and gas engines being employed in 61 stations. Ninety-five additional electricity works are in progress or authorised.

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LIGHT RAILWAY INQUIRIES IN 1903

During the past year we have published from time to time particulars of the light railway schemes submitted to the Light Railway Commission, including reports of the proceedings at the official investigations into the merits of these projects. We give below the results of the applications for electrical lines lodged with the Commissioners in November, 1902, and May, 1903.

It will be seen that, of the 25 applications 4 were granted, 7 partly granted, in 5 decision was reserved, 5 were withdrawn, and 3 rejected. (In addition there were two applications (Crystal Palace and Trent Valley Amendment) from May, 1902, into which inquiries were not held. The former scheme has been withdrawn, while an inquiry into the latter still remains to be held):—

November, 1902.

Title.	County.	Promoters.	Engineers.	Mileage.	Gauge.	Result.
					Ft. in.	
Avonmouth	Gloucestershire..	Philip Napier Miles	Kirkland & Capper	2¼	4 8½	Granted.
Dartford Extensions	Kent	Dartford District Council	W. C. C. Hawtayne	7¼	4 8½	Partly granted.
Devonport Corporation	Devonshire	Devonport Corporation	C. Chadwell	1¼	3 6	Decision reserved.
Doncaster Corporation	Yorkshire	Doncaster Corporation	W. H. R Crabtree	1¼	4 8½	Granted.
Dudley, Halesowen and District	Worcestershire & Staffordshire	Dudley, Stourbridge and District Electric Traction Co. and British Electric Traction Co.	S. Sellon	3½	3 6	Owing to competition with Quarry Bank scheme several lines withdrawn
Grimsby District	Lincolnshire	Great Central Railway Co.	C. A. Rowlandson	7¾	4 8½	Decision deferred till 1904.
High Peak District	Chester & Derby	Derbyshire and District Traction Synd.	J. E. Waller	20¼	4 8½	Withdrawn.
Quarry Bank, Brierley Hill and Rowley Regis	Staffordshire and Worcestershire	Quarry Bank, Brierley Hill, and Rowley Regis District Councils	R. P. Wilson	3½	3 6	Partly granted.
Ripon and District	Yorkshire	Power and Traction (Ltd.)	R. A. Smith	4½	3 6	Ditto.
Rowley Regis	Staffs. & Worcs.	Rowley Regis District Council	R. P. Wilson	3¾	3 6	Rejected.
Rugby and District	Warwickshire	O. W. Bowen and S. Horton	Pritchard, Green & Co.	4½	3 6	Granted.
Torquay and District	Devonshire	Power and Traction (Ltd.)	R. A. Smith	8	3 6	Rejected.

May, 1903.

Bath Electric Tramways (Light Railway Extensions)	Somerset	Bath Electric Tramways	G. Hopkins & Son and Harper Bros.	3½	4 8½	Partly granted.
Bideford, Westward Ho! and Appledore (Light Railway Extensions)	Devon	Bideford, Westward Ho! and Appledore Railway Co.	S. Sellon	1¾	4 8½	Ditto.
Bromley and District	Kent	British Electric Traction Co.	S. Sellon	6½	4 8½	Rejected.
Devon South Hams	Devon	T. W. Barber and J. Ford	T. W. Barber	44½	3 0 4 8½	Decision reserved.
Harrow Road and Willesden	London & Middx.	Harrow Road and Paddington Tram Co.	S. Sellon	1	4 8½	Withdrawn.
Hove and District	Sussex	British Electric Traction Co.	S. Sellon	3¾	3 6	Ditto.
North Somerset	Somerset	W. Vaughan-Jenkins and others	S. W. and A. L. Yockney	7½	4 8½	Decision reserved.
Portsmouth and Hayling	Hants	W. Kennedy and R. Spence	W. Cobbett & Co. and G. G. Eady	4	4 8½	Granted.
Stretford	Lancs.	Stretford District Council	E. Worrall	4	4 8½	Partly granted.
Upper Wharfedale	Yorks. (W.R.)	A. Lupton and Wm. Robinson	E. O. Ferguson	5¾	4 8½	Withdrawn.
West Manchester	Lancs.	West Manchester Light Railways Co.	W. B. Myers-Beswick	7	4 8½	Partly granted.
Pwllheli, Nevin and Porthdinllleyn	Carnarvon	North Wales District Light Railway and Electric Power Syndicate	A. Ward-Thomas & J. W. Donaldson	12	4 8½	Decision reserved.

PARLIAMENTARY NOTICES.

During October and November we gave some particulars of the notices of intention to promote electricity supply and traction bills, &c., and we are now able to give the following further particulars:—

A bill has been lodged for incorporating the *Lincolnshire and Yorkshire Electric Power Co.* for the purpose of supplying electricity in bulk to authorised undertakers, and for supplying electrical energy for power in certain districts of Lincolnshire and Yorkshire. Among the promoters are Messrs. A. Lupton and H. E. Leetham (who with others are first directors). The capital of the proposed company is to be £999,000 in £10 shares, but with power to divide into preferred and deferred half shares and borrowing powers to the extent of £533,000, which may be raised by the issue of debenture stock. It is proposed to acquire land for three generating stations, at Market Rasen, (Lincs.), Beverley (East Riding) and Easingwold (North Riding). The area of supply is to be the whole of Lincolnshire, the whole of the East Riding and a large portion of the West Riding, and the whole of the North Riding with the exception of Middlesborough and parts of Guisborough and Stokesley Unions. It is also sought to empower the company to erect overhead cables subject to consent of the public authorities, and to limit the dividend payable by the company to 8 per cent. per annum, but subject to a sliding scale. Power is also sought to enter into agreements with all the Yorkshire and Lincolnshire railway companies to supply them with energy in bulk for motive power, lighting and any other purpose, for use within or without the area of supply. The powers are to be exercised within three years.

The North Wales Power and Traction Co. have deposited a bill in which power is sought to construct generating stations for the supply of electricity in North Wales, including the whole of the Counties of Carnarvon, Merioneth, Anglesey and Denbigh, excepting Wrexham borough and rural district and so much of the county of Flint as comprises the urban districts of Prestatyn and Rhyl and the rural districts of Overton and St Asaph. The capital proposed to be expended on the works, if authorised, shall not, without the consent of the Board of Trade, exceed £1,000,000, which includes a proposed subscription not exceeding £100,000 to any incorporated company or to any firm or person agreeing to take a supply of electricity from the company. It is also sought to take over the powers granted in 1901 to the Portmadoc, Beddgelert, and South Snowdon Railway Co. so far as they relate to the construction of generating stations and the generation of electricity and the supply thereof within certain parts of Carnarvon. The powers of the company for the supply of electric energy are to be limited to authorised undertakers and to persons requiring a supply for power, and the profits divisible by the company are limited to 10 per cent. subject to a sliding scale. The powers are to cease if not exercised within two years.

One of the most interesting of the new power schemes is that for the supply of electricity in bulk in the lower Thames district and in parts of South Essex. In the area scheduled in the *East London and Lower Thames Electric Power Bill* eight London boroughs are included and all the urban districts of south-east Essex, including Hackney, Bethnal-green, Stepney, Poplar, Deptford, Greenwich, Bermondsey, West Ham, Ilford, Woodford, Wanstead, Leyton, East Ham, Barking, Romford (urban and rural), Grays, and nine parishes in Orsett Union, &c. The proposed capital is £2,000,000, in £10 shares. The bill has a clause providing that the company shall not supply energy in any area of supply of authorised distributors without their consent.

A group of promoters (including Major L. H. Isaacs and Sir Robert Dashwood) have deposited a bill for the construction of an underground electric railway under the *River Thames* between North and South Woolwich. The proposed will be ¾ mile in length, and will commence in North Woolwich and terminate in South Woolwich. The generating station will be on the north side of the river. The capital required £200,000, with the right to borrow £80,000.

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The Derbyshire and Nottinghamshire Electric Power Co. have deposited a bill to enable them to assign a preference to any shares, to repeal the existing borrowing powers, to enable the company to borrow any sum not exceeding the amount of the share capital at the time actually issued and accepted, to expend £144,000 in payment of interest out of capital, to enable the company to acquire the undertakings of local authorities and others, to issue shares at a discount, to pay commission on the placing of shares not exceeding 10 per cent., and to subscribe for shares or lend money to other undertakers,

In the *Lothians Electric Power* provisional order, it is sought to incorporate a company for establishing electricity works and for generating and supplying electric energy for power, &c. Four sites for generating stations are specified, Kingsknowe, Lasswade, West Linton and Auchengray, and the area of supply is the county of Midlothian (excepting Edinburgh and Leith and the parishes of Stow, Heriot and Fala and Soutra), and certain parishes in the counties of Haddington, Peebles and Lanark. At a recent meeting of parties interested in this scheme it was stated that it was considered advantageous not only to co-operate, but possibly to unite with the Fife Electric and Scottish Central Companies, with both of which Mr. H. Graham Harris (Messrs. Bramwell and Harris, consulting engineers, Westminster) was associated. It had been resolved to issue the balance of the capital of the Fife Company at 25 per cent. premium. One-half the capital of the Lothian Company would be sufficient to carry the bill to a conclusion. With the exception of the Mid-Lothian County Council, no opposition was likely to be offered. The idea of the scheme was to supply electric power to any person wanting it within the district in bulk.

The Clyde Valley Electric Power Co. have lodged a bill, in which they seek to repeal the clause in its Act prohibiting the erection of generating stations on sites other than those scheduled in the Act, and for power to erect such stations on any lands that may be owned, leased or acquired by the company. The company also seek power to take over the electric lighting undertaking of any local authority or other undertaker within the area of supply, or any extension thereof, and in particular the electric lighting undertaking of Clydebank.

To the *Manchester Corporation Tramways* bill are four schedules setting out the terms upon which Aston-under-Lyne, Withington and Altrincham tramways are to be worked by the Corporation. The agreement with Ashton-under-Lyne Corporation is not yet signed and sealed, but Manchester Corporation propose to construct or reconstruct and electrically equip the Manchester, Audenshaw, and Droylsden tramways and keep them in repair, and Ashton Corporation is to do the same for Ashton-under-Lyne tramways. Each Corporation grants to the other running powers over its lines, but the net profits made by each in the other's district are to be handed over to the other. The managers of the two Corporations are to agree as to the net profits or go to arbitration. Manchester Corporation will supply current required in Manchester, Audenshaw and Droylsden for working and lighting the tramways, and Ashton Corporation will give like service to its district.

In the bill deposited by *Newcastle-on-Tyne Corporation* for the construction of additional tramways, &c., the total cost of the new lines is estimated at £129,740.

The Tyneside Tramways and Tramroads Co. are seeking authority for constructing a short extension of their system at an estimated cost of £3,374.

The Great Northern and City Railway Co. have deposited a bill to extend the time (until 1907) for completing their Moorgate-street to Lothbury extension.

In the bill deposited by the *Metropolitan Railway Co.* power is sought to convert and consolidate their existing capital and to raise additional capital.

In the *Kirkcaldy Burgh* order authority is sought to enable the Corporation to provide, sell, and let for hire lamps, meters, electric fittings and apparatus, &c., and to enter into contracts for the supply by the Corporation of energy beyond the burgh.

Govan Burgh are applying for a provisional order to authorise the purchase or manufacture and to supply within their area of electricity supply, electric lamps, fittings, meters, dynamos, &c.

LEGAL INTELLIGENCE.

Tampering with Electricity Meters.

At Durham Police Court on Wednesday last week, two women (named O'Hara and Jones) were summoned for fraudently obtaining electricity, the property of the Northern Counties Electricity Supply Co.

Mr. MARQUIS, for the prosecutors, stated that the company put penny-in-the-slot meters into houses at Low Spennymoor for registering the supply of electricity for lighting certain premises. The company's collector (Mr. W. J. Fleming) found in O'Hara's meter a hat-pin. For 1d. electricity was supplied for 5½ hours, and the effect of the insertion of the hat-pin was that the pendulum was stopped, thus preventing the supply of electricity being cut off after the expiration of 5½ hours. The company were reluctant to prosecute and did not press for a heavy penalty. They had brought the case as a warning.

The woman said the penny would not go down, so she tried to push it with a hat-pin, which got fast in the meter. She had no intention of defrauding the company.

A fine of 10s., including costs, was imposed.

In the second case, Mr. FLEMING said on opening the meter he found a hat-pin had been pushed in in a similar way to the last case. There was no head on the pin, and they had not, he presumed, been able to get it out of the meter. The meter happened to be down to zero, so he could not definitely say any current had been used after it had stopped registering. The meter showed signs of having been tampered with at that particular place.

Defendant said she did not know how the pin had got in.

Mr. FLEMING said he did not say defendant had done it, but the meter was in her house, and she was responsible.

Fined 10s., including costs.

Cardiff Power Station Incident.

At Cardiff, on Monday, the man Frederick Parks, who, out of revenge for dismissal, recently disconnected the field circuit of a tramway generator at the Roath power station, was charged with "having feloniously and maliciously injured certain electric lines with intent to cut off a certain supply of electricity" on Dec. 24. The evidence was to the effect that, after dismissal by the manager (Mr. Arthur Ellis), prisoner entered the station at night and disconnected the cables, bringing all the cars in the town to a standstill. The witnesses called were Mr. Arthur Ellis, Mr. K. Cramp (shift engineer), Mr. W. Ashford (switchboard attendant) and Mr. W. G. Gregory (assistant switchboard attendant).

Mr. ELLIS deposed that at half-past nine on the night in question he was on the Hayes Bridge, when he noticed the current cut off all the trams in the district. Thinking it might be a local fault, he waited, but as the current did not come on he went to the sub-station and telephoned to the power station, and himself followed as quickly as possible. He found prisoner laid out and being attended by a doctor. He made inquiries, and communicated with the police. The damage to the machinery he estimated at £100, in addition to the loss in suspension of traffic for about 20 minutes. Internal troubles might have been set up in the machine which would probably take some time to develop, and almost at any moment they might have a similar occurrence, caused by this man's interference. Prisoner had been engaged as a wireman, and was discharged, so that at the time he had no business on the premises. He believed Parks had not suffered so much from shock as from the fall from the platform. Mr. Ellis said he was in his office at 5:30, and knew that a heavy load was on the two large machines that were running. He was particularly anxious, having regard to what happened at Bristol the night before, not to run any risks. He, therefore gave instructions to transfer the load from the big machine to four smaller ones standing in case of emergency. But for these instructions Cardiff would have had a panic similar to that at Bristol, and as to the damage that might have been done, he could not estimate it. Prisoner was the man who actually fixed these particular cables in position, and so knew where to go to disconnect them.

After police evidence had been taken, prisoner was committed for trial at the sessions, bail being refused.

Workmen's Compensation Act.

The Court of Appeal recently gave judgment in an appeal of the Lancashire and Yorkshire Railway Co. from an award of the County Court Judge at Blackpool. Defendant was an engine driver, named Benson (in the employment of appellants), who was killed by an accident before he had signed on for the day, and was returning from a signal-box to the engine shed, after going for information required in connection with a special report demanded of him.

The MASTER OF THE ROLLS said it seemed to him deceased's place of business was the engine shed, and that until he got there to resume his daily occupation, he could not be said to be in the course of his employment. If he chose to approach the shed by a route that would necessitate his crossing the metals, he did so at his own risk. He carried with him no insurance or protection at the hands of his employers. It was a fallacy to say that the man had entered upon his employment merely because he found himself on his employer's premises. The County Court Judge's decision must, therefore, be reversed.

The Lords Justices concurred, and the appeal was allowed, with costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer with good commercial knowledge and experience in estimating costs and preparing tenders is required by Messrs. Vickers, Sons and Maxim (electrical department), Sheffield. See advertisement.

An electrical engineer is also wanted to take charge of dynamos, motors and other electrical plant in steel works. Applications to Messrs. Vickers, Sons and Maxim (Ltd.), Sheffield. See advertisement.

An assistant is wanted for the testing department of an electricity works. Must have had technical training and experience in testing and calibration of electricity meters. Applications to city electrical engineer (Mr. Victor A. H. M'Cowen), Belfast, by Jan. 13. See advertisement.

The post of assistant instructor in machine drawing at the City and Guilds Technical College, Finsbury, is vacant. Applications to Prof. W. E. Dalby, Leonard-street, Finsbury, London, E.C. See advertisement.

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The governing body of the South-Western Polytechnic, Chelsea, London, S.W., are about to appoint a new principal on the retirement of Mr. Herbert Tomlinson, F.R.S. Commencing salary £600. Applications to secretary by Feb. 15.

An assistant electrical engineer is wanted by the Bengal-Nagpur Railway Co. (Ltd.), with thorough mechanical and electrical training. Applications to company, 132, Gresham House, London, E.C., by Jan. 15.

Southend-on-Sea Light Railways and Electric Lighting committee require two tramway inspectors with previous experience. Applications to Mr. W. E. J. Heenan by noon Jan. 18.

On Wednesday, Manchester Corporation confirmed the recommendation of the Electricity committee to appoint Mr. Standen Leonard Pearce chief electrical engineer of the Corporation electricity department for one year at a salary of £800 per annum, subject (1) to his devoting his whole time to the duties of his position, (2) to arrangements with Dr. Kennedy and Mr. G. F. Metzger, and (3) to any other arrangements which the Corporation may make from time to time with consulting engineers.

Mr. C. A. Burge, superintending engineer of postal telegraphs for the North Wales district, has been transferred to the southern district (Ireland) vice Mr. L. Collins, superannuated; Mr. W. Slingo has been appointed superintending engineer of the North Wales district.

Mr. A. Moir, formerly assistant superintendent engineer at Newcastle, has been appointed a first-class technical officer at the General Post Office, London.

Aberdeen.—A report on the necessity of extensions of plant at the Ferryhill generating station to meet next winter's anticipated demand has been prepared by the city electrical engineer (Mr. J. Alex. Bell), who recommends that the following additional plant be procured:—

One 740kw. direct-coupled generating set, with condenser, air pump, steam and exhaust pipes, foundations and switchboard connections, £10,800; two boilers, each capable of evaporating 15,000lb. of water per hour, with mechanical stokers, steam pipes, foundations, flues and brickwork, £4,300; coal bunkers of mild steel of 800 tons capacity, with bucket coal-conveyer, electrical driver, weighing machines, and rails, &c., complete, £3,500. Allowing 10 per cent. for contingencies, say, £11,860, this would bring the total to £20,460.

The committee have endorsed Mr. Bell's proposals, and recommend the Council to obtain tenders.

Acton (Middlesex).—At a recent meeting the sub-committee appointed to interview the Board of Trade on the question of the revocation of the provisional electric lighting order (with the result reported in our issue for Dec. 25) reported that they had since endeavoured to obtain a reduction in price of current which the Metropolitan Electric Supply Co. had offered to supply in bulk, but without result. Supply would be available in four months:—

The Chairman (Mr. A. W. W. King) said he had unwittingly misled the Council. He had understood the provision for the right to demand a revision of prices at the expiration of 9 or 18 years was for the benefit of the Council only, but the Metropolitan Company maintained that the right was a mutual one. The company said they would go forward with their provisional order unless they came to terms with the Council. The company offered (provided the Board of Trade did not revoke the Council's order, and refused the Empire Electric Light and Power Co.'s application for an order) to supply electric current in bulk at 10,000 volts to a sub-station at 3d. per unit for the first two hours' daily use of the half-yearly maximum demand, and ¾d. per unit for all units in excess of that quantity. The agreement would be for 27 years, either party having the right to teminate at the ninth or eighteenth year on three years' notice. If the agreement were so terminated, the Council would have to repay to the company two-thirds or one-third (as the case might be) of the cost of the trunk mains. The Council would erect the sub-station and lay distributing mains. He moved that these terms be accepted.

Mr. Hunt seconded, and the motion was carried, and a sub-committee appointed to settle the terms of the contract.

Argentina.—The "Review of the River Plate" states that the River Plate Electricity Co. have secured a new contract for the public lighting of La Plata. The company have agreed to increase the number of lamps and to decrease their charges.

Mr. R. Seeber has been granted a concession (for 50 years) for an electric tramway from Riniero to Riachuelo, Buenos Ayres.

The Compañia Transatlantica de Electricidad have declined to carry out the terms of their concession obtained in 1899 from Buenos Ayres Municipality for the construction of an electric tramway between Barracas and the North Basin.

Bath Tramways.—The British Westinghouse Co. have executed some quick work in connection with this contract. On May 1 ground was broken for the generating station, car sheds and office buildings, and these have since been erected and equipped throughout. The generating station has a capacity of 675kw, and the car sheds hold 40 cars. The complete electrical equipments for the latter consist of Westinghouse 49B/90, with Westinghouse magnetic brakes. The Board of Trade inspection took place on Dec. 12, 7½ months after commencement of the work.

Belfast.—The adjourned monthly meeting of the Corporation was held on Monday when it was reported that the electric department had made considerable progress during the past year.

The total connections to the supply mains for lighting and power now amounted to the equivalent of 100,000 8 c.p. lamps, an addition of 44,000 for the year, almost equal to the increase of any two former years together. The motor load was continuing to grow. There is now 1,880 H.P. in motors connected, an increase of 600 H.P. for the year. The maximum load during the winter reached 2,190kw., the highest on record, and it is necessary to instal more plant during the coming year. The units sold showed a satisfactory increase, the estimate for the year being 1,989,000 units, against 1,491,841 for the previous year, an increase of 33 per cent.

The Corporation were recommended by the Law committee to oppose the Ulster Electric Power and the Belfast and North-East Electricity and Power Gas Bills as it was considered undesirable to have a competing system of electrical supply in the district. This recommendation was agreed to.

With regard to the Holywood Tramway Bill, it was decided that, as the formal consent of the Corporation was not required until 18th inst., the matter should be referred back for further consideration.

Birmingham.—The first municipally-owned electric tramway route in Birmingham—from the top of Steelhouse-lane to the City boundary in Aston-road—was opened on Monday.

Bispham.—Blackpool Corporation have refused to extend gas mains into the village, and it is proposed to ask the Blackpool and Fleetwood Tramroad Co. to supply electricity for public lighting.

Brompton and Kensington (London).—The Brompton and Kensington Electricity Supply Co. announce a reduction in the charge for electric current:—

For lighting the price per unit will be 5½d. up to 500 units per annum; between 500 and 1,000 units, 5½d. for the first 500 and 5d. after; between 1,000 and 2,000, 5½d. for the first 500, 5d. for the second 500 and 4¾d. after; between 2,000 and 3,000, same rate as above, but 4½d. per unit for the third 1,000; between 3,000 and 4,000, rate as above, but 4¼d. per unit for the last 1,000. The charge for current for power and heating supplied through separate meter remains at 3d. per unit, and the existing scales of discounts are abolished.

Buluwayo (Rhodesia).—The Buluwayo Waterworks Co., who have supplied electrical energy from their station since 1898, have now the total equivalent of 13,000 8 c.p. lamps connected. The population of the district served by the works is 4,000, and the total plant capacity 415kw. There are 600 consumers of electric current on the company's books. Overhead cables are employed, and the generating plant includes Robey engines, Babcock-Wilcox boilers and E.C.C. generators. The price of current at Buluwayo is on a sliding scale from 2s. to 1s. 7d. per unit.

There is a total mileage of telegraph wires in Rhodesia of 4,765 owned by the British South Africa Co. These lines are carried on 2,360 poles. The same company owns the telephone system, which consists of five exchanges (at Salisbury, Buluwayo, Umtali, Gwelo and Selukwe), the number of subscribers at each place being respectively 107, 130, 30, 28 and 23. The rates are 15 guineas per annum per mile for private subscribers.

Cardiff.—The borough electrical engineer and tramways manager (Mr. A. Ellis) presented, on Tuesday, a lengthy report to the Electric Lighting committee upon street lighting. Estimates were submitted for the electric lighting of the principal thoroughfares not at present so lighted.

To carry out this work where there were at present no mains, Mr. Ellis estimates, would involve a capital expenditure of £7,430. 10s. 8d., and the annual extra cost for lighting would be £3,346. To electrically light certain thoroughfares where mains were provided would cost £1,561. 12s. 6d., annual cost £1,610.

After discussion it was agreed to defer further consideration of the report.

Cathedral Lighting.—Mr. H. A. Willey (of Willey & Co., electric lighting contractors, Exeter) has provided and fitted, free of charge, electric light wiring and fittings for the nave, choir, aisles and Lady Chapel of Exeter Cathedral. There are 41 seven-light fittings, and steel tubing is employed for the wiring. Current is taken from the Corporation mains, and is distributed from a main switchboard on the western side of the south transept. The nave will be lighted by 14 electroliers, the choir by 13 similar fittings, and the other parts of the sacred building will be adequately illuminated. The specification was prepared by Mr. T. Hammond, A.I.E.E., and carried out with the assistance of the city electrical engineer, Mr. H. D. Munro.

Cheltenham.—The monthly report of the borough electrical engineer (Mr. Hamilton Kilgour) for December states that at present there are 749 consumers, with the equivalent of 47,270 8 c.p. lamps connected.

Collision between Cable Steamers.—While the s.s. "Mirror," of the Eastern Telegraph Co.'s cable fleet, was proceeding to her berth in Stonehouse Pool, off Plymouth, on Saturday, owing to a

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squall coming on, she collided with the same company's dismantled c.s. "Chiltern." Very little damage was done to the "Mirror," which proceeded to her moorings. The "Chiltern" was, however, submerged, but is expected to be refloated in the course of a day or so.

Crediton.—The District Council will not oppose the application of Christy Bros. and Middleton for a provisional electric lighting order.

Derby.—It has been agreed to adopt arc lighting for the electric tramway routes, and an expenditure of £1,250 has been sanctioned.

The Council have authorised expenditure of £7,155. 8s. for connecting the Osmaston and Normanton-road electric tramway routes. A portion of the Burton-road route (estimated to cost £4,684) has been abandoned.

Dewsbury.—Charges having been made against the borough electrical engineer (Mr. R. H. Campion) of receiving a commission of 10s. per barrel on oil supplied to the electricity works, the Electricity committee are satisfied that these charges are without any foundation, and have decided in favour of the town clerk conducting proceedings for libel as solicitor for Mr. Campion at the cost of the Corporation.

Doncaster.—The ratepayers have approved the Corporation's bill for the extension of the electricity supply area, &c.

Dundee.—The receipts of the tramways department for the past year were £43,369. 5s. 9d., an increase of £4,456. 7s. 9d. over 1902, the number of passengers carried being 11,185,035, compared with 1,176,069.

Dutch Indies Cable Enterprise.—It is announced that the islands of Banca and Billiton, as well as Pontianak (Dutch Borneo), will shortly be connected with the telegraphic system of the Netherlands Indies by submarine telegraph cables between Java–Billiton–Borneo, Billiton–Banca and Banca–Sumatra.

Eccles.—At Wednesday's Council meeting it was reported that an agreement had been made with Salford Tramways committee for constructing the permanent way of certain tramways. See also Salford note.

Electricity in Mining—In some recent articles by M. Emile Guarini on electric power appliances in mines, the writer instances two cases of the economy arising from the adoption of electricity. M. Guarini says:—"Prior to the introduction of electricity the Burma Ruby Mines were unable to make any dividends, the expense of the operation being too high. Since its adoption the expenses have been reduced by £6,000 per annum, permitting the payment of profits. At the Sheba Mine the economy in operating expenses since the introduction of electric power in 1896 has amounted to £10,000 per annum." The contracts for the power equipment for both mines were executed by Messrs. Johnson & Phillips, Old Charlton, Kent, who have made a speciality of transmission of electric power in mining.

Fiscal Commission.—It is understood that Mr. Chamberlain will inaugurate the proceedings of the Tariff Commission at the Westminster Palace Hotel, Victoria-street, Westminster, London, S.W., on 15th inst. The Commission, under the presidency of Sir Robert Herbert, will sit daily, and will be assisted by sub-committees appointed to deal with details. The sittings of the Commission will, it is stated, be held in camera. Mr. W. A. S Hewins (the secretary) will, however, prepare a brief report of each day's proceedings for the Press.

Mr. Geo. Flett, managing director of Dick, Kerr & Co. (Ltd.), has accepted a seat on Mr. Chamberlain's Commission to inquire into the fiscal question.

Gateshead.—The Town Council have agreed to a proposal of the County of Durham Electrical Power Distribution Co. for a reduction of charges for electric current to consumers, the company's period of supply under the provisional order being extended from 13 to 14 years.

Great Northern and City Railway.—Feb. 1 has been provisionally selected for the opening of this line.

Hackney (London).—Some doubt having arisen as to the terms of Mr. R. Hammond's engagement as consulting engineer, legal opinion obtained by the Electric Lighting committee is to the effect that

"Mr. Hammond has been appointed by the contract consulting engineer for the whole of the works necessary for the supply of electricity within the parish under the provisional electric lighting order. The instalment of scheme B was introductory only to the execution of the complete undertaking to which the borough was committed and which was defined by the contract. No better course could be adopted than to accept Mr. Hammond's terms."

Mr. Hammond had previously expressed his willingness to abide by his letter of January, 1903, and to waive the final 1 per cent. commission due to him on completion of all future extensions of mains, meters, public lighting and apparatus comprising the distributing system. The Electric Lighting committee recommended that a supplementary agreement be entered into with Mr. Hammond in accordance with the advice of counsel and recognising his position as consulting engineer for the whole of the works necessary for the supply of electricity within the borough under the order.

The same committee reported that, since the termination of the agreement with the National Electric Construction Co., a number of likely consumers had been lost owing to the inability of the Council to continue the "free" wiring or to find contractors willing to put their capital into the business. It was understood that if the London County Council again brought in a bill to obtain powers for borough councils to wire consumers' premises, those who had previously opposed would not renew their opposition. The committee had, therefore, passed a resolution that a conference of representatives from borough councils possessing electric light undertakings be convened for early next month.

Hartlepool.—Northern Counties Electricity Supply Co. propose to commence supply of electric current to-morrow (Saturday).

Insurance of Machinery.—The Stuttgarter Mit und Rückversicherungs A.G., an insurance enterprise established at Stuttgart in 1891 (capital £240,000), with the general objects of a life and fire insurance company, added to its business in 1902 a department for the insurance of machinery. The latest report of the company indicates that this branch of operations has proved very successful.

The risks undertaken by the company include accidents to machinery through the ignorance of workmen, or their inability to understand the workings of the machines; the improper setting of the machine; electric power accidents, or incidents interfering with the working of the machine; accidents from water, lightning or breaking, but not including wilful damage or damage from known defects in the machines, from ordinary wear and tear, damage during transfer of interchangeable parts, or from fire or causes which can be separately insured against. In some cases special policies are, however, issued to cover the risks thus exempted from the general policy, which covers no risk for injury to workmen. From the nature of the case a well-considered clause is necessary, providing for arbitration in case of dispute, and this is provided. The rates for insurance run from 4s. to 8s. per cent. of the insured value, except in the more serious risks, which rise to 10s. per cent. The limit of indemnification under the policy is 80 per cent. of the ascertained damage. The lowest premium accepted is £2. 10s. (50 marks), and a charge is made of 3s. for each policy issued.

Islington (London).—The Council have asked the London County Council whether they would be prepared "to take the electricity required for the electric tramways under their control from the Metropolitan Borough Councils who are also electric lighting undertakers, provided the latter are prepared to supply such electricity under suitable conditions and at reasonable rates."

Leeds.—At the meeting of the Leeds Chamber of Commerce on Wednesday, Mr. E. Matheson referred to the omnibus bill of Leeds Corporation, and complained that the latter was seeking to do things in the West Riding of the county at the expense of the Leeds ratepayers and in opposition to Yorkshire traders.

About two years ago (he said) a company was promoted for supplying electricity for light and power to factories outside the city. Leeds Corporation opposed the laying of cables through the streets of the city, but Parliament over-ruled the objection, and the company obtained its powers. The present bill would give Leeds Corporation powers over any local authority or company "in any district adjoining or near to the city." He had been told that this would practically cover the whole of the West Riding except the large towns. Not only would the Corporation by the bill get powers to supply electric energy to townships that had already power to supply it, but they would have power to prevent any company manufacturing or selling it. That was going outside the duty of a municipality, and unless that clause was opposed it would slip through.

A resolution was unanimously passed that clause 116 in the bill to be promoted by Leeds Corporation next session, seeking powers for selling electrical energy outside the limits of the city, and clause 111, giving power to the city to refuse a right of way to electrical companies, should be confined to the immediate suburbs outside the city.

The City Council on Wednesday decided to adopt the recommendation of their Tramways committee to introduce the "split turn" system on their lines. It is to be tried for a period, and if the men are still dissatisfied the whole question is to be reopened.

Light Railway.—The Board of Trade have confirmed the Quarry Bank, Brierley Hill and Rowley Regis Light Railway Order, 1903.

Liverpool.—Mr. Muirhead, on the presentation of the Electric Power and Lighting committee's minutes at Wednesday's meeting of the Corporation, inquired if the committee, when renewing its stock of electric lamps, took into consideration the question of quality of the lamps as well as the price and also the encouragement of British manufacture.

The Chairman (Mr. Dart) replied that the committee got the very best kind of lamps, both of British and foreign manufacture. It could not be denied that the price of foreign lamps was little more than half that of English lamps.

Llanelly.—The District Council have again passed resolutions not to proceed with their bill for the construction of electric tramways and for confirmation of an agreement with the British Insulated and Helsby Cables (Ltd.), &c.

London County Council Tramways.—Holborn Borough Council will oppose the County Council's electric tramway project for Tottenham Court-road, and the Marylebone Council are also recommended by their Parliamentary committee to oppose

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Monday has been fixed for the official inspection of the electric tramway route from the Elephant and Castle to Greenwich via Old Kent-road.

Marylebone (London).—At the meeting of the Council last evening the two motions of Councillor Edward White, (1) that the engagement of Mr. Arthur Wright, the electrical adviser to the Council, be determined, and (2) that a return be presented to the Council of the total costs in connection with the recent arbitration proceedings between the Council and the Metropolitan Electric Lighting Co., were on the paper, but on being reached it was found that Councillor White was not present to move them.

Mr. Councillor E. R. Debenham pointed out that these motions had been on the paper for a considerable time and with regard to the first motion it was unfair to a professional gentleman of the standing of Mr. Arthur Wright that such a motion should remain unsettled. He moved that both motions be struck out, and this was approved.

The Electric Supply committee reported that the parliamentary agents of the Council (Messrs. Sharpe, Parker & Co.) had submitted a draft of of the bill to be promoted by the Council next session to amend the Electric Lighting Order Confirmation (No. 1) Act, 1901, and for other purposes. The committee had considered the bill in detail, and after agreeing to several amendments had resolved that as drafted and amended it be approved, and they had authorised the parliamentary agents to deposit the bill, and to take all necessary steps to promote same.

The Mayor (Rev. Russell Wakefield) brought forward the report of the committee appointed to interview the Metropolitan Electric Supply Co. The reference to this committee and its constitution was given fully in our issue for December 11, p. 309. They had had two interviews with the company, but the company declined to agree to the setting aside of the award unless they received in some form or other a sum equivalent the £1,212,000 awarded by the arbitrator. That settled the point strictly referred to the committee. The company, however, indicated that they would be willing to facilitate the completion of the purchase of their Marylebone undertaking, on terms which they were asked to put in writing and their letter, dated 5th inst. was as follows:—

"The company would be prepared to recommend the shareholders to assist the Council in the following manner: That, subject to the Council leasing the Marylebone undertaking to the company from Jan. 1, 1905, until Dec. 31, 1931, the company, instead of requiring the immediate payment of £1,212,000 in cash, to accept as stock having a charge upon the revenues and rates of the borough in priority to any subsequent loan, and bearing interest at a rate to be agreed, the Council to undertake to obtain for the stock a quotation on the London Stock Exchange and redeem it at par in 42 years. The annual rent to be paid by the company to be a fixed sum practically equivalent to the yearly interest on the stock. As regards capital to be provided by the Council in respect of the period from Jan. 1, 1902, until the commencement of the lease, the company to pay interest from the commencement of the lease at the same rate as that agreed for the stock. On the termination of the lease, the Council to purchase, on terms to be arranged, a portion of the Willesden works (which portion the company would so arrange as to be suitable and efficient for the supply of Marylebone in 1932), and compensate the company, also on terms to be arranged, for the capital to be expended by them in the borough during the lease. This suggestion was made on the supposition that no competition will be allowed within the Marylebone area, and it would therefore be necessary to provide that, in the event of such competition being sanctioned, the company should have power to terminate the lease, the company from the date of such termination supplying the Council with all electrical energy which the Council cannot themselves generate, subject to existing arrangements regarding the fixing of price by an arbitrator to be appointed by the Board by the Board of Trade. If the Council are prepared to adopt such a suggestion, it would, of course, be necessary that the borrowing powers proposed by the pending bill should be reduced and other necessary amendments provided for."

In addition (continued the Mayor), the company had, in the course of their interviews, put before the delegates a suggestion that if the profits of the undertaking in the borough became greater as the years went on than they now are, the company would pay a percentage on these extra profits to the Marylebone Council. This did not, however, appear in the above letter, and the town clerk wrote the company to discover whether this was an intentional omission. In answer the following letter from the company had been received just before the meeting now being held:—

"In answer to your letter of yesterday's date, I am directed to inform you that the point to which you refer appears to my directors to be a mere matter of detail, which might be subsequently discussed if the general outline of our letter of Jan. 5 is agreed to by the Council."

This (said the Mayor) was the full report of the delegates appointed, and it was evident that it would, under the circumstances, be desirable, before the public meeting on the 19th inst., that the Council should have an opportunity of considering the bill which they were promoting in Parliament. For this purpose a special meeting would be held on Thursday next to discuss the bill, and the Electric Supply committee should present to this special meeting a report on the letters and proposals of the Metropolitan Company. This was agreed to without discussion.

Municipal Telephony.—Hull Telephone committee last week considered the agreement with the National Telephone Co. in regard to intercommunication between the company's existing and the Corporation's proposed systems. This was conceded by the company in return for permitting the company to retain their underground wires, but a dispute has now arisen as to extensions. Negotiations are proceeding.

Musselburgh.—The Town Council have decided to engage an electrical engineer to report upon the proposal to adopt a surface-contact system of electric traction for the local tramways.

Newburn.—The District Council are approaching the Newcastle and District Electric Lighting Co., with regard to a supply of electric current in the district.

Newcastle-on-Tyne.—The receipts of the Corporation tramways were £120,697 and expenses £102,627, leaving a net profit of £18,070 for the six months ended September.

Nottingham.—The City Council on Monday considered a recommendation of the Electricity committee to apply for sanction to a further loan of £100,000 for completing the equipment of the first section of the St. Anne's generating station and also for extensions of the distributing system.

The Chairman (Sir John Turney) gave particulars of the progress of the undertaking, and said that in 1895 they started with 114 consumers, representing 11,500 8 c.p. lamps, while to-day they had 2,500 consumers with an equivalent of 232,413 8 c.p. lamps. Last year they sold 6,510,476 units at an average price of 2·19d. per unit, compared with 62,879 units at an average of 5·97d. in 1895. From the start there had never been a deficiency on the undertaking, and in 1902-3 the gross profit was £31,696 and the net profit £8,879, out of which £6,000 had been applied in reduction of rates. Works costs had been reduced, and the total cost was now 1·21d. per unit. The proposed loan would suffice for requirements for three years.

The recommendations were unanimously agreed to.

Outrage.—A murderous attack was made on Monday upon Mr. Wilmot E. Lane, secretary of the Electric Lighting and Traction Co. of Australia, who, while engaged in business at his offices in Cannon-street, London, was struck two severe blows with an axe. A youth named Thomas Efford Schutz, who has been in the service of the company for nearly four years, is under remand charged with the attack on Mr. Lane.

Presentation.—The staff and employés of the Sunderland Corporation tramways have presented the retiring general manager (Mr. Harry England) with an oak clock on his departure to take up the position of manager of the Wakefield and District tramways.

Rangoon.—The Municipality recommend the Local Government to grant a licence to the Brush Co., whose tender the municipal engineer considers the most favourable out of the four recently received for the erection of electricity works in the district.

Reading.—At the Corporation meeting last week, it was reported that a conference on the question of fractured axles had taken place at the London offices of the contractors (Messrs. Dick, Kerr & Co.) between members of the Corporation and representatives of the contractors (Mr. Flett, Mr. Rutherford and Mr. Buckmaster).

On Nov. 27 a formal notice had been given to the contractors that the result of tests of axles carried out by the engineers (Messrs. Winslow and Bowen) proved that the steel employed was of bad quality, that the method of cutting the keyways was such as to materially weaken the axle, and that the fractures were considered to be due to these causes. The contractors were to supply new axles, to the full number in the specification, having a tensile strength of 32 to 35 tons with an elongation of 20 to 25 per cent., the keyways in such new axles to be cut in a proper manner, and the present wheels to be removed from the axles now in service and pressed on the new axles. The whole of this work was to be done at the contractors' expense. The contractors had called for the tests, and having inspected same, admitted the low quality of the steel, which they explained came as a great surprise to them, although such cases occasionally occurred in manufacture. They stated they were not the makers of the steel, and would have to take the matter up with their sub-contractors. The contractors' representatives thereupon freely agreed: (1) To cancel all existing claims for replacement of axles, (2) to supply new axles to the full number in the specification having a tensile strength of 32 to 35 tons, and an elongation of 25 per cent., and having keyways properly cut; (3) to put new wheels (to be supplied by the Corporation) on to the new axles, and to fix the same under the cars at Reading. The tramways committee had accepted these terms, and recommended that the arrangements made with Messrs. Dick, Kerr & Co. be confirmed.

The recommendation was agreed to.

Reigate.—Sanction to a further loan of £7,000 for extensions of the electricity undertaking has been obtained by the Council.

Regulations for the Manufacture of Electric Accumulators.—In our issue for Aug. 21, 1903, we printed the draft of the proposed regulations for the manufacture of electric accumulators made by the Home Office in pursuance of sec. 79 of the Factory and Workshop Act, 1901. No objection of substance was made to the regulations (except those since withdrawn) by employers, workmen, or other persons affected. In formally issuing the regulations, which apply to all accumulator works from Jan. 1, 1904 (in substitution for the special rules established under the Factory Act of 1891), the following observations by the chief inspector of factories (Dr. Arthur Whitelegge) are made by way of explanation of certain of the regulations and to indicate additional safeguards which it has not been thought practicable to define as formal requirements:—

Regulation 1.—The word "windows" in par. 2 does not exclude skylights nor does the wording require that the necessary through ventilation

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must always be maintained by means of windows alone. When pasting is done, for instance, as in Regulation 5 (*b*), through ventilation can be maintained by the windows on the one hand and the exhaust draught at the bench on the other.

Regulation 2.—The words "effectual separation" do not necessarily involve separate workrooms. This portion of the regulation has been left in general terms, since in some cases the desired effect may be attained by apparatus entirely closed in, or by suitable screens (not necessarily extending from floor to ceiling) and local exhaust ventilation.

Persons engaged in the pasting room are exposed to special dangers. The requirements of Regulations 2, 3, 5 and 6 must be regarded as the minimum that can be demanded for the control of dust, but other means of protection in this direction should also be devised when practicable. In this room especially good light is necessary, preferably from windows in the wall. The incidence of poisoning on persons thus engaged has led manufacturers in some instances to alternate the work of pasting with that carried on in the formation room. No regulation requiring the wearing of gloves by persons engaged in pasting has been inserted, but it need hardly be pointed out that their provision in certain cases where, as a precaution against cracking of the skin, or even against lead poisoning, their use seems desirable, would be entirely in harmony with the regulations.

Regulation 8 (*d*).—Special forms for use by appointed surgeons in reporting particulars as to persons suspended are provided. A health register also is provided for use by the appointed surgeon. When the surgeon examines persons he should enter the date in the second portion of the register at the top of one of the 12 columns headed "Date and result of examination," and in the space below (opposite the name of each person examined on that date) a brief note of the condition found. Where definite ill effects are observed, their presence and character should be further described where necessary in the fourth column of the first part of the register. In the first part of the register the date of visit is again to be noted, with a statement of the total number examined, notice of suspension from work or written certificate permitting resumption of work by the surgeon, and his initials.

Regulation 9.—Arrangements for washing overalls should, so far as possible, be such as to exclude its being done at the homes of the workers. It may also be noted here that there are processes which it is difficult to define, such as the handling of formed plates containing peroxide of lead, where use of overalls may be as desirable as in the process of pasting.

Regulation 10.—While the provision of separate lockers for workmen employed in lead processes is not expressly required, advantage would accrue were this plan adopted, each locker being divided into two portions, one portion for clothing put off during working hours and the other for overalls.

Regulation 15.—Evidence is accumulating that lead dust, whether generated in the process of manufacture or from sweeping the floor, dusting shelves, &c., is the main source of danger to all persons in the room. Hence, in the carrying out of Regulation 15, it is suggested that, whenever practicable, moist methods of cleansing should be adopted.

Rotherham.—The omnibus bill of the Corporation (in which additional powers are sought for the electric tramway and electricity supply undertaking) was approved at a ratepayers' meeting on Wednesday.

Royal Society of New South Wales.—At a recent meeting of the engineering section of this Society Mr. S. H. Barraclough was elected chairman, Mr. J. Haydon Cardew hon. secretary, and Messrs. C. O. Burge, G. R. Cowdery, J. Davis, H. Deane, T. H. Houghton, R. T. M'Kay, J. N. C. MacTaggart, H. E. Ross, P. W. Shaw and J. Taylor will constitute the committee.

Royal Warrants.—The following firms and companies have authority to use the Royal Arms by virtue of warrants of appointment:—

To the King.

From the Lord Steward.—Edison and Swan United Electric Light Co., London, for electric lamps; Electrical Power Storage Co., London, for secondary cells.

To the late Queen Victoria.

R. C. Murray, London, for scientific apparatus; Tasker, Sons & Co., Sheffield, for telephone and electric lighting work.

To Queen Alexandra.

From the Lord Chamberlain.—City and Suburban Electric Carriage Co., London, for electric carriages.

Salford.—At the Corporation meeting on Wednesday, Mr. Higson objected to a proposal by the Tramways committee to construct the permanent way of the Worsley-road and Parrin-lane tramways by Corporation workmen. He asserted that the lines already constructed by direct labour had been badly laid, and that money had been extravagantly spent.

The chairman of the committee (Ald. Linsley), in reply, said the committee had intended to let the work to contract, but had been pressed by Eccles Corporation to do it themselves, the latter body being of opinion that the work would be better done if carried out by direct labour. There being only a little over a mile of track, the committee had acquiesced in the proposal.

Other members complained of the way some of the existing lines had been laid, and opposed the committee's recommendation, which, however, was ultimately adopted.

The Electricity committee recommend the Corporation to apply for sanction to a further loan of £25,000 to cover anticipated expenditure on house-service connections, &c., during the next two or three years.

School Lighting.—West Ham Education committee have decided to adopt electric lighting in the Stratford Higher Elementary School.

South Africa.—The "British and South African Exports Gazette," states that—

Pretoria Town Council have been making inquiries as to the total horse-power generated by steam and used in the district, and intend to propose the substitution of electric motors, to be supplied with current from the municipal electricity works.

The general manager of the *Cape Town* Docks (Mr. Hammersley-Heenan) recommends the installation of electric cranes and travellers at the docks.

King William's Town Electric Co. are putting down an additional unit of plant at their generating station.

Messrs. E. R. and F. Turner, Ipswich, have installed electric lighting plant at Messrs. J. P. Malan & Co.'s *Worcester* (Cape Colony) flour mill.

Mr. Robert Poole is supplying the electric cableway to be used during the construction of the Zambesi River railway bridge.

Generating plant to supply electricity in an area of 4 sq. miles is about to be installed at *Indwe* Collieries (Cape Colony).

Exports from the United States to South Africa in September last included electrical machinery of the value of £602, a decrease of £333 compared with September, 1902, and scientific instruments (including telegraph and telephone wire, £2,644, a decrease of £703.

Southend-on-Sea.—During the past year the number of passengers carried on the Corporation electric tramways was 3,288,408. The traffic receipts amounted to £15,475.

Spain.—Particulars are given in the *Madrid Gazette* for Jan. 1 of Royal orders authorising concessions, without State subvention, for several electric lines of tramway and railway in Spain, the concessions being for varying periods of from 60 to 99 years.

Stirling and Bridge of Allan Tramways.—Bridge of Allan Council have referred to a committee a request of Stirling Council for consent to the latter authority acquiring the existing tramways and converting them to electric traction, and extending the system to Bannockburn.

Stockport.—The Mayor, as chairman of the Tramways committee, gave an explanation to the Council on Wednesday, of the circumstances under which the committee had on Monday called for the resignation of Mr. H. McCormick, manager of the municipal tramways, and Mr. J. Sykes, senior clerk.

There had been, he said, no allegation of dishonesty. The cash books were in perfect order. The action of the committee was in respect of neglect of duty in not properly entering up the stores and other books necessary to the proper management of the undertaking.

Mr. James Fernley said there was a feeling in the town that the committee had been somewhat severe.

The action of the committee was confirmed.

Street Lighting Contracts.—During the past year or so the Gilbert Arc Lamp Co. (Ltd.), of Chingford, have carried out three small street-lighting contracts for Eccles, where some interesting lighting with small watt, open-type 6ft. carbon lamps is being done. The company claim to be pioneers of small-watt street lighting on any large known scale, and state that their 5-ampere 250-volt open type, and also their later 200-watt enclosed lamps, have proved very successful.

Sunderland.—For the position of assistant tramway engineer Sunderland Tramways committee received 84 applications, and these have been reduced to Messrs. D. A. Hamilton (Lancaster), L. E. Harvey (Halifax), J. G. Laing (Harrogate), W. T. Robson (Hull), G. W. Robinson (Birkenhead), and T. Wilkinson (Aberdeen).

Swansea.—At the meeting of the Electricity committee on Wednesday it was decided, on the recommendation of the borough electrical engineer (Mr. Prusman) that the supply of electricity to Morriston should be effected on the two-phase system, and that the same mains should be used for lighting and traction. The construction of the Morriston, Bryn-road and Walter-road tramways will, it is hoped, be commenced in a month's time.

Victoria (Australia).—Subject to the permission of the Minister of Public Works, Mr. A. E. Morgans, M.L.A., has agreed with Essenden and Flemington Councils to construct a series of electric tramways, the several local authorities having the right to purchase at the expiration of 14 years.

U.S. Trade with Britain and British Possessions.—The following figures are extracted from a report prepared by Mr. E. Seymour Bell, British Commercial Agent in U.S.A., and refer to electrical machinery exported to the United Kingdom and British possessions by the United States during the years ended June, 1901, and 1903 respectively. Mr. Bell, in his report, anticipates an enormous over-production of all kinds of machinery and other exportable articles in the United States at an early date, "as immense sums have been spent in extending and improving works all over the country." The demand in the United States for these goods is said to have already commenced to fall off, and when this

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feature becomes more pronounced a large overplus will remain to be dealt with in the manner indicated below:—

	1901.	1903.
British North America	$807,419	$1,240,900
West Indies and Bermuda	26,349	51,799
British East Indies	317,081	25,622
,, Australasia	169,539	200,469
,, Africa (all Africa)	34,843	122,434
Hong Kong	11,873	18,808
Total exprtd. to British oversea possessions	1,367,104	1,660,032
Percentage of total United States exports..	23·5	28·7
Exports to the United Kingdom amounted to	2,760,733	2,256,062
Percentage of total United States exports..	47·5	39·0
The total exports from United States were	$5,812,715	$5,779,459

West Bromwich.—Sanction to a further loan of £12,177 for extensions of the electricity undertaking, repayable in 25 years, has been obtained by the Council.

Workhouse Lighting.—Rathdown (Dublin) Guardians have decided to ask the principal electrical contractors in Dublin for estimates of the cost of fitting up their workhouse for electric lighting.

York.—The City Council have increased the salary of Mr. Beckett, mains and works superintendent, to £175, with a further increase of £25 in 12 months.

Social.—On Friday last there was held the second annual social gathering of the employés of the Sir Hiram Maxim Electrical and Engineering Co. The company included Sir Hiram Maxim, Mr. de Meray (chairman of the company), Mrs. de Meray, most of the directors and the chiefs of the various departments. During an interval in the programme Sir Hiram entertained the party with an account of the early struggles in the introduction of electric glow lamps, and Mr. de Meray referred to the increase of the company's business, necessitating the extension of the factory. He referred with satisfaction to the help which the employés had rendered to the company during the progress of the works.

The usual seasonable "high jinks" were held at the works of Messrs. Crompton & Co., Chelmsford, on Saturday last, when a Christmas-tree entertainment and a baby show again formed conspicuous items on the programme, the arrangements being carried out under the supervision of Mr. H. C. Hawkins. Mrs. Crompton, aMrs. Brunton and Mrs. Price had to decide upon the merits of bout 20 infants, and this "turn" proved, as usual, a very popular ne. Col. and Mrs. Crompton received a very hearty reception and cordial vote of thanks.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Brighton Corporation invite tenders for supply and delivery of steel poles, trolley wires, bases and section pillars, cast-iron fittings, pole brackets, overhead line fittings, span and guard wire, switch gear, feeder, distributing and telephone cables, bonds, wood paving blocks and granite setts. Specifications from the tramway engineer (Mr. Thos. B. Holliday), Lewes-road, Brighton. Tenders to town clerk (Mr. Francis J. Tillstone), Town Hall, Brighton, by 10 a.m. Jan. 18. See also advertisement.

Hornsey Borough Council invite tenders for two dry-back or water-tube boilers, smoke-consuming apparatus, two 300kw. steam dynamos, one 100kw. steam dynamo and two motor generators. Specifications after 12th inst. from the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, S.W. Tenders to the town clerk (Mr. F. D. Askey), Southwood-lane, Highgate, London, N., by 10:30 a.m. Feb. 8. See also advertisement.

Tenders are invited on behalf of the Municipality of *Johannesburg* for the supply of solid copper and flexible protected tramway rail bonds. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, London, S.W., after 11th inst. Tenders to Messrs. Mordey and Dawbarn by noon 18th inst. See also advertisement.

Tonbridge Electric Lighting committee invite tenders for 50 electricity meters. Specifications from the resident electrical engineer (Mr. J. A. Bernard Horsley). Tenders to the clerk to the Council, Tonbridge Castle, Tonbridge, by noon Jan. 23. See advertisement.

Belfast Gas and Electric committee invite tenders for motor balancer and motor boosters. Specifications from the city electrical engineer (Mr. Victor H. M'Cowen). Tenders to the town clerk (Sir Samuel Black), Town Hall, Belfast, by Jan. 22. See advertisement.

Belfast Gas and Electric committee also invite tenders for electricity meters. Tenders to Sir Samuel Black by noon Jan. 15.

Whitby Urban District Council invite tenders for the supply and delivery of feeding and distributing mains. Specifications from the electrical engineer (Mr. L. H. King), to whom tenders by Jan. 25. See advertisement.

Glasgow Corporation invite tenders for providing and erecting at their generating stations two 3,000kw. 6,500-volt three-phase turbo-alternators and condensing plant; one 2,200 H.P. engine coupled to a double-current generator and transformers; and six 500kw. motor generators and rotary converters. Tenders to Mr. James G. Monro, City-chambers, Glasgow, by Jan. 11.

Erith Urban District Council invite tenders for two Lancashire boilers, steam feed pump, pipes, &c.; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam engine of 500kw.; and extensions to main switchboard and cable connections. Tenders to the clerk (Mr. Charles H. Fry) by noon Jan 18.

The Guardians of *St. George's* (Hanover-square) Union invite tenders for the electric wiring and mains required at their Fulham-road workhouse. Tenders to Mr. Thos. Worlock, St. George's (Hanover-square) Hall, Mount-street, London, W., by Jan. 13.

Wallasey Urban District Council invite tenders for about 7,100 yds of concentric armoured cable, with joint boxes and section boxes Tenders to Mr. H. W. Cook, Public offices, Egremont, Cheshire, by Jan. 16.

Pontypridd Urban District Council invite tenders for pipe work and meters. Tenders to the chairman of Electric] Lighting and Tramways committee by noon Jan. 15.

Tenders are invited for the public electric lighting of the city of Punta Arenas (Straits of Magellan). Tenders will be opened on June 28. Further particulars from the Chilian Legation, 29, Queen's Gate-terrace, London, S.W.

Liège municipal authorities invite tenders until 16th inst. for track material and apparatus for the Maghin-Fetinne-Guillemins electric tramway. Particulars (for 12fr.) from the Bureau Administratif, and tenders to L'Annexe de l'Hotel de Ville, Liège.

Tucuman (Argentina) Municipality invite offers for public electric lighting.

Azul (Argentina) Corporation invite tenders for erecting and working electricity works.

TENDERS RECEIVED AND ACCEPTED.

Todmorden Corporation have accepted the following tenders in connection with their electricity supply department:—

Yates and Thom, steel boilers.
E. Green & Son, economiser.
Electric Power Storage Co., storage battery.
Worthington Pumping Co., condenser, pumps and injectors.
Bertram Thomas, switchboard.
W. T. Glover & Co., cable work.
Bruce Peebles & Co., steam dynamo and Willans engine.
Rodgers and Kaye, crane.

The "Australian Mining Standard" states that the Austral Otis Engineering Co. (agents of Ganz & Co.) are supplying to the order of Messrs. Bewick, Moreing & Co. a three-phase alternating-current power plant at the Oroya-Brownhill mine, Western Australia. The plant will comprise a three-phase generator and three-phase motors of an aggregate capacity of 200 B.H.P., switchboard, &c.

The British Electric Plant Co. have secured the order for four generators, each of 60kw., for the two turbine steamers (each of 15,000 tons displacement) at present being built in Belfast and Glasgow for the Allan Line. The lighting of each boat will necessitate the equivalent of 4,000 8 c.p., and electric fans and motors for various purposes will also be installed.

Among recent contracts obtained by Messrs. Bellis an Morcom are the following:—

Through the Electric Construction Co., eight 1,100 H.P. engines, capable of giving 25 per cent. overload, for coupling to E.C.C. generators; two 250 H.P. engines for coupling to E.C.C. dynamos; four condensing plants to deal with exhaust steam from above, for the Park Royal station of the Great Western Railway Co.

Seven engines, coupled to E.C.C. dynamos, for H.M.S. "Formidable," "Implacable," "Irresistible," "London," "Bulwark" and "Venerable."

From Laird Bros., three engines, coupled to Siemens dynamos, for H.M.S. "Liffey," "Moy," and "Ouse."

From Hawthorn, Leslie & Co., three engines, coupled to Siemens dynamos, for H.M.S. "Boyne," "Doon," and Kale."

From Metropolitan Asylums Board, one engine, coupled to Siemens dynamo, for Grove Hospital.

From Bruce Peebles & Co., two engines, for coupling to Peebles dynamos, for Todmorden.

From Allgemeine Elektricitäts-Gesellschaft, four engines for coupling to A.E.G. generators, for East London Harbour Board.

From Messrs. Dick, Kerr & Co., two engines, for coupling to English Electric generators, for East London (South Africa) Municipality.

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The International Electrical Engineering Co., Clun House, Surrey-street, London, W.C., have secured the order for the complete equipment of the new Peterborough works of Messrs. Werner, Pfleiderer and Perkins. The plant consists of a number of electrically-driven overhead travelling cranes, electric locomotive, motors, generators, switchboards, &c. The same firm have carried out an installation of generators and motors at Messrs. Werner, Pfleiderer and Perkin's London works.

Messrs. Rowland Carr & Co. have received a further large order for troughing and paving covers for telephone work at Oporto to the extent of about 10 miles.

The contract for the electrically-operated swing bridge to carry the railway across Dover Docks from the new Prince of Wales' Pier has been placed with Sir W. G. Armstrong, Whitworth & Co.

BUSINESS NOTICES.

The business of the Electrical Transmission Co., of Hammersmith, has been amalgamated with that of the Sturtevant Engineering Co. (Ltd.), 127, Queen Victoria-street, London, E.C., and (works) Bankside, S.E. This amalgamation will largely extend the operations of the Sturtevant Company, and the Bankside works will now be devoted to the manufacture of apparatus connected with the higher forms of motor control for lifts, hoists, cranes, pumps, &c. At the Hammersmith works the manufacture of main switches, traction accessories, feeder and section pillars, speed regulators, motor starters, &c., will be carried on. The offices of the amalgamated company will be situated at the Queen Victoria-street address.

Messrs. Moul & Co., 76-78, York-street, Westminster, London, S.W., have taken over the electrical department of O. Berend & Co. (Ltd.) (in liquidation). The former company notify that orders placed with the receiver and manager of the last-mentioned firm will be executed by them, and all quotations of O. Berend & Co. (Ltd.) remain in force.

The Davis Electric Lamp Co., 17, Moor-street, Cambridge-circus, London, W.C., are now connected on the telephone 7253 Central.

Messrs. Monté Callow & Co. have appointed Mr. R. A. Young, Ward's-buildings, High Bridge, Newcastle-on-Tyne, district representative for the sale of "Perfecta" motor starters, regulators and controllers Mr. Young does not propose to sell motors or to engage in general electrical contractor's work.

Messrs H S Sanders and J. B Wake, mica merchants, &c., 23, Great St. Helens, London, E.C., have dissolved partnership. Debts by Mr. Wake.

Mr. Robert Mitchell, formerly demonstrator in the Physical Laboratory of the Royal College of Science, South Kensington, and latterly with Sir George Bullough, of Messrs. Howard and Bullough, Accrington, has joined the directorate of the Phœnix Dynamo Mfg. Co. (Ltd.), Bradford.

Mr. Charles J. Hall has resigned his position as manager of the electrical department of Messrs. John Fowler & Co. (Leeds), Ltd., of Leeds, which was commenced by Mr. Hall for the firm in 1891.

After Jan. 15, the addresses of the New General Traction Co. (Ltd.), the Coventry Electric Tramway Co. (Ltd.) and the Norwich Electric Tramways Co. will be 20, Bishopsgate-street Within, London, E.C.

Mr. E. Macgregor Duncan, consulting engineer, 27, Old Queen-street, Westminster, has opened an office at St. Lawrence-chambers, Butter Market, Ipswich, in order to deal with his consulting work in the eastern counties.

The offices of the Buenos Ayres Electric Tramways Company (Ltd.) are now at 78, Cornhill, London, E.C., and Mr. C. A. Hunii has been appointed secretary, vice Mr. T. H. Evans, resigned.

Mr. Douglas Wells, M.I.E.E., notifies us that he has removed from No. 11 to No. 10, Rue de la Pépinière, Brussels. Mr. Wells represents several British electrical engineering firms.

LIQUIDATIONS, BANKRUPTCIES, &c.

The trustee in the failure of Dr. F. H. Bowman, consulting electrical engineer, 39, Victoria-street, London, S.W., has been released.

The trustee in the bankruptcy of Geo. Calvert, electrical engineer, &c., formerly trading at 487, Kingsland-road, London, N.E., has been released.

Mr. E. H. Hawkins, 3, Barbican, London, E.C., has been appointed trustee in the failure of Thos. Hyom (trading as Tom Hyom), electric light fitter, &c., 139, Fawcett-road, Southsea.

Claims against the City and Suburban Electric Carriage Co. (1903), Ltd., must be sent by Feb. 17 to Mr. W. B. Peat, 3, Lothubry London, E.C.

The Electrical Wool-Pulling Syndicate (Ltd.) is to be wound up voluntarily. Mr N. R. Dickinson is liquidator.

A meeting of the Column Printing Telegraph Syndicate (Ltd.) will be held on Feb. 8, at 5, New Bridge-street, London, E.C., to receive an account of the winding-up.

Winding-up Petition.—The petition of Mr. A. G. Paine for the winding-up of the Electric Tramways Construction and Maintenance Co. (Ltd.) will be heard in the High Court on Jan. 12.

Sale by Auction.—By order of the Court, Messrs. Fuller, Horsey, Sons and Cassell have been instructed to offer for sale by auction (in one lot) at the Mart, London, E.C., on Tuesday, Jan. 26, at 1 o'clock, the valuable freehold engineering works known as the Trusty Engine Works, Cheltenham, occupying an area of about 4 acres, with sidings to the Midland Railway. The whole of the fixed plant and machinery, and the goodwill of the business will be included. Orders to view from the auctioneers, and particulars (when ready) of Messrs. Mackrell and Ward, solicitors, 1, Walbrook, London, E.C., Messrs. Rodgers & Co., solicitors, 30, Bank-street, Sheffield, Mr. R. Hooper Radford, 15, St. James's-row, Sheffield, Mr. Howard Field (receiver), 38, Mincing lane, London, E.C., and of the auctioneers, 11, Billiter-square, London, E.C. An advertisement contains additional particulars.

Works, &c., for Sale.—Some modern well-equipped car-building works, occupying a covered area of 8¾ acres, with 25 acres available for future extensions, are advertised for sale in another column. Applications to Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C.

Some manufacturing premises are advertised for sale or letting on lease, without restriction and with or without steam power. The premises adjoin Laindon station, Essex, 22 miles from London. Particulars from Messrs. I. Levy & Son, 62, Albany-road, Old Kent-road, London, S.E.

Catalogues, &c.—A new catalogue of "Neptune" copper rail bonds for electric tramways and railways, manufactured by Messrs. Felten and Guilleaume, of Mulheim-on-Rhine, Germany, reaches us from Messrs. W. F. Dennis & Co., 49, Queen Victoria-street, London, E.C., who are sole agents for these goods in the United Kingdom. All parts of these bonds, with the exception of the steel drift pins, consist of solid drawn copper, the bonds being drop-forged from one piece and the terminals accurately made and finished to an even surface. The flexible bonds are also made throughout from drawn copper, the heads being fixed to the connecting wires or strips by drop-forging, in accordance with a patented process, the property of the manufacturers. Various designs of these bonds are illustrated, described and priced, and examples of rail bonding with "Neptune" bonds are given.

From the International Electrical Engineering Co., Clun House, Surrey-street, London, W.C., we have received a bulletin describing an electrical installation with hoisting machinery in some collieries at Gilly Lez-Charleroi, Belgium. The colliery company decided to use three-phase alternating-current plant for working and the order was placed with the International Electrical Engineering Co., who put down a 300 B.H.P. Van den Kerchove engine with boilers of the Galloway type. The three-phase alternator is of the International Company's manufacture, with stationary armature and revolving field. The most important part of the installation is the hoisting machine, which is the largest of its kind in Belgium driven by three-phase current and absorbs more than 75 per cent. of the total output of the machinery installed.

The January "Progress" leaflet of the General Electric Co. is ready. Several items of apparatus in the company's list have been reduced in price.

Messrs. Gibbon Bros, of Dudley, Worcs., have ready a new illustrated catalogue of elevating and conveying machinery.

Calendars, &c.—The peculiarities of our climate necessitate frequent reference to the barometer, and Messrs. Stegmann & Co., electric lighting contractors, &c., of Clapham Junction, London, S.W., are sending out a handy form of barometer-thermometer as a New Year's greeting to their customers and friends.

From Messrs. Cecil Hodges & Co., 52, Queen Victoria-street, London, E.C., we have received an illustrated complimentary card with an intimation that we have been "switched over from 1903 to a full current of prosperity for 1904."

The useful blotting-pad New Year's emblem of the Hart Accumulator Co., Marshgate-lane, Stratford, London, E., has also to be acknowledged, and will find a place amongst our desk equipments.

From the Coalbrookdale Company we have to acknowledge the receipt of a useful daily reminder pad for 1904, in which room is found for description and illustration of a large number of the company's special class of manufactures. As this pad is in a substantial case, it will last out the year, which is more than can be said for a good many pad calendars on the market.

The British Prometheus Co. (Ltd.), of Kingston-on-Thames, are issuing a neat desk calendar, which is strongly made.

From the Willesden Paper and Canvas Works, Willesden Junction, London, N.W., we have to acknowledge the receipt of a hanging tear-off calendar showing various uses of Willesden insulating paper.

Amongst the annual calendars and diaries which reach us from year to year, the useful pocket-book and memoranda issued by the

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Eastern and Associated Telegraph Companies is conspicuous, and we have to acknowledge the receipt of this pocket-book for 1904. The chronological data is of particular interest to electrical men.

The regular annual reminder of the New Year is to hand from Messrs. W. H. Willcox & Co., the well-known engineers' sundries men of 23, Southwark-street, London, S.E., who forward a hanging pad calendar upon which a small portion of the infinite variety of goods manufactured and supplied by the firm are listed and illustrated.

"Lockwood's Builders and Contractors' Price Book," 1904.—This excellent annual, published by Messrs. Crosby Lockwood & Son, London (price 4s), is to hand, and is, as usual, crowded with information for all who have to do with building and general contracting work The editor (Mr. Francis T. W. Miller), in his preface, reviews the uneventful history of the building trade of the metropolis during the past year, and notes a lack of enterprise in that particular branch of industry. The electric lighting section of the book, which is a lengthy one, has been entrusted to Mr. A P. Haslam. Besides the varied contents of special value to builders and contractors, there is, in the form of appendices and lists of various kinds, a good deal of information of value to traders in general. The book is fully indexed, and may be accepted as a good guide to prices current in the building trades. The editor does well to call attention to the fact that the labour charges included in the book are those for the metropolitan area. In an appendix (H) there is given in full the Phœnix Fire Office rules issued in January, 1902! The present rules of the Phœnix Company (dated March, 1903) differ in many important points from those of January, 1902. We fail to find any trace whatever of the new Wiring Rules of the Institution of Electrical Engineers, published in February, 1903. This strikes us as a singular omission, more especially as already many of the leading fire offices have adopted these rules.

Imports.—The following are the values of imports to this country during December last :—

Electrical machinery, £49,375; telegraph cables and apparatus, £1,379; other electrical goods and apparatus, £86,969. The respective totals for the 12 months ended Dec. 31 were £554,643, £57,360 and £819,057.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Dec. 31 to Jan. 5, with the ports of destination :—

Africa—Alexandria, £151 ; Cape Town, £396 ; Delagoa Bay, £4,148 ; Durban, £531 ; East London, £113 (including £22 telegraph material); Tangier, £30 ; *Argentina*—Buenos Ayres, £84 ; *Australasia*—Adelaide, £1,308 ; Perth, £413 ; Sydney, £2,948 (including £94 telegraph material). *Canada*—Toronto, £15. *Chili*—Valparaiso, £59. *France*—Paris, £734. *Germany*—Hamburg, £35. *Holland*—Amsterdam, £20. *Hong Kong*, £368. *India*—Bombay, £113 ; Calcutta, £548. *Japan*—Yokohama, £859 (telegraph wire). *Sweden*—Stockholm, £98 (telegraph wire) *West Indies*—St. Lucia, £28. *Zanzibar*—£88 (including £59 telegraph material). Total (for six days), £13,087, against £44,239 for one week last year (Dec. 31 to Jan. 6).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

October 22, 1903.

22,800 **J. T. PEARSON.** Burnley. Electric belts.
22,804 and 22,805 H. LEITNER and R. N. L. LYNTON. Byfleet. Regulators for electric circuits.
22,820 C. D. BURNET. Liverpool. Fuse boxes or fittings.
22,840 A. M. BARNES. Lampholders for electric lighting.
22,858 F. A. CHANDLER and B. BONNIKSEN, Coventry. Electric clocks.
22,904 E. A. CAROLAN (G.E. Co., U.S.) Controlling electric boosters.
22,905 E. A. CAROLAN (G.E. Co., U.S.) Rheostats.
22,906 E. A. CAROLAN (G.E. Co., U.S.). Machines for covering electric conductors with insulating material.
22,907 E. A. CAROLAN (G.E. Co., U.S.). Controlling devices for electric vehicles.
22,908 E. A. CAROLAN (G.E. Co., U.S.). Switches.
22,909 E. A. CAROLAN (G.E. Co., U.S.) Dynamo-electric machines.
22,910 E. A. CAROLAN (G.E. Co.,U.S.). Bearings for measuring instruments.
22,911 E. A. CAROLAN (G.E. Co., U.S.). Alternating-current motors.
22,912 E. A. CAROLAN (G.E. Co., U.S.). Dynamo-electric machines.
22,913 E. A. CAROLAN (G.E. Co., U.S.). Alternating-current motors and controlling same.
22,914 E. A. CAROLAN (G.E. Co., U.S.) Emergency brakes for vehicles.

October 23, 1903.

22,919 R. M. SERVICE. Glasgow. Compound for insulating, waterproofing, &c.
22,955 W. H. COPUS. Wire terminal grip.
22,981 J. HARMATTA. Weeding by electricity.
23,057 B. G. LAMME. Single-phase alternating-current motors. (Date applied for Oct. 31, 1902, date of application in U.S.)*
23,086 H. M. KILGOUR. Regulation of dynamo-electric generators.
22,996 W. R. N. GARD. Incandescent lamp holders with shade carriers.

October 24, 1903.

23,021 V. HOPE. Manchester. Switches, cutouts, &c.
23,043 W. D. WHYTE. Glasgow. Magnetic compasses.*
23,049 E. W. LEWIS. Coventry. Attaching wires to terminals of sparking plugs.

October 26, 1903.

23,102 and 23,103 J. F. CAREY. Application of electricity for the production of scenic effects at places of entertainment.
23,110 T. L. BOYDEN. Wolverhampton. Electric potential governors.
23,120 J. BIJUR. Storage battery plates.*
23,151 H. KOLLER and P. ASKENASY. Apparatus for producing circulation of electrolyte in electrolytic processes.*
23,158 P. J. BUFFAUD and R. TAVIAN. Electric igniters.
23,161 R. A. FLEISS. Electrically heated handles.*
23,173 L. WILSON. Protecting devices for parallel feeders.*
23,181 J. MANNHEIM. Electric traction systems.

October 27, 1903.

23,192 A. D. JONES and JANDUS ARC LAMP AND ELECTRIC CO. Dynamo-electric generators and motors.
23,224 J. H. GOEHST. Electrically illuminated signs.*
23,225 J. H. GOEHST. Electric lamp sockets.*
23,254 A. BEARSE and H. B. CROUSE. Ground anchors for cables.*
23,260 P. A. NEWTON. Receiving instruments of printing telegraphs (Eltypic Mfg. Co., U.S.)*
23,285 G. E. SUNDQUIST and R. H. WAHL. Liverpool. Telephone relays or repeaters.*
23,302 G. B. BOWELL and PEARSON FIRE ALARM. Automatic fire-alarm systems.*

October 28, 1903.

23,318 A. J. HOWARD. Taunton. Suspending overhead conducting wires.
23,333 J. M, MOSS. Liverpool. Magnetic separators.
23,337 E. MOORE. Isle of Man. Adjustable arm rest for telephone.
23,350 WARWICK MACHINERY CO. (G.E. Co., U.S.). Automatic brakes for elastic-fluid turbines
23,353 WARWICK MACHINERY Co. (G.E. Co., U.S.) Drilling apparatus
23,355 WARWICK MACHINERY Co. (G.E. Co.,U.S.). Electrically operated valves
23,356 WARWICK MACHINERY Co. (G.E. Co., U.S.). Governing mechanism.
23,359 F. H. DE VEULLE. Birmingham. Sparking plugs.
23,375 A. SCHNELLER and D. KOELEMAN. Electric silent discharge apparatus.

October 29, 1903.

23,406 W. PARKINSON. Kingston-on-Thames. Twin-wire switch.
23,443 and 23,444 CROMPTON & Co. and W. A. PRICE. Chelmsford. Electrical instruments.
23,461 P. A. RUBENS. Electric generating apparatus.
23,469 F. C. NEWTON. Automatic switch for motors.
23,478 A. ARTOM. Electrical transmission of energy through space. (Date applied for Aug. 23, 1903, date of application in Italy.)*
23,482 G. ROSSET. Secondary batteries. (Date applied for Nov. 24 1902, date of application in France.)*
23,488 A. ARTOM. Electrical transmissions of energy through space. (Date applied for Sept. 12, 1903, date of application in Italy.)*
23,490 O. IMRAY. (C. Potter, U.S.) Storage battery plates.*

October 30, 1903.

23,521 S. WHIPP. Rochdale. Loose handle automatic magnetic blow-out circuit-breakers.
23,523 J. ZACHARIAS and E. LASKER. Liverpool. Astatic magnet.*
23,538 L. CALLENDER and A. CALLENDER. Derby. Electric hypodermic syringe.
23,540 A. H. ADAMS and A. H. CURTIS. Resistance boxes.
23,545 A. BLACKMAN. Batteries.
23,546 A. B. CRUICKSHANK. Telephone mouthpieces or receivers.
23,557 A. P. STECKEL. Electrical clutch and brake mechanism.*
23,574 H. SHOEMAKER. Wireless signalling systems.*
23,585 E. L. PINCHING and W. H. WALTON. Electrical fire calls.

October 31, 1903.

23,592 G. J. PHILPOTT and G. H. ALDERTON. Brighton. Electric circuit controllers.
23,608 J. TOMLINSON and H. LOMAX. Manchester. Switches.
23,630 A. JAMES and LONDON MOTOR ENGINEERING CO. Overhead wiring spans, cars, circuit-breakers, frogs and trolley heads.
23,636 W. A. BROWN. Raising and lowering arc lamps.
23,647 J. MCLAUGHIN. Arc lamps.*
23,652 SOCIÉTÉ ANONYME DES ATELIERS DE MECANIQUE DE PRECISION DE TERRITET. Electricity meters. (Date applied for, Nov. 10, 1902, date of application in Switzerland.)*
23,663 SIEMENS BROS. & CO. (United Telpherage Co., U.S.) Telpherage.*
23,664 SIEMENS BROS. & Co. (Siemens and Halske A.G., Germany.) Automatically starting and braking motors.*
23,686 A. JOHNSON. Hereford. Fog or danger signal, electric railways.
23,712 H. NEAMER. Dry batteries.
23,715 and 23,716 E. M. T. BODDAM. Electric and interlocking apparatus for electric signals and points.

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23,717 E. M. T. Boddam. Operating electric signals by contacts with trains.
23,743 L. P. C. Hodson. Electrical indicators.
23,750 E. Danneels. Electric signalling apparatus for railways.*
23,767 Halsey Electric Generator Co. (Halsey Electric Generator Co., U.S.) Galvanic batteries.

November 3, 1903.

23,780 H. A. Meredith. Birmingham. Insulated cam for contact breaker of internal combustion engines.
23,830 W. W. Barton. Electric light fittings.
23,833 P. M. A. Matthews. Manchester. Electrical resistances.
23,836 D. H. Gainsford and F. Smart. Northampton. Contact maker.
23,851 Stothert and Pitt and W. Pitt. Electric cranes.
23,853 E. du Bois and Reason Mfg. Co. Mercury electrolytic apparatus for meters and switches.
23,854 O. Imray. Effecting a phase-shift of 90deg. or more between pressure and field in the shunt circuit of alternating-current meters. (Siemens-Schuckert-Werke G.m.b., Germany.)*
23,262 H. von Kohler. Electric log recording apparatus.*
23,863 J. H. Hallberg. Electric distribution systems.*
23,876 A. Korn. Autographic telegraph systems.*

November 4, 1902

23,881 O. D. Lucas. Insulating materials and substitutes for ebonite.
23,915 W. L. Miller. Glasgow. Electric light adapter for reading lamps.
23,918 and 23,919 L. R. Keogh and B. Broughton. Canada. Manufacture of alumina and by-products.*
23,928 J. Bush. Automatically cutting-out resistance in alternating-current electrmotors.
23,930 A. N. Petit. Sound receiving and reproducing instruments.
23,933 J. Laird. Shades or reflectors for electric lamps.
23,948 G. J. Conaty. Birmingham. Electric tramcars.
23,961 E. Cunliffe-Owen, E. W. J. Macdonald and A. F. Harmer. Meters for use in electric heating and other systems or for recording periods of time.
23,978 E. Girand. Overhead conductors. (Date applied for Nov. 5, 1902, date of application in France.)*

November 5, 1903.

23,987 E. de la R. Rendell and G. A. Minshall. Stoke-on-Trent. Electric ignition devices.
23,988 H. J. Fuller. Leeds. Electrically operating switches.
24,013 J. W. Thompson. Leeds. Electric light switches.
24,023 C. O. Bastian. Arc or mercury vapour lamps.
24,025 J. D. White. Printing telegraph receivers.
24,055 J. A. Gamble. Liverpool. Apparatus for telephones, &c.
24,070 F. W. Howorth. (D. P. Perry, U.S.) Storage batteries

November 6, 1903.

24,083 E. S. G. Rees. Wolverhampton. Electric propulsion of vehicles.
24,090 H. Levi and L. Levi. Hull. Automatic fire alarm.
24,098 J. Azarola. Manchester. Apparatus for limiting currents.*
24,102 W. W. G. Webb, J. Hall, C. H. Offord and A. C. Barfield. Electric ignition apparatus.
24,116 B. C. Molloy. Electrical machines.
24,127 J. Zwiebel. Electric bath tubs and electrodes.*
24,129 A. P. Zani. Structure of alternators.
24,130 F. W. Gould. U.K.I. electric dental and manicure engine.
24,142 H. C. Levis. (A. G. Davies, U.S.) Regulating electric lamps.
24,144 O. Junggren. Electrically controlled valves. (Date applied for, Nov. 15, 1902, date of application in U.S.)*
24,145 A. R. Dodge. Elastic fluid turbines. (Date applied for, Nov. 7, 1902, date of application in U.S.)*

November 7, 1903.

24,164 C. H. Iles and W. Armistead. Wolverhampton. Sparking plugs.
24,200 M. Margowski. (R. Klemm, Germany). Portable electric fan.
24,212 H. J. Haddan. (S. Zielenziger, Germany.) Controlling arc lamps.*
24,214 W. R. Macdonald and G. E. Heyl-Dia. Connections for fuses.
24,216 T. H. Marsh and H. H. S. Marsh. Cutouts having two or more fuses.
24,217 T. H. Marsh and H. H. S. Marsh. Automatic fuse cutouts and cut-ins.
24,220 O. Gergacsevics. Liverpool. Electric gas lighters.
24,223 J. E. Waller. Combination of electric lamp with a cigar lighter.
24,235 W. J. Davy. Arc lamps.

November 9, 1903.

24,244 P. S. Sheardown. Dublin. Supporting trolley wires.
24,248 R. Cumming. Glasgow. Collectors of electricity for railways and tramways.
24,261 A. Brebner. Group-flashing apparatus.
24,282 and 24,285 B.T.-H. Co. (G. E. Co., U.S.) Switches
24,283 B.T.-H. Co. (G. E. Co., U.S.) Switch with indicator.
24,284 B.T.-H. Co. (G. E. Co., U.S.) Third-rail insulators.
24,286 B.T.-H. Co. (G. E. Co., U.S.) Double-throw switch with indicator.
24,302 A. G. Bloxam. Magneto-electric induction apparatus. (A. Schoeller, Germany.)*
24,305 O. J. Lodge. Electrical deposition of smoke, fume, mist, fog and the like.
24,310 Aktien Gesellschaft "Magneta." (Electrische Uhren ohne Batterie and ohne Contacte). Magnetic inductors. (Date applied for, Jan. 20, 1903, date of application in Switzerland.)*

November 10, 1903.

24,333 M. Cooper. Sparking plug for electrical ignition.
24,343 W. Wainwright. Leeds. Telegraph perforators and typewriters.
24,356 F. R. Dade. Coventry. Contact breakers.
24,366 G. C. Lilley. Magnetic compasses.
24,396 E. M. Risac. Galvanic batteries.
24,413 E. J. Piper. Electric current meters.

November 11, 1903.

24,444 G. Green and F. E. Prior. Rock Ferry. Ships' telegraphs.
24,445 G. Hookham. Electricity meters.
24,449 G. F. H. Satow. Liverpool. Sparking plug.
24,465 G. H. C. Koloschf. Positive electrode.
24,469 J. Hinks & Son and A. H. Wright. Suspending chain for electric lamps.
24,472 E. Ruhstart and W. E. Grimmer. Germany. Electric furnaces.*
24,474 J. Gell. Automatically controlling the speed of Wheatstone telegraphic transmitters and the like.
24,483 E. Liddle and G. E. Druiff. Switch.
24,500 E. Weintraub. Transmitting alternating current through a vapour. (Date applied for, March 23, 1903, date of application in U.S.)*
24,501 E. Weintraub. Rectifying alternating currents. (Date applied for March, 23, 1903, date of application in U.S.)*
24,502 E. Weintraub. Transmitting alternating current through a vaporous conducting medium. (Date applied for, May 9, 1903, date of application in U.S.)*
24,515 and 24,516 J. F. Armstrong and A. Orling. Automatic detecting, recording and transmitting telegraphic apparatus.

November 12, 1903.

24,518 T. Joyner. Dorset. Illuminated bell pushes.
24,581 M. Margowski. Portable electric fan.
24,621 J. E. Hopthrow, sen., and J. E. Hopthrow, jun. Automatic guide for engaging trolley head.
24,623 A. G. Bird. Controlling an electric generator, dynamo or booster and battery for constant or variable pressure.
24,626 W. P. Thompson (Pfluger Accumulatoren-Werke A.G., Germany.) Plates for secondary batteries.
24,630 J. Shaw. Liverpool. Current-collecting devices.

November 13, 1903.

24,680 E. G. Craven. Electrical transmission, &c., of sound.
24,693 J. Cerpaux. Telephone apparatus.
24,695 J. C. Best. Electric ignition miners' safety lamps.
24,700 C. L. Nordon. An indicating contact maker.
24,701 T. J. Howell. Electric motion in conjunction with the creation and multiplication of electricity, applicable to machinery of all kinds requiring power.*
24,730 J. H. St. H. Mawdsley. Dynamo-electric machines.
24,744 C. F. Hilkier. Thermostatic fire alarm devices.

November 14, 1903.

24,755 F. G. Baily. Edinburgh. Fuse holders, boxes, &c.
24,770 H. M. Bremner. Glasgow. Making electric contact.
24,791 B.T.-H. Co. (G.E. Co., U.S.) Synchronising dynamo-electric machines.
24,792 B.T.-H. Co. (G.E. Co., U.S.) Cut-outs.
24,793 B.T.-H. Co. (G.E. Co., U.S.) Fluid pressure regulators.
24,794 B.T.-H. Co. (G.E. Co., U.S.) Arc-extinguishing devices.
24,795 B.T.-H. Co. (G.E. Co., U.S.) Cut-outs or fuses.
24,796 B.T.-H. Co. (G.E. Co., U.S.) Emergency brakes.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

LACOSTE AND BATTMAN (LTD.)—Reg. Dec. 31, capital £160,000 in £1 shares, to acquire and take over by way of contribution or otherwise the business of auto-car manufacturers carried on at Levallois-Perret, near Paris, by Lacoste and Battman, and to carry on same and the business of motor manufacturers, makers of and dealers in electric accumulators, cycles, carriages and vehicles, electricians, mechanical engineers, machinists, &c.

HENRY S. TETT & CO. (LTD.)—Reg. Dec. 31, capital £50,000 in £1 shares (20,000 5 per cent. cumulative preference, 20,000 ordinary and 10,000 as determined by board), to acquire the business of an ironmonger, electric light contractor, &c., carried on by H. S. Tett at Faversham and Sittingbourne, and the business of H. S. and F. Tett at Preston-next-Faversham, Kent. Reg. office, 10/11, Market-street, Faversham.

WILLEY & CO. (LTD.)—Reg. Dec. 31, capital £100,000 in £1 shares, to acquire the business of electrical, gas and mechanical engineers carried on at Exeter and London under the style of Willey & Co., and to carry on the business of electrical, gas, mechanical and general engineers, manufacturers of and dealers in electricity and gas meters, apparatus and appliances for use in connection with the production, generation and utilisation of electricity, gas, steam, &c. First directors: H. A. Willey (permanent managing), S. Simpson, T. G. Westlake and S. J. H. Willey.

STATUTORY RETURNS.

BRITISH COLUMBIA TELEPHONES (LTD.)—The return to Nov. 4 gives the capital as £100,000 in 3,000 preference and 7,000 ordinary shares of £10 each, of which 3,000 preference and 6,000 ordinary have been taken up. £10 per share has been called up on 3,000 preference and 4,000 ordinary and £2. 10s. per share on 2,000 ordinary. £75,000 has been received. Mortgages and charges, £30,000.

ELECTRIC LIGHT INSURANCE AND MAINTENANCE CO. (LTD.)—The return to Oct. 21 gives the capital as £10,000 in £1 shares, of which 6,329 have been taken up. £1 per share has been called up on seven shares and 10s. per share on 5,882, and £2,843 has been received, leaving £75 in arrears. £3,411 is considered as paid, being £1 per share on £500 and 10s. per share on 5,882 shares. Mortgages and charges, £5,000.

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NEW ST. HELENS AND DISTRICT TRAMWAYS CO. (LTD.)—In the return to Nov. 12 the capital is £150,000 in 20,000 preference and 10,000 ordinary shares of £5 each, of which 15,980 preference and 9,000 ordinary shares have been taken up. £5 per share has been called up and £125,410 has been received, including £510 paid on 1,020 forfeited shares. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

AUTOMATIC TELEPHONE CO. (1903), LTD.—Mortgage dated Dec. 2, 1903, to secure £950, charged on plant and machinery on premises of Messrs. Margo & Co. of 72 and 74, London-street, Greenwich, S.E., has been registered. Holder, Mrs. D. Margowski.

FENNER, JAMES & CO. (LTD.)—A debenture dated Dec. 18, 1903, charged on company's undertaking and property, present and future, including uncalled capital (if any), has been registered. Holder, Capt. W. A. Grant.

FRINTON-ON-SEA AND DISTRICT ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Dec. 22 of £700 debentures, part of series created May 7, 1903, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. Holders: W. Webster and A. A. Mackay. No trustees. Previously issued of same eries, £1,800.

NEWMARKET ELECTRIC LIGHT CO. (LTD.)—Issue on Dec. 23 of £500 first mortgage debentures, part of series created Oct. 16, 1899, to secure £15,000, charged on company's lands, buildings, plant, works, undertaking and general property, present and future, including uncalled capital. Trustees: G. H. Verrall and F. E. Gripper. Previously issued of same series, £13,600.

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS (LTD.)—Trust deed dated Dec. 8, to secure £160,000 debentures created Nov. 25, 1902) has been registered. Property charged: Boughton-le-Spring and District Tramways Order (1900), benefit of £5,176. 11s. deposited in Court, with interest thereon; tramways constructed or to be constructed under said order; land and buildings acquired for purposes thereof, with permanent way and fixed plant, the benefit of certain agreements, and company's undertaking and property, present and future, including uncalled capital. Trustees: Debentures Securities Investment Co.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26⅛d. per oz. (Jan. 7). Consols 87⅛—87⅛ for money, 87⅜—87⅝ for account; 2½ per cent. annuities 86¾—87¼ (Jan. 7). Consols Pay Day, Feb. 3; Stocks and Shares Continuation Days, Jan. 12 and 26; Ticket Days, Jan. 13 and 27; Pay Days, Jan. 14 and 28; Mining Share Carry-over Days, Jan. 11 and 25.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—The directors recommend a dividend at the rate of 6 per cent. per annum on the ordinary shares for half-year ended Dec. 31. £4,000 is set aside for reserve, £2,000 for maintenance during current half-year and £1,000 to accident insurance fund, leaving £6,775 to be carried forward.

ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)—Warrants for interim dividend on the 6 per cent. cumulative preference shares, and interim dividend at the rate of 10 per cent. per annum on the ordinary shares have been posted.

ROYCE LIMITED.—The directors have intimated to the preference shareholders "that, instead of, as hitherto about this date, paying an interim dividend on the shares, they prefer waiting until the balance-sheet for the full year's working to the end of March has been prepared."

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended Dec. 31, 1903. The following statement, dated Dec. 9, shows the condition of the company at the close of the quarter ended Sept. 30, 1903:—

Surplus July 1, 1903, as per last quarterly report ...		$13,019,724 55
Net revenues, quarter ended Sept. 30, 1903		2,347,195 76
From which deducting for—		$15,366,920 31
Dividend of 1¼ per cent. paid Oct. 15	$1,217,017 50	
Interest on bonded debt	286,300 00	
		1,503,317 50
Left a surplus Oct. 1, 1903, of		$13,863,602 81
The net revenues of the quarter ending Dec. 31, based upon nearly completed returns for October, partial returns for November, and estimating the business for December, will be about		2,150,000 00
From which appropriating for—		$16,013,602 81
Interest on bonds		286,300 00
		$15,727,302 81
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,217,017 50
Deducting which leaves a surplus, after paying dividend, of		$14,510,285 31

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared payable on and after the 15th Jan.

VENEZUELAN CENTRAL RAILWAY CO.—At a meeting on Monday it was decided to voluntarily wind up the company, and an agreement with Electric Equipment and Securities (Ltd.) was confirmed. The latter company is composed of preference shareholders in the railway company, and will become purchasers of the undertaking. Mr. Chaplin was appointed liquidator of the former company.

WAIPORI FALLS ELECTRIC POWER CO.—The first meeting of this company was recently held at Dunedin, (N.Z.) The chairman (Mr. F. Oakden) stated that the various experts consulted had expressed complete confidence in the company's project from both its commercial and engineering aspects. The operations of the past year had been confined to the hydraulic work. The directors had secured the services of Mr. E. E. Stark, electrical engineer, of California. After receipt of a report from Mr. Stark, an extraordinary meeting would be held to deal with contracts and financial matters.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Jan. 2	1,471	+ 362	31	88,618	+ 6,922
Ayr Corporation	...	...	...	...	...	...
Barnsley	Dec. 25	211	- 46	51½	9,202	- 58
Bexley District Council	Jan. 1	166	...	18	2,146	...
Birkenhead	,, 3	1,022	+ 22	...	...	...
*Birmingham Tramways	,, 2	5,306	+ 228	26	133,819	+ 8,532
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	Dec. 31	844	- 90	§39	87,948	- 176
Blackpool and Fleetwood	Jan. 2	224	+ 15	1	20,917	- 42
Blackp'l, St. Anne's & Lytham	Dec. 31	175	+ 150	19	1,319	+ 818
Bolton Corporation	Jan. 3	2,149	- 116	40	73,850	+ 8,318
Bournemouth Corporation ..	Dec. 20	986	...	40	41,162	...
*Bradford Corporation	Jan. 3	3,517	+ 268	37	151,119	+ 20,157
Brighton Corporation	,, 3	730	- 3	39	37,011	+ 2,591
Brisbane Tramways	Nov. 18	2,244	- 57	20	46,840	+ 375
*Bristol Trams & Carriage...	Jan. 1	4,838	+ 180	6	27,509	+ 1,060
*Buenos Ayres & Belgrano...	Dec. 6	8,455	+ 300	7	22,560	+ 918
Burnley Corporation	Jan. 2	865	+ 149	40	40,230	+ 7,014
Burton Corporation	,, 3	321	...	22	7,862	...
Calcutta Tramways Co.....	,, 2	R40,230	+R8,607	1	R40,230	+ R8,607
Camborne-Redruth	,, 4	105	...	9	1,126	...
Cardiff Corporation	,, 3	1,782	+ 199	1	1,782	+ 199
Carlisle Tramways Co.	,, 2	200	+ 3	¶52	10,062	+ 857
Central London Railway ...	,, 2	6,591	- 92	1	6,591	- 92
Chatham & Dist. Lt. Rys....	Dec. 31	526	+ 82	52	28,137	...
City & South London Rly..	Jan. 3	8,272	- 164	1	8,272	- 164
Cork Electric Trams Co. ..	Dec. 31	377	+ 17	42	26,658	- 3,358
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams..	,, 25	557	+ 90	51½	24,810	+ 1,765
Dover Corporation	Jan. 2	179	- 10	†40	9,177	+ 63
Dublin & Lucan Railway...	Dec. 31	177	+ 23	26	8,295	+ 213
Dublin Southern District..	,, 31	610	+ 35	¶26	26,844	+ 8,527
Dublin United	,, 31	3,035	+ 35	¶26	103,985	
Dudley—Stourbridge	,, 25	806	- 83	51½	42,683	+ 3,786
Dundee Corporation	,, 23	830	+ 9	...	...	...
	,, 30	810	- 55	...	...	...
East Ham Council	Jan. 2	589	+ 116	†40	25,779	+ 7,633
Gateshead & Dist. Trams...	Dec. 25	1,060	+ 19	51½	45,264	+ 5,457
Glasgow Corporation	Jan. 2	14,965	+ 778	31	424,686	+ 43,191
Gravesend-Northfleet.....	Dec. 25	294	+ 21	51½	12,381	+ 1,363
Greenock & Port Glasgow..	,, 25	497	+ 42	51½	27,868	+ 2,330
Halifax Corporation	,, 23	1,140	- 60	§39	53,653	+ 5,827
	,, 30	1,236	+ 145			
Hartlepool Tramways	,, 25	302	+ 22	51½	13,881	+ 950
Huddersfield	...	...	...	...	...	...
Hull Corporation	Jan. 2	2,140	+ 368	†40	75,695	+ 5,014
Ilkeston Corporation.....	Dec. 23	120	...	7	855	...
	,, 30	138	...			
Ipswich Corporation.....	Jan. 2	387	...	...	...	...
Isle of Thanet Co.	,, 2	232	- 26	1	232	- 26
Kidderminster & District...	Dec. 25	114	- 15	51½	6,479	+ 172
Kirkcaldy Corporation	...	...	...	...	...	...
Lanarkshire Trams Co.....	,, 31	570	...	§30	14,414	...
*Leeds Corporation.....	Jan. 2	5,269	+ 355	40	220,728	+ 13,407
Liverpool Corporation	Dec. 26	10,838	+ 263	52	522,891	+ 17,537
*Liverpool Overhead Rly. ...	Jan. 3	1,563	+ 67	1	1,563	+ 67
London County Council ...	Dec. 26	9,655	+ 655	§39	384,958	+ 70,261
Lowestoft	...	...	...	...	...	...
Manchester Corporation ...	Jan. 2	11,134	+ 2,710	29	339,517	+ 168,461
Mersey Railway	,, 2	1,643	+ 580	1	1,643	+ 580
Merthyr	Dec. 25	248	- 26	51½	10,242	+ 20
Middleton	,, 25	286	+ 20	51½	16,081	+ 1,945
Newcastle-on-Tyne Corp...	Jan. 2	3,744	+ 499	1	95,042	+ 499
*Newport (Mon.)	,, 2	420	+ 236	13	5,697	+ 2,946
Oldham, Ashton & Hyde ...	Dec. 27	566	+ 5	51½	20,040	+ 1,629
Perth (W. A.) Elec. Trams.	Jan. 1	1,697	+ 266	53	62,180	+ 7,424
Peterborough	Dec. 25	163	...	48	7,475	...
Poole and District.....	,, 25	265	- 53	51½	15,309	+ 2,094
Portsmouth Corporation ...	Jan. 2	1,337	- 9	†40	71,348	+ 4,583
*Potteries	Dec. 25	1,907	- 87	51½	82,010	+ 3,718
Reading Corporation.....	,, 31	531	...	...	...	...
Rothesay	,, 25	40	+ 8	51½	6,992	+ 1,607
Salford Corporation	Jan. 4	3,984	+ 676	40	158,566	+ 43,985
Sheerness	Dec. 23	51	...	37	3,053	...
Sheffield Corporation	Jan. 3	4,620	+ 311	1	4,620	+ 311
*Southampton Corporat'n...	Dec. 31	810	- 172	...	...	...
Southend Corporation	,, 30	198	+ 9	39	13,037	+ 2,051
Southport Tramways	,, 25	252	+ 27	51½	15,870	+ 2,728
S. Staffordshire Trams. ...	,, 25	1,058	+ 169	51½	47,449	+ 8,899
*Sunderland Corporation ...	Jan. 8	1,231	+ 14	40	49,292	+ 2,203
*Swansea Trams	Dec. 25	599	- 50	51½	26,637	+ 2,131
Taunton Trams	,, 25	60	- 6	51½	3,073	- 200
Tynemouth and District ...	,, 25	230	- 21	51½	15,637	+ 722
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council..	Jan. 2	587	+ 23	†40	28,035	+ 3,454
Weston-super-Mare	Dec. 23	19	- 9	51	5,731	- 525
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District ...	,, 25	869	- 98	51½	19,862	+ 7,596
Wrexham	,, 25	156	...	38	5,278	...
Yorkshire Woollen District	,, 25	628	...	44½	17,663	...

(a) These comparisons are with the corresponding period last year.

* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 4 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Jan. 6.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Jan. 6. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4¼–5	4 17 6	April, Oct	4¼	4⅜
St.	6%	† Do. Permanent 6% Deb. Stock	125 –130	4 12 4	..	..	..
10	10/0	Barcelona Tramways Ord.	7½–8½	5 17 8	..	..	..
10	5/0	† Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 –102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 –3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4½	5 17 8	..	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Prov. Certs.	97 –102	4 8 3	..	100	..
10	8%	Bristol Tramways and Carriage Ord.	20 –21	3 10 10	Feb, Aug	..	..
10	4%	† Do. Cum. Pref. (fully paid)	10¼–10½	3 15 11	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	106 –108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 –82	3 12 9	..	..	..
St.	5%	Do. Pref. Ord. Stock	91 –94	5 6 2	..	..	..
10	4/2½	Do. 5% Cum. Perp. Pref.	10¼–10¾	4 13 0	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝–104⅞	4 6 7	..	..	..
100	4½	Do. Vancouver Power Debs.	100 –103	4 9 4	..	..	..
10	6/0	British Electric Traction Ord.	11¼–11⅝	6 16 2	..	11⅛	11⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼–11⅝	5 2 2	Feb, Aug	11⅛	11⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –123	4 1 4	..	123	121½
5	..	Buenos Ayres and Belgrano Ord.	3 –3½	..	..	3⅜	3⅜
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼–5⅝	5 4 0	..	5⅝	..
5	3/0	Do. "B"	4¾–5¼	5 14 3	..	..	..
St.	5%	† Do. 5 per Cent. Debs.	104 –107	4 13 6	..	..	..
St.	5%	† Do. 5% 2nd Deb. Stock Prov. Certs.	98 –101	4 19 6	..	..	..
5	2 6	Calcutta Tramways	6¾–7½	3 2 1	..	6⅛	..
100	4½%	† Do. 4½% 1st Deb. Stock (red.)	104 –107	4 4 2	..	..	..
1	1/0	†Cape Electric Tramways Shares	1⅝–1⅞	9 1 4	..	1⅞	..
St.	4%	Central London Ordinary Stock	93 – 96	4 4 9	June, Dec	94⅜	92½
St.	4%	Do. 4 per Cent. Pref. Stock	99 –102	3 18 10	..	99⅜	99
St.	4%	Do. Deferred Stock	93 –96	4 8 4	..	93	..
100	4%	Do. 4 per Cent. Debs.	115 –118	3 7 11	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	5 –5½	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	47 –50	6 5 0	Feb, Aug	49	47
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 –129	3 18 7	Feb, Aug	..	..
St.	5%	Do. (1896)	123 –126	4 0 4	..	..	..
St.	5%	Do. (1901)	120 –125	4 1 1	..	122½	100½
St.	4%	Do. 4 per Cent. Perpetual Debs	109 –112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101 –104	4 16 9	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12 –13	4 4 7	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3½–4½	6 13 4	..	..	..
.	5%	† Do. 5 per Cent. Deb. Stock (red.)	92 –97	5 3 1	..	..	..
0	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 –8	3 15 0	..	..	..
0	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	‡Imperial Tramways Ord	20 –21	4 13 0	Mar, Sept	..	..
10	6%	††Do. 6 per Cent. Pref.	14½–14¾	4 2 10	Mar, Sept	..	..
St.	4½%	††Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	5 –5⅜	2 8 9	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼–10⅝	4 13 0	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	97 –99	4 0 9	Jan, July	..	..
10	5,0	†London United Trams. 5% Cum. Pref.	11 –11½	4 6 11	..	11⅞	..
St.	4%	† Do. 4% 1st Mort. Deb. Stock	102 –104	3 16 11	..	102½	..
St.	..	Mersey Con. Ord. Stock	8 –11	..	..	8	..
St.	..	Do. 3 per Cent. Perp. Pref.	12–15	..	..	12	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞–1⅛	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞–1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 –104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 –107	4 4 1	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½–2½	..	May	..	..
St.	5%	†Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 –102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½–9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 –10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 –105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 –94	3 9 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*†African Direct Tel. 4% Mrt. Deb. (red.)	98 –102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2½–3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	49 –52	6 1 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	92 –94	6 8 3	F,My,Ag,N	93⅞	93⅜
St.	1/0	Do. Deferred	7⅞–8½	0 12 5	F,My Ag,N	8	7⅛
100	$2	†Commercial Cable Capital Stock	160 –170	4 14 2	Ja,Ap,Jy,O	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	88 –92	4 7 0	Ja Ap,Jy,O	90	..
10	7,0	Cuba Submarine Ord.	7 –8	10 0 0	Feb, Aug	7⅞	..
10	10/0	Do. Preference 10 per Cent.	16 –17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April Oct	..	..
50	4½%	† Do. 4½ per Cent. Deb.	98⅝–101⅝	4 9 1	Jan, July	..	..
20	3/0	Direct United States Cable	10 –10½	6 3 10	Ja,Ap,Jy,O	10¼	..
100	4½%	†Direct West India Cable 4½%Rg.Db.(rd.)	98 –101	4 9 1	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	121 –126	5 11 1	Ja,Ap,Jy,O	123½	121
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 –90	3 18 5	Ja Ap,Jy,O	89	..
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –108	3 14 1	May, Nov	106½	106
10	2/6	Eastern Extension	11 –11½	6 1 9	Ja,Ap,Jy,O	11⅝	11
St.	4%	Do. 4 per Cent. Deb. Stock	106 –109	3 14 4	Feb, Aug	107	..
100	4%	* Eastern & S. African 4% Mrt. Deb.1909	99 –102	3 18 10	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝–102⅞	3 18 11	May, Nov	..	..
10	5,0	Great Northern of Copenhagen	24½–25½	4 18 1	Jan, July	..	..
100	4½%	†Halifax & Bermuda4½%1stMt.Db.(red.)	98 –101	4 9 6	June, Dec	..	..
25	12/6	Indo-European	37 –40	6 5 0	May, Nov	..	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 –102	5 18 3	Mar, Sept	..	..
100	4%	†Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 –100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 –6	3 6 8	..	..	..
2½	..	West Coast of America	½	..	..	..	..
100	4%	† Do. 4 per Cent. Debs.	95 –98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜–½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 –8½	9 4 8	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	*†Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	3/0	†Western Telegraph	11¾–12½	5 14 3	Mr,Jn,O,D	12¾	11⅝
100	5%	*†Do. 5% Debs. (2nd Series, 1906)	99 –102	4 18 0	June, Dec	..	..
St.	4%	† Do. 4% Deb. Stock (red.)	98 –101	3 19 3	..	99	98½
		FINANCIAL, INVESTMENT, &c.					
5	3/0	†Elec. & Gen. Investment 6% Cum. Pref.	5 –5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8¼–8¾	4 11 5	Ja Ap Jy O	8¾	8⅜
10	3/0	Do. 6 per Cent. Pref.	12½–13	4 12 4	Ja Ap,Jy,O	12⅝	..
8	4/0	Reuter's	6¾–7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	118 –123	4 18 9	April, Oct	119½	..

Share.	Last Dividend	Name.	Price Wed., Jan. 6.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Week to Jan. 6. Highest.	Lowest.
		TELEPHONES.					
5	6 0	Chili Telephone (fully paid)	4¾–5½	5 14 8	August ..	..	..
St.	6%	National Co. Pref. Stock	102 –104	5 18 0	..	103	102½
St.	5%	Do. Def. Stock	77 –80	6 2 10	..	..	..
10	6,0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 5 9	Feb, Aug	..	..
10	6,0	Do. 6 per Cent. Cum. 2nd Pref.	13 –14	4 5 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼–5⅜	4 13 0	Feb, Aug	..	..
St.	3½%	*†Do. Deb. Stock 3½ per Cent. (red.)	95 –97	3 12 2	June, Dec	96½	..
St.	4%	† Do. 4 per Cent. Deb. Stock (red.)	100 –102	3 18 5	..	..	..
1	0/7½	Oriental	¾–1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 –1½	..	..	..	..
5	3 0	†United River Plate	5½–6	5 16 8	July	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	4¾–5½	4 15 3	June, Dec	..	..
St.	5%	*†Do. 5 per Cent. Deb. Stock (red.)	102 – 105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝–¾	..	..	..	..
1	..	Do. 7 Cum. Pref.	1⅛–1⅜	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	114 –117	3 17 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½–13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10 –11	4 1 10	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	101 –104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. &Power 1stDebs.	100 –103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10 –10½	4 5 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	9¾–10¼	3 8 4	Mar, Sept	..	..
5	3 0	Calcutta Electric Supply Ord.	6¼–7¼	4 6 8	..	6⅜	..
St.	4%	Central Elec. Sup.Co.4% Guar.Db.Stock	105 – 108	3 13 11	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8¾–9¼	5 8 1	Feb, Aug	9¼	9⅛
5	2/3	Do. 4½ per Cent. Pref.	5¼–5¾	3 18 3	Feb, Aug	5⅝	..
5	2/3	† Do. City Undertaking 4½% Cm. Pref.	4¾–5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –105	3 16 3	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5½–6	4 3 4	March ..	..	..
St.	4½%	*†Do. 4½ per Cent. Deb. Stock (red.)	105 –108	4 3 8	Jn, Dec ..	105	..
10	5/0	City of London Electric Lighting Ord.	10½–11	6 16 4	Feb, Aug	10¾	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	13	..
St.	5%	*†Do. 5 per Cent. Deb. Stock (red.)	121 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	† Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7½–8½	4 14 2	..	8¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Mar, Sept	11¾	..
St.	4½%	† Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 1 10	..	..	..
St.	27,6‡	Do. Second Deb. Stock Prov. Certs.	99 –102	..	..	100½	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5½–6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 –103	4 7 5	..	..	..
10	..	Havana Electricity Co. Shares(£8 paid)	7½–8½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½–8¼	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	10½–11½	4 6 11	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & NottingHill Co. (Joint Station) 4% Deb. Stck.(red.)	101 –104	3 16 11	..	..	..
3	..	London Electric Supply Ord.	1¾–2¼	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	5 –5½	5 9 1	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 –100	4 0 0	Mr,Jn,S,D	..	..
10	8 0	Metropolitan Electric Sup. Ord.	17–18	4 6 1	April, Oct	17½	..
5	..	Do. 4½ per Cent. Cum. Pref.	5¼–5⅜	..	..	5⅜	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	3 19 6	Jn, Dec ..	..	..
St.	3¾%	† Do. 3¾ per Cent. Mrt. Db. Stock (red.)	95 –98	3 11 4	..	..	..
100	4½	†MidlandElec.Corp.for P.D.1stMort.Db.	95 –98	4 11 9	..	..	..
10	6,0	Notting Hill Electric Ord.	12½–13½	4 8 11	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5¼–5⅜	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 –101	4 0 6	..	..	..
1	..	Rand Electric	⅞–1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 –102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½–15½	4 13 9	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	7½–8½	4 2 4	Feb, Aug	8⅜	8⅛
St.	3½%	† Do. 3½ per Cent. Deb. Stock (red.)	98 –101	3 10 4	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3 –3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	..	..
1	1/9	South London Electric Supply Ord.	3½–3¾	4 13 4	..	..	..
5	2/6	Urban Electric Supply Ord.	4¾ 5¼	4 17 7	..	..	..
5	2,6	Do. 5% Cum. Pref.	4¾–5¼	4 17 7	..	..	..
5	6/6	Westminster Electric Supply Ord.	12 –13	5 0 0	Mar, Sept	12⅞	12⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½–¾	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅜–½	..	Mar, Sept	..	..
5	4,0	British Insulated & Helsby Cables Ord.	6 –6½	7 13 10	July, Feb	6⅛	..
5	3 0	Do. 6 per Cent. Pref.	5½–5¾	5 4 4	Jan, July	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	102 –107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n4½%1stMt.Db.	103 –105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	4½–4¾	6 6 4	..	4½	4⅜
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock	94 –97	4 2 6	..	..	..
½	..	Brush Electrical Engineering	¾–1¼	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 –1½	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –100	4 10 0	Mar, Sept	..	..
St.	4½%	† Do. Perpetual 2nd Deb. Stock	75 – 80	5 12 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	11 –12	6 5 0	Jan, July	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5¼–5½	4 6 11	Jan, July	..	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Debs.(rd.)	104 –108	4 3 3	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅞–1	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	90 –95	4 15 3	..	..	..
1	0,7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾–2¼	6 13 4	Jan, July	..	..
100	5%	*†Do. 5 per Cent. 1st Mort. Debs. (red.)	97⅝–100⅝	5 0 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8¾–9¾	..	..	..	..
5	..	Do. 6 Cum. Pref.	5¼–5¾	..	..	..	..
St.	4½	† Do. 4½ Deb. Stock	103–105	4 5 9	..	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½–1½	..	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock (rd.)	71 –76	5 5 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 –81	6 3 5	..	..	..
5	4/6	Edmundson's Elec. Corp. Ord.	6 –6½	5 7 8	H'lf-yearly	6½	6⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	6 –6½	4 12 4	..	6⅝	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 –107	4 5 4	..	106	..
2	1/2½	Electric Construction Co.	1⅜–1⅝	6 8 0	Jan, July	1⅜	..
2	2 9⅜	Do. 7 per Cent. Cum. Pref.	2½–3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 –101	4 0 9	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	½–½	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾–1	..	..	..	..
St.	5%	†Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	†General Electric (1900) 5% Cum. Pref.	9¾–10¼	4 17 7	..	9¾	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 –98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	13½–14½	6 17 11	Feb, Aug	13¾	..
5	2,3	Do. 4½ per Cent. Pref.	5 –5¼	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 –112	4 0 9	Feb, Aug	..	..
10	15/0	†India Rubber, Gutta Percha, &c., Wrks.	18 –19	5 5 3	Feb, Aug	18⅝	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 –103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾–11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 –37	6 9 8	Mar, July	34	..
100	4%	† Do. 4 per Cent. Deb. Bonds, 1909	100 –103	3 17 8	Jan, July	..	..
5	3/6	Willans and Robinson Ord.	4½–5¼	5 18 2	Apr, Oct	5⅛	4⅞
5	3,0	Do. 6 per Cent. Cum. Pref.	5¼–6¼	4 16 0	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –102	3 18 5	May, Nov	..	..

In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend ‡ The London Stock Exchange Committee have refused to quote these.

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Copyr AYS.—Continued.

—	Nam (Fig	Maximum Discharge Rate in Amperes.	TRANSFORMERS, BOOSTERS & BALANCING TRANSFORMERS. No.	Make and Size.	Location.	METER
54	LA	...	1 1	Westinghouse bal. Mather and Platt	Station	Ferranti, H ham, Thoms Westinghou
55	LI	...	...	...	...	Ferranti Hookh
56	LO	...	2	80k.w. B.T.H. mot. gen.(1), 40k.w. balancer (1)	Station	Schattner, B Vulcan & W

ined complete (as this), price 1s. 6d., post free

shall	—	Three-wire for lighting. Separate generators for traction				
nedy	S	H.T. single-phase. Transformer sub-stations, 2 and 3-wire a.c., and 3-wire c.c. for lighting. Same generators for traction.				
W.	—	Three-wire for lighting. Arcs 10 in series. Same gen'rs for traction				
nedy	—	Three-wire with batteries for light'g. Separate generators for traction				
legg	—	Three-wire for lighting. Same generators for traction				
s ...	—	Three-wire for lighting. Separate generators for traction				
eece	—	Three-wire for lighting. Separate generators for traction				
bred	—	Three-wire for lighting. Separate generators for traction				
ion	S	H.T. single-phase, 2-wire distributing network. Transformer sub-stations. Separate generators for traction				
son	—	Three-wire for lighting. Same generators for traction				
and	—	Three-wire. Separate generators for traction				
	—	Three-wire for lighting. Separate generators for traction				
ire-	—	3-wire for lighting. Same gen'rs, compound wound, for traction				
llar	—	3-wire, 460 v., Lighting. Traction, 500 v.—*See* Remarks.				
tz	—	Three-wire for lighting. Separate generators for traction				
Elec- Ltd.	—	Three-wire for lighting. Separate generators for traction				
ham	—	Three-wire for lighting. Separate gen'rs, comp'd wound, for traction				
V.	—	Three-wire for lighting. Same gen'rs, comp'd wound, for traction				
...	—	Three-wire for lighting. Separate gen'rs, comp'd wound, for traction				
	S	Three-wire for lighting. Same generators, compound wound, for traction				
W-	—	Three-wire for lighting. Shunt wound generators and batt'y for traction				
W-	—	Three wire for lighting. Separate compound wound generators for traction.				
er	—	Three-wire for lighting. Separate generators, compound wound, for traction				
l	—	Three wire for lighting. Same generators for traction				
in	—	Three-wire for lighting. Separate compound wound generators for traction				
en- F.	—	Three-wire for lighting. Same generators, compound wound, for traction				

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—	Name of Town or District. (Figures in brackets indicate estimated population.)	Date of Lighting Order.	Date Supply was commenced.	Types ar
1	ABERDEEN ..... [154,000]	1890	Mar., 1894	e copper in culvert rompton-Davies ca ng filled with comp
2	ASHTON-UNDER-LYNE [43,890]	1892	1899	eders—2-wire & 3 istributors—Tripl
3	¶ASTON MANOR ..... [77,310]	1898	Sept., 1903	.I.W. lead-c and armoured
4	AYR ..... [28,000]	1890	Jan., 1896	T.—Callender conc T.—Callender conce
5	BARKING ..... [21,547]	1897	May, 1899	eders.—Concentric reet Lighting.—3-co istributors.—Single
6	BARNSLEY ..... [41,683]	1890	Feb., 1900	.I.W. lead-cov armoured, 3-c
7	BATLEY..... [30,321]	1898	Aug., 1903	Feeders. — Calle sheathed, also
8	BEXLEY..... [14,579]	1899	Oct., 1903	Anchor" conc. lead- riple conc. lead-cove rmoured three core
9	BIRKDALE ..... [15,000]	1898	Aug., 1902	Callender V.B.
10	BLACKBURN..... [129,116]	1890	Feb., 1895	ubber cables suppor within C.I. conduits, paper cables.
11	BLACKPOOL ..... [50,000]	1890	Aug., 1893	B.I.W. and St. insulated cable
12	BOLTON ..... [171,000]	1891	Oct., 1894	T.—Rubber-ins'd arm'd T. Distributors—Three- T. Feeders—Triple-conce section—Single core, pape
13	BOOTLE..... [58,558]	1895	April, 1898	.I.W. paper-insulate and Simplified Und
14	BOURNEMOUTH ..... [60,000] (tramways & public lighting)	1899 & 1900	1900 & 1902	Paper and lead-
15	BOURNEMOUTH, BRANKSOME & POOLE	1890-1-7-9 1900	1891	Callenders' pape Concentric and t fibrous and vul
16	BRADFORD ..... [279,809]	1883	Sept., 1889	Distributors—Arm' eeders—Paper-insu
17	BRIGHTON ..... [123,478]	1883	Sept., 1891	Lead-covered, armoured cabl
18	BURNLEY ..... [100,000]	1890	Sept., 1893	B.I.W. and Call
19	BURTON-ON-TRENT... [50,386]	1890	Mar., 1894	Siemens ..... T.—B.I.W. Co.'s concentr T.—Silvertown single rul ramway cables, B.I.W. Co.
20	CAMBORNE and REDRUTH [14,726]	1899	Oct., 1902	Callender V.B. L.S. and S.T.
21	CARDIFF ..... [164,420]	1891	Dec., 1894	Vulcanised rubber, co centric and 3-core ca concentric feeders an
22	CARLISLE..... [45,478]	1895	May, 1899	Callender & B.I.W. lea armoured. Middle Wi Triple concentric. A
23	CHELTENHAM and Charlton Kings [53,245]	1890 1899 1900	May, 1895	Lead-covered cables, p ead-covered armoured ead-covered armoured
24	CHESTER ..... [40,000]	1890	Dec., 1896	Callender bitumen'd Concentric feeders
25	CHRISTCHURCH ..... [5,000]	1900	1903	Blover and Call and V.B. cable
26	CLECKHEATON..... [12,523]	1900	Nov., 1902	B.I.W. feeders, tripl Extension armoured
27	COATBRIDGE and AIRDRIE [30,083]	1890 1898	Mar., 1894	Callender. Dist tric. Feeders-
28	COLCHESTER ..... [38,351]	1893	Dec., 1898	Feeders—Siemens jute and Distributors—Siemens jute Henley's tramway feeders covered and armoured
29	COLNE ..... [23,000]	1898	Sept., 1901	B.I.W. Triple-co

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BOOSTERS & TRANSFORMERS.	Location.	METERS.	PRICE PER UNIT. Small figs. (1) indicate first hour, (2) first two hours, &c. Lighting.	Power.	TARIFF SYSTEM. W. indicates the WRIGHT system of charging. D. indicates Discounts	Price of Gas in District.	Gasworks owned by. L.A. = Local Auth. Co. = Company.	—	REMARKS.
les	Cotton-st. Station	Ferranti, Thomson, Bastian and Hookham; Reason prep.	6d.—2½d.	3d. & 1d.	W.	3/2	L.A	1	Natural draught. Hand stoking. Worthington feed pumps. Motors, &c. on hire, and lamps sold.
bal.	Dee Village Station								B. and W. chain grate stokers. Weir feed pumps. Condensing water pumped from Dee, ¼ mile distant, by electrically driven centrifugal pump controlled from works.
bal. rator	Station	Hookham ...	4d.	1½d.	...	2/4	Co.	2	Refuse destructors in addition. 220-tube Green economiser. Natural draught Hand stoking. Motor-driven three-throw pump and Holden and Brooke injector and steam pump. Jackson 75-kilowatt motor-generator, for small lighting or traction loads
ouse	Station	...	...	...	Time switch system.	2/3 to 2/7	Co.	3	Two 96-tube Green econ. Nat. draught. Vicars stokers. Well water. Motor feed pumps, Boby water htrs. and detartarisers. Hunt coal conveyer
r Sie-	Sub-stations	Hookham, Thomson, Aron and Reason.	5d.	2d	...	3/9	2 Co.'s	4	Free wiring powers applied for. Elctr. condensers to come.
com- motor	Station	B. T. H., Vulcan; Rochdale prepayment	4½d.	3½d. to 1½d. 1rams 2d.	D. for power only	3/10	Co.	5	96-tube Green economiser. Natural draught. Vicars and chain grate stokers. Worthington and Weir feed pumps. River water. Free or municipal wiring.
osters, boos	Station	Hookham ...	7d.(1)—2d. or 4d.	1½d.	W.	2/10 to 3/4 less 2½ for cash	Co.	6	Green economisers. Hand stoking. Motor feed pumps. Natural draught. Town and well water.
n'r.	Station	Hookham ...	6d.(1)—3d.	3d.(1)—1d.	W.	2/1	L.A.	7	Royle exhaust steam feed heater. 2 192-tube Green economisers. Vicars stokers. Weir feed pumps. Town water. Motors on hire.
ooster	Sub-station Station	...	6d.	6d.—2½d.	...	4/3	Co.	8	288-tube Green economiser. Natural draught. Proctor stokers. Electrically-driven pump and injectors. Water from town or hot well.
ba- set	Station	B.T.H. and Reason	7d.(1)—2d.	2d.	W.	3/2	L.A.	9	Lowcock 96-tube economiser. Natural draught. Steam jets only in connection with fire bars. Bennis stokers. Two Weir pumps. Schmidt superheaters. River and town water.
Berry (4)) . 25kw.	Undergrnd. street boxes and in houses	Aron, Bastian, Ferranti, Hookham and Thomson	6d.(1)—3d.	2½d. & 1½d	W.	3/3	L.A.	10	No economisers. Induced draught. Hand firing. Ring boiler feed. Weir pumps. Heater and filter. Heating and cooking 2d. per unit. No free wiring.
iswan, .T.H.,	Fixed in chambers	Thomson & Aron	7d.(1)—2d. Churches 5d.	Tramways 2d. up to 250,000, 1½d. after. Private 2½d. 2½d. 1st 500 1½d. 2nd 1d. the rest Traction 1½d. 12,000 at 2d. per unit per annum and 1d. over	W.	2/4	L.A.	11	1024, 288 and 192-tube Green econ. Proctor and Smoke Preventer Co.'s stokers Five steam pumps; one electric 3-throw. Motors and arcs on hire and main tained.
alt. tarks	Station	Ferranti, Hookham, Shalbrgr., B.T.H., and Westinghouse; Watson prepayment	6d.(1)—3d. or 4d.		W. & D.	2/6	L.A.	12	Traction sup. to Co. 448-tube Green econ'r. Wilton's induced draught. Hand firing and mechanical stokers. Mumford feed pumps and injectors. Cowan's boosters and balancers. Donat Cooling tower. Morton Coal Elevator. 450 kw. traction set being installed.
ooster ter	Station ,,	Hookham, Ferranti, & Geipel	5d.(1)—3d.		W.	2/8	Co.	13	48 tube Green econom'r. Worthington, Weir, and electric feed pumps. About 38 miles of tramways. Cass and Bennis stokers. Motors on hire. Brush and Berry transformers in sub-stations and houses. 192-tube Green economiser. Natural draught. Bennis mechanical stokers. Worthington feed pumps. Parker boosters. "Easy" wiring system. Running right leased to Liverpool Corporation.
	...	Hookham, B.T.H.	3½d. & 2d.	3½d.	...	3/2	Co.	14	Two steam-driven fans. Injectors and donkey pumps. Economiser 384 tubes. Superheaters. Proctor mechanical stokers. Hall feed pumps; town water supply.
rans...	Sub-stations								
.....	Station								
mo. gen.	Sub-stations	Hookham, Aron, Westinghouse Elec. Co.; Vulcan prepayment	7d.(1½) & 3d. or 6d.	3d.	W. & D.	3/2	Co.	15	Two 120-tube, one 288-tube Green econ'rs. Heenan & Froude & Sturtevant induced draught superheaters. Hand firing. Water softener. Cooling towers. Free & assisted wiring. Motors and radiators hired.
ancer osters	Bolton-rd works	Aron, Bastian, Ferranti, Hookham and Thomson	4d.	Sliding scale 1½d. to 2d.	2½ % dis. at 2 months, for lighting only	2/8	L.A.	16	Three stations. Three Green econs. Marine boilers induced draught, Lancs. & B. & W. natural. Hand & mech. stoking. Elec. and steam feed pumps. Arcs and Motors (¼ H.P. to 60 H.P.) on hire. Free lamps
.....	Station	Ferranti, Reason, Thomson and Aron	7d.(1)—1d.	7d.(1)—1d.	W.	3/0	Co.	17	288-tube and 300-tube Green economisers. Natural, forced and induced draught. Steam and electrical feed-pumps. 725kw. plant specially provided for traction.
..... t.	Station	Ferranti, Hookham & Thomson	4d.	3d.(1)-1d.	D.	2/3	L.A.	18	Charge for gas also subject to discount. Green econers. Proctor & Leache stokers. Natural draught. 4-Erith underfeed stokers with forced draught.
Berry	Street boxes & consumers premises	Shallenberger, Hookham, Westinghouse, and Ferranti	6d.(1½)—3d.	3d.(1½)—1d. or 2d. 1st 10,000 1½d. after	W.	2/7 net to 2/9	L.A.	19	Bailey & Weir feed pumps and Parker motor-driven pumps. River water. 2 Green economisers. Forced draught. Perret furnaces. Hand stoking. Pearn and Bailey feed pumps. River water. Hire purchase wiring.
..... booster ster — ton (10), ler (10),	Station	Hookham, Reason and Vulcan	7d.—4d.	4d.-1½d.	W.	4/9	Co.	20	3 Berryman feed heaters. 2d. 1st 100,000, 1½d. after, for tra tion. Greens econ'rs. Natural draught. Hand fired. 2 Hall pumps. "Free" wiring, 4½d. per lamp per quarter, 7d. prep'nt., 1s per cent. on motors.
.....	Station and sub-station	Thomson, Aron, Ferranti, Reason, Bastian and Hookham; Vulcan prepayment	7d. (1)—2d. 4½d. flat rate	4d. & 1d.	W.	3/1	Co.	21	Works supply lighting Camborne, Redruth, Illogan and C.R. Tramways.
..... ble- enders" British ughouse	Station	Ferranti, Hookham, Reason and Bastian electrolytic	5d. to 4d.	2d.-1½d.	D.	2/3	L.A.	22	Nat. draught. Hand-firing. Outers of H.T. mains carried. Town water 288-tube econ'r. Vicar's stokers at Nainway Station. Engines fitted with air pump and jet condenser.
	Sub-station	Thomson, Westinghouse, Ferranti and Elec Co.'s	6d. to 3½d.	6d. & 1½d.	Discounts on system analagous to W.	2/6	Co.	23	192-tube Green econ'r. Natural draught. Automatic stoker. Three Worthington feed pumps. Caledonian Railway arc lamps at 2½d. per unit, company agreeing to take min. of 12,000 B. of T. units per annum.
ncers s	...	Ferranti and Hookham	4½d.	2½d.—1½d.	D.	3/0 net	Co.	24	Nat. draught. Hand-stoking. Brake and Worthington feed pumps and injectors. Town water. 384-tube Green economiser. Cont.-current machines supply current to Tramway Co.
ster...	Station	Hookham;	7d.(1½)—3d. or 6d.	3d.	W.	4/4	Co.	25	288-tube Green economiser. Steam set forced draught. Hand firing. One B. & W. chain grate. Three Erith underfeed stokers. Worthington and Weir pumps. Town water.
ers ...	Station	Reason prep.	5d.	2d.	...	2/8 less 10 per cent	L.A.	26	Superheaters. Economisers. Natural draught. Hand firing. Dearumaux water softener. Free and assisted wiring. Motors and radiators on hire. Tramway not yet running.
cers	Station	Ferranti and Reason	5% dis.	5% dis.					192-tube Green economiser. Meldrum forced draught. Hand firing. Electrically-driven Thornton and Crebbin pumps. Back water. No free wiring, &c. New 350 kw. set in hand.
osters									
er- ..ot	Station	Thomson ...	5d.	2½d. to 1d.	...	2/2	Co.	27	No economisers. Natural draught. Vicars stokers. Two 3-throw steam feed-pumps. Three injectors. Tramways not yet opened.
	Station	Hookham, Schattner and Reason	7d.(1)—4d.	By arrangement	W. 7d. for 1st 800 hours per ann.	3/0	Co.	28	Mumford feed pumps and Mather and Platt electric pump. Hancock injector. Hand stoking. Town water. Free wiring under consideration. Tramways being constructed.
	Station	Reason electrolytic, B.T.H. &	6d.(1)—2½d.	2½d. and	W.	2/9 less	L.A.	29	96-tube Green economiser. Proctor stokers. Hall compound feed-pumps. Exhaust steam injector. Current supplied to Colne-Trawden Light

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THE ELECTRICIAN:

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NOTES.

THE engineers connected with the electrical equipment of the London County Council tramways are to be congratulated on the results of their work. It will be remembered that the type of conduit was one designed by Mr. A. N. CONNETT, being similar to that used by his firm on the Bournemouth tramways with the modifications necessitated by the employment of a centre slot instead of a side slot. This conduit proved so successful on the Tooting lines of the London County Council that a precisely similar one was chosen for the Greenwich lines, which are now completed; and, in fact, the whole of the track construction gave such satisfactory results that very few alterations have been found necessary. A valuable Paper describing in great detail the civil engineering work on the Tooting lines was read by Mr. ALEX. MILLAR at the Institution of Civil Engineers on Tuesday. By the rules of this Institution we are debarred from publishing more than a short "official" abstract of this Paper, but we recommend our readers to obtain access to the Paper itself when it appears in the *Proceedings* of the Institution in a few months' time. The collection of detailed drawings alone is of considerable value, and the only fault we have to find with the Paper is that sufficient credit is not given to Mr. CONNETT and the engineers of Messrs. J. G. White & Co., who were responsible for a large proportion of the design. An illustrated description of the Greenwich lines appears in this issue.

ON another page of this issue will be found a description of the newest London "tube," the Great Northern and City Railway. This line was commenced in the beginning of 1899, and has, therefore, taken just four years to complete. There are two or three features of novelty in connection with it, but its electrical equipment is very much on standard lines. As on the Mersey Railway and the Metropolitan District lines, two conductor rails are employed. Both of these are placed outside the running rails. By adopting this plan it has been found possible to construct a fireproof concrete footway 18in. wide in the centre of the four-foot way, upon which passengers may alight from the trains and walk to the stations in the event of a breakdown occurring. Another feature of interest is the size of the tunnel, which is greater than that of any other tube railway in London. If occasion arose it would be possible to bring the Great Northern main line rolling-stock down to the City, but up to the present there is no means of effecting an interchange of traffic at Finsbury Park, and even if there were it is not quite clear that any advantage would be gained by such a proceeding.

AN extension of the line from Moorgate-street to Lothbury is in progress, and there is no doubt that this will augment the traffic very considerably. The receipts will also be enhanced by the connections with the City and South London Railway at Moorgate-street and Old-street stations, the above-ground premises of the South London at the latter station being used jointly by both companies. In order to lessen noise and vibration the lower half of each steel ring forming the actual tube has, for part of the line, been cut out and a vitrified blue brick invert substituted. This is said to be less resonant than the complete ring and has the effect of stopping the transmission of sound waves. Extreme precautions have been taken to prevent outbreaks of fire, and the line is without doubt the finest of its kind in this country.

MR. W. E. BURNAND, in his interesting article published elsewhere in this issue, suggests a method for testing large alternators, which, like Mr. BEHREND'S method recently described in these columns, is a modification of one by Mr. W. M. MORDEY in a Paper read at the Institution of

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Electrical Engineers nearly 11 years ago. If the method proves as successful in practice as it appears to be on paper, it is evident that it will have a useful field of application, as it applies a test to an alternator almost under similar conditions to those which will obtain in actual service. In addition to the disadvantage, common to nearly all similar methods of alternator testing, that the power to compensate the losses has to be supplied mechanically and measured, the method possesses a further drawback—viz., the introduction of gearing, unsatisfactory in several ways, between the machine under test and an auxiliary alternator. Still, Mr. BURNAND'S proposal is a step in the right direction towards the ideal of a purely electrical method for testing alternators economically and in conditions such as obtain during ordinary running.

AT the first meeting of the Royal Commission on London Traffic after the Christmas holidays, some important and interesting evidence from the tramway promoter's point of view was given by Mr. STEPHEN SELLON. His arguments in favour of legislative reform, particularly as regards the local veto and the purchase clause under the Tramways Act of 1870, were so well supported by many excellent examples of the abuse of these powers by the local authorities, that, despite the subject having been discussed on many occasions in our columns, we have felt justified in giving his views at some length. No doubt many will not see eye-to-eye with Mr. SELLON in all his ideas, but he certainly speaks with moderation in his proposals as to the relationship bet ween the local authorities and tramway companies.

AN interesting instance of the conflict between municipal and private enterprise in tramway matters, which has been emphasised in evidence before the Royal Commission on London Traffic, occurs at South Shields. In the last session of Parliament both the South Shields Corporation and the British Electric Traction Co. promoted almost identical Bills for the construction of electric tramways. At present there are about 1½ miles of horse tramways in South Shields worked by a subsidiary company of the British Electric Traction Co., and the latter, arguing that it was an effort on the part of the Corporation to set up competition with the lessee company, offered to come to a compromise in the matter, which suggestion, however, was not acted upon. Eventually the Corporation Bill was passed, and the Company defeated, with the proviso that in the event of competition taking place between the new Corporation lines and the existing ones, suitable compensation should be made to the lessees. Now, however, as will be seen in our "Tenders Invited" columns this week, the Corporation have adopted the novel plan, for this country at any rate, of publicly inviting tenders for a lease of the lines authorised by its Act of 1903. The option of leasing the lines was reserved to the Corporation in the Act.

AN interesting legal case may be expected shortly if we judge by the proceedings at the last meeting of the Willesden Urban District Council reported elsewhere in this issue. The Metropolitan Electric Supply Co., which supplies a great part of its district in Paddington and Marylebone from a station in Willesden, apparently desires to give a power supply to works of the London and North-Western Railway Co. adjoining its Willesden generating station. The Willesden Urban District Council, which supplies electricity under the Willesden Provisional Orders objects. The Company rightly contends that there is nothing in the Council's Provisional Order to prevent the Company supplying in competition with the Council, although the latter might object to mains being laid in its streets (which is not necessary as the two works are adjoining). On the other hand, the Council contends that it is specifically provided in the Company's Provisional Order that it may not supply energy beyond the area specified in the Order. This contention appears to be correct, but there may be something in the Company's subsequent Act relating to the Willesden works which would give the case another aspect. If legal proceedings are taken, as is threatened, it will, we believe, be the first case of the kind.

THIS week we have pleasure in presenting readers of *The Electrician* with a Supplement sheet giving details, in tabulated form, of all electricity works in the United Kingdom which supply energy for both lighting and tramways. It has been our custom hitherto to include all electric lighting stations in one table, but the total number has now reached such large proportions that we have been obliged to print two separate sheets, as explained last week. We tender our hearty thanks to resident engineers of stations in operation and to consulting engineers of stations in progress for their kind assistance and co-operation in enabling us to obtain the necessary statistics. Next week we propose publishing another Supplement giving particulars of the "Power" schemes in operation, in progress and projected, in the following week our annual table of electric railways and tramways of the United Kingdom, and on February 5th a map of the United Kingdom showing the positions of these railways and tramways.

Radium.—The Paris correspondent of the *Morning Post* states that a Bill providing for the opening of a special credit of 150,000 francs to enable M. Curie to continue his radium experiments was issued to the deputies on Tuesday.

Italian Power Transmission.—Brescia is to be supplied with electricity from a water-power station situated at Caffaro, 31 miles distant, near the Italian-Austrian frontier. Five 2,500 H.P. sets will generate three-phase current, which will be transmitted at 40,000 volts.

The Metric System.—There is an interesting clause in Mr. Herbert Spencer's will to the effect that, should a bill be introduced in Parliament on the subject of the metric system, his pamphlet against the metric system is to be reprinted, with certain specified alterations, and distributed among the members of both Houses of Parliament.

Wireless Telegraph Notes.—An intimation has been received at Dover that the Goodwin Sands lightships are to be put in communication with the shore by means of wireless telegraphy, and that the installation will be complete in about a month. Four lightships will communicate with the Admiralty wireless telegraph station near Shakespeare Cliff, Dover.

Church Struck by Lightning.—A somewhat unusual occurrence, for this time of year, took place yesterday morning, when a church at Godshill, about 6 miles from Ventnor, was struck by lightning. Considerable damage resulted, the pinnacles on the tower being hurled down, the clock face torn off, the font broken, the windows smashed, and the church roof almost ruined beyond repair.

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Tunnelling through Mont Blanc.—In connection with the projected tunnel to be constructed through Mont Blanc, it is suggested that the great water power of the Dora should be used to supply electrical energy for the workshops, for driving air compressors, hauling plant, &c., during the process of tunnelling, and that afterwards it should furnish electrical energy to propel the trains, the nuisance of smoke in the tunnel from steam locomotives being thus obviated.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Cape St. Jacques—Haiphong	Dec. 15, 1903 ..	Jan. 11, 1904
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903 ..	—
St. Kitts—San Thomé	Dec. 22, 1903 ..	Jan. 8, 1904
St. Vincent—Grenada	Dec. 29, 1903 ..	—

New Foreign Technical Journals.—Two new Continental publications of a technical nature have been recently brought to our notice. Both commenced their career with the New Year. The first is the *Schweizerische Elektrotechnische Zeitschrift*, which is edited by Herr Siegfried Herzog, and will appear in Zürich on alternate Saturdays. It is the first Swiss publication devoted exclusively to electrical subjects. The *Technische Literatur* is devoted to recording, abstracting and reviewing articles appearing in other technical publications and books. The reviews are published in the language in which the book is written. An index to publications and articles on subjects of engineering (civil, mechanical, electrical, &c.), chemistry and allied branches of knowledge in three languages, is appended. This paper is edited by Herr Otto Wolters, and is published weekly by Gebrüder Jänecke in Hanover.

Power Station Operated by Gas.—What is considered to be one of the largest gas-driven power plants in France exists in Valenciennes. *L'Industrie Electrique* states that after being operated by steam engines, this station was converted to a gas-driven one in consequence of a dispute arising with the local gas company with regard to certain concessions held by the company. An amicable settlement was arrived at, the company working the electricity station agreeing to a minimum purchase of 50,000 cubic metres (1,750,000 cubic ft.) of gas per annum at a price of 10c. (0·94d.) per cubic metre. Four 110 H.P. gas engines have been erected in the engine-room, and they are remarkable for the fact that one of the two cylinders, which are mounted in tandem, is double-acting, the other being single-acting. Connected to them by belting are four dynamos, each generating about 400 amperes at a voltage of from 225 to 250. A smaller set of about 40 H.P. capacity is used in connection with the buffer battery and for light loads. Electrical energy is distributed on the three-wire system by means of overhead lines. For lighting purposes electricity is sold at a price of from 55c. to 75c. (5·2d. to 7d.) per kilowatt-hour, and for power purposes the charge is from 35c. to 50c. (3·3d. to 4·7d.) per unit.

Double-tariff Meter.—An apparatus is being placed on the market by the Electrical Co. for registering electrical energy supplied at a double rate of charging, according to the hours of the day during which energy is consumed. The apparatus consists of two watt-hour meters of any make, and a contactor clock. On the arbor, to which the hands are attached, are mounted two cams, these actuating two contact springs. By setting the cams suitably, the shunt circuits of the two watt-hour meters is opened and closed by the contact springs at the predetermined times. The clock is made to run for one month with one winding. One of the meters referred to registers the total number of units consumed, while the other marks the number of units sold during any particular period. All the contacts of the contactor are on the front of the clock, and periodical inspection may be made without disturbing the seals. The company is also putting on the market a complete apparatus, consisting of two watt-hour meters and a contactor, mounted on a slate or wooden base, and already inter-connected. These double-tariff meters may be used either for continuous or for alternating current. For use with the former system, the company has devised an apparatus with only one watt-hour meter, which possesses, however, two counting mechanisms acted upon by the contactor clock.

Electrification of the North-Eastern Railway.—In the course of the next fortnight the North-Eastern Railway will have settled the final draft of the service of electric trains which are to be run on the Newcastle suburban lines recently electrified. The whole of the installation is not yet completed, but the board are considering the advisability of beginning a service of trains for the completed portions. The sections of line which are to be worked electrically are those from Newcastle to Tynemouth, and round through Monkseaton, Benton and Gosforth back to the Newcastle central station, the main line from Manors to Benton, and the riverside loop from Byker to Percy Main, as well as the railway now in course of construction from Gosforth to Ponteland. The aggregate length is about 40 miles, but the line from the central station to Heaton South Junction consists of four tracks, and the greater part of the remainder of two tracks. On the main line the local traffic only will be electric. The trains will attain an average speed of 22 miles an hour, it being intended that they shall complete the journey from Newcastle to Tynemouth in 23 minutes, including stops, while quick trains, running through, will reduce the time to 15 minutes. Nearly the whole of the rolling stock is now completed. *The Times* announces that some preliminary trials to ascertain adjustments for the adaptation of auto cars to the regular train service took place on Tuesday over a section of the main line going north at York. The new car was run to Skelton Bridge and back with satisfactory results. It is proposed shortly to conduct a further series of trials on the light railway between Selby and the village of Cawood. The new auto car is between 50ft. and 60ft. long, and is fitted at one end with an engine chamber, accommodating a Wolsey petrol engine. A dynamo generates electricity and supplies energy to a four-wheel bogie underneath the engine compartment. Seating accommodation is provided for 52 passengers. The car is lighted and heated by electricity. A speed of 30 miles an hour can be got up, and a stoppage made in as many seconds. Illustrated descriptions of the work in connection with the "electrification" scheme will be found in *The Electrician*, Vol. XLIX., p. 721, and Vol. LI., p. 237.

Obituary.—It is our painful duty to announce the death of Mr. R. C. Quin, which took place at Tamney, co. Donegal, on Monday. Mr. Quin had gone over to Ireland to inspect some granite quarries, and while standing on a pier a tidal wave swept in and carried him out into the Atlantic. A friend, Mr. Frederick Margerison of Bradford, jumped in to his rescue and succeeded in bringing him to the pier, where another gentleman held out a coat for him to clutch. Mr. Quin caught the garment, but almost immediately released it and fell backwards. Mr. Margerison was also carried away by a heavy sea, and only reached the shore with difficulty. At the inquest, which was held on Tuesday, his conduct was warmly commended by the jury, who requested the coroner to report the circumstances to the Royal Humane Society. Born in London in 1865, of Irish parents, Robert Cornelius Quin became a pupil of Mr. J. N. Shoolbred in the early eighties, and was subsequently attached to the construction staff of the Bradford Corporation electricity works—the first municipal station in the United Kingdom. In 1891 he was appointed chief assistant at Brighton, and five years later the Blackpool Corporation secured his services as Borough Electrical Engineer and Tramways Manager. Here he designed and carried out numerous alterations and extensions of the works, the plant capacity being five times greater when he left than when he was first appointed. He also converted the tramways from the conduit to the trolley system. After leaving Blackpool, in 1902, Mr. Quin established a consulting practice in London in partnership with Mr. Speight, and was retained by two or three local authorities in the North of England to advise with regard to their electricity undertakings. Among these were West Bromwich and Shipley, both of which stations are now in operation. A few years ago Mr. Quin patented an ingenious device for disconnecting a trolley wire from the mains if it

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became broken and fell, and he read a Paper on a kindred subject before the Municipal Electrical Association in 1900. He was a frequent speaker at these meetings. In 1900 he also read a Paper on "The Combined Management of Tramway and Lighting Departments," and in 1897 one on "The Localisation of Faults in Underground Mains." Mr. Quin was also an occasional contributor to our correspondence columns, and only last month we published letters of his on "Cut-outs" and on "Steam Turbines *v.* Reciprocating Engines." We regret also to announce the death of Mr. E. Thompson, one of the joint managing directors of the firm of Nalder Bros. and Thompson (Ltd.). Ernest Thompson was born in 1868, and educated at private schools and at the Finsbury Technical College. He then became a pupil at the Immisch Motor Works, and on the completion of his term there he obtained further practical experience at the works of Messrs. Siemens, Bros & Co., and later on in the Brush Company's test room. In 1893 he became an assistant in Messrs. Nalder Bros. & Co.'s works, where he took charge in the test room of the ammeter and voltmeter department, and he continued in this position until 1896, when the business of Nalder Bros. & Co. was divided, and Mr. Nalder purchased the ammeter, voltmeter and switchboard section of the business and took Mr. Thompson into partnership. He was first taken ill in October, 1902, and on his doctor's advice took a voyage round the world. Unfortunately, the benefit this did him was not lasting, and he had only been at work again for three months when he had a relapse and passed away last Saturday.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, January 18th.

INSTITUTION OF ELECTRICAL ENGINEERS: NEWCASTLE LOCAL SECTION.

7:30 p.m. Meeting at the Durham College of Science. The discussion on Dr. W. M Thornton's Paper, "Experiments on Eddy Currents," will be taken, and if t me permits the following Paper will be read: "Power Distribution in Shipyards and Engine Works," by J. A. Anderson.

TUESDAY, January 19th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7:30 p.m. Meeting at Owens College. Paper to be read: "Coal Consumption in Central Stations," by A. S. Giles.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting, when the following Paper will be further discussed: "The Electrical Re-construction of the South London Tramways on the Conduit System," by A. Millar.

WEDNESDAY, January 20th.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

1:45 p.m. Visit to the works of Messrs. Elliott Bros., Lewisham. Train leaves Charing Cross at 1:45 p m.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, S.W. Paper to be read: "The Equipment of a Sub-station with Rotary Converters," by C. S. Davies.

ROYAL METEOROLOGICAL SOCIETY.

7:30 p.m. Ordinary Meeting at 25, Great George-street, Westminster, followed by the Annual General Meeting.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. Meeting at the Royal Institution, Liverpool. Paper to be read: "Voltage Regulation in Alternating-current Plants," by H. S. Meyer.

THURSDAY, January 21st.

INSTITUTION OF ELECTRICAL ENGINEERS: LEEDS LOCAL SECTION.

7:30 p.m. Meeting in the Yorkshire College. Paper to be read: "Alternators in Parallel," by H. Bohle.

FRIDAY, January 22nd.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, South Kensington. Agenda: (1) "The Photographic Action of Radium Rays," by S. Skinner. (2) "Astigmatic Aberration," by W. Bennett. (3) "Some New Cases of Interference and Diffraction," by Prof. R. W. Wood. (4) Exhibition of Instruments by Messrs. Crompton & Co.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel, when Mr. Fletcher Moulton, K.C., F.R.S., will deliver his Presidential Address.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by the Rev. Walter Sidgreaves on "Spectroscopic Studies of Astrophysical Problems at Stonyhurst College Observatory."

TESTING LARGE ALTERNATORS.

BY W. E. BURNAND.

The tests mainly required on alternators are for ascertaining the efficiency, regulation on unity and lower power-factors and for heating under load. Two general methods appear to be available for making these tests, firstly, by the rather barbarous method of loading up the machine with resistances, choking coils, &c.; or, secondly, by more scientific methods which may be said to have had their commencement with Hopkinson, in which the machine under test and other apparatus connected with it are supplied only with the amount of power lost in the system. Unfortunately the second method, as hitherto practised, seldom gives results strictly comparable with what will occur in actual use, and though it may be said to be scientific, if by science is meant measurement, it is hardly so if this is qualified by saying measurement of the thing you want to measure. The first method, however, is so cumbersome and expensive that in the case of really large alternators it becomes quite impracticable, and the machine either has to go untested or some modification of the second class made, and the results that will occur in use with the machine deduced therefrom.

When two machines of equal capacity are available, they may be coupled together and the Hopkinson test pure and simple carried out, the power-factor of the load being varied as desired by manipulation of the field strengths.

As a rule, however, two machines are seldom available, and recourse must then be had to opposing half (approximately) of the armature to the other half, and circulating current through the windings in the manner described by Mordey, Behrend

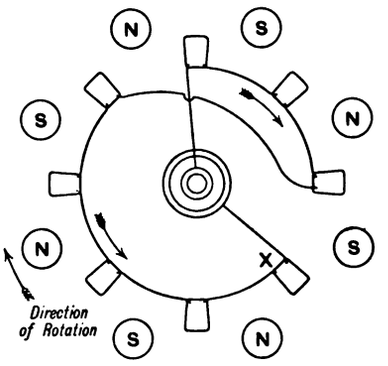

FIG. 1.

and others. But the methods I have seen described have always been open to some great objection, such as, when the armature is the rotating part, putting great unbalanced strains on the machine, causing vibration which in some cases endangers the integrity of the machine, and also, in the majority of cases, the armature reaction, and consequently the core losses and regulation observed are entirely unlike what will occur in actual use, and, therefore, vitiate the results obtained as tests for regulation, efficiency or heating under full load conditions.

It seems to the writer that these objections can be overcome in a simple manner by the following methods:—First, as to the unbalanced strains in the machine; the cause of this will be readily understood by reference to the diagrams. Fig. 1 represents an eight-pole alternator, connected so that three coils oppose the other five. Connected thus, the five coils circulate a current round the armature against the E.M.F. of the three coils, the strength of which can be regulated by the field strength or by means of a rheostat in circuit. Thus half (approximately) of the armature will oppose the rotation of the machine, and the weaker half will help it, the difference in rotative effort plus friction having to be supplied from an external source. The arrows in Fig. 1 show the direction of this effort exerted by the two sides of the armature, from which it will be seen that both tend to force the armature in the same direction. If the armature is stationary, this is not usually of any great consequence, but if the armature is rotating, the effect is just the same as if a heavy weight were located at the point marked

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r, which naturally tends to put severe strains on the framework of the machine. This could be balanced by a weight on the opposite side, the value of which could be calculated from the apparent horse-power of the machine, the peripheral speed, diameter and power-factor, but a much better way would be to prevent these strains altogether, by dividing the armature circuit into quarters instead of halves, as shown in Fig. 2, coupling A and C in series, opposed to B and D. By this means the stresses, which are indicated in the figure by arrows, balance themselves round the circumference of the armature, leaving no unbalanced strains to be transmitted through the shaft to the framework of the machine.

Having got over this difficulty, there still remains that of armature reaction. The difficulty here results almost entirely from the great lag or low power-factor of the currents circulating round the armature, when the current is caused to circulate by a higher E.M.F. in one half of the armature than in the other half. Thus the current in the coils is nearly at its maximum when they are directly opposite the pole pieces of the machine, whilst with a power-factor of unity the current is zero in this position, the conditions being reversed again in the midway position—*i.e.*, the lagging currents are nearly zero here, whilst the current with unity of power-factor should be at its maximum. It is evident that this must have a great effect on any test for regulation or efficiency, the 1. power-factor having comparatively little influence on the poles, whilst with currents lagging nearly 90deg. the coils on the weaker half, or the half in which the current flows against the induced E.M.F., have a powerful tendency to help the magnetic field, and on the stronger half a powerful demagnetising tendency, thus

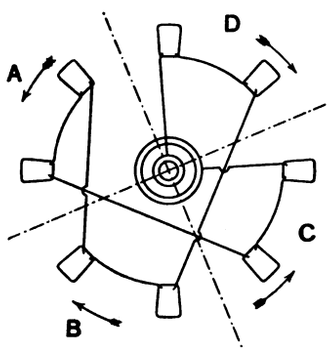

Fig. 2.

giving rise to induced currents in the magnetic system, and also affecting the core losses of the machine. The mechanical strains also are not those met with in use—there is more tendency to vibration, and less of a straight pull or push backwards on the coils than is the case under load, when the current through the coils is at a maximum at the point midway between the poles—hence in a position of maximum effect.

The effect this has with a current lagging about 90deg. is that for every time a coil passes a pole piece, it is first subjected to aforce in a backward direction till it gets opposite the pole, and then in a forward direction till in the midway position. Thus there is a severe racking strain backwards and forward at the rate of four times the frequency of the machine, whereas with a current in phase with the E.M.F. the strain is always in one direction, either backward or forward, considered with respect to the direction of rotation, according as the current circulates with or against the E.M.F.

The method devised by the writer to overcome these difficulties is to connect up the armature as in Fig. 2, the number of coils in the quarters A and C being equal to that of B and D, so that the E.M.F. of two quarters opposes and balances the E.M.F. of the other two quarters, and to circulate an alternating current through the armature from an external source of the same frequency as the machine under test, and whose phase with respect to this machine may be readily adjusted. This external source may consist of a small alternator with the same number of poles as the machine under test and coupled to the same shaft, or it may be a machine of a different number of poles, driven from the shaft through chain or spur gearing. This machine, of course, may be in circuit with the large one, either direct or through a transformer, and only need be of a size capable of supplying the electrical losses in the large generator and connections. By this arrangement practically all the effects of full load can be simulated in a manner to get practically reliable results. The auxiliary alternator can be so driven with relation to the machine under test as to circulate a current of leading, lagging or any desired power-factor.

The heating can, therefore, be determined for any of these conditions, and the regulation likewise. The efficiency can be determined from the balance of power required to drive the machine at its working speed with full load current circulating through the armature, at any desired power-factor, after subtracting the power lost in the outside connections, the auxiliary alternator and the gearing driving it, all of which can be easily determined with an accuracy near enough to give materially correct results for the machine under test.

Fig. 3 shows the manner of testing the regulation of the machine, the voltmeter and power-factor indicator being in connection with the half of the machine in which the current flows in the direction of the E.M.F., the frequency meter being connected at any convenient place, say, in parallel with the voltmeter. A reading is first taken with no current passing through the armature; afterwards a reading is taken with full-load current passing, the power-factor of which can be regulated by causing the auxiliary alternator to lead, lag, or keep in phase with the E.M.F. of the machine under test, the amperes being readily adjusted by a rheostat in the field of the small alternator.

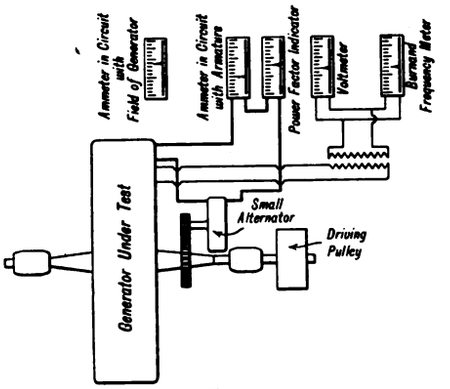

Fig. 3.

Assuming the speed kept constant, the difference in the voltmeter readings gives the drop in half the armature. If the machine is designed to work with the armature coils all in series, the regulation is, of course, double this value; if the two halves are to be in parallel the regulation is direct as given by the voltmeter readings. Should it not be possible to get the speed quite the same as when unloaded, the effect of this can be calculated from the difference in frequency, the E.M.F. being proportional to this at constant excitation.

A variation of this method might be to have a voltmeter on each half of the armature, the difference in the reading with full-load current passing giving the regulation, but the first method is probably preferable for a generator, as the armature reactions in the half referred to more nearly approach those of practice than is the case in the other half of the machine, in which the current circulates against the E.M.F. as in a motor.

It would not do to take the ratio of the voltage required to circulate full-load current through the machine to the voltage of the machine under test as a measure of the regulation of the machine, since, as a rule, the E.M.F. of the auxiliary machine will not be in phase with the E.M.F. of the machine under test. As a somewhat exaggerated example might be cited the case of a machine requiring an E.M.F. in quadrature with its own—say of half its own value—to circulate full-load current through it, the current to be in phase with the E.M.F. of the machine under test. The regulation in this case, instead of being 50 per cent., is actually about 10 per cent, as is readily apparent when attention is paid to the vector phase relations of the two E.M.F.s and current.

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LONDON COUNTY COUNCIL TRAMWAYS.

Although not yet officially announced, it may be confidently anticipated that the electrically-equipped Greenwich lines of the London County Council tramways will be opened for traffic on Sunday next. The route which these lines follow may be seen in the accompanying map (Fig. 1). It will be remembered that in May last the electrical equipment of the lines to Tooting from Blackfriars, Waterloo and Westminster bridges was completed, and the lines were opened by the Prince of Wales. In the latter part of last year a section of line along Camberwell New-road to Vauxhall bridge, which is also marked on the map, was completed. The lines to be opened next week, it will be seen, join at the Elephant and Castle with the existing lines, whence one route is along the Old and New Kent roads to New Cross Gate and thence to Greenwich, another route being via Walworth-road, Camberwell-road, Camberwell Green and Peckham to New Cross Gate, also connecting on to the Greenwich lines. Another piece of track, along St. George's-road, Great Dover-street and Newington causeway, has also now been equipped for electric traction, but the Council is not yet quite ready to put electric cars on it.

The new lines are all double track with the exception of a few yards in London street, Greenwich, in which the narrowness of the street necessitated single track. The total length of the new lines between the Elephant and Castle and Greenwich is equivalent to 19 miles of single track. Conduit construction has been employed throughout, and, except in a few matters of detail, it is exactly similar to that employed on the Tooting lines, which was described in considerable detail and fully illustrated by drawings and photographs in our issue of April 24, 1903. The first exception is that, instead of 30ft. lengths for the track rails, 45ft. lengths have been employed. This lessens the number of rail joints, which is not an unimportant matter, for, of the small amount of trouble that has been found in the working of the lines, a considerable portion has been due to the joints employed.

In the Dick-Kerr type of joint, used on the Tooting lines, part of the head of the rail is cut away and part of the fish-plate takes its place. This gives a very smooth and even joint when new, but, probably owing to the fact that the fish-plate has no bearing under the head of the rail, it is inclined to work loose when subjected to the strain of heavy and continuous traffic. Ordinary six-hole fish-plate joints have, therefore, been employed on the newer lines, and they are strengthened by a sole-plate consisting of an inverted rail the flange of which is bolted to the flanges of the other rails. This produces an excellent joint, which has, however, one disadvantage—viz., that owing to slight inequalities in rolling, the two adjacent rails are not always exactly equal in height; and this necessitates the grinding down of the head of one of the rails after the joint has been completed, to avoid hammering when the car goes over it.

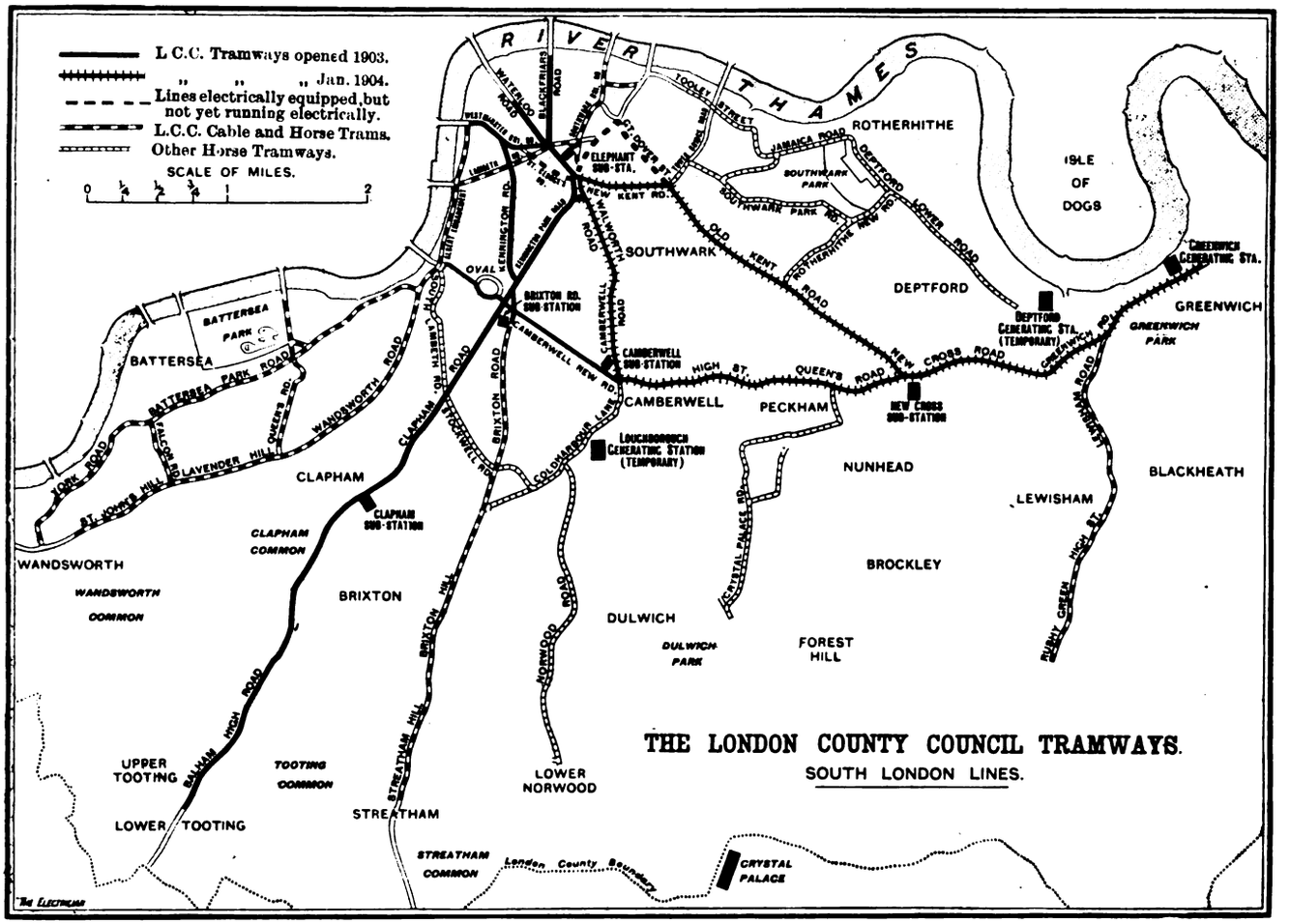

FIG. 1.—MAP OF L.C.C. TRAMWAYS.

Another modification is in the arrangement of the sump pits. On the Tooting lines the cleaning pits, placed at intervals of 40yds., were at one side of the tracks, and connected to the conduits by 12in. pipes with a slope of 1 in 10. It was found, however, that, instead of the mud flowing down to the sump pit, it tended to accumulate in the conduit nearer the pit and occasioned considerable trouble. Now the pits are placed between the two lines of track, and the mud drops straight down into them from the bottom of the conduits. Although in this way the pits are much broader, it is only necessary to make them 2ft. wide in the direction parallel to the rails, so that the amount of space to be excavated beneath the roadway is not excessive. It may further be mentioned that where the new lines cross bridges it has unfortunately been impossible to employ conduits as deep as those in

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other places. There was no option, therefore, but to employ shallower conduits, and these have to be cleaned daily to prevent evil results by the accumulation of mud. The last modification is in the type of the slot point, in which some improvement has been effected.

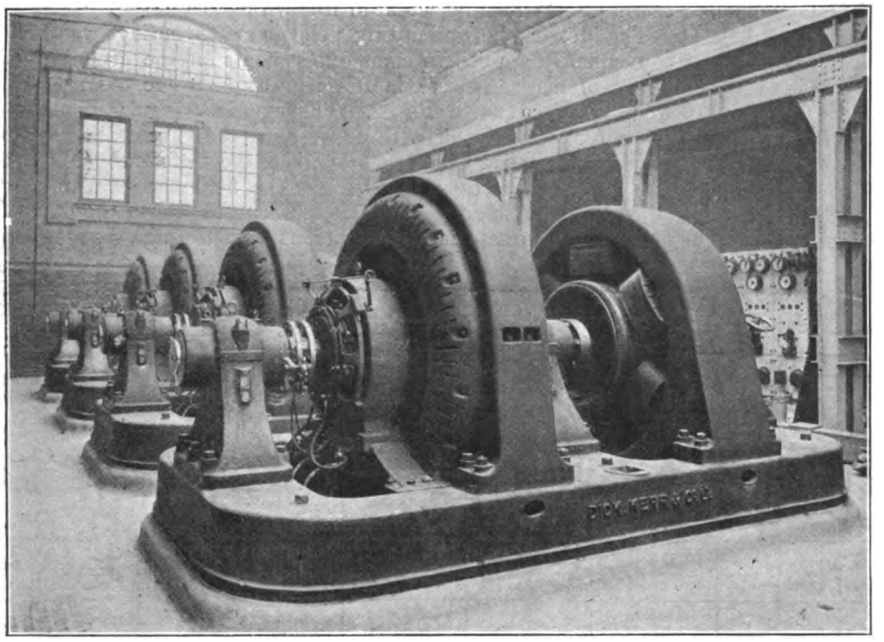

Fig. 2.—Elephant and Castle Sub-station.

In the short piece of route upon which single track has had to be adopted the conduit is arranged as in Fig. 3, one conduit being for the cars in one direction and the other for the cars in the opposite direction. As it will be remembered the plough

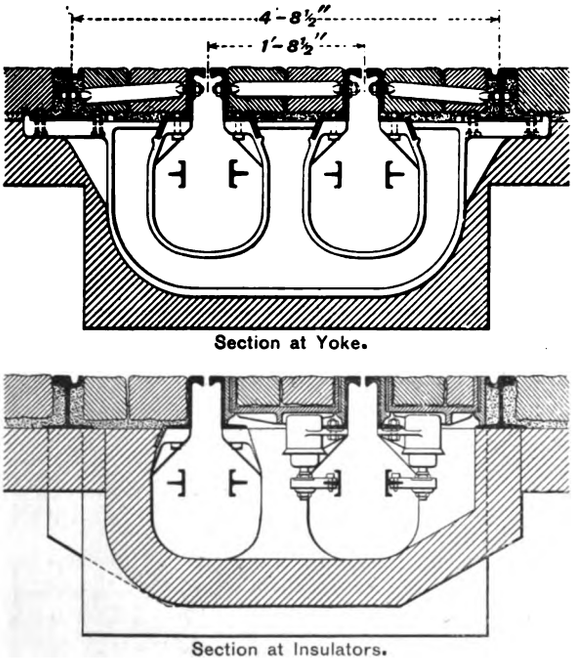

Fig. 3.—Arrangement of Double Conduit on Single Track.

Scale: ½in. = 1ft.

is free to slide laterally, the fact of the conduits not being in the centre of the track is quite immaterial. On account of the diminished space, it is seen that the insulator pits have had to be arranged alternately on the two lines of conduit, but there is room for the same method of supporting the conductor rails as on the other sections. The main difference is, as is seen, in the double yoke which has to be employed

The track is fed from three sub-stations and is divided up into half-mile sections as on the other lines. The sub-stations are at Elephant and Castle, Camberwell Green and New Cross Gate. These receive high-tension three phase current from the temporary generating plant placed in the engine room of the London Electric Supply Corporation at Deptford, and this is converted into continuous current at 500 volts by synchronous motor-generators. The pressure of the high-tension current is 6,600 volts and its frequency is 25 ∽ per second. Fig. 2 is from a photograph of the Elephant and Castle sub-station, in which there are five 300kw. motor-generators. At New Cross there are four motor-generators of similar size, and at Camberwell there are three. The high-tension cable from Deptford to these sub-stations is three core, the conductors having a section of 0·15 sq. in. The cables are paper-insulated and lead-covered, and they are laid in stoneware ducts embedded in cement, exactly similar to those employed previously. In addition to these main cables from the generating station to the sub-stations, each sub-station is connected to its two adjacent ones by a 0·075 three-core cable. At the generating station at Deptford there are two 1,500kw. Ferranti-Dick, Kerr generating sets, the engines of which are exactly similar to those in the temporary generating station at Loughborough Junction,* the alternators being in accordance with Messrs. Dick, Kerr & Co.'s standard practice. Steam is supplied to these sets by the London Electric Supply Corporation on somewhat similar terms to those arranged with the South London Electric Supply Corporation at Loughborough Junction.

(To be concluded.)

AN EMERGENCY OR MASTER SWITCH FOR CENTRAL STATIONS.

BY W. M. THORNTON, D.SC.

Most modern generating stations for the supply of electrical energy in bulk have one weak spot In the event of an arc developing at the main 'bus bars it cannot, as a rule, be quickly extinguished without either danger to the attendants or damage to the machines. It may happen, and it has occurred several times to my own knowledge, that the short-circuit arc at one part of a switchboard is so fierce that it cannot be passed to get at the main switches of all the machines on load. In such a case it has been necessary, in order to save the board and leads, to break the main exciting circuit. The suggestion which is here made, and which is offered to all central station engineers who have to deal with generators excited from 'bus bars, is that an auxiliary switch should be fitted to these, so that in emergency all the fields, instead of being broken, could be *simultaneously short-circuited.*

The uncertainty of how to meet each particular short-circuit danger as it arises is the bane of the station engineer. He has to choose between the risks of a wrecked board or broken-down insulations, and he has always to face an interruption of supply varying from five minutes to three weeks. It will be shown that the device of short-circuiting the fields enables the station to be shut down without shock to any part of the system, the magnetisation taking a few seconds to diminish until the voltage required to maintain the arc cannot be generated. As the arc ceases and the bars are cleared, all but one of the main switches can be opened, the field circuit restored and supply re-established.

* See *The Electrician*, Vol. LI., p. 112.

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Systems which, like the Newcastle and District Electric Lighting Co., are not worked in parallel are not liable to total interruption of supply, unless all the generators have a common exciting circuit, an arrangement which would defeat the object of having independent machines. To guard against damage by short circuits at the switches or in the leads it might in certain cases be desirable to provide a means of destroying the fields safely, even where parallel working is not employed.

The danger of breaking the main exciter circuit or all the fields in succession can scarcely be exaggerated. It is to some extent modified by the use of solid poles and magnet frames, the eddy currents in which help to retard the decay of magnetisation, and so to prevent an excessive rise of voltage on the windings. The energy stored in the fields, which is equal to $Li^2/2$, where L is the total inductance of the exciting circuit and i the current in it, is dissipated at three places when the current is interrupted: in the arc at break where the local heating is intense, as eddy currents in the magnetic cores, and in the copper of the windings. When an inductive circuit is broken with a quick-break switch, the greater part of the energy is no doubt dissipated in maintaining the arc, but the withdrawal of the magnetic force from a large solid core is accompanied—when the conductivity of the core is good—by enormous eddy currents, chiefly located in the outer layers of the iron. To support a large arc at a length of a few inches requires a high voltage, but if the insulation of all magnetic windings were made to carry thousands instead of hundreds of volts there would not be any objection to breaking the field circuit. As things are, however, and will probably continue to be, it is necessary to devise other methods of dealing with sudden rushes of magnetism.

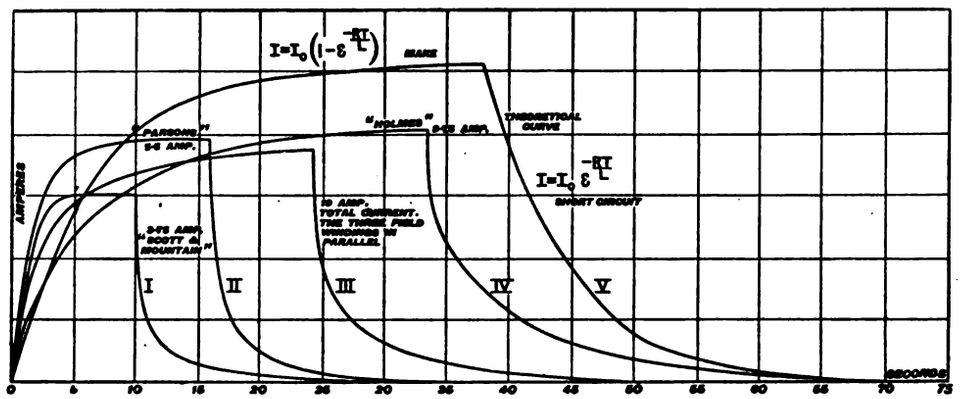

FIG. 1.—RISE OF CURRENT IN FIELD MAGNET WINDINGS AND DECAY DURING SHORT CIRCUIT.

When an active inductive circuit is suddenly short-circuited, the current fades away at a rate which is the inverse of that at which it increases when the voltage is suddenly switched on. Closing the switch the current in the windings is left to itself, whilst that of the exciter opens a circuit breaker or is otherwise interrupted. The former is maintained by the collapse of the field which it itself maintains, and therefore decays logarithmically, as shown in Fig. 1. The most important point to notice is that there is no rise of voltage on the windings, though the rate at which the lines collapse is greatest at the moment of closing the switch. This can be seen from the second parts of all the curves in Fig. 1, for, since the current is proportional to the effective voltage in the windings, it therefore falls from a maximum at the start to zero. Another way of considering the change is, that if the voltage rose instead of falling at or any time after the short-circuit, the current in the winding would also rise and the magnetic energy of the field, therefore, increase by virtue of its own decrease!

The idea of short-circuiting field magnet windings was first conveniently applied in some experiments on the growth and decay of magnetism in large generators.* The connections were arranged as in Fig. 2. The exciter was placed across the outer terminals of a three-way switch. From the centre to one outer terminal a low non-inductive resistance (N.I.R.) was fixed, and across the other pair the field-magnet windings (F.M.W.). From the figure it is seen that when the switch blade is in contact with a the current flows through the magnet windings in the usual way, the non-inductive resistance being then short-circuited. When it is thrown over into contact with b the windings are short-circuited and the full exciter voltage is then applied to the resistance, the current in which may be broken as quickly as possible. The centre terminal of the switch and b correspond to the exciter 'bus bars on a board. If it is desired for the purpose of experiment to make and short-circuit the current as rapidly as possible the resistance must be able to carry the voltage for at least the time of decay of the magnetism. The smaller its value the less will be the flash on throwing over, for if it is small compared with that of the windings the change of current and, therefore, of magnetisation, is correspondingly small. Even if, for the purpose of not unduly overloading the exciter, the resistance is made two-thirds that of the windings, the sluggishness of the magnetism, in starting to move—an effect which was first pointed out by Heaviside—allows the change-over to be made before many lines have collapsed. Moreover, the change takes place in the region of comparatively low permeability and least sensitiveness—at the top of the magnetisation curve. In an experiment made on a 500kw. generator—the fields of which had an inductance of 54 henries—excited at 480 volts, the magnet windings were short-circuited by means of the three-way switch with no more flash than one obtains on breaking an arc lamp circuit at the same voltage.

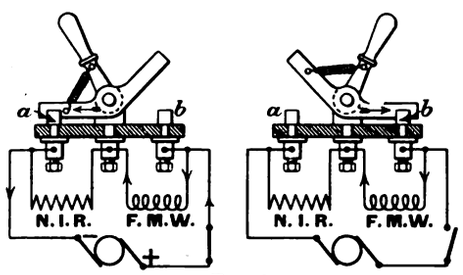

FIG. 2.

It will be seen at once that any number of field magnet windings can be connected in parallel, so that the magnetisations of all the machines can be destroyed together. Short-circuiting the exciting 'bus bars of a station, however large, can be done quite safely even if the fields are of unequal size or have not the same rate of decay; for since each winding is short-circuited, its current is independent of the rate of change in the other fields. The smaller the time constant† of the winding of a machine the greater the flash at throwing over for machines of approximately the same size. Applying the method to small machines there is more necessity for using a quick break switch than with larger sizes; a 5kw.

* *The Electrician*, May 30 and June 13, 1902.

† The "time-constant" of a circuit is the time in seconds taken by the current to reach 0·63 of its full value.

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generator requires smarter handling than a 500kw. To demonstrate the practicability of the method I arranged the fields of 50kw. 34kw., 10kw. and 5kw. machines in parallel; the first having a time-constant of about five seconds, the last of one second. Such a range is the severest test which could be applied. The current was obtained from storage cells capable of giving 80 amperes for a few minutes. The substituted non-inductive resistance consisted of 2·8 ohms of iron wire about 12 S.W.G. The curves of Fig. 1, recorded photographically, indicate the nature of the currents at make and short-circuit with each machine separately and then all together. The vertical scales are adjusted so that the influence of the machines with smaller fields can be more easily seen. It will be noticed that curve III. rises quicker than IV., and also falls more rapidly. This is the exciting 'bus bar current; the actual currents in the windings, that is I., II., and IV., are the same whether one or all of the machines are connected. The theoretical curve is calculated on the assumption that the permeability of the core remains constant throughout, which is never realised in practice. The general form of the change is, however, the same in all the cases. In each winding the current approximates to

$$i=\frac{E}{r}\left(1-\epsilon^{\frac{rt}{L}}\right),$$

and the 'bus bar current is

$$I=\Sigma\left(\frac{E}{r}\left(1-\epsilon^{\frac{rt}{L}}\right)\right),$$

r and L having the appropriate values for each machine. In view of these experiments there can be no doubt that a station containing several large units on load may be shut down with ease and safety in a few seconds by the operation of a single switch.

THE SCHÜLER-FERRANTI SINGLE-PHASE MOTOR.

As indicated in Fig. 1, this motor is a combination of an ordinary single-phase induction motor and a repulsion motor. In Fig. 2 are recorded some tests, made with a six-polar single-

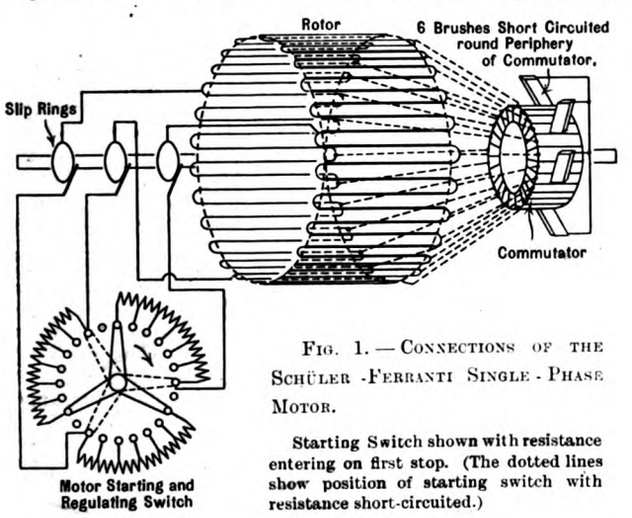

FIG. 1. — CONNECTIONS OF THE SCHÜLER-FERRANTI SINGLE-PHASE MOTOR.

Starting Switch shown with resistance entering on first stop. (The dotted lines show position of starting switch with resistance short-circuited.)

phase motor possessing an armature wound as for continuous current and run as a repulsion motor pure and simple. When wound for three-phase working the same motor is capable of developing 5 H.P. at 220 volts, and runs at a speed of 960 revs. at a frequency of 100 ∿ per second. According to the curves in Fig. 2 the starting torque is good, but it decreases rapidly. The maximum of power—*i.e.*, 2·5 H.P.—is developed by the motor at a speed of about 500 revs. per min., when the current taken amounts to 26 amperes, the voltage being 220 volts. We see, therefore, that the actual output is but 32 per cent. of the volt-amperes, this 32 per cent. representing the product of efficiency and power factor. When the same motor was run as a single-phase induction motor, with a three-legged resistance in its rotor circuit, the curves of Fig. 3 were obtained. At starting the torque is zero, but it increases gradually to its maximum, and the motor behaves in this respect in exactly an opposite manner to the repulsion motor. It occurred

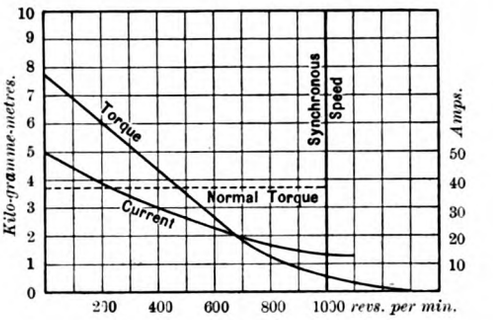

FIG. 2.

to Mr. Schüler to combine these features of both types of machine in one motor, and the outcome is the arrangement represented diagrammatically in Fig. 1. In Fig. 4 the starting torque is

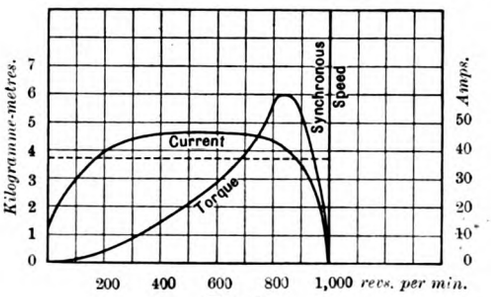

FIG. 3.

plotted as a function of the starting current. At any speed the motor torque is approximately equal to the sum of the torques, due to the repulsion motor and to the induction single-phase

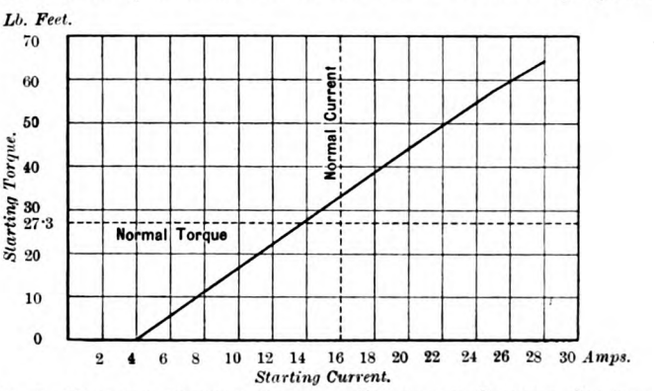

FIG. 4.—RELATION BETWEEN STARTING TORQUE AND CURRENT, SCHÜLER-FERRANTI SINGLE-PHASE MOTOR, 5 H.P., 960 REVS., 400 VOLTS, 50∿.

motor respectively. This characteristic feature is well shown in Fig. 5. At starting, the three-legged resistance is inserted in full in the rotor circuit, and the current will flow by way of

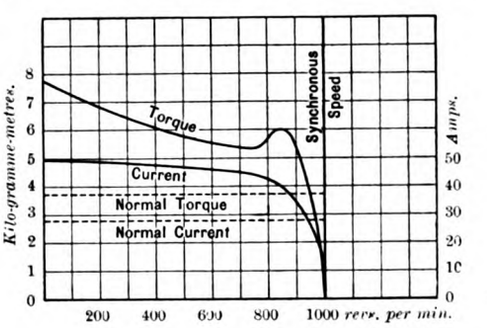

FIG. 5.

the commutator and the short-circuited brushes. The motor then starts as a repulsion motor. By gradually cutting out the starting resistance, part of the induced armature current

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flows through the resistances, and the motor begins to act also as an ordinary single-phase induction motor. Although the torque decreases somewhat with increasing speed, this is—as shown in Fig. 5—much less marked than in the case of the pure repulsion motor. By means of the three-legged resistance, the motor speed may be varied in wide limits, the torque varying only to a small extent. Arrangements might be made for lifting off the brushes from the commutator after the motor has been started, but as this would involve extra complication, it is hardly likely to find favour in practice. The motor may be reversed by shifting the brushes 90deg. or, where this is not practical, by providing a second set of brushes placed at 90deg. Another way of achieving the same result is by using a three-phase stator winding, and by using two phases at a time for each direction of rotation (Fig. 6).

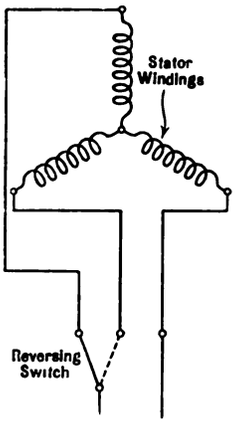

FIG. 6.

This article is compiled partly from an article by Mr. Schüler in the *Elektrotechnische Zeitschrift*, and partly from some information supplied by Messrs. Ferranti (Ltd.)

APPLICATION OF SINGLE-PHASE ALTERNATING CURRENT FOR TRACTION AND RAILWAY SERVICE.*

BY B. G. LAMME.

The present direct-current railway system has limitations in voltage, speed control, &c., which have long been recognised by the electrical profession. Many systems have been devised with more or less success—generally with less—in order to overcome these limitations, so that the possible field for the direct-current systems could be extended. It has also been recognised by some of those familiar with the problem that a single-phase alternating-current motor having the characteristics of a direct-current series motor would at once furnish a means of attaining many results now impossible with the direct-current system. Such a motor obtained, then the voltage limitation can at once be removed, as the transforming properties of alternating current can be brought into use. Also economical operation at any desired speed can readily be obtained through the same property of alternating current. Furthermore, the use of single-phase permits a single overhead wire where track return is used, thus retaining a most valuable feature of the direct-current system. It is thus evident that a motor of this character will permit the retention of most of the present advantageous features of the direct-current system, and also enables the use of other features not permissible without great complication and expense with the present direct-current system.

There has been perfected only one class of single-phase motors which possess the characteristics of the direct-current railway motor, and this one class of motors very closely resembles the direct-current machine in the general features. These motors may all be given the general name of commutator type single-phase motors, as all of them have commutators on the armature or rotating member, and the armature is provided with a direct-current type of winding. Some variations from the usual types of armature windings have been proposed, but the various direct-current types have proven most successful.

All these commutator types of motors, which have the variable speed characteristics suitable for railway service, may be broadly classified as belonging to the series type. By this we mean that the field or exciting current is in series with the armature circuit, either directly or through transformer action, either in the motor itself or outside the motor. The series type of motor can be subdivided into two classes—viz., the straight series motor, in which the current in the field wholly or partly passes through the armature, or vice versa and those in which the field or armature forms a secondary circuit, the primary of which can be either part of the field structure of the motor, or may be outside of the motor. All these motors—whether of the straight series or of the transformer type—have the property that the field magnetism varies with the load, although not necessarily in direct proportion. Hereafter we will refer to these two types as the straight series and the transformer types of motors. All these motors are related to a greater or less extent in their characteristics, and in many instances one type can be readily changed to the other type. In fact, by closing a single switch, we have changed a straight series motor into the transformer type with the armature closed on itself, forming a secondary circuit, with a change in performance apparently due only to the amount of material in the magnetic circuit being insufficient for the best performance as a transformer type.

In these commutator type single-phase motors, the two most important elements, besides the speed characteristics, are the efficiency and the power-factor. The efficiency of such motors will usually be less than that of a direct-current railway motor of the same output. The losses in one of these alternating-current motors can be considered as made up of the following elements:—First.—Iron loss due to reversals of magnetism in armature and field at the frequency of the supply circuit Second.—Armature iron loss due to variations in magnetism dependent upon rotation of the armature. Third.—Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element. Fourth.—Losses in field windings. Fifth.—Loss in armature windings. Sixth.—Brush losses Seventh.—Friction and windage. Comparing these losses item by item with those of a direct-current motor, we see at once that certain losses will necessarily be greater than in the direct-current motor.

First.—Iron loss due to the frequency of the supply circuit and induction in the primary element. No such loss exists in a direct-current motor, as the machine is excited by continuous current. This loss in the alternating-current motor will not be relatively large per cent. unless the motor is worked at a very high induction, or unless the construction of the magnetic circuit is such as will allow eddy-current losses. It is at once evident that the field magnetic circuit must be laminated as completely as the armature circuit, and that there no local circuits permissible in the field structure. It is also evident that a field structure of a straight series motor will, in general, have lower losses than of the transformer type, where the field itself forms part of the transformer, as in this latter case the total induction in the field structure will generally be greater than in the series type.

Second.—Armature iron loss due to variations in magnetism dependent upon rotation of the armature. There will be a loss in the armature due to the alternating magnetism from the primary or field circuit. This can be charged against the field loss or primary loss, as maintained above. In addition to this loss, there is a loss due to the rotation of the armature in the field. This will be dependent upon speed of rotation, inductions in the core, teeth, &c., and in general will practically average the same as that of a direct-current motor of same capacity.

Third —Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element. This is a loss which appears to some extent in the field pole face of direct-current machines, due to the bunching of the lines from armature teeth. This loss is relatively small on direct-current machines, if the poles are properly laminated and if the air-gap is relatively large compared with the width of the armature slots. This loss in direct-current motors is included in the armature iron loss measurements, due to the methods generally used for determining iron loss on such motors. This loss will appear in the field surface or face of the alternating motor, and may be considerably greater than in the direct current, if a smaller air-gap is used than in direct-current practice. By air-gap we mean clearance from iron to iron.

If the field structure is of the slotted type, the slots being of such form as to give bunched lines, then there will also be a loss in the armature service due to the bunching of these lines. It should be noted that the frequency of the secondary currents set up by the bunched lines from armature or field teeth is generally very high compared with the frequency of the supply circuit, or of that due to the rotation of the armature in the field. We believe that in general the loss due to the bunched lines will not be much greater in the alternating-current single-phase motor than in the direct-current, except where very small air-gaps are used on the alternating-current motor.

Fourth.—Loss in field windings. This loss is very similar to that in direct-current machines, as the amount of copper in the field windings will generally be no greater than on direct-current motors of same capacity, and may even be considerably less. The straight series motor will generally have a lower copper loss than the transformer types where the field structure is used as the primary of the transformer.

Fifth.—Loss in armature windings. The loss in the armature windings will be very similar to that in a direct-current machine, as far as the working current is concerned. In addition to the working current, there may be secondary currents in the armature turns short circuited by the brushes, which still further increase the armature loss. The resultant armature loss may, therefore, be somewhat greater than on a corresponding direct-current machine, unless the normal resistance of the armature winding is reduced below that of a corresponding direct-current machine. In practice, the loss in the armature winding is made practically equal to that of the direct-current machine in order to avoid increased heating.

Sixth.—Brush losses. The brush losses due to the reversal of current in the single-phase alternating-current motors are generally

* From the *Electrical World* of New York.

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somewhat greater than in a direct-current motor. Such motors are usually wound for a comparatively low voltage on the armature, and thus greater brush capacity is required than in direct-current practice. The brush losses are thus increased, due to the greater number of brushes, and, in addition, there may be local currents in the short-circuited coils, which may produce additional loss in the part of the brush next to the commutator. In practice this loss is evidently comparatively small, as our experience shows no signs of deterioration in the brushes in regular service. Therefore, the increased brush loss may be considered as principally due to the increased number of brushes required.

The brush loss due to the local currents in the short-circuited turns can be reduced considerably by the use of very narrow brushes, a brush spanning one bar or even less. With such a brush there would be short-circuiting only while the brush is bridging two bars, while at intermediate positions there would be no local current. As, in general, the commutators of such motors have a relatively large number of bars, this would mean a very thin brush, possibly less than ¼in. in thickness. Such brushes we consider too thin for street car purposes, as any roughness on the commutator would tend to break the brushes. In some of our very early experiences with such motors, we used brushes of ¼in. in thickness, but found they required entirely too much attention, and therefore they were abandoned in favour of brushes of a thickness corresponding to direct-current practice, the later designs of motors permitting the use of such brushes.

Seventh.—Friction and windage. The friction in bearings and the windage loss in such motors will be very similar to the corresponding losses in direct-current motors, but the brush friction loss will, in general, be somewhat greater, due to the increased brush capacity. Also, the large number of commutator bars generally used tends to increase brush friction to some extent.

It is evident from the above considerations that the various losses in different parts of the single-phase alternating-current motors are either equal to or greater than the losses in the corresponding direct-current motor, although no individual loss, except that due to the reversal of magnetism in the field, may be much greater than in the direct-current motor. The sum total of the slight increases make a difference of from 1 to 5 per cent. in the efficiency of the motor, this difference being less with larger motors. The frequency of the supply circuit also has a small effect on the efficiency, although the relation of the losses in the various parts is so involved that no definite figure can be given for this effect. The losses in the single-phase motor are, to a certain extent, dependent upon the speed at which the motor is operated, with a given current and torque. Assuming a given current, with the motor running at reduced speed, we can note the effect on the losses as follows:—The iron loss due to the frequency of the supply circuit is changed but little. The iron loss due to changes in magnetism in the armature, and due to bunching of lines from the teeth, are very considerably decreased, due to the lower armature speed. The losses in the field and armature windings are practically unchanged, and short-circuit loss in the brushes is not greatly changed. Friction losses in brushes, bearings and windage are all decreased. Therefore, at lower speed, the actual losses in the motor are considerably decreased, but not in proportion to the decrease in output of the motor. Therefore the efficiency decreases slightly with the reduction in speed with a given torque, this efficiency decreasing more rapidly the more nearly the zero speed is approached. With changes in load, with a given voltage applied, the efficiency curve has very much the same shape as the efficiency curve of a direct-current motor, starting low at light load and high speed, and rising to a maximum, and then falling off considerably at very heavy overloads.

After efficiency, the next most important consideration in the performance of such motors is the power-factor. This is a feature which does not appear at all in direct-current machines, as the apparent input in such motors represents true energy. In the single-phase railway motor the apparent input in general does not all represent true energy, as a certain component of the input is required to magnetise the motor, and this component represents practically no energy. Also, magnetic leakage in the alternating motor represents a component of the apparent input which is practically wattless. In a straight series motor a certain magnetising current is required with a given field winding. The alternating flux through the field winding sets up alternating E.M.F.s which lag practically 90deg. behind the energy component of the motor, and the product of the field current by the field voltage thus represents a wattless component of the input of the motor. With increase of load, the field current increases, the induction increases, and, therefore, the field volts also increase. The wattless component in the field thus varies with the product of two values which are both increasing with the load. The energy supplied to the motor increases approximately in proportion to the current supplied. Therefore, the wattless component in the field increases more rapidly than the energy component. Consequently, if this were the only wattless component in the motor, the power-factor would decrease with the increase of load and would be highest at no load. Other wattless components of the input are represented by the cross-magnetising effect of the armature, if such exists, and by the stray field around the windings. As these effects will also increase more rapidly than the energy component, it is therefore evident that the power-factor in this type of motor will be highest at no load or at highest speed, and will decrease with the load or speed with a given voltage applied. But if the windings are so proportioned that the wattless component at the rated capacity is relatively small, then a high power-factor will be obtained at the rated load and speed. At lighter loads and higher speeds the power-factor would be considerably higher. Such a motor can give very high power-factors at half loads with correspondingly increased speed. If the motor is operated at lower voltages, then the power-factor at a given speed will be very nearly the same as when operated at the same speed at a higher voltage and higher load. Therefore, it is evident that as the speed is reduced, no matter what load is carried, the power-factor will be decreased, and at start the power-factor will be lowest, as the energy component in this case represents only the losses in the motor. We have tested a 100 H.P. motor showing 92 per cent. power-factor at 100 H.P., and approximately 98 per cent. power-factor at half load, the voltage being the same in both cases. This question of power-factor is largely a question of design, as the magnetising or exciting compound of the input depends upon the air-gap, amount of material, &c. In general, larger air-gap means more exciting current. The magnetic leakage in these motors may be relatively high, or may be comparatively low, this being to a considerable extent a function of the design of the motor, just as in all alternating-current machinery. Generally, it is made as low as possible without sacrificing other important features. If the armature cross-induction in a series motor is large, due to excessive armature ampere-turn per pole, small air-gap, &c., the armature self-induction will be large. Increasing the number of poles will reduce the cross-magnetising effects, but at the same time will require somewhat smaller air-gap, or increased excitation. These two features are, therefore, to a certain extent balanced against each other.

There are various schemes for improving the power-factor of the commutator type single-phase motors. These are generally most effective at high speeds, but at start or at very low speeds the improvement is small. In certain designs of both straight series and of the transformer type motors, the magnetising current can be supplied in whole or in part to the armature circuit instead of the field magnetic circuit by means of brushes on the commutator. At certain speeds, this current can be supplied at a considerably reduced voltage, thus requiring a reduced magnetising input compared with excitation applied to the field. This excitation can be supplied from the secondary of a series transformer, the primary being in circuit with the primary winding of the armature. The armature excitation will thus vary as the field excitation would normally vary, thus giving the varying field induction, and the series speed characteristics. While this arrangement is effective in improving power-factor at certain speeds, yet, as a rule, this gives the least effect at the time when it is most required—viz., at start and at very slow speed. This method also requires a second system of brushes in the commutator, thus spacing the brushes on the motor the same distance apart as if double the number of poles were used. For instance, a four-pole motor would have brushes spaced 45deg. apart instead of 90deg. At start there should be practically the same input required for magnetising, whether the current is supplied to the armature or to the field. Comparing the straight series with the transformer type of motor, it should be noted that the straight series motor requires less magnetising current, as the magnetising current is only supplied to one element of the field. With the transformer type of motor a magnetising field must be furnished as in the straight series, but there is also a second field set up due to the transformer action, and this also requires a magnetising current. In other words, it may be considered that there are two magnetic fields set up, approximately 90deg. apart, each field requiring a certain magnetising current. These two fields may be considered as forming one resultant field of higher value than either of the components, with a magnetising current of higher value than either component. In the series motor the transformer part of the field can be made to practically disappear, only the exciting field remaining; the resultant induction is, therefore, much less than with the transformer type, the field having an approximate average value of 70 per cent. of that of the transformer motor, the magnetic circuit being reduced in proportion. It thus appears that the straight series motor can be made to give a somewhat higher power-factor than the transformer type, with the field used as a transformer, and this is obtained with somewhat less weight. This difference in power-factor could be compensated for at higher speeds by some means of excitation applied to the armature through the commutator, as indicated above. But for traction service, where the least weight with great compactness of design is desirable, it appears to us that the straight series motor possesses some advantages. The transformer type of motor with the trans

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former in the motor itself can be compared with the straight series motor with a separate transformer, if high voltages are to be used on the line. We consider that a number of more compact motors under a car with one separate reducing transformer forms a more suitable combination than a similar number of larger motors, each with its transformer inside itself.

There is one other method of improving the power-factor on these motors, and that is by the use of resistance in series with the motors. If the voltage on the motors is controlled by the use of an external rheostat, as in common with direct-current motors, then the power-factor with a given torque will be constant and independent of the speed. With a given torque the wattless component of the input of the motor is practically constant independent of the speed, and if the speed is controlled by rheostatic loss, then the energy component will also be practically constant, and the power-factor can be made higher at all loads. This may appear to be a good feature to those who have not considered the problem carefully, but it is a fact that a high power-factor obtained in this way represents a less desirable condition than the low power-factor which would be obtained if the rheostatic method of starting were not used. With a given wattless input from the circuit, the best possible condition as regards effect on the supply system is that represented by the minimum expenditure of energy. A wattless component has a certain effect on the regulation of the system, and any improvement in power-factor by increasing the energy component means that much additional effect on the supply system. It is surprising that so many are so imbued with the idea of high power-factors that they are even willing to obtain it by increasing the losses in the apparatus, thus in reality increasing the load on the system. A high power-factor obtained by rheostatic control would represent no more advantageous condition than the use of resistance in series with an induction motor, when running, to increase its power-factor. If a permanent resistance connected be parallel with an inductance motor it will not increase the power-factor of the motor itself, although any measurements of the input to the motor and resistance will show a higher power-factor than that of the motor itself; but anyone can readily see the absurdity of this combination, although it does not raise the power-factor. The use of resistance in series with a motor in order to give higher power-factor at starting would represent a similar absurdity, although it would not be as evident on the face of it. Leaving out the question of power-factor, the rheostatic method of starting and controlling the motor will, in certain instances, possess advantages over other methods, especially where the loss in the rheostat will average but a small part of the total power expended over a given period. This method of operation should not necessarily be abandoned in all cases, simply because voltage control can be obtained.

The next point, and one which is of considerable interest to the electrical fraternity at large, is the question of commutation in the commutator type of single-phase alternating-current motor. In the early times in the electrical business it was discovered that there were many things that could not be done with alternating current, and among these was the commutation of alternating current without excessive sparking. This opinion has become so well established that at the present time many engineers are very doubtful of this point. This opinion is based principally upon experiments in commutation of alternating current, mostly made many years ago, and not upon the theory of commutation itself. In many cases it was considered that the alternating current had some mysterious property which caused sparking when attempts were made to commutate it. If we go back to the early periods we also find many things which could not be done with direct current, but which are done at the present time. I well remember the time —about 13 years ago—when I was informed by a number of the leading engineers of that time, that it was useless to consider the construction of slotted armatures for railway generators of the then gigantic size of 200kw. At that time the Westinghouse Company had a railway armature of this size almost completed, and this advice was very discouraging. But as the armature was so nearly ready to test, it was decided to assemble the machine and find out how badly it would work. The result of the tests was such that the Westinghouse Company immediately abandoned the surface-wound type of direct-current armature in favour of the slotted type. Other companies probably had similar experiences, for the slotted type is now almost universally used. The above is merely given as an illustration that in direct-current apparatus many early opinions have been abandoned. If one of the 200 H.P. New York Subway motors had been attempted 10 or 12 years ago, conclusions undoubtedly would have been drawn by many engineers, showing the absurdity of attempting to make high-class motors of this size. In the same way, advances in the art have led to a more complete understanding of the underlying principles of commutation among those interested in the design of commutating apparatus, although such knowledge, except in a general form, is limited to a small number of engineers. Very few of all those who handle modern direct-current generators or motors really know why their machines commutate so much better than some of much older designs which were apparently built on the same lines. Motor designers with a wide experience in the problem of commutation are now awakening to the fact that commutation of alternating current does not furnish a set of new and mysterious phenomena, but that the laws which apply to direct-current commutation also apply to alternating-current commutation, and that the problem is one of degree principally. If a continuous-current of X amperes have its direction reversed in a coil without sparking as the coil passes under the brush, then there should be no difficulty in reversing this current if it varies periodically from X amperes to zero and up to X amperes again. The trouble is that when opinions on commutation of alternating current were originally formed it was not known how to commutate the current of X amperes.

The principal difficulty in commutation of alternating-current motors has been the presence of local secondary currents in the coils short-circuited by the brushes, such currents being due to pulsating or alternating magnetism through the short-circuited coils. Various arrangements have been tested at different times for lessening the effect of these secondary currents. Such motors are usually built with a comparatively large number of commutator bars, with a very small number of armature turns per bar, to lessen the effect in the short-circuited coil. Very narrow brushes have been tried in order that the period of short circuit may be lessened, and two or more parallel windings forming the so-called "Sandwich" type have been tried. These windings lie side by side on the core, but are practically independent of each other and connect to alternate commutator bars, or to every third bar, &c., dependent upon whether two or three parallel sets are used. With two of such parallel windings on a core a commutator brush of a width slightly less than one bar could be so placed that it would never short-circuit a coil of either winding. In this case the brush passes from one winding to the next, and breaks connection with the first winding before passing to the next bar of the first winding. With this arrangement the short-circuiting of the coils would be diminished, but the type of winding is one which we do not consider satisfactory for railway motors. We consider that this is simply transforming the trouble due to the short-circuited coil to another trouble, which would, in the end, be just as serious—viz., the tendency of such windings to produce blackening and pitting of the commutator bars. Such an arrangement would require very thin brushes if but two parallel windings were used, while with three parallel windings the brush could have a thickness corresponding to two commutator bars. A number of other devices have been tested at various times by different experimenters, but these are attempts to cure an existing difficulty rather than to lessen or eliminate the cause of the difficulty.

Within the past year or two there has been a great awakening to the possibilities of this problem, with the consequence that there is now a world-wide appreciation of the field of operation for commutator types of single-phase motors, which will accomplish results not hitherto attainable. Single-phase motors having good commutating properties are now on the market in this country for the commercial frequency of 25 cycles per second. Higher-frequency motors could probably be built with reasonably good results, but as 25 cycles has become a commercial frequency in this country, it is probable that this will become the standard for traction service for single-phase motors. A single-phase motor having series characteristics having been obtained, it is at once evident that it opens up various methods of control hitherto not utilised in railway service. Having the motor which can be controlled in speed by variations in the voltage supplied to it, then voltage control can at once be obtained due to well-known properties of alternating-current transformers. Such methods of control are dependent upon the use of alternating current, and have not been applied in railway apparatus heretofore, because there was no suitable motor on the market. Many forms of apparatus for varying the voltage on alternating-current circuits have been known and used, and most of these devices permit voltage variations with comparatively small loss in power. Therefore, with an alternating motor with the series characteristics, it is at once evident that we can obtain a traction system in which the power expended is practically proportional to the work done, and therefore the least power will be consumed at starting and at low speeds. This is an ideal condition for railway service, but has not been permissible with the direct-current system, except by great complication.

There are a number of ways in which the various single-phase commutator type of motors can be controlled in speed. With the straight series type, the voltage applied to the terminals can be varied, the field windings can be varied, commutated, &c., or the relative values of armature and field strength may be varied. Also, with certain designs of motor exciting brushes may be placed on the commutator, as we have indicated before, and the voltage applied to these brushes may be varied. All these methods may be used also with the transformer types of motors. Also, by shifting the polarity of the fields to one side or the other of the normal position, the speed can be affected to a greater or less degree, and similar results can be obtained by shifting the armature brushes. The latter method we do not consider a suitable one for traction motors.

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Also series-parallel control can be used, if desired, just as on direct-current motors, and rheostatic control can also be used. These two methods have practically the same effect on economy as found with direct-current motors with these methods of control. Single-phase motors of all types, in common with polyphase induction motors, have one feature which is not shared by direct-current motors—viz., there is an active voltage between the field turns. The alternating magnetic flux through the field of the alternating motor generates an E.M.F. in the field windings, just as in the case of an alternating-current transformer. In the direct-current motor the only voltage in the field coils is that represented by the current flowing against the resistance of the windings. Therefore, in a direct-current motor a short-circuit can occur between one or more turns of the field coil without disastrous effects on the motor. Those who have had a wider experience in the operation of electric railways and are familiar with the extremely high temperatures momentarily obtained under certain conditions, will appreciate the importance of this feature of the direct-current motors. If direct-current motors were so designed that short circuit between two turns due to overheating or other conditions would disable the motor so that it could not be operated, then it would be necessary to very considerably increase the dimensions of such apparatus in order to get emergency capacity. It will at once be appreciated that the alternating-current motor, with an active voltage between field turns, must be designed to stand heavy overloads without danger of short-circuits between field turns. Therefore, either these motors must be designed with more margin of temperature than the direct-current practice, or the windings used must be such as will permit of more insulation between turns than is used in direct-current practice. If such motors are wound for voltages corresponding to direct-current railway practice, then there is greater danger from short-circuits in the field than with direct-current motors, and if the motors are wound for comparatively high voltages —say, 3,000 volts, for instance—then the danger from this source is very considerably increased, for in a 3,000-volt motor a large number of comparatively small wires must be used in each coil, and these must be well insulated from each other, and the entire winding must be well insulated from ground. Experience with alternating-current high-voltage stationary motors has shown that such motors are not nearly as safe as those wound for 200 or 400 volts, and we believe that for motors under a car, subjected to the extreme variations of traction service, the danger from short circuits and grounds will be very much greater than in the case of stationary motors. If such traction motors are wound for low voltages, say, 200 volts, approximately, then heavy conductors and but a very small number of turns will be necessary on the field, and each conductor can be separately insulated both from other conductors and the ground.

Therefore, the alternating current permits the use of low-voltage motors, with the consequent advantageous construction of field coils where the conditions of operation in direct-current practice prevent the use of any lower voltage than that supplied by the line. Troubles from oil and dirt, such as frequently occur with direct-current motors, will become of great importance in alternating-current railway motors wound for very high voltages. We believe that, except for very special cases, it will be found safer to step-down the voltage on the car by a transformer, thus supplying the motors with low voltage from the secondary circuit rather than to wind each motor so that it becomes a transformer subjected directly to the high voltage of the system. In cross-country work, where high voltage would preferably be used, the step-down transformer method also furnishes additional protection from lightning, as it is well known that it is easier to insulate one transformer from lightning than to insulate two or four motors. The question of safety to the passengers and apparatus in the car also should be considered in this matter.

A large number of estimates have been made comparing the general performance, cost, &c., of equipping roads with single-phase alternating-current motors instead of direct-current motors, supplied from rotary converter sub-stations. In all these cases the advantage has appeared decidedly in favour of single-phase, except in a small number of cases where some small limiting condition was placed upon the alternating-current system. If the starts are very infrequent and the running periods long, then the gain in efficiency by elimination of the rheostatic losses at start may be more than compensated for by the slightly lower efficiency of the motors themselves. Where such conditions apply, generally high trolley voltage will be used, and there will be enough gain in efficiency in the transmission and distributing to more than balance the loss in the equipment. Furthermore, the elimination of the rotary converters will furnish a still further gain in efficiency. In estimates made up to the present time, we have, in practically all cases, found higher total efficiency for the single-phase railway than for the direct-current railway with sub-stations. In cross-country work the gain in the transmission and distributing system and the rotary converters compensate for other losses. In city work, where starts are very frequent and low speeds necessary at times, the gain by elimination of the rheostatic control has appeared as a very important item in the efficiency.

It thus appears that while suburban work was once thought to be the most important field for the single-phase railway, it has now become evident that city work, where traffic is very congested in parts of the system, will prove to be one of the best fields for this system. Of course, it is recognised that for heavy railroad service, where all kinds of speeds should be obtained economically, the single-phase railway system will, undoubtedly, show to great advantage compared with any known direct-current system. But as considerable time will be required to equip any railroad service, it is probable that the single-phase railway system will be well tried out before there is a good opportunity to give it a thorough trial for heavy work. There is no difficulty in designing single-phase motors for sizes up to 300 H.P. or larger, and of sufficiently small dimensions to be used with a single reduction gear on locomotives. There is also no difficulty in designing regulating devices for controlling the power of such motors. For example, a 600kw. induction regulator manufactured by the General Electric Co. has been in commercial operation at Niagara Falls for many years, and a regulator of this capacity would be sufficient to control a 2,400 H.P. locomotive. The induction regulator furnishes an ideal method for locomotive control, as the voltage supplied to the motors can be varied over a wide range without making or breaking the circuit.

In conclusion, we would say that the subject of the commutator type of motor is now being thoroughly studied by engineers in all the principal manufacturing companies in the world, and there is no longer any question that such motors can be built successfully for commercial service. When it is once shown that such motors are feasible and that, therefore, a new field of development is opened, there is immediately a willingness on the part of most of the manufacturing concerns to undertake the perfection of such apparatus. What is needed in any line of development is a promise of success, and it may be taken as true that success will then be obtained.

ROYAL COMMISSION ON LONDON TRAFFIC.

The Royal Commission on London traffic resumed its sittings on Thursday last week, January 7th.

Mr. JAMES W. BRADLEY, engineer and surveyor to the city of Westminster, dealt with the various causes of obstruction to traffic in London, and specially complained that tube railway companies should not be allowed to have their entrances and exits on the surface of already congested thoroughfares. This had been done in very many instances despite strong protest by the local authorities, and he named the stations on the Central London Railway, and others now under construction. In his opinion private property should be purchased by the companies for the purpose of their entrances and exits, and the ratepayers should not be forced to consider the probability of the further widening of the thoroughfares, whose congested state was in a large measure due to the cause mentioned. It was very often the case that when a street was widened by the local authority, some such concern as a tube railway company made it the occasion to turn such widening to their own use. On the question of street openings by electric light and other companies he was very emphatic that greater supervision should be vested in the local authority, especially as Westminster was a greater sufferer than most London boroughs in this respect. During the 12 months ended March 31, 1903, the seven electric supply companies having the power to open the streets in Westminster disturbed the roadways no less than 2,500 times. He confirmed the evidence of the Mayor of Westminster as to the use and practicability of subways for tramways, pedestrians, pipes, wires, &c. Such a line of tramways from Hyde Park Corner, Piccadilly-circus, Charing Cross and on to the Strand and City would take the whole of the short distance traffic over this route. There were difficulties, of course, but the trouble with regard to the acquisition of vaults extending under the roadways would not be nearly so great as was generally supposed. Along the route he had named, there would be no such vaults to acquire with the exception of two small areas, one in the Strand and one in Piccadilly, aggregating 1,055 sq. yards and 778 sq. yards respectively. The cost of acquiring these vaults would be £32,000. This estimate could be taken as reliable, as he had had the vaults in question measured up, and the above figures represented the actual area.

Mr. STEPHEN SELLON, late chief engineer to the British Electric Traction Co., and now consulting engineer to that company, said that local authorities in this country had frequently abused the powers which Parliament has given to them, and he quoted many instances in which this had been done. From 1880 to 1895 tramway business in this country had been at a standstill, the reasons for this being the purchase clause (sec. 43) of the Tramways Act of 1870 and also the veto possessed by the local authorities under the Parliamentary standing orders. As instances of the evil effects of these clauses he instanced the Stirling tramways and the Wolverhampton lines. In the former instance, owing to the arbitrary procedure of the local authority, these lines had not yet been converted to electric traction, although the British Electric Traction Co. wished to come to terms. Also, in the case of Wolverhampton, great inconvenience to the public had been occasioned by the inability of the British Electric Traction Co. to come to terms with the Corporation. Now the Wolverhampton Corporation had constructed a

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surface-contact system, with the result that the British Electric Traction Co., which owned the outside lines, was prevented from bringing its passengers into Wolverhampton.

The CHAIRMAN: I do not wish to discuss the question of who was right and who was wrong in these particular instances, but I take it that your view is that the purchase clause and the local veto are injurious to public interest?—Yes.

SIR FRANCIS HOPWOOD: Are you referring to these country cases as illustrating a state of things equally applicable to London?—Yes.

Continuing, Witness, said that for the same reasons electrification had been delayed on the lines worked by the London County Council in the south until this year, whilst on those leased in the north there was no immediate prospect of electrification. The unreasonable opposition of various authorities to the overhead trolley was responsible for the delay in the north, as the leasing company would gladly have agreed to conversion on that system, but it could not face the extravagant capital charges which conduit work would entail. The one exception in London was the London United Tramways Co., which had the good fortune to find more reasonable local authorities outside the county of London, and with persistence over several years it had broken down the opposition of the London County Council with regard to the small portion of lines in the county of London. The result had been that two years ago the first electric lines in London were opened, with splendid results With fair and free conditions similar developments would have taken place over all the London tramways. As it was, however, tramway development in London was ridiculously small and inadequate in extent. It had been stopped for years past, so far as private enterprise was concerned, and whilst the present obstacles were maintained private enterprise could do nothing. These obstacles he summed up as follows:—(1) Procedure in obtaining powers; (2) vetoes on construction matters; (3) tenure. With regard to the first, he said that costliness was common to all methods of obtaining statutory powers, and this went a long way to discourage or deter schemes of undoubted public utility being introduced. In regard to the promotion of schemes by provisional order under the Tramways Act of 1870, he said this was unsatisfactory because the Board of Trade had no discretion to dispense with the consents of the local and road authorities; it could not override the opposition of the frontagers; no compulsory powers for the purchase of land could be given, and even the granting of the order by the Board of Trade was not final. Promoters were still put to the expense in many cases of opposition in either or both Houses of Parliament. Experience was that procedure by provisional order was inapplicable for any London schemes, and even the London County Council found procedure by private bill necessary. The greatest difficulty in the way of the latter method of procedure was the operation of Standing Order 22 relating to the consent of the local authority. The large number of opponents who were given a locus was also a source of immense expense. This locus to oppose tramway schemes was much too freely given. Coming to procedure under the Light Railways Act, he said that, whilst this was in some respects more economical and satisfactory than the preceding two, it had its usefulness greatly discounted by several drawbacks. Chief amongst these was the slowness of procedure. He had had to wait as long as two years for an order to be confirmed by the Board of Trade after it had been passed by the Commissioners. There was also the difficulty of railway company opposition, in face of which it was useless to promote an order. Again, it was impossible for the Commissioners or the Board of Trade to refer any special order to Parliament for decision. In addition, there was the final appeal to the Board of Trade by the opposition under which the promoters had to defend their order once more, although it had been passed by the Commissioners. Treating the question generally, he said that under all the existing methods the business of tramway promotion in London was a lottery. The road authority veto he considered the most serious drawback. This took more than one form. For instance, there was a veto on promotion, and a veto on constructional matters, in addition to the veto by frontagers and landowners. The local veto on promotion had to be purchased upon almost any terms the local authority cared to impose.

The CHAIRMAN: It is open to a promoter to reject any terms which he does not consider reasonable?—Yes, but I am assuming a promoter who already has business in the town and is desirous of extending in accordance with the wishes of the town.

Continuing, Witness said that all these onerous conditions which had to be accepted by promoters made it bad for the travelling public. But very often the local authority, after imposing all sorts of conditions as the price of its consent, sought to bind the company in the matter of fares, and in this connection it was regrettable that no power of appeal to an arbitrator existed. He agreed that the local and road authorities were entitled to be fully heard in the interests of their districts, but such objections should be considered by an impartial tribunal who would decide the matter on the broad question of public interest. He regarded it as totally unnecessary that the 29 borough councils in London should have the power to block schemes, nor did he regard it as proper that the London County Council should have an absolute veto. This latter veto had been exercised with very disastrous effects to the extension of lines outside the county, because these had not been able to connect with the London County Council's lines and their reconstruction was therefore delayed. There should be some authority to compel the linking-up of tramways. Before the London County Council were granted another yard of tramway it should have to satisfy some independent tribunal that it was making satisfactory arrangements for intercommunication with outside lines. As to the extortions by local authorities of money payments before the line was constructed, he said he would have no objection to dividing profits after a reasonable return had been secured to the promoter for his outlay. What he did object to was having to pay before it was quite certain that any profit at all would be made.

Sir FRANCIS HOPWOOD: Both the rent and the fares might be on a sliding scale subject to revision?—Yes.

In answer to further questions by the chairman, Witness said that these extraordinary conditions were always sprung upon the promoter after he had put himself to great expense and deposited his plans. In fact, it was not uncommon to have them imposed whilst the bill was passing through Parliament. Another condition often imposed was that the company should purchase its electric power from the local authority. This he did not object to, but it was absolutely unfair to force the promoter to pay a price for all time which was not adjustable. He asked for an arbitration clause in this connection. The benefit of the abolition of the veto was shown by the success of the Light Railways Act, despite the drawbacks he had already mentioned. There was only one way of running tramways in London and outside; it was to have the lines under the jurisdiction of one authority. His company owned lines north and south, but there was the London County Council between them. Amalgamation of interests had been very largely carried out in America, because every system of transfer ticket had been proved a failure. Therefore, this same process would have to be adopted in London. No matter who owned the lines, one authority must work them. A long list of instances were then given in which the power of veto upon promotions had been exercised. Two notable ones were specially referred to. In the first instance, his company had wished to make a connection between its Croydon lines and the Tooting terminus of the London County Council lines. This involved the construction of a short length of line within the county of London. But although the company offered to transfer the line to the Council, and then take a lease of it, its proposals would not be listened to. Thus a most important connection was allowed to go unconstructed. The other case was of a somewhat different character. A certain local authority agreed to give its consent to a line on conditions, and a committee of the Council came to London to discuss clauses. When the terms came to be considered, a most exorbitant account of expenses was presented which actually included expenses of the members at Epsom races and also their losses. The promoters paid this, as, otherwise, the Bill could not have gone forward. Another necessary condition to tramway improvement was the abolition of the right of frontagers to oppose a line. As to the wide locus of gas, water and telephone companies, he specially mentioned the latter's efforts, which, between 1888 and 1893, were simply an attempt to force tramway owners to pay the cost of replacing an inferior and out-of-date telephone system by a modern one. Between the dates mentioned the National Telephone Co. opposed every tramway bill or order, endeavouring, with success in some cases, to obtain clauses which retarded the whole industry. This led to the appointment of a joint committee in 1893, which put an end to this particular kind of opposition. The question was as to whether the tramway companies should use an earth or metallic return and the proceedings of this committee showed that the telephone system was a bad one, and no such clauses had been obtained since. The opposition of gas and water companies with regard to electrolytic action on their pipes was much better dealt with by the technical officers of the Board of Trade, or by the inclusion of some technical men upon the special tribunal which was proposed. The railway company opposition on the score of competition had a more legitimate appearance, yet he did not think this ought to be taken into account, because the traffic carried by an electric tramway was of an absolutely different kind to ordinary railway traffic. The veto of construction was the next obstacle, after having got over the difficulties of promotion. Under the act, the local authority had power to demand certain things, such as special paving for the roads, the design of the overhead and electrical work and many other details which retarded the progress of the particular work and the industry generally. With regard to the purchase clause in the Tramways Act of 1870, he suggested that the initial term should be 50 years, with recurring periods of 15 years, and that no purchase of a part of an undertaking involving severance should be permitted. The purchase should be effected upon the terms of a going concern.

Friday, January 8.

Mr. SELLON, continuing his evidence, discussed the desirability of the establishment of a special tribunal. He said his previous evidence had shown that the creation of the Light Railway Commission had been a step in the right direction, and a similar tribunal could very properly deal with London traffic. The Light Railway Commission, however, as at present constituted, was not of sufficient strength for this work, and it would need the addition of four or five gentlemen. So constituted it could very well deal with all applications for tramways and light railways in the kingdom. It should have no powers of initiation, however, which he thought could be carried out by a separate technical commission or a technical sub-committee of the original tribunal. Assisted in this way, the tribunal could lay down a programme for the guidance of promoters, and afterwards all schemes should only be sanctioned in accordance with this programme. In addition, he would put upon this technical commission the following duties amongst others. The duty of making a comprehensive survey of the metropolitan area (which he defined roughly as from Windsor to the Kent and Essex boundary, and from Hertford to Reigate) as regards arterial road locomotion, drawing up a plan showing the additional thoroughfares needed and the tramways wanted in them. Further, the duty of hearing and deciding by a delegate any technical points of difference between public authorities and tramway promoters in the execution of the works authorised by the tribunal. The general tribunal should also have the power to refer any schemes to Parliament which involved great principles. The only way of dealing with the street traffic in London was by tramways upon the surface and in shallow tunnels, but the particular points where tramways should either rise to the surface or fall underground was a point of detail which could very well be decided by the tribunal. Tube railways could never answer the

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purpose of the street tramway. They provided for quite a different class of traffic.

The CHAIRMAN: I suppose you recognise there would be some difficulty in running tramways right through London?—I agree, but if you had such a system the cost of the widenings which would be necessary would be small compared with the expense of constructing subways.

Continuing, Witness said the idea of extensive shallow subway construction seemed to be to relieve the streets of the very use to which they were intended—viz., traffic. A complete system of through tramways all over London would abolish the omnibuses, and this had been the effect in all large provincial towns. To ensure these conditions, the tribunal referred to should have the power to amend or modify existing acts or orders as far as might be necessary to ensure harmonious working between old and new undertakings. It should also have the power to require working and running power agreements to be entered into with a view to the efficient working of the whole London system, an object which he feared was hardly obtainable by bargaining between the London County Council and individual tramway owners. In fact, a single working authority for the whole of the London tramways would afford the only satisfactory solution. No better instance of the need of this was available than the want of intercommunication between the County Council lines in the north of London and those running beyond into Middlesex and Hertford. An example of the advantage of having the tramways in one hand was to be seen in the agreements which the Metropolitan Electric Tramways Co. had entered into with the Middlesex and Hertford County Councils. The fusion of the tramway interests of these parties had gone a long way to solve the traffic problem in the northern suburban area. It had been arranged that the Middlesex and Hertford County Councils should construct and own the tracks. The company would own the electrical equipment, car sheds and rolling stock, and would work the whole system. The company would pay annually to the County Councils 4½ and 4 per cent. respectively upon the capital cost of track construction, including the cost of land. The company would then be entitled to receive 4½ per cent. in the one case and 6 per cent. in the other upon its own capital expenditure, and after these charges had been met, the remaining profit would be divided up in the rates of 45 and 40 per cent. respectively to the County Councils and 55 and 60 per cent. to the Company. The tribunal he advocated should have the power to do for the whole metropolitan area what had been done in the northern suburbs. The procedure under this tribunal should admit of no veto by an authority or person, and the control of road authorities in matters of construction and equipment should be limited to the points affecting the public use of the streets. There should be a prompt appeal to a permanent technical authority to obviate delay or undue expense in construction. Above all, the powers of private enterprise should be invited and encouraged to co-operate in a task which in its entirety was too great, as recent events appeared to prove, for a body having such enormous governing responsibilities as the London County Council. Reverting to the question of tramway purchase he made the following alternative proposal—viz., that assuming the London County Council disagreed with the 50 years' tenure, there should be but one authority empowered to purchase, and that should be an *ad hoc* body. This policy had been adopted in Belgium. The action of the London County Council in its discussion as to the purchase of the London Southern Tramways emphasised the drawbacks of the present conditions. This was an undertaking which he considered would undoubtedly be a profitable one if the electrification of it were put in hand. Yet the County Council had been for a long time undecided whether to purchase it or not. The company owning it, of course, would not be justified in going to the expense of conversion. Dealing with the economic aspect of tramways, Mr. Sellon argued that they were a means of increasing the carrying capacity of the highway. The efficiency of tramways in reducing the cost of transport was extremely well shown by a comparison between the accounts of the London General Omnibus Co. and the North Metropolitan Tramways Co. By these it was seen that a tramway horse was worth 20 per cent. more as regards vehicle miles and 78 per cent. more as regards passengers carried as compared with an omnibus horse. In addition, the operating costs were less and the fares were lower on the tramways in spite of the tramway company having to pay higher rates and taxes by reason of being rated upon its track. This being the case with horse traction, the adoption of mechanical traction would give still greater advantage to the vehicle on rails. Even an automobile 'bus would stand no chance in these respects against an electric tramcar, in spite of the claim which had been made for automobiles on the ground of overtaking power as against tramway vehicles.

The CHAIRMAN: Surely an automobile has the advantage over a tramcar, in that it is free to move in any direction, and so avoid being stopped by the traffic in front of it?—There may be that in favour of an automobile, but I deny that they can ever carry the amount of traffic dealt with by tramways.

Witness, continuing, said he had made estimates which proved to him that a tramway would pay excellently upon the routes in London taken by the 'busses, with a consequent saving in street space if the latter were taken off the street. The following figures related to a surface tramway from Victoria station via Victoria-street, Parliament-street and Whitehall to Charing Cross, a distance of 1·5 miles:—Capital expenditure on construction, including permanent way, electrical equipment, overhead construction, &c., £26,000; annual expenditure (fixed charges), including 6 per cent. dividend on construction capital, £3,510; working expenses, 5·25d. per car-mile. On the basis of the returns for the 'bus traffic carried over the same route, at 1d. fare for the whole route, 16,169 passengers would have to be carried daily. This would make the receipts 1d. per car-mile in excess of the working expenses, capital charges, &c. To earn the same amount the 'busses now carried considerably over 20,000 passengers per annum, from which it was clear that the existing 'bus traffic was sufficient to enable a tramway carrying the same traffic to pay extremely well. In contrast with these figures, the cost of a subway for tramways based on the estimates put forward in evidence by the London County Council would amount to about £600,000 along this route, on which amount the charge for interest and sinking fund alone would be £36,000 per annum, as against £3,500 for analogous charges on the tramway capital. Witness then handed in a map showing a number of routes in the City of London where he proposed to lay surface tramways. The streets scheduled included Victoria Embankment, Queen Victoria-street, Cornhill, Leadenhall-street, Lombard-street, Fenchurch-street, Strand, Fleet-street, Ludgate-hill, St. Paul's-churchyard, Cannon-street, Eastcheap, Great Tower-street, Oxford-street, Holborn, Newgate-street, Cheapside and Poultry. All these were main east and west routes, but there were also included a number of cross routes connecting them. The north to south routes included tramways from Holborn to Blackfriars via New Bridge-street, St. Bride-street and St. Andrew-street, along Farringdon-road and Farringdon-street, and another route along Aldersgate-street, St. Martin's-le-Grand, Gresham-street, King-street, Queen-street, Southwark Bridge, to the existing lines in the Southwark Bridge-road. Also other routes from Finsbury-square along Moorgate-street, Princes-street, King William-street over London Bridge to Tooley-street and Great Dover-street, and from Shoreditch High-street along Bishopsgate-street to Gracechurch-street. A number of smaller cross connecting routes were also proposed. A number of plans and photographs were also put before the Commissioners with a view to showing the great obstruction which was caused by carts and vans standing at the sides of the streets for the purpose of loading and unloading. Notable instances of this were St. Paul's-churchyard, Cannon-street, Eastcheap, and the Whitechapel and Commercial-roads. In Cannon-street, he pointed out that the available width of the street, 31ft. 5in., was by this means reduced to 17ft. 5in.

Lord COBHAM questioned witness with regard to a number of instances of the abuse of the veto by authorities which were submitted. One of these was in connection with a bridge over which a tramway was to run in Warwickshire. His lordship said he was a member of the county council in question, and the facts of the case were not quite in accordance with the view put forward by the witness.

Mr. SELLON suggested that perhaps what he had intended to convey had not been so clearly put as it might have been, but he contended that the County Council of Warwickshire wanted the tramway company to pay a portion of the cost of a bridge which had been built previously to the tramway proposal.

Lord COBHAM said that if the statement with regard to this particular instance was not quite accurate it appeared as if all the instances quoted were a number of ex parte statements upon which a good deal could be said by the other side.

WITNESS replied that he was quite prepared to put all the documents relating to the affair before the Commission.

By Sir GEORGE TROUT BARTLEY: The technical commission which he proposed should be a permanent technical official body. As an expert he seriously recommended a tramway down Lombard-street, with this reservation, that if it was necessary to widen the thoroughfare the question of a subway tramway should be considered, and the two costs compared. Naturally, there would be certain points where it would be advisable that the tramways should go under the surface, and this might conceivably be one of them.

By Sir ROBERT REED: No doubt the enforcement of certain hours for loading and unloading would largely diminish the difficulties of standing vehicles referred to, and especially if particular hours for special streets were specified. He suggested the removal of this obstruction because he considered tramways were necessary. Exclude the tramways, and he saw no objection to the present state of affairs continuing.

Then you admit that your evidence has a certain amount of bias in it?—Yes, to that extent.

By Mr. FELIX SCHUSTER: He had merely indicated on the map what he considered desirable routes, where it was practicable to put tramways. The question of the extent to which the lines should be in subways or on the surface was one of detail which could be settled by the tribunal. He saw no difficulty in managing the cross tramways at the Mansion House. The available space for doing this would be very great if the omnibuses were eliminated. Pressed for further details of the Lombard-street line, he said he inclined to a surface tramway.

By Mr. MURDOCH: He was quite certain that the trolley system could be adopted in London in spite of the network of overhead wires for the telephones and telegraphs. The London County Council was even now suggesting its use on some routes. The construction of subways in London for tramways, as had been suggested by some witnesses, would land the whole thing into bankruptcy.

By Sir J. DICKSON-POYNDER:—The figures quoted by Mr. Emden, the Mayor of Westminster, with regard to receipts from subway tramways were impossible. No tramway in the world, constructed under such conditions, could carry sufficient traffic to make £23,000 per annum profit. It was nearer £9,000 for a surface tramway.

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SINGLE-PHASE MOTORS.

Efforts towards the realisation of a single-phase motor combining the large starting torque and the ease of speed regulation of the continuous-current motor with the simplicity of construction of polyphase motors have been made ever since the early days of our industry. A simple and complete solution of the problem was not found during those years when the continuous versus alternating controversy was at its height; and when the advent of the 200-volt lamp enabled the area for economical direct distribution by continuous current to be greatly enlarged, interest in the single-phase motor sensibly diminished Moreover, greater familiarity with poly-phase problems brought conviction as to the economy of first cost of two and three-phase machinery and plant as compared with single-phase, so that for a long time it appeared that the only field remaining for the application of the single-phase motor was in connection with those electricity works which had continued to employ the single-phase system with which they had started. For these purposes, the simple Langdon-Davies motor in England and those made by Brown, Boveri & Co., Lahmeyer and others abroad, all of which were ordinary induction motors with phase-shifting devices for use at starting, afforded ample provision. The main disadvantage of these motors was that, owing to insufficient starting torque, they could not be started on a load; further, the necessity of a supplementary starting winding tended to increase their cost, and the power-factor of the machines at light load was extremely low and fell very far short of unity at full load.

Of late years, however, a strong and beneficial impetus has been given to single-phase motor design, arising chiefly from considerations concerning the electrification of railways, and several ingenious designs have been expounded in various countries and at various times. So far as present solutions are concerned, the simplicity of polyphase motors has not yet been equalled, and the achievements attained were made possible only by re-introducing the commutator. This is a drawback, but it is not an insuperable obstacle to the adoption of the single-phase motor.

Continuous-current motors of the series type were adapted already in the early days of the electric industry for alternating currents by being supplied with laminated poles. But, owing to haphazard design and the high-frequency currents then in vogue, they sparked badly and were employed in small sizes only. After a long period of comparative rest, these

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motors were brought again to the front and perfected for traction purposes by LAMME in America and FINZI in Italy. In principle they are still the same as the ordinary series motors of the continuous-current type, but by applying to their design our present knowledge of the causes and conditions underlying sparking phenomena, machines have resulted which do not spark excessively, provided the frequency of the supply does not exceed, say, 20 to 25 cycles per second. This is one of the weak points of these motors, and one which prevents them from being fed directly from lighting mains. Moreover, on account of sparking at the brushes at starting, they cannot be supplied directly with current of high pressures. This latter difficulty is overcome, however, by transforming down the current before it reaches the motors, and the transformer may serve at the same time for regulating the speed of the motors. Repulsion and "repulsion-induction" motors are altogether different in principle. Current at low or high pressure, as the case may be, is conducted to the windings of the stator and currents of low voltage are induced in the armature windings. By means of brushes, placed at suitable positions round the commutator and connected together, similar paths are provided for the current through the armature as in the case of a continuous-current machine, and the action of these currents on the field produces the requisite torque. In the repulsion-induction motors, the repulsion principle is combined with the induction principle. Buried away in the *Proceedings* of the Institution of Civil Engineers for 1898 will be found descriptions of quite a series of different types of repulsion and repulsion-induction motors by Mr. L. B. ATKINSON, some of which have also been patented, but little has been heard of them since. Better known, and apparently a commercial success, is the repulsion-induction motor invented by Dr. ARNOLD of Carlsruhe some years back. The motor starts as a repulsion motor, but after a certain speed has been reached, the brushes are lifted off the commutator by means of a centrifugal regulator, the segments of the commutator being short circuited at the same time. From this speed upwards, the motor runs as an induction motor with a squirrel cage armature. Objections of a mechanical and electrical nature may be urged against this design, two of the chief drawbacks being that the torque greatly diminishes with increasing speed and that no speed regulation is provided. Similar in conception is the Schüler-Ferranti motor, which has recently been brought out in a commercial form, and a description of which will be found on another page of this issue. It differs chiefly from the Arnold motor in that the change from the repulsion to the induction principle is not sudden, but gradual, and that between starting and full speed the effects of both principles are superposed. In mechanical respects, too, it is superior, and possesses the great advantage of easy and fairly efficient speed regulation.

M. LATOUR has done valuable work in France and has invented and suggested quite a number of repulsion and series-repulsion motors. The latter, representing a combination of the pure series single-phase and the repulsion motors, appear particularly promising. M. LATOUR has paid special attention to the question of power-factor, and he has designed motors with a power-factor near unity and possessing a large starting torque. Similar is the Winter-Eichberg series-repulsion motor, which has been successfully employed for traction by the Union Elektricitäts Gesellschaft. Speed regulation is obtained by varying the impressed voltage by a transformer. At the Southport meeting of the British Association of last year, Mr. W. CRAMP described a repulsion motor which commutated sparklessly; but the low power-factor of the motor tested by the author tells against its application to practical purposes.

Quite recently (*Elektrotechnische Zeitschrift*, December 10, 1903) a single phase motor without commutator, and said to possess a large starting torque, has been patented by Dr. M. CORSEPIUS in Germany. The stator consists of two windings, spaced 90deg. apart, and two rotors are provided. One of the latter is comparatively thin and rotates loosely on the motor shaft, while the second one, the working rotor, is keyed to the shaft. The thin auxiliary rotor possesses a squirrel-cage armature and is set in motion—as in the case of ordinary single-phase induction motors—by a phase-shifting device. When rotating, the auxiliary rotor reacts on the two windings of the stator in such a manner as to produce a considerable difference in phase of the currents flowing therein, a large torque being exerted, in consequence, on the rotor proper. The efficiency of a 5 H.P. experimental motor tested by the inventor reached 80 per cent., and the product of efficiency and power-factor came, in the best case, to 0·61. Too little is known of this motor at present to allow of a definite expression of opinion as to its value, but it is worthy of mention, if only to show how numerous are the ways by which the solution of the problem may be attempted.

In spite of the progress which is being announced by two or three manufacturers in the design of single-phase motors, there is considerable difficulty in obtaining detailed information as to the construction of the actual machines. This is, we believe, largely due to the fact that a considerable number of the improvements are of such a nature that they cannot be protected by broad patents, being, as we have already suggested, rather the application of our fully-developed knowledge in dynamo and motor design to the old principles upon which the construction of single-phase motors must rest. The paucity of published detail should, therefore, encourage manufacturers to devote attention to this class of motor, for the patent position is probably such that it is open to every manufacturer to develop and perfect a good single-phase motor on the lines most suitable to his present workshop and pattern store equipment. It must not be forgotten, however, that the single-phase motor has still a limited field of application, although for electric traction there are certainly vast possibilities in the future.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Localisation of Faults in Electric Light and Power Mains. By F. CHARLES RAPHAEL. 2nd edition. (London: "The Electrician" Printing and Publishing Co.) 1903. 7s. 6d,

The author of the above book is to be congratulated on producing a work, the details of which leave practically nothing to be desired. The title hardly conveys to the mind the comprehensiveness of this valuable work, which not only deals with the subject of the localisation of faults in a particularly clear and practical manner, but also gives reasons for faults, the methods to be adopted for preventing them, and many other useful hints on matters of detail connected with the question of general distribution. To the mains engineer, accustomed to the chasing of faults with no better instruments than a pick and shovel, it is not unusual to associate the methods for fault localising, as suggested in text books on testing, with the use of a sort of scientific laboratory on wheels, and naturally he is inclined to adhere the more closely to the pick and shovel. A short time spared to the perusal of the work in question, however, will show that the formulæ necessary in connection with the tests are very simple, and the instruments required inexpensive and very easily manipulated.

Chapter 1. deals with many important points concerning the cause of faults, important because they are just those points

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which, so often receiving the least attention, result in disaster. In recommending the use of concrete bottoms to all pits, it might be borne in mind that one of the latest practices is to dispense with brick and concrete altogether, and to attach a frame and cover by levelling screws to the sides of a cast-iron box, which not only can be used as an "earth" plate, but precludes both gas and water contained in the subsoil from percolating through to the interior of the box. The author in this chapter gives a very clear description of the principles of the Wheatstone bridge and its application in connection with fault localisation. The measuring of insulation resistance by the "direct deflection" method is also dealt with, and reference made to the best types of instruments suitable for this method of testing. There are, in addition, valuable hints as to the use of reflecting and other galvanometers, and the chapter concludes with a description of several well-known portable testing sets, which, however, does not include reference to the Kelvin set, an instrument extensively used, and perhaps worthy of mention in such a useful category.

Chapter 2 should be of particular interest to central station engineers, as it deals with important problems of the testing of networks while alive and under different conditions of working. Owing to the rapid development of electricity supply on a large and commercial basis, the possibilities hitherto afforded for a quiet Sabbath's testing with the mains thrown "dead" have long since disappeared, and it is for this reason that the methods by which the conditions of efficiency of the distribution system may be obtained without interruption to the supply, are of such particular interest and, in fact, necessity, at the present day. The author, in dealing with this subject, has evidently probed it thoroughly, and has thereby compiled a practically exhaustive treatise on the question in all its aspects. In Chapter 3 the testing of high-pressure mains is dealt with in a similar manner, and it is pointed out that the question as to the advisability of "earthing" one main, as required in some of the tests, should receive careful consideration, bearing in mind the double stress put upon the insulation of the "unearthed" mains working on the same system.

The author, up to this stage, having fully discussed the problems of testing for general efficiency, comes in Chapter 4 to the question of actual fault localising by loop methods of testing, and advocates the use of a stretched or slide wire, in place of a standard resistance box, describing a bridge of this type designed by himself. It is rightly pointed out that central station engineers have been slow to realise the advantages of this method of testing. There is no doubt, however, but that those engineers who have made a careful study of the subject, and have benefited by actual experience in various methods of fault localisation, will entirely agree with the author in his recommendations. Murray's and Varley's methods are both described in this chapter, which concludes with some useful notes on false zero and contact-resistance errors. Chapter 5 explains the "fall of potential" test, and, after giving several examples illustrating the simplicity of this method, the author points out the advisability of keeping the testing current absolutely constant while the several readings are being taken. Experience shows that this is not so easily achieved as might be imagined, and this is, perhaps, one of the reasons why the loop tests as described in the preceding chapter seem to be coming more prominently into use.

Chapter 6 is of peculiar interest as it discusses the fascinating possibilities of fault localising by induction methods. If, by means of a coil of wire and telephone receiver, the seeker after a fault could in all cases be induced to the faulty spot, then, truly, fault finding would be made easy, and it seems tantalising to have to consider the many obstructions which arise as a general rule to thwart what at first appears to be such a simple and speedy method of localisation. The individual to whom the instruments are attached, while promenading the streets with bent head and vacant gaze, would readily forgive the uncomplimentary remarks of the general public, not to mention the invidious attentions of the proverbial "small boy," if he could but feel that he would safely reach his goal. Unfortunately the inductive effects from other mains or of currents straying in several directions through the earth, as explained by the author, more often than not entirely circumvent the tests, which, although very often most successfully carried out on mains in outlying districts and country roads, fail to be of much use in the busy thoroughfares of the city. The extreme simplicity of the telephone system where local conditions allow of its being adopted, should lead engineers interested in the question of testing to carefully study this chapter, which will be found full of the most valuable information on the subject.

Chapter 7 deals with miscellaneous methods of testing and methods to be employed in meeting specially unfavourable conditions for fault finding. In Chapter 8 reference is made to several important questions concerning general distribution problems, such as the fusing of networks, dividing into sections, earth systems, &c. It also gives some useful examples of special conditions of loop testing and particulars as to the methods adopted for breaking down faults. In Chapter 9 there are some very interesting descriptions of fault-indicating systems by means of test wire laid with the network, a practice which up to the present does not appear to have gained much favour in this country although used to a considerable extent abroad. Chapter 10 contains the mathematical proofs for all formula given in the preceding chapters, and the author by this excellent arrangement has thereby succeeded in eliminating all but the very simplest of algebraic symbols from the tests dealt with in the previous chapters. It also describes the ingenious model designed by Mr. Trotter for illustrating the relative potentials resultant on "earth" leakage in a three-wire network. In conclusion, the author includes the Cable Makers' Association standards for wire gauge and size of conductors for supply mains, and gives a full description of his special design of direct-reading fault localiser. Every detail in the design of this useful instrument has evidently been thoroughly well considered, and the fact that it is direct-reading greatly enhances its value.

Apart from the use that this work should be to engineers in the supervision of their distribution systems, it makes most interesting reading, furnishing such a large amount of general and valuable information in connection with mains systems; and in recommending it to the special attention of the station engineer, it is hardly necessary to add that the author, by completing the treatise on a subject of so much import at the present day, has now perfected the previous edition, which met a long-felt want at the time it was published.

J. C. A. WARD.

THE GREAT NORTHERN AND CITY RAILWAY.

The greater part of this line is underground, and runs from Finsbury Park station (Great Northern Railway) to Finsbury-pavement in the City, a distance of about 3¼ miles. The intermediate stations are located at Drayton Park, Highbury, Essex-road, and Old-street, and, to deal with the heavy traffic between the City and the suburbs it is necessary to have a rapid and frequent service of trains. As the stations are comparatively near together, it is essential to employ a high rate of acceleration to ensure a rapid service. Another requirement of the line is that the trains must be capable of operation in either direction and from either end, so that the time and space required for the shunting of a locomotive at the crowded termini may be avoided.

It is proposed to run a three-minute service of seven coach trains, the single journey being completed in about 13½ minutes, including three intermediate stops of 20 seconds each. The trains will be worked on the shuttle principle at the termini, thus avoiding shunting, and it is intended to complete the double journey in 30 minutes. With this service there will be 11 trains running. Each train, which weighs about 200 tons when normally loaded, has a seating capacity of 505 passengers, and is composed of three motor cars and four trailers.

The underground portion of the line consists of two 16ft. tunnels, opening out to nearly 23ft. diameter at the

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stations. The rails are laid to standard gauge on longitudinal sleepers in the tunnels, while that part of the track which is in the open is of the standard type with cross sleepers. The track and tunnels are arranged to allow of the existing Great Northern rolling stock running over the line should extensions and a connection be made with that line, the tunnels being of ample size to take these coaches even with the doors open. Between the centres of terminal stations the length of double track is about 3½ miles. Power for operating the system is supplied from a single generating station situated near the line at Poole-street, New North-road, a little over 1 mile north of Moorgate street station. From this generating station current is fed directly to the collector rails, and there are, therefore, no sub-stations. The length of line and position of the generating station are such as to enable the system to be economically operated without feeding at any other points, and a convenient section of collector rail is also possible. Considerable ingenuity has been displayed in the lay-out of the necessary plant in the limited area available for the power house, and, with the exception of space for another set, the engine room is as full as possible. The site adjoins the Regent's Canal, from which circulating water is taken and returned at a point 100yds. on the down lock side of the intake. In this generating station plant is installed sufficient to deal with the passenger lifts at Essex-road and Finsbury-pavement stations, the lighting of the system and the purely traction load. Steam is supplied from 10 Davey-Paxman "Economic" boilers, each having an effective grate area of 40 sq. ft., and capable of evaporating 11,200lb. of water per hour at 212°F. when using coal having a calorific value of 13,500 B.Th.U. The boilers are fitted with Vicars automatic stokers throughout, and these are driven by two B.T.-H. motors, each able to drive the whole number of stokers if necessary.

Coal is handled by means of an electrically-driven Hunt conveyor arranged to deal with 30 tons per hour; this conveys coal straight from barges to overhead bunkers, and also removes ashes on its return journey. There are four Wheeler surface condensers, each having a cooling surface of 2,400 sq. ft., and arranged with steam-driven combined air and circulating pumps. Each is capable of maintaining a 26in. vacuum when dealing with 22,000lb. of steam per hour. As a matter of fact, these condensers are of very ample proportions, having a cooling surface of 2 sq. ft. per horse-power, and the reason for this is somewhat strange. It appears that the locks of the canal are only operated on week days, and one of the conditions upon which the canal company allowed condensing water to be drawn from the canal was that the temperature should not be increased on Sundays. As on these days there is practically no change of water between the locks, the cooling surface of the condensers had to be made large in order to comply with the condition. There is also an auxiliary condenser of the same type, capable of dealing with auxiliary plant and the exhaust from the boiler feed pumps. These condensers discharge into a hot well, from which the water is delivered by two three-throw vertical lift pumps of the Blake-Knowles type, electrically driven by B.T.-H. enclosed motors. All the condensers have combined air and circulating pumps driven by steam. The lay-out of piping is interesting from the point of view of economy of space, a complete steam ring having been provided from boilers to main engines and an auxiliary ring to the small units, steam pumps, &c.

The four main engines are splendid specimens of the vertical cross-compound type by Messrs. John Musgrave & Sons, fitted with Corliss valves, running at 100 revs. per min. and having a normal capacity of 1,250 I.H.P. at a steam pressure of 150lb. per square inch. An arrangement is provided so that, should the high-pressure cylinder become inoperative for any reason, steam can be admitted directly to the low-pressure cylinder and the engine run as a single-cylinder engine. The usual automatic relief-valve is also provided for atmospheric exhaust in the event of the condenser vacuum failing. The engines are directly connected to four standard B.T.-H. over-compounded railway-type generators, rated at 800kw. each, but capable of taking at any time during continuous service a load up to 1,200kw. for two hours, without objectionable heating. These generators are, further, as in the case of all B.T.-H. standard railway generators, able to withstand momentary overloads of 100 per cent. without injurious sparking. They are compound wound to give 525 volts at no load and 575 volts at full load.

Two Peache engines by Messrs. Davey, Paxman & Co., with a normal rating of 170 B.H.P. each, of the single-acting tandem compound type, drive two B.T.-H. six-pole 120kw. generators at 375 revs. per min. They are compound wound for the same voltages as the main generators, and have an overload capacity of 50 per cent. for two hours. These sets supply energy for the lighting of the power house, &c., and for operating the electrically-driven auxiliary plant when it is not convenient to take power from the main generators for this purpose. In addition to these functions, however, the auxiliary sets may be employed for tunnel and station lighting if anything should go wrong with the traction supply. All lighting mains are entirely separate from those supplying the conductor rails, and, in fact, the two systems may be kept quite distinct. Under ordinary conditions, however, the lighting is supplied from the traction 'bus bars.

In addition to the supply from the canal mentioned previously, water is also obtained from the mains of the New River Co. A storage tank, directly connected to the latter, is also provided. Water taken from the canal is very dirty, and varies in hardness and composition from time to time during the year by reason of floods, droughts and the drainage which it receives. For softening and purifying this water, and also for softening the town supply, which varies in quality, a Desrumaux plant has been installed at the back of the boiler house capable of treating 8,500 gallons per hour; this reduces hardness to about 5deg. and alkalinity to 6deg. An automatic arrangement is fitted between the softener and storage tank, whereby the softening process is suspended and recommenced as occasion may require, thus giving a continuous supply of purified and softened water, with a minimum of supervision. A Masson-Scott plant is installed for the removal of oil and grease from the exhaust and for the purification of water for boiler feed purposes. This plant is capable of dealing with 10,000 gallons per hour.

On a gallery at one end of the engine room there is a standard B.T.-H. switchboard having 16 panels, consisting of four main generator, four feeder, two auxiliary generator panels, three auxiliary power and three auxiliary lighting panels. The circuit breakers are B.T.-H. MK and ML magnetic blow-out type, and the measuring instruments are of the Thomson astatic illuminated dial and feeder type. Cables run from the switchboard along the outside of the boiler house wall and then down a special cable shaft into the tunnel. The 'bus bars on the board are so divided that the auxiliary generators, station lighting and auxiliary motor panels can be isolated from the main generator and heavy feeder panels by the operation of one switch, and in this way the passenger station lighting is continued on if any accident occurs to the other parts of the switchboard, &c. Separate paper-insulated feeding cables are provided for traction, for lighting and for lifts, and rubber-insulated cables for lamp circuits and connections. The arrangement of the cables from the switchboard, through the cable subway, is a very excellent one, and is so designed that any cable may be identified at any point without the use of labels; it is also worthy of note that in no place do they cross. There is also a 30-ton, three-motor, overhead crane in the station, in addition to motor-driven economisers, &c.

Power is conveyed to the motors on the cars by means of two insulated rails per track, one placed 2in. higher and outside of each track rail. The rails are of channel section, weighing 80lb. per yard, and rolled to about 42ft. lengths. They are of a special quality of low carbon soft steel, having a conductivity 14 per cent. of that of pure copper of equal size. These rails are supported on earthenware insulators 10in. outside of the gauge, and carried on spindles supported by cast-iron brackets fixed to the sleepers. The system of collector rails is divided up into four sections, fed independently from the generating station, and the rails of the up and down tracks are interconnected through circuit breakers at different points to equalise the currents in the two pairs of rails. The track rails are 85lb. to the yard, flanged, and laid through the

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tunnels on longitudinal timbers and rolled steel chairs. As they carry no current they are not bonded. The steepest gradient is 1 in 57, and the sharpest curve has 40ft. radius.

As previously mentioned, each train consists of three motor cars and four trailer cars, one motor car being at each end of the train and one in the centre. The seating capacity of the motor cars is 54, and of the trailer cars 56 passengers. All cars are of the corridor type, the seats being arranged transversely, and are 50ft. 6in. in length over the buffers. The motor cars are carried on two McGuire trucks per car; the driving wheels are 36in. in diameter, and the trailer cars are mounted on Brush trucks. The cars were supplied by the Brush Mfg. Co. and the Electric Tramway and Carriage Works. On each truck of the motor cars is mounted one B.T.-H. series-wound continuous-current geared motor, operating at approximately 500 volts, current being collected by four collector shoes per truck. The capacity of each motor is 125 H.P., rated on the standard B.T.-H. basis of 75°C. rise in temperature above the surrounding air after one hour's run on full-rated load. The gear is of steel, machine cut, and enclosed in a waterproof gear case.

The multiple unit system of control of the British Thomson-Houston Co. has been adopted, and by means of this the whole train may be operated from any one of several master controllers, or may be broken up and operated in smaller units. Each motor car constitutes a complete unit, and can therefore be operated individually if desired. A complete and detailed description of this system of multiple control was published in our issue of May 1, 1903, in connection with our article on the new trains for the Metropolitan-District Railway, and illustrations of the exterior and interior of one of the Great Northern and City cars were given in our issue of April 24, p. 36. The electromagnetic switches which are controlled by the master controllers are situated in a separate compartment on the motor car, however, and access may be gained to them quite easily. These compartments have been lagged with sheet iron over uralite, and all cables have fireproof insulation and are supported on earthenware cleats enclosed in sheet-iron troughing where they are located under the car with a view to making the whole absolutely non-inflammable. The trains are equipped throughout with air-brake apparatus of the quick acting type, each motor car carrying a motor-driven B.T.-H. air compressor, reservoir, &c. There are also conductor's emergency cocks at the end of each car for applying the brake in case of need.

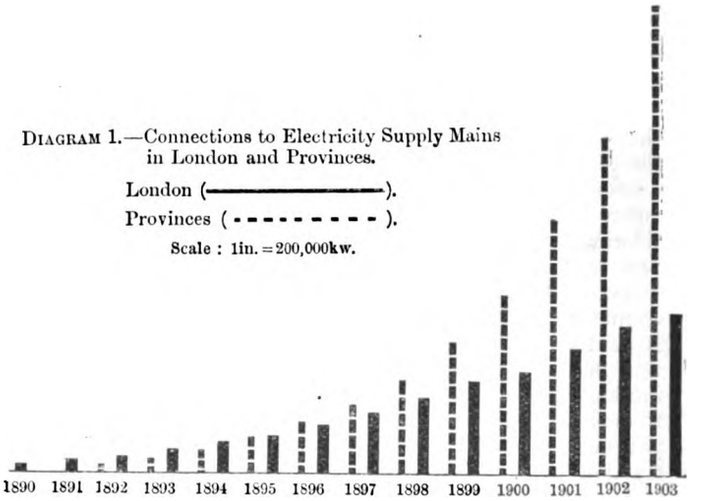
All lighting circuits are carried in iron tube, and the tunnels are provided with lamps every 100ft. The passenger stations are lighted on the rail and street level by B.T.-H. enclosed arc lamps, and at each station switches are fixed which control the B.T.-H.-Edison incandescent lamps in the tunnel half-way to the next station in each direction, the lamps being five in series, and the circuits are run so that there is never more than the voltage of one lamp between two wires in the same iron pipe. Special throw-over switches are provided to take the lighting current from the conductor rails at any time when the special lighting cables are not being used. Repair shops, equipped with all the necessary tools and driven by a single motor, are situated at the side of Drayton Park station. Provision is made for receiving power either from the rails or from the lighting main. The feeder cables are carried along the side of the tunnels and are suspended by means of iron racks.

The engineers for the Great Northern and City Railway are Sir Douglas Fox and Mr. Francis Fox. The contractors for the entire line are Messrs. S. Pearson & Son, who are under contract to work the line for the Great Northern and City Railway Co. during a period of three years from the date of opening. The contractors for the entire electrical equipment, including power house plant, line, and car and lighting equipments, are the British Thomson-Houston Co. The whole of the engineering work for the British Thomson-Houston Co. was under the direction of Mr. A. H. Walton, assisted by Messrs. Winkfield, Dundas and Thomas, and Mr. R. P. Brousson acted as engineer for Messrs. Pearson. It is probable that the line will be open to the public early next month.

CONNECTIONS TO ELECTRICITY SUPPLY WORKS.

As promised in our issue of last week, we now give statistics and diagrams relating to the connections to the various supply undertakings of the United Kingdom. These figures apply to the aggregate connections to electricity supply stations (including power and tramway loads) but do not include the power supplied from purely tramway power houses. Once again the increase in connections for the provinces is much in excess of that for London, and the annual increment continues to increase year by year. The total number of kilowatts now connected in London is 167,640, and in the provinces 488,127, making a total of 655,767. This shows an increase of 152,196kw. over and above the corresponding

DIAGRAM 1.—Connections to Electricity Supply Mains in London and Provinces.



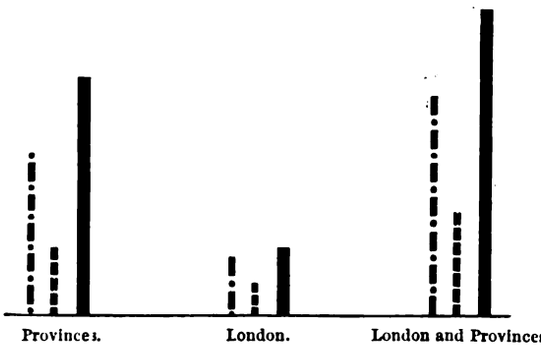


DIAGRAM 2.—Connections to Continuous and Alternating-current Stations.

Alternating Current (— — — —). Continuous Current (——————).
Alternating and Continuous (— · — · — · —).
Scale: 1in. = 200,000kw.

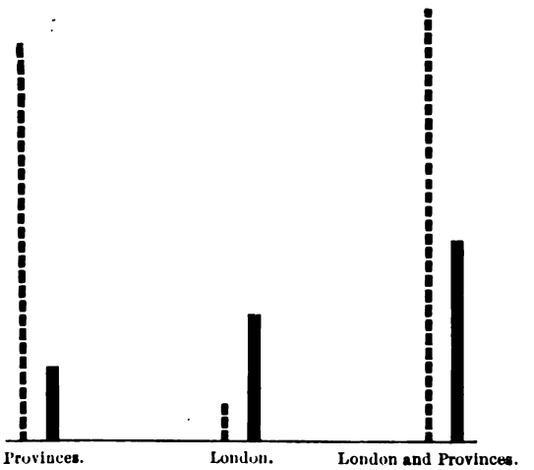


DIAGRAM 3.—Municipal and Company Connections.

Municipal (— — — — — — —). Company (——————).
Scale: 1in. = 200,000kw.

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figure for December 31, 1902; and the rate of increase for the past year is no less than 50 per cent. greater than that for the previous year. This must be attributed in a large measure to the number of new combined lighting and tramway stations which have been opened and to the increase in the tramway load of those already running.

The equivalent of 8 c.p. lamps connected in the United Kingdom to date is nearly 22 millions. From diagram 3 it will be seen that the connections to stations under municipal control in both London and the provinces have increased out of all proportion to those under company control, and for the first time the former are more than double the latter. On the whole, it must be conceded that the general progress of the electric lighting and tramway industry is very satisfactory, as is evidenced by the accompanying diagrams. The figures given in tabular form below are those from which the diagrams were drawn.

Table I.—*Details of Connections in London and Provinces.*

LONDON (167,640kw.)	Municipal (36,940kw.)	S	16,370kw.
		S I	13,750kw.
		S I S	6,820kw.
	Companies (130,700kw.)	S	57,300kw.
		S I	20,400kw.
		S I S	53,000kw.
PROVINCES (488,127kw.)	Municipal (411,201kw.)	S	204,564kw.
		S I	67,352kw.
		S I S	139,285kw.
	Companies (76,926kw.)	S	40,673kw.
		S I	6,448kw.
		S I S	29,805kw.

Table II.—*Connections to Alternating and Continuous-current Stations.*

—	—	S	S I	Totals.
London.....	73,670kw.	34,150kw.	59,820kw.	167,640kw.
Provinces	245,237kw.	73,600kw.	169,090kw.	488,127kw.
Totals	318,907kw.	107,950kw.	228,910kw.	655,767kw.

Table III.—*Municipal and Supply Company.*

—	Municipal.	Company.	Totals.
London	36,940kw.	130,700kw.	167,640kw.
Provinces	411,201kw.	76,926kw.	488,127kw.
Totals	448,141kw.	207,626kw.	655,767kw.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Effect of Concentration upon Radio-activity.—Some experiments have recently been made to test whether the radio-activity of radium is influenced by the continuous bombardment to which it is subjected by its own radiations. In order to test this point E. Rutherford has made measurements of the radio-activity of radium bromide when in the solid state and when diffused throughout the mass of a solution more than a thousand times the volume occupied by the radium compound. The results show that such a dilution has no appreciable influence on the radio-activity. This experiment shows that, over the range investigated, the radio-activity of radium is not influenced by its own intense radiations. The result is in agreement with previous observations, for neither the radio-activity of any active product nor the rate of loss of its activity has been found to be affected by its degree of concentration. It is thus improbable that the energy given out by radium is due to an absorption of an unknown external radiation which is similar in character to the radiations which are emitted. Experiments are in progress to test whether still further dilution of the radium solution produces any alteration in its radio-activity.

[E. RUTHERFORD, *Nature*, January 7, 1904.]

Glass for Ultra-violet Light.—E. Zschimmer announces that he has produced at Schott's works in Jena a new kind of glass which largely transmits ultra-violet light. This announcement is important in view of the fact that all varieties of glass hitherto produced completely absorb all rays having a wave length smaller than 305$\mu\mu$. Flint glass does not even transmit rays anywhere near that point. Quartz and fluorspar do transmit ultra-violet light freely, but all attempts to render them optically perfect in lenses more than some 5cm. in diameter have failed. The author does not give any information concerning the preparation of the new glass, but gives photographs of spectra which show that it transmits actinic light down to 280$\mu\mu$ or even 248$\mu\mu$. He also describes a glass which, besides transmitting ultra-violet light, intercepts the visible spectrum as far as the blue, and therefore acts as a perfect actinic filter. It has already been used for the light cure and for celestial photography, and the negatives obtained show an increase of some 40 per cent. in the stars recorded with the same exposure and the same aperture.

[E. ZSCHIMMER, *Zeitschr. Instrumk.*, December, 1903.]

Electro-mechanical Gearing.—No mechanical system has been hitherto devised which allows of a continuous variation of speed with any considerable power. The electric motor is the most elastic machine in use, but where the motive power is supplied in a mechanical form it requires its complete transformation into electric power. Paul Gasnier has devised a new system of transmission which he calls the "electro-mechanical" system, which, with very simple constructions, enables one to produce a continuous variation of the velocity of the working part from complete stoppage to the maximum, and only requires secondary dynamos of about one-third or one-fourth of the original motive power. A varying fraction of the motive power is always transmitted direct to the shaft. The rest, which varies with the velocity, is absorbed by one of the dynamos working as a generator and given out by the other dynamo working as a motor. This transmission is particularly convenient where the distances to be traversed are small, as in automobiles. It is superior to pure electric transmission in weight and efficiency. The principle is the following:—A train of epicyclic gearing is employed in such a manner that the final shaft is always driven both by the motive power and by the motor dynamo. These two machines are, however, separate, and can have different velocities. In one arrangement there is an epicyclic train of straight-cut wheels, composed of a central pinion concentric with an outer and larger pinion having internal teeth. The two pinions are joined by a number of idle wheels. It suffices to combine the three things—outer pinion, inner pinion and supports of the idle wheels—each with one of the three organs—motive power, dynamo and final shaft—to obtain the desired result.

[P. GASNIER, *Comptes Rendus*, December 28, 1903.]

Synchronous Rotations.—In the telegraphic transmission of photographs, half-tone blocks, handwriting and drawings, the main requisite is the accurate synchronism of two cylinders, one at the transmitting station and the other at the receiving station. The adoption of the telautograph principle renders this synchronism unnecessary in the case of drawings, but when the picture has to be split up into a number of elements of various intensities the synchronous cylinders become indispensable. A. Korn gives some hints as to how this synchronism can be best secured. A shunt-wound continuous-current motor is the best for securing a uniform speed, and it can be maintained in uniform rotation at a given speed with the aid of a Hartmann-Kempf speed indicator, in which the frequency is indicated by a set of springs tuned to different natural pitches, one of which, having a pitch corresponding to the revolutions of the cylinder, responds, while the others remain at rest. The record is traced on the cylinder in a close spiral. The uniformity of the revolutions is not, however, sufficient to insure a good record, since a lag too slight to be discovered might be fatal to a proper transmission. It is, therefore, necessary to have an automatic controlling and correcting device. The author describes such a device. The principle is that the faster cylinder is arrested at each revolution for the small fraction of a second by which it is in advance of the slower cylinder. To avoid the necessity of stopping both cylinders alternately, the receiving cylinder is made to rotate

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1 per cent. quicker than the transmitting cylinder, so that the corrections are always in the same direction. The stoppage is made by a catch which is released by a current from the transmitting station as soon as the transmitting cylinder has completed its own revolution. During the stoppage, the driving shaft revolves in the receiving cylinder with slight friction, sufficient to make the latter revolve at full speed on release.

[A. KORN, *Phys. Zeitschr.*, January 1, 1904.]

Selenium Cells.—Bidwell's theory attributes the sensibility of a selenium cell to the presence of selenides from which selenium apparently never is free. This view is supported by the facts that the conduction of the cell is electrolytic in character and that selenium is a poor conductor, while the selenides are not. Besides, sunlight actually brings about a combination of metal and selenium, forming a stable conducting selenide. A. H. Pfund has tested this theory by a number of experiments, and concludes rather that the sensitiveness is due to some direct action of light upon the selenium itself. He purified selenium by a method devised by Lehner, in which the selenium is dissolved in hot nitric acid and evaporated to form the dioxide, which is then sublimated until it has lost all colour. He used carbon electrodes instead of metallic electrodes. Granting that in a selenium cell most, if not all, of the conduction is electrolytic in character and due to the presence of a selenide, it follows that there is an actual motion of the components of the selenide towards the electrodes of the cell. It is not unreasonable to suppose that light, in falling upon selenium, might also change its crystalline character, and that this new modification might offer less resistance to the ions of the selenide as they wander towards the electrodes, thereby producing indirectly an increase in their velocities, which is equivalent to a decrease in the resistance of the cell. If the new modification of selenium is stable only in light, it would revert to its original condition when light is cut off, the change taking place more rapidly at first. This would account for the fact that light produces changes in the resistance of a cell whether a current be flowing or not, and affords a possible explanation of the fact, discovered the author, that the position of maximum sensibility is independent of the metal in the selenide.

[A. H. PFUND, *Phil. Mag.*, January, 1904.]

RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 447.)

The connection between radio-activity and the atomic changes that maintain it have been discussed in a Paper entitled "Radio-active Change" (Rutherford and Soddy, *Phil. Mag.*, 1903, VI., 5, p. 576). In preceding articles on the products of radio-active change, the radio-activity has been used as the means by which infinitesimal quantities of matter have been brought within range of experimental investigation. It remains to frame a consistent physical explanation of the nature of radio-activity itself. The discussion in earlier articles of the nature of the α and β radiations assists us materially in this task. Evidence was then brought forward to show that the α-rays are caused by the radial expulsion from the active substance of positively-charged particles of atomic dimensions (Rutherford), while the β-rays are high-velocity cathode rays, or negatively-charged particles of sub-atomic dimensions (J. J. Thomson and Becquerel). Now, in the changes suffered by radio-activity during the processes of decay and recovery that have been considered, the character of the radiation is not sensibly affected. Hence we must regard these changes in radio-activity as being caused by alterations in the number of particles projected as rays in unit time. This consideration is important, for it precludes the view that the decay of the activity of thorium X, for example, is analogous to the decay of the radiations from a hot body cooling. The character of the particles projected remains unaltered, and the weakening of the activity is caused by a diminution in the number emitted in unit time. So radio-activity will be completely defined as the simultaneous occurrence of two processes: (1) The projection of charged particles with enormous velocity; (2) the production of new types of matter in minute amount, which can be investigated when they also are radio-active. What is the precise connection between these two processes? Thorium X furnishes a convenient example, for (1), the projection of rays, can be determined by measuring its radio-activity, (2), the production of new matter, by measuring its emanating power. It was found (Rutherford and Soddy, *Phil. Mag.*, 1903, VI., p, 4. 570) that when one part of thorium X is kept in solution and its emanating power tested from day to day, it decayed with time according to the same law and at the same rate as the radiations from another part of the same sample that had been evaporated to dryness in a platinum dish. This points to the conclusion that the two processes (1) and (2) are causally connected. Another example, giving the same result, is to be found in the first Paper of Rutherford (*Phil. Mag.*, 1900, V., 49, p. 170) on the imparted activity of thorium. Here we have (1) the projection of charged particles, or α-rays, from the radio-active emanation, (2) the production of the new matter which causes the imparted activity. A steady current of air was blown over a thorium compound into the tube shown in Fig. 27 in the direction of

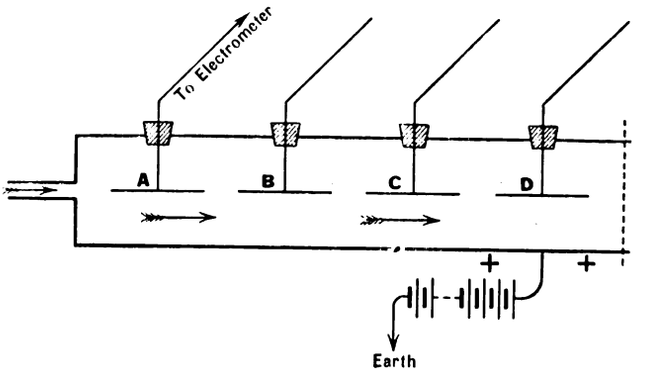

FIG. 27.

the arrows for several hours continuously. At the commencement the ionisation current due to the rays from the emanation was measured by connecting the four electrodes A, B, C, D separately with the electrometer, the exterior of the tube being connected with the + pole of a battery giving 300 volts, the other pole of which was earthed.

In this way the whole of the imparted activity produced by the thorium emanation is deposited on the electrodes, which are negatively charged with respect to the tube. The decay of activity suffered by the emanation in the time required for its passage through the tube caused the current to the electrode A to be greater than to B, and the ratio of the currents due to the emanation at the four electrodes was determined. After the emanation had been kept passing for several hours, the electrodes were removed from the apparatus and the imparted radio-activity on each determined. It was found that the four electrodes exhibited substantially the same ratio in their imparted activities as in the determination of the current due to the emanation. That is to say, as the radio-activity of the emanation decays with time, its power to impart radio-activity to its surroundings correspondingly diminishes. The number of particles projected as rays from the emanation during its change into the new matter causing the imparted activity is proportional to the amount of the latter (as measured by its radio-activity) produced.

It follows, therefore, that both the projected particles, or rays, and the new matter are products of the parent element by the *same* change. Translating this result into the language of the atomic theory, and considering now the individual changing atom, the rays constituting the radio-activity of thorium are expelled at the moment the atom of thorium changes into thorium X, the rays constituting the radio-

* These articles are based on a series of 12 lectures which Mr. Soddy has delivered at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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activity of thorium X are expelled at the moment the thorium X atom changes into the emanation, and so on. The atomic theory, put briefly, is that the atoms of any one element are all alike, and different from those of any other. Hence, we may assume that the same kind of atom changing expels some fixed number of rays. Whether one or more is expelled is immaterial, but the number must always be the same for the same kind of atom undergoing the same change. Thus the activity of any single type of radio-active matter, in the sense of the number of particles projected from it in unit time, furnishes a measure of the number of atoms undergoing change.

Several important and definite conclusions follow from this point of view, which have in many cases been found capable of direct experimental test. In the first place, since the production of thorium X from thorium proceeds at a constant rate in any given mass of thorium compound without reference to the physical and chemical conditions (see p. 379), it follows that a definite fraction of the total number of thorium atoms are changing in each unit of time into thorium X, and this change is accompanied by the projection into space of a definite number of α particles. Hence, to whatever chemical process thorium is subjected it should prove impossible to entirely free it from radio-activity—that is to say, there must exist a certain constant non-separable radio-activity. Now, this has been shown to be true, so far as our experimental knowledge goes, not only of thorium, but also of uranium and radium, and in each case it is important to note that the non-separable activity consists entirely of α-rays. The next deduction from the position that the expulsion of the rays accompanies the change of the atom, is that radio-active matter must be continuously diminishing in quantity. A radio-active atom is a changing atom. For feeble examples, like uranium and thorium, it is not necessary that the change should be great enough to be appreciable. It is probable that in these cases the quantity in existence remains practically constant over very long epochs of time. But if this is true it follows equally that the quantity of uranium X and thorium X produced from them must also be excessively small. In order that this insignificant amount of matter should be able to give sufficient rays to be appreciated it must be changing much faster than the original element, and its quantity in consequence must rapidly diminish. Hence its radio-activity decays, and the rate of decay, together with the intensity of its radio-activity, depend upon whether it is changing slowly or rapidly. We have seen that the activities of uranium X, thorium X, the emanation of thorium, and the matter imparted by the latter to other objects, all decay in a G. P. with the time at characteristic rates, represented by the equation (p. 378)

$$\frac{I_t}{I_0} = e^{-\lambda t},$$

in which λ is a numerical constant different for each type of matter. The expression $\frac{I_t}{I_0}$ represents the ratio of the number of rays expelled in unit time for any time t to the number expelled initially, and may be replaced by $\frac{n_t}{n_0}$, where n_t represents the number of atoms of the substance changing in unit time, for time t, and n_0 the number initially, so that

$$\frac{n_t}{n_0} = e^{-\lambda t}.$$

To find the rate of change, let N_0 = the total number of atoms originally present and N_t the number left unchanged at time t,

$$N_t = \int_t^\infty n_t \, . \, dt = \frac{n_0 e^{-\lambda t}}{\lambda},$$

$$N_0 = N_t \text{ when } t = 0,$$

$$N_0 = \frac{n_0}{\lambda},$$

$$\frac{N_t}{N_0} = e^{-\lambda t}.$$

Differentiating, $$\frac{dN}{dt} = -\lambda N .$$

The result is thus a very simple one. The rate of change of the atoms undergoing radio-active change is always proportional to the amount remaining unchanged. If N atoms of any type of radio-active matter are present, λN changes per second, where λ is the radio-active constant. From the values of λ already given it follows that about $\frac{1}{8}$th of the thorium emanation, $\frac{1}{500000}$th of thorium X, and $\frac{1}{3000000}$th of uranium X undergoes change per second.

Now, the law of radio-active change just developed is already well known to us as the law followed by a particular kind of chemical reaction—viz., that known as mono-molecular. In reactions which are of the type of the decomposition of the single molecule into simpler parts, the quantity of the substance undergoing change decreases in a geometrical progression with the time. Both are simple consequences of the law of probabilities, the number of changes occurring under constant conditions increasing with the number of changing systems. But the case is completely different when the reaction is not of the type of a decomposition but of a combination. For, here, in order for the change to occur, the combining molecules or atoms must first approach within each others spheres of influence. The rate of change, in consequence, depends upon the concentration, and this diminishes with the progress of the change. The rate of change proceeds in these cases according to some power of the number of changing systems present. Hence, radio-active change cannot be of the nature of a combination together, or, as a chemist would say, the polymerisation, of the atoms of the active element, but must be due to a decomposition or disintegration. The term *changing atom* can now be logically replaced by the more definite conception expressed by the use of the term *disintegrating atom*, with considerable advantage to the clearness of the mental picture conveyed. We may suppose that, owing to the action of disruptive forces of which we have at present no other knowledge, the atom of the radio-element suddenly explodes. The lighter fragments, hurled into surrounding space with enormous speed, constitute the α rays, while the heavier parts reform into a new atom. The latter is frequently excessively unstable, lasting but a few minutes, hours or days before changing once more, and so on until a stable configuration is again attained. This gives us an insight into the reason of the stability of the elements. They are the selected forms out of many others, capable only of limited existence. Matter has passed to its present position of apparent immutability by a long process of natural selection. The permanent structures have survived at the expense of the transitory, and radio-activity affords us the first means of studying these ephermal elements.

(To be continued.)

A NEW POTENTIOMETER.

BY W. CLARK FISHER.

Since the publication by the writer in these columns some years ago of a series of articles on the Crompton form of potentiometer, and their subsequent amplification and publication in book form,* several instruments of the same type have been placed upon the market by other makers, and the original, or parent instrument, has itself been modified in construction and design. There was, in those respects, ample room for improvement, and with the makers' new resources it would have been strange indeed had they not been effected. Except, however, in the matter of details of construction where differences, some retrogade, some in advance, do exist, some of the potentiometers in the market to-day are but replicas of the parent instrument described by the writer years ago, and show no advance from the users' or electrical point of view.

Manifestly, to anyone acquainted with the subject, there is no particular charm attached to 15 sections and a 1·5-volt drop of potential, but seemingly their adoption in the parent instrument has led to repetition on the part of others, another proof of that curse of the instrument-making world, the system of slavishly copying what has already been done, which, to the writer's personal knowledge, amounts in some instances to the attachment to shop orders of illustrations from other makers' lists.

In the description mentioned the writer made promise of further description of an instrument that should be ideal in every respect

* "The Potentiometer and its Adjuncts," by W. Clark Fisher, Assoc. M.Inst.C.E., "Electrician" Series.

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for the purpose of universal electrical measurement, but circumstances at the time prevented the fulfilment of the promise, and it was not until the current year, when entering into business on his own account, that the writer was able to complete the design and bring to a successful issue sketches and ideas that he then had in mind, and which are here formulated in a new instrument of greater accuracy, range and general usefulness.

In describing this new instrument, in order to show its essential difference and material improvement on the older form, a diagram of the electrical circuits of the latter is herewith introduced, Fig. 1.

The principles of working having been previously explained and, being now well known, it is unnecessary to do more than state briefly that a secondary cell, E, supplies a constant fall of potential over ABC, where AB consists of a slide wire and BC a given number of sections of wire each equivalent in ohmic value to AB. The potential F, it is desired to compare, is connected in series with galvanometer G, to the sliding contacts HH', each capable of being slid along the contacts of BC and continuously over the whole length

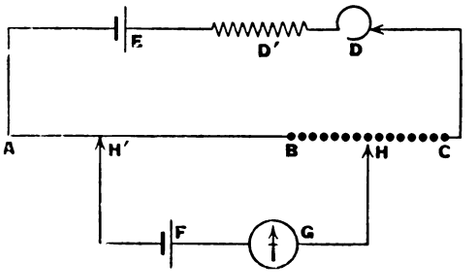

Fig. 1.

of AB respectively, until, the potential of F being equal to that portion of AC embraced by HH' no galvanometer movement is observable, when HH' is the value of F in terms of E as produced on AC. D and D' are fine and coarse adjustment rheostats used for controlling the fall of potential of E over AC.

In comparison the essential features of the new instrument patented and manufactured by the writer are diagrammatically expressed in Fig. 2, where similar letters denote similar parts having similar functions to those similarly indicated in Fig. 1: but with the following important modifications and additions.

I. In the old pattern instrument the rheostats D and D' were purely empirical in value and bore no relative and known relation to ABC either in part or in whole, being merely roughly adjusted and suitably subdivided so as in the aggregate their ohmic value was sufficient to cut down E when at its maximum to the normal working conditions at the ends of AC, an auxiliary rheostat being sometimes furnished by means of which the potential at AC might

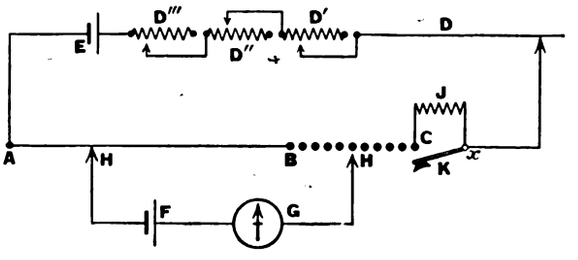

Fig. 2.

be still further and materially reduced for special purposes, though to an indefinite and unknown amount, since this auxiliary rheostat also bore no known and definite value.

In Fig. 2 the rheostat D takes the form of a straight wire similar to AB and, carrying a suitable scale, is definitely calibrated in known terms of AB taken as a unit. D'D''D''' are rheostats duly calibrated in terms of D and so graded that D' consists of 10 coils each of the same ohmic value as D, D'' consists of 10 coils each equal to D' in the aggregate, and D''' bears the same ratio to D''. So that there are practically two potentiometers, AC and DD''', in series, calibrated and of known value in absolute terms throughout.

II. An addition to the old pattern instrument is a coil (or coils), J (Fig. 2), capable of being short-circuited by the key K and having a potential stud, *x*, with which, when necessary, H can make contact. Preferably, this coil is made nine times the ohmic value of AC, though it can be of any other suitable value and such value be either multiplied or subdivided.

By these modifications, improvements or additions the following advantages are claimed over the older form of apparatus and should be inherent in an ideal instrument:—

1. The instrument is self-checking for accuracy throughout its range, without the necessity of the use of auxiliary apparatus, alteration of, or addition to, connections in use.

2. It possesses means of compensation for any known errors in standards, by which the same are made direct reading and subsequent corrections eliminated.

3. Higher potentials than at present may be compared direct on the instrument without the use of a volt or ratio box.

4. The working potential of the instrument may, *after* standardisation, be altered to any value *without* re-standardisation and yet its altered value over any portion of the working part be *definitely known*.

5. Considerable saving is effected in the *cost* of necessary additional apparatus, especially in the measurement of current.

6. Greater accuracy obtained in the measurement of small potentials.

7. Greater accuracy in the comparisons for ohmic value of standard resistances.

8. Indefinite prolongation of lower portion of scale, enabling thermo-junction temperature measurements to be taken with greater ease and accuracy.

9. Indefinite prolongation of whole scale, with consequently greater range.

10. The whole instrument alive for measurements, with no *dead* portion as in older form of apparatus.

Proof of the existence of such advantages may be found in the following methods of use:—

Checking for Accuracy.—Connect up as in Fig. 2; key K being closed and steady sources of potential of suitable value at E and F. When HH' are placed at any given value and the rheostats adjusted until balance is obtained, note is made of the *total* number of units *in circuit, including rheostat values*. If, then, the rheostats be altered any given percentage of the whole circuit, balance will be found by the re-adjustments of HH', at points directly proportional to, and as the value of, the percentage alteration. *Example*—

1st position—Total circuit value 2,000, rheostats 500 HH' at 1,500.
2nd ,, ,, 2,500 ,, 1,000 HH' at 1,875.

Circuit being raised 25 per cent. in total value, the balancing point is correspondingly increased, and in this manner the whole range of the instrument may be gone over, including coil J.

Another method of test, particularly for a 10 to 1 ratio, is obtained by the use of coil J, when its value is nine times that of AC, in that case with HH' at a desired value, and balanced at a suitable point with J short-circuited, the key K is opened and rheostats increased to 10 times their former value, then HH' should balance at points 10 times their previous value. *Example*—

1st position—HH' at 1,050, rheostats = 250, K closed.
2nd ,, HH' at 10,500 ,, = 2,500, K open.

Compensation for Error.—In the event of the use of, say, a standard resistance for the measurement of current having a known error in value, if, after the standardisation of the instrument by Clark cell or otherwise, the total units in circuit be altered directly in proportion to such error, it is eliminated, and current values are read direct without the necessity of corrections in any readings.

Example.—$\frac{1}{100}$th ohm standard with known negative error of 0·3 per cent. is employed. The rheostat and total circuit value being 2,100 when standardised by a Clark cell, the error in the resistance being negative, the fall of potential over AC has to be reduced, 0·3 per cent. being *added* by means of the rheostats, making the circuit total 2100 + 6·3 = 2,106·3. The error being thus compensated all readings are direct and correct in value. The connections for this operation are as Fig. 2, with key K open or closed as desired. In the former, care should be taken to include coil J in the value of the total circuit.

High Potential Measurement.—In the older type of instrument the direct measurement of E.M.F. is limited to that on the working portion, AC, of the instrument, which is 1·5 volts if one secondary cell be used at E, or 3 volts if two cells be used and the Clark cell F when standardising balanced at half its value. Higher values of E.M.F. than the foregoing are measured by means of a volt or ratio box, by means of which a given and known fraction of the total voltage is carried to the instrument.

In the new instrument here described, with connections as in Fig. 2, a Clark or other standard cell is placed at F, and the sliders HH' placed at scale values corresponding to its value or a multiple or sub-multiple thereof, the high potential to be measured takes the place of E, then the adjustment of rheostats until balance is obtained gives as the value of E the total number of units in circuit.

Example.—Clark cell, with sliders at 1,434 units.
Total units in circuit when balanced = 101,500.
Constant being equal to 1 volt per 1,000 units.
101,500 units = 101·5 volts.

So that range of E.M.F. measurement is enormously increased and is direct reading, circuit total of 57,000 units being 57 volts, 4,700 units being 4·7 volts, &c.

Definite Alteration of Potential.—The old instrument when once adjusted to standard value allowed of no alteration without re-standardisation, since the rheostats, possessing no definitely-known value or relationship to the working portion of the instrument, would not allow of the same being done. In the new type instrument, owing to the calibration of the rheostats in terms of the normal working portion of the instrument, their grading and added number, and the addition of ratio coil, or coils, J, it will be instantly realised from what has gone before that the instrument may, after standardising, be re-adjusted to any given extent, and the potential definitely raised or lowered a known amount.

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Example.—By the interposition of J after standardising, and the raising of the rheostats to 10 times their former value (if J be of the ratio to AC already given), the working potential of AC is at once lowered to exactly one-tenth its former value.

Measurement of Small Potentials.—It frequently happens that tests of this description have to be made, and whereas in the older form instrument having a slide wire, across which a potential of 0·1 volt was maintained under standardised conditions, with a scale of 1,000 parts, it gave, and gives, 0·0001 volt per division, or 100 microvolts, which for many purposes is too high, but by means of the additional coil, or coils, J, and the rheostats this may be reduced after standardisation to a limit governed only by the sensitiveness of the galvanometer employed, which should naturally be of low resistance, and if properly chosen for the intended work will allow of a scale of 1 microvolt per division if necessary and yet leave ample margin of sensibility.

Resistance Comparisons.—In the comparison of standard or other resistances where a high degree of accuracy is necessary or where the available, or for other causes, current is small, in the old-type instrument 1 part in 10,000 or 15,000 was the extreme limit in the one case, when the whole scale of the instrument was available, and considerably less in the other case in proportion to the length of scale available.

By the employment of J and the shifting of H on to x (Fig. 2), the total scale value is raised to an amount governed, as in the last case, solely by the sensibility of the galvanometer, but comparisons of standards of approximately equal value may be effected with the greatest ease under ordinary conditions to 1 in 100,000 and, if necessary, higher. In the case where small currents only are available, owing to the capability of definite drop in potential of AC, its whole scale length may be utilised and yet the highest accuracy of measurement of the old instrument be maintained of 1 in 10,000.

Where coils of ratio value are to be compared, two courses only were open in the older form—*i.e.*, the higher value was balanced at a point high up the scale, and the lower at a corresponding point lower down, which, if very carefully done, gave results having an inaccuracy of about 1 in 5,000. The other method adopted by the writer, and not generally known, was the shunting of the largest standard by a high resistance and the tapping off this high resistance shunt of a potential point of an equivalent ratio to the resistance being compared; this allowed of comparison being made at *one* point high up the scale, as in the comparison of equal resistances, and allowed of measurements of the order of 1 in 10,000 with ordinary care. In the new instrument, in addition to the foregoing being carried out on AC alone, with the same accuracies, they may be conducted with a far higher order of accuracy on A.r, and also by the use of the rheostats, for whereas AC may, like the old pattern instrument, consist of a 15,000 part scale, the addition of J may raise it up to 150,000 or more.

Temperature Measurement.—Whether this be conducted by increase of resistance by heat of a platinum wire through which a current flows, and the potential at the ends of which is compared with that of a standard resistance at constant or air temperature, or whether it be conducted by means of thermo-electric junctions, measurements can be effected on the new type instrument with greater ease and accuracy than has hitherto been the case owing to the ready means by which, as has already been explained, the potential of AC may be dropped to any extent, a known and given amount to any value. This extension of the lower part of the scale so that it occupies the whole of AC with the remainder swallowed up in the coil J is of considerable importance, for whether standardised by substitution or by the interpolation of a Clark cell at E, the instrument may be given, by means of the rheostats, any desirable direct-reading scale, such as the whole length of the slide wire with its 1,000 part scale for 100°C., &c.

Saving in Cost.—This is most apparent in the matter of standards for the measurement of heavy currents. With the old instrument it was, and is, fashionable for the saving of cost and weight of material to cut down the ohmic value of such standards, with the result that they not only ceased to be direct-reading, but had a very condensed scale, often limited to a fraction of AC, so that there was loss of accuracy.

In the instrument here described, by the introduction of coil J and consequent lowering of the potential at AC to one-tenth its former value, standards may be employed of an equivalent reduction in ohmic value over those now in use and yet the whole range or scale of AC be utilised, instead of fractions of the same with their consequent inaccuracy; moreover, the instrument is direct-reading in every respect. As an instance of saving in cost, a solid manganin standard for 3,000 amperes giving a reasonable range on the old instrument costs about £50, in proportion to ohmic value and degree of accuracy. A standard utilising the *whole* scale of the new-type instrument would cost but slightly more than *one-tenth that sum* and yet give greater accuracy in results and ease in working.

Prolongation of Scale.—Owing to the calibration of the whole electrical circuit and the consequent absence of any dead part (otherwise portions of unknown value) the whole instrument is available for measuring purposes, whereby the scale range is very much increased, together with variety of purpose and combining power.

The instrument is made in three grades, and an illustration of the highest or "laboratory" type is given in Fig. 3.

In it the top row of fitments are four rheostats with their sliders; the middle fitment is a 150-section scale, the slider making contact with that number of studs below the slide rails, whilst in front, starting from the left, comes the slide wire with rails and slider, short-circuit "snap" switch for coil J, ditto for galvanometer circuit, fuse box and multiple-way switch, the whole being mounted on a substantial ebonite slab, which itself is fitted on a mahogany base of sloping desk form, for greater ease in working and observation, the terminals being mounted at the back on top so as to be well within view. The slide rails are of substantial cross-section, and, in addition to forming bearing surfaces and contacts for sliders, are silvered and have scales engraved thereon. Every part is get-at-able easily, and of maximum strength throughout. A lid is provided for protection from dust when not in use, without interference with terminal connections. A removable plate-glass top is also supplied, if required, having fittings which enable the whole of the sliders to be operated from without by "straight line"

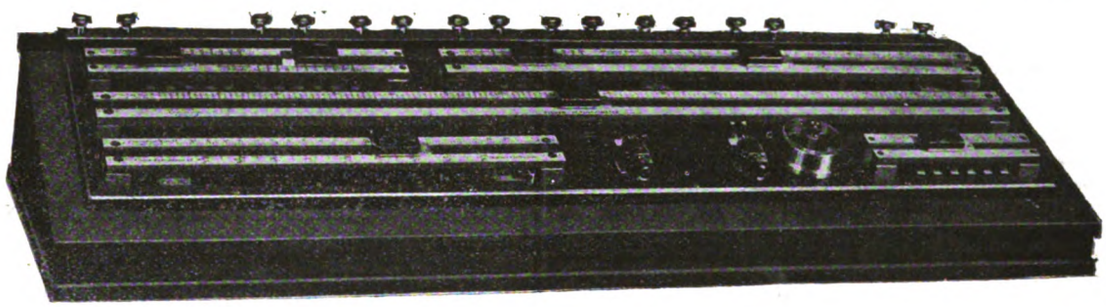

Fig. 3.

movements. Much has been said at odd times with reference to dust. So far as the writer's experience goes, he has never experienced trouble on that score. A little fine rouge and alcohol, a piece of rag and camel's hair brush, go a long way towards the alleviation of its effect. A writing desk, or watchmaker's lathe, if left any length of time, accumulates dust, which is usually wiped off before use. Why not a potentiometer? Amateurs at potentiometer construction and users of imperfectly constructed instruments are frequently troubled with and raise the cry of "thermo-electric effects." Such effects, or something like them, troubled the writer when he also was a tyro at the design and construction of this class of instrument; but it is now many years ago since they, or something very like them, were eliminated to an extent that live matches applied to homes where they might be supposed to live failed to drive them out for detection by a very sensitive galvanometer. Thermo-junctions are, of course, easily made; they are also, in some instances, very easily eliminated or negatived; but what is often mistaken for thermo-effect is sheer pure leakage. Also in the case of a very highly insulated instrument and connections, including galvanometer, a static charge in the coil of the latter gives weird results from a "spot-watching" point of view—the negative side of a town supply connected up to one set of terminals and studs of the multiple switch for voltage measurement and the positive side connected up ditto for current measurement gives an exciting, if not painful, result, which is only excelled by the spectacular effect produced by an attempt at measuring the voltage of a central station when one of the milking cells of the battery is being used to run the instrument. But thermo-electric effects in a properly designed and manufactured instrument should not, and do not, exist.

The question of a potentiometer bristling with fuses was gone into at the request of Mr. Patchell, of the Charing Cross and Strand Company, some five or six years ago, but from experiments then made they were not adopted. To be efficient they had to be very fine, and if very fine the remedy ready for use was worse than the

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likelihood of disease, owing to sundry vitiating effects produced under certain circumstances. Moreover, their action as a safeguard is doubtful, for, assuming them to be in the galvanometer circuit, they will not save its suspension; nothing can happen until the galvanometer key is depressed, and once that is done, before any fuse can possibly act, the calibration of the instrument is gone, and in nine cases out of ten the slide wire nicked at the point of contact with slider. Again, if fuses are placed in the main circuit, measuring results are, as stated above, vitiated, and placed anyhow and anywhere they form a convenient home for the much-dreaded "thermo-electric" microbe. In the above instrument they are fitted for use under certain circumstances, but in such a manner as to render their interchange at any time with other and more substantial connections an easy matter.

As shown in the illustration (Fig. 3), "straight-line" movements are adhered to throughout. It might also be pointed out that in some instances instead of the provision of a coil, J, *in series* with AC and the rheostats, the reduction of voltage on either AB or AC is effected by shunts capable of interpolation *across* AC in whole or in part, and in compensation for the use of which the rheostats are proportionally *reduced* in value after standardisation instead of being *increased* as is the case when J is placed in series.

THE ELECTRICAL RECONSTRUCTION OF THE SOUTH LONDON TRAMWAYS ON THE CONDUIT SYSTEM.*

BY ALEXANDER MILLAR.

The Paper first gives a short sketch of the events which led up to the adoption of the conduit system of electric tramways for the central portion of London, and states the reason why a centre conduit was chosen in preference to a side conduit. The lines of which the reconstruction is described are those known as the "Tooting lines," extending south of the River Thames from three northern termini at Westminster, Blackfriars and Waterloo bridges to a southern terminus at Tooting. The route length of the lines in question is slightly over 8 miles, and the length of single line 16¾ miles.

Dealing with the roadwork and permanent-way construction, the Paper describes first the structure of the conduits, which are 2ft. deep by 1ft. 2½in. wide. This consists chiefly of cement concrete and cast-iron yokes, the latter spaced at 3ft. 9in. intervals, which support the slot-rails and form a template to which the concrete panels are moulded. Chambers are formed at intervals of 5yds. for the reception of the insulated supports from which the ⊢ shaped conductor-bars, supplying current to the cars, are hung. These insulators have a porcelain body in appearance like an inverted jar, and are protected and secured in an iron cap, which is bolted to the slot-rails. The steel rod which carries the conductor-bars is cemented to the inside of the porcelain cup, and the actual attachment to the bars is made by means of cast-iron clips capable of adjustment by means of an eccentric washer. The conductor-bars have a sectional area of 2·15 sq. in., and, under test, they have given 1/7·14 of the conductivity of Matthiessen's standard of pure copper. The separate insulated supports were subjected to a 2,000-volt alternating pressure in the shops, and after erection in place the whole electrical system was subjected to a similar test between conductor-bars, and 1,000-volt alternating pressure between conductor-bars and earth. The bars are placed symmetrically in the conduit 6in. apart, and the minimum air-gap between the conductors and conduit structure is 2in.

Drainage of the conduit is provided for by connecting it to the sewers at intervals of 60yds. These connections pass through a settling-chamber, which intercepts the mud from passing into the sewers. The slot-rails are supported by the yokes, and the track-rails by an 8in. concrete bed, and both are held to gauge by tie-bars fixed to projecting lugs on the yoke head. At junctions and crossings steel castings take the place of the rolled rails, and specially wide yokes are used to embrace the converging conduits and to support the track-rails as well as the slot-rails. The mechanism for operating the slot and track points at junctions is contained in a concrete pit built immediately underneath the track. Both track points are fitted with 8ft. movable tongues, which are connected together to the slot leaves by a series of cranks and adjustable links, so that the whole can be moved in unison by inserting and manipulating a lever either in a box in the footpath or alongside the track. The free end of the slot leaves is bevelled off, so that a car trailing through can push over the points without any external assistance. A feature about the work is that at no part is the slot wider than ⅜in., and the arrangement for maintaining this at points and elsewhere is described. The paving material, except in the margins, which are laid to suit the existing material in the street breasts, is of granite setts, bedded on cement concrete, jointed with bitumen and cement mortar.

The line is divided into ½ mile electrical sections, each ½ mile section being fed by separate distributors, connected to the sub-station switch-board 'bus bars, the positive through a maximum cut-out and ammeter, and the negative through an ammeter only. By means of these appliances and a double-pole change-over switch a perfect control of each section of the line is maintained. The current is generated by two 1,500kw. continuous-current sets erected in a station at Loughborough, from which feeders convey current to the three sub-stations at the Elephant and Castle, Brixton and Clapham, and are connected direct on to the 'bus bars. The normal difference of pressure between conductors at the main station is 625 volts, and on the line approximately 550 volts. The method of dealing with faults on the line is described, and diagrams and drawings are given to show the method of connecting up the conductor bars at junctions and crossings.

The collection of current is effected by an arrangement called a "plough," which is suspended from horizontal transverse girders fixed to an extension of the side frames of one of the car trucks. The actual contact is made by two cast-iron shoes, mounted on a wooden diaphragm at the bottom of the plough shank, and pressure is maintained against the conductor bar by the aid of flat steel springs. Flexible copper fuses, set to blow at 200 amperes, connect the shoes to the copper leads, which are aid in chases inside the plough shank. From the lead top terminal cables are taken to the car motors. The cross girder of the carrier, from which the plough is hung, has open ends, and is so designed that in the event of a plough taking the wrong road at points, it can travel to the side of the car and drop off without causing any damage. In its normal position the plough can be released by withdrawing a bolt, which frees a hinged flap, and allows the plough to slide down out of the guide.

The last part of the Paper is devoted to a description of the operations, and deals with the difficulties attending the work of reconstruction, and the methods of handling the work. The Paper is accompanied by numerous illustrations and by an appendix giving the comparative cost of electric conduit construction as compared with cable conduit construction.

* Abstract of a Paper read before the Institution of Civil Engineers on Tuesday.

CORRESPONDENCE.

CUT-OUTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If I may be permitted to again occupy your valuable space, I would remark that the objectionable action you assert (in your issue of December 18) as sometimes resulting from the use of reverse current cut-outs on generators, in that they occasionally cut off undamaged machines, is one which I think has hardly ever happened when the device used has been a true reverse-current apparatus—*i.e.*, one that only acts on a reversal of the current and is independent of everything else. In any case, if the reverse-current device be set, as I recommended in my letter of the 12th ult, at 30 per cent. of the full-load current, I think it would be quite impossible for a healthy machine to be cut out of circuit. I am glad that Mr. Leonard Andrews, in his letter of the 8th inst., agrees with me that reverse-current cut-outs should not be set so as to operate at too small values of reverse current. A number of reverse-current relays have recently been supplied by my firm, and, as we have been requested to do so by the different customers, these have been set to operate at a reverse current equal to 10 per cent., or less, of the full-load current. I think, however, that engineers are ill advised in requesting this, and that greater satisfaction would be obtained if the current were 25 or 30 per cent.

As regards the alternating currents which are mentioned by Mr. Quin, I have never come across a case in practice where these have been discovered. Directly the alternating current assumes a dangerous value it will either pull up the engine or cause the machine volts to drop, with the result that the reverse-current device will operate and cut the machine out. Contrary to Mr. Quin's statement, the relay which I mentioned would not be affected in the least by an alternating current passing through it; it would certainly not become demagnetised. This same remark will answer Mr. Andrews' conclusion No. 3. A large series current will not wipe out the effect of the permanent magnet at all. I think in this case Mr. Andrews has condemned my apparatus without being aware of its construction. The relative dimensions of the permanent magnet and the current-carrying part are so

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constructed that any possible current in the latter is powerless to have any appreciable magnetising or demagnetising action on the former. As regards his other remarks, Mr. Andrews apparently pins his faith on a cut-out in which there are both a series and a shunt coil. I think such devices are wrong in principle, as their action depends on the value which the voltage across the shunt coil may have when the accident occurs. The two chief points to be kept in mind are :—

1. The reverse-current device is to act when a reverse current occurs of a certain fixed value, or anything greater than this value. It must not be affected by, or dependent on, anything else.

2. The releasing pull or the switch should be constant and not depend on the value of the reverse current which may be flowing.

"W. S. T." (December 25, 1903) asks me to explain why I think that "a minimum current cut-out on a generator is worse than useless." In the first place I do not see any reason for putting on a *minimum* current cut-out at all, as a small current in the right direction does not necessarily show there is anything the matter with the generator or system. At times of light load, say with a traction system just starting up in the morning, the current will fluctuate to values below that to which the minimum device is set. In order to prevent the machine being continually cut out, the arrangement would have to be wedged up, with the great probability that the wedge will be left in, so that the cut-out will remain useless. The gravest objection, however, to the use of a minimum device is that with a sudden reversal, the current may attain a sufficient value in the reverse direction to hold the switch in before the same has had time to open circuit. In this case, of course the consequences would be disastrous.—Yours, &c.,

Manchester, Jan. 9. CHARLES C. GARRARD.

THE OSCILLOGRAPH AND THE ONDOGRAPH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Many letters and an editorial note having been published in your columns recently on the histories and advantages of strobographs and oscillographs, I hope that I, being the first inventor of strobography and oscillography of alternating currents, may be allowed to say something on the matter. Not only did I invent the first strobograph, which differed from M. Hospitalier's principally by the use of photography instead of a recording pen, although founded on the same condenser-discharge method, but I also invented the oscillograph (the very name of which has been coined by me); in addition, I also proved theoretically their reliability, and I have discussed from the mathematical point of view their properties and conditions, and construction and employment in the following Papers :—

"On the Determination and Photographic Registering of Periodic Curves." Describing and discussing strobography by photography. *La Lumière Electrique*, August 29, 1891.

"New Researches on the Alternating-Current Arc." A description of a complete photographic strobograph and numerous curves taken by it, and by the oscillograph. *La Lumière Electrique*, September 16, 1893.

"Oscillographs: New Apparatus for registering Electrical Oscillations." A short description of the bifilar and soft-iron oscillographs. *Comptes Rendus*, 1893, Vol. CXVI., p. 502.

"General Conditions for Registering and Indicating Instruments," The first theory of the oscillograph. *Comptes Rendus*, 1893, Vol. CXVI., p. 748.

"On the Registering of Theoretical Currents." Report to the International Congress of Physics, Paris, 1900.

Also a more complete treatise of the subject in the *Revue Générales des Sciences*, July 15 and 30, 1901.

"New Oscillographs." Description of new pattern. *L'Eclairage Electrique*, May, 1902.

"The Theory of the Oscillographs." *L'Eclairage Electrique*, October 28, 1902.

Numerous other Papers of mine deal with applications of oscillographs to alternating currents.

During 10 years these two methods of strobography and oscillography have found very few supporters, amongst whom the best known and the cleverest are Messrs. Barr, Burnie and Rogers and Mr. Duddell, the latter having made several noticeable improvements in the bifilar pattern of oscillograph, and whose work in oscillography is justly admired in his own and other countries.

Now that attention is again drawn to the subject by the very ingenious and handy ondograph of my friend M. Hospitalier, I think it is only fair that the pioneer worker in the field should not be forgotten; the more so because he never ceased striving during those 10 years to improve his method. For instance, the first self-contained oscillograph with a permanent magnet was shown by me at the International Electrical Congress of 1900, and since that time I have succeeded in applying the same improvement to the bifilar type; in the bifilar pattern as well as in the iron-band pattern of 1900 (both now constructed in France by the renowned firm of Carpentier) the spring and band of each vibrating set are separately enclosed in removable oil cases according to my British patent 23,417 of June 6, 1900, this method affording the only means of rapidly changing one set for another and easily repairing the broken band, as well as of easily bringing the two or three spots of double or treble oscillographs in agreement on the plane tracing desk or on the photographic plate. I also constructed a cinematographic recorder registering up to 200 periods consecutively in a few seconds, and I have great hopes for the future of the oscillograph. But although being an enthusiastic father of the oscillograph, I cannot entirely agree with its uncle, Mr. Duddell, as to those exclusive and universal applications in workshop practice; certainly it is the only reliable instrument for serious and extensive research, but a cheap simple oscillograph cannot replace a good double oscillograph, because it cannot register many curves showing phase differences on the same plate. Moreover, in many cases one cannot dispense with the projector lens.

There remains, certainly, a limited field of useful application for strobography, and I agree with M. Hospitalier, who was, perhaps, a little too oblivious of former workers in this field in his Institution Paper, that such convenient and portable pen-recording strobographs as his ondograph will prove very serviceable instruments for the purpose of practical research in shops or the engine room, to those who do not attempt to obtain absolute correctness of results or who are not acquainted with the optical methods of registering. But it is to be feared that some experimenters will too easily lose sight of the imposed limits of the strobographic method and be tempted (as M. Hospitalier himself is sometimes) to try to apply it to phenomena for which it does not seem at all applicable, such as, for instance, the analysis of resonance effects produced by a capacity of 1mfd. to 5mfd. It would be quite a mistake to use the ondograph, whose own capacity is 4mfd., in such a case, and it would also be wrong to use the same instrument on circuits of small power in which the presence of the ondograph condenser causes considerable changes in the phase, and consequently the wave form of the current. All these difficulties have been discussed in my Papers on the subject (*La Lumière Electrique*, August, 1891), but seem to have escaped notice by more recent inventors.—Yours, &c. A. BLONDEL.

Paris, Jan. 11.

STEAM TURBINES *v.* RECIPROCATING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As stated at the end of his last communication, our managing director, Mr. Morcom, is at present out of England; but, even if he had been at home, we are sure that he would not wish to occupy more of your valuable space in carrying on the discussion on present lines. We are quite satisfied to leave the matter in the hands of your readers on what has been already said.—Yours, &c.

For BELLISS AND MORCOM (LTD.),

Birmingham, Jan. 11. Geo. B. Parrott, Secretary.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my letter of January 4th I am sorry to find that, in copying the MS., the typist omitted Shipley from the list of turbine stations with its coal cost of 0·37d. The average figure is correct with this included. The next average should read 0·68d., and not 0·643d.—Yours, &c.,

Bedford, Jan. 13. JOHN H. BARKER.

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LEGAL INTELLIGENCE.

Escott v. Corporation of Newport.

In the Divisional Court on Tuesday the Lord Chief Justice delivered judgment in this case, which was an appeal by defendants against a decision of Judge Owen at Newport in an action by plaintiff for trespass, and for an injunction. Judge Owen held that plaintiff was entitled to damages and to an injunction, though he had not actually issued the injunction. The trespass complained of was the driving into plaintiff's land of an iron pillar with the object of supporting an overhead electric cable. The Corporation carried out the work without giving notice as required by the Lands Clauses Act, and they claimed the right to do so under sec. 51 of their local act, the land in question (they contended) being part of a public street.

The LORD CHIEF JUSTICE said the principle involved was an important one, but he wished to make it clear that he only dealt with that particular case, and on the particulars before the Court, He held that defednants were empowered under the provisions of sec. 51 of their act to enter upon plaintiff's land, being part of a street, and to erect the pillar. The land had not been taken, but something had been done which defendants were entitled to do, but he did not say that that affected plaintiff's right to compensation.

The appeal was, therefore, allowed with costs, but leave to appeal was given.

London County Council v. North Metropolitan Tramways Co.

This action was mentioned before Mr. Justice Ridley on Monday, and is brought for an injunction to restrain the company from proceeding with the work of converting a portion of their tramways to electric traction. The trial has been fixed for 27th instant.

Smith v. Cheltenham and District Light Railway Co.

At Cheltenham County Court on Friday, Judge Ellicott re-heard the action brought by a local solicitor against the defendant company for the recovery of damages sustained through breach of contract, they having failed to convey him to the top of Cleeve Hill on Nov. 11, after paying his fare and receiving a ticket for that purpose.

On the first occasion plaintiff was non-suited. The breach of contract arose through the breakdown of a car at Prestbury, and plaintiff had to walk a distance of 2 miles. The company paid 5d. (the amount of fare), 3s. (cost of conveyance from Prestbury) and 1s. for shoe-leather worn out in the walk up the hill, into court, but denied liability.

For defendants it was contended that the company were not liable for damages for inconvenience, as plaintiff had not shown there was an absence of means of conveyance to the hill that night.

Judge Ellicott gave judgment for the fare paid (5d.), but for no damages, and refused plaintiff's application for leave to appeal.

Legal Causes.

Causes entered for trial with an electrical interest during the present Hilary Sittings at the Royal Courts of Justice :—

COURT OF APPEAL.

CHANCERY DIVISION.—*General List.*

National Telephone Co. (Ltd.) *v.* Hull Corporation. (Appeal of plaintiffs from order of Mr. Justice Buckley, June 17, 1903.)

Patent Exploitation (Ltd) *v.* American Electrical Novelty, &c., Co. (Ltd.) (Appeal of plaintiffs from order of Mr. Justice Buckley, June 24, 1903.) (Not before judgment given in House of Lords by same petitioners *v.* Siemens Brothers & Co. By order.)

KING'S BENCH DIVISION.—*Final List.*

Smith *v.* Charing Cross, Euston and Hampstead Railway Co. (Appeal of plaintiff from judgment of Mr. Justice Kekewich, July 14, 1903.)

Sellar *v.* Charles Bright & Co. (Ltd.). (Appeal of defendants from judgment of Mr. Justice Phillimore (in chambers), Nov. 18, 1903.)

New Trial Paper.

Cole *v.* Isle of Thanet Electric Tramways and Lighting Co. (Ltd.). (Application of defendants for judgment or new trial on appeal from verdict and judgment dated Nov. 6, 1903, at trial before Mr. Justice Bigham and a special jury.)

Exchange Telegraph Co. (Ltd.) *v.* the B.D. Syndicate (Ltd.) and others. (Application of defendants Mellis and Wyman for judgment or new trial on appeal from verdict and judgment, dated Dec. 3, 1903, at trial before Mr. Justice Walton and a special jury.)

CHANCERY DIVISION.

Before Mr. Justice. Byrne.—Companies Winding-Up.

Ferranti Limited. (Petition of Estler Bros.)

Electric Tramways Construction and Maintenance Co. (Ltd.) (Petition of A. J. Paine.)

Crowther & Co.'s Electrical Industries (Ltd.) (For payment into company's liquidation account.)

Before Mr. Justice Buckley.—Causes for Trial with Witnesses.

Bradshaw *v.* Isle of Thanet Electric Tramways and Lighting Co. (Ltd.)

Before Mr. Justice Joyce.

English Electric Metallurgical Co. (Ltd.) *v.* Glasdir Copper Works (Ltd.) (Motion.)

Before Mr. Justice Swinfen Eady.

In re the Clayton Engineering and Electrical Construction Co. Boddington *v.* the Company. (Further consideration.)

HIGH COURT OF JUSTICE.

KING'S BENCH DIVISION.

Civil Paper.

National Electric Wiring Co. *v.* Miller. (Plaintiffs' appeal from Judge Smyth.)

Special Jury Actions.

Salmony & Co. (Ltd.) and another *v.* Elektrizitäts Actiengesellschaft. (Commission.) (Settled)

Telegraph Construction and Maintenance Co. (Ltd.) *v.* F. W. Berk & Co. (Ltd.). (Trespass).

Day *v.* City and South London Railway Co. (Assault.)

St. James' and Pall Mall Electric Light Co. *v.* the King. (Petition of right.)

PARLIAMENTARY NOTICES.

The bill of the Chesterfield Corporation provides for the construction of 17 sections of electric tramway within and beyond the borough at a cost of £95,020. 15s. ; also to extend the area of electricity supply, &c.

In the bill for powers to construct the North Yorkshire Dales Railway, between Hellifield and Scorton (about 51 miles), authority is sought to work the line by electric power and to acquire land for three generating stations. The share capital is £960,000, with power to borrow £450.000.

The Trafford Park Estates Co. has presented a bill for (inter alia) powers to construct short lengths of tramway to connect up with the Manchester Corporation system.

A bill has been deposited for incorporating a company with powers to construct an electric tramway from Preston to Blackburn, about 6½ miles. The line will be a single one for about 5 miles, and double track for the remainder. The generating station will be at Samlesbury. It is proposed to carry passengers and parcels up to 56lb. The proposed capital is £200,000. The first directors are Messrs. W. Griffiths and F. S. Pilling.

Wakefield and District Light Railway Co. seeks powers to construct additional electric tramways in Wakefield, Pontefract, Normanton, Whitwood, Castleford, Featherstone and Knottingley, of a total length of over 25 miles, at an estimated cost of £183,918. The company seek powers to raise £165,000 additional capital with the usual one-third borrowing powers, but the company shall not create debenture stock. It is proposed that the tramways in Wakefield and the urban districts of Methley, Stanley and Altofts shall not be purchased by the local authorities for 25 years, and in the other districts for 42 years.

The Mid-Cheshire Tramways Co. wish to purchase the undertaking of the Stockton and Hazel Grove Tramways Co., to extend the tramways further south and to adopt electric traction. The generating station is to be near Vernon Collieries, Poynton. Power is sought to use the tramway for the carriage of goods, including minerals, merchandise and live animals. Running powers are sought over such of the Stockport tramways as connect with the Manchester tramways. Capital powers £200,000.

The Leicestershire and Warwickshire Electric Power Co. wish to postpone the period for a substantial commencement of their undertaking.

The Cheshire Electricity and Power Gas bill seeks authority to incorporate a company, with a capital of £1,000,000, to erect generating stations and to supply electricity and power gas in the whole of the county of Chester.

The Ulster Electric Power Co. have scheduled nearly the whole of the province of Ulster for their area of supply, and the proposed capital is £900,000.

The Belfast and North-East of Ireland Electricity and Power Gas bill covers to some extent the same area, and here the capital is £1,500,000.

In the River Steamboat bill of the London County Council provision is made for through steamboat and tramway fares.

The Metropolitan District Railway bill proposes to authorise the adoption of zone fares when the electrification of the line is completed.

The Great Northern and City Railway Co. seek an extension of time for the completion of the undertaking.

The Charing Cross, Euston and Hampstead Railway want authority to make certain deviations of the authorised line, to raise further capital, &c.

The Portmadoc, Beddgelert and South Snowdon Railway bill provides for purchase or leasing of the North Wales Narrow Gauge Railways.

In the North Staffordshire Railway Co.'s bill powers are sought to work both the railways and the canal under the company's control by electricity.

The London United Tramways propose to construct two pieces of railway to connect with the Hammersmith station of the Metropolitan District Railway, and also to extend their tramway system in Brentford, Ealing, &c., at a cost of £530,000.

In the Plymouth Corporation bill power is sought, in order that the borrowing powers of the Corporation for the purposes of the Public Health Acts may not be unduly restricted, to exclude from calculations of the maximum amount which the Corporation are empowered to borrow under those acts the sums already borrowed or which may hereafter be borrowed for the purposes of the Electric Lighting Act, 1882, or of the Plymouth Corporation Electric Lighting Order, 1894.

The Harrow Road and Paddington Tramways Co. seek power to transfer their undertaking to the Metropolitan Electric Tramways (Ltd.).

The Saddleworth and Springhead Tramways propose to abandon the undertaking and dissolve the company.

The Bristol Tramways and Carriage Co. are promoting a bill to extend their system in Bristol and neighbourhood.

The London, Camberwell and Dulwich Tramways Co. wish to obtain £120,000 further capital powers.

The Southport and Lytham Tramways Co. seek to raise £30,000 further capital.

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Preston, Chorley and Horwich Tramway Co. seek authority to make deviations from their authorised line, to raise additional capital (£100,000), &c.

The Imperial Tramways Co. want power to make further extensions in Middlesbrough, Stockton-on-Tees and Thornaby.

In the Romford and District Tramways bill the Empire Electric Light and Power Co. seek authority to extend their authorised lines.

Watford and District Tramways Co. ask an extension of time to construct their lines, &c.

The Isle of Thanet Light Railways Co. seeks authority to make certain deviations.

The Dolter Electric Traction Co. wish to construct about 6½ miles of tramway in Torquay and district, but seek no capital powers.

By the Holywood Tramways bill it is sought to incorporate a company to construct tramways in Belfast and County Down, the capital being £54,000.

Memorials alleging non-compliance with the standing orders have been lodged against the following bills:—

London County Council (Tramways and Improvement) bill (by Metropolitan Borough of Holborn, Maple & Co. and James Shoolbred & Co.): Rotherham Corporation bill (by Rotherham Rural Council); Leeds Corporation (Consolidation) bill (by Yorkshire Electric Power Co. and West Riding County Council); London United Tramways bill (by Middlesex County Council); London United Tramways (Railways) bill (by London County Council); Llanelly Tramways and Improvement bill (by British Insulated and Helsby Cables, Ltd.); North Wales Electric Power Bill (by Sir R. H. Williams Bulkeley),

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The first sitting of the examiners to take proofs of compliance with standing orders is to be held on the 18th inst.

MUNICIPAL, FOREIGN, & GENERAL NOTES

APPOINTMENTS VACANT AND FILLED.

Bexley Electric Lighting and Traction committee invite applications for the position of engineer and manager of the Council's electric lighting and tramways undertakings. Salary £300 per annum. Applications to the clerk to the Council (Mr. Thos. G. Baynes), Council Offices, Bexley Heath, Kent, by noon 23rd inst. See advertisement.

An electrical engineer is wanted to take charge of dynamos, motors and other electrical plant in steel works. Applications to Messrs. Vickers, Sons and Maxim (Ltd.), Sheffield. See advertisement.

An electrical engineer is required by shipbuilders in China for repairing and installing electric lighting plants on board ship. Applications to "Aralia," care of Messrs. Abbott's, 32, Eastcheap, London, E.C. See advertisement.

Wimbledon Urban District Council have a vacancy for a mains superintendent. Salary £125, rising by annual increments of £25 to £175 per annum. Applications to chief electrical engineer (Mr. H. Tomlinson-Lee), generating station, Durnsford-road, Wimbledon, by noon, 25th inst. See also advertisement.

A firm of electrical street installation engineers and iron founders require the services of a qualified electrical engineer as traveller. Apply to "Representative," care of Mr. J. H. Boardman, solicitor, 41, John Dalton-street, Manchester. See advertisement.

West Ham Corporation require an assistant in the mains department, also an assistant in charge of generating station. Salary £2. 10s. in each case. Application to chief engineer (Mr. James K. Bock), electricity works, Abbey Mills, West Ham, E. See advertisement.

Another assistant, with factory experience, competent to give instruction in the theory and practice of electric machine design, construction and testing, is wanted in the department of electrical engineering of the City and Guilds Central Technical College, Exhibition-road, S.W. Salary £150 per annum. Applications to Prof. Ayrton. See advertisement.

Two assistant superintendents of telegraphs are required for the Government of Ceylon. Salary R.3,500, rising to R.5,000 by biennial increments of R.500, with certain travelling allowances. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to Jan. 30. See also advertisement.

A junior English master capable of teaching evening classes in theoretical and practical physics is required immediately for the Merchant Venturers' Technical College, Bristol. Applications to the Registrar by January 27. See advertisement.

A switchboard attendant is required for combined light and traction direct-current and alternating-current station. Application to Works Engineer, electricity works, South Shore-road, Gateshead. See advertisement.

Southend-on-Sea Light Railways and Electric Lighting committee require two tramway inspectors with previous experience. Applications to Mr. W. E. J. Heenan by noon Jan. 18.

Warrington Corporation require a tramways manager. Applications by 18th inst.

Mr. J. Gray Scott, who has been borough electrical engineer of Croydon since 1902, has been appointed engineer and general manager of the Hong Kong Electric Traction Co. (Ltd.)

Mr. A. C. Cramb, chief assistant engineer, has been appointed borough electrical engineer at Croydon in succession to Mr. J. Gray Scott at a commencing salary of £400 per annum, rising by annual increments of £50 to £600.

Mr. Tom Welch, Coventry, has been appointed shift engineer at Fulham Borough Council electricity works.

Mr. Harry A. Nott is resigning his position as mains superintendent at Wimbledon to take up the post of assistant electrical engineer to the sanitary commissioners, Gibraltar, at a salary of £200, rising to £250 per annum. The appointment was advertised in our issue of Dec. 11.

Mr. R. B. Leach of Manchester has been appointed mains superintendent and meter inspector at Aston, and Mr. A. G. Turner of Watford chief clerk of the electricity department.

Mr. G. W. Youngs has been appointed clerk of the electricity department at Colchester.

Mr. L. E. Harvey of Halifax has been appointed assistant tramway manager at Sunderland at £200, rising to £250 per annum.

Ashton-under-Lyne.—Mr. Alfred Dickinson has been retained as consulting engineer to act for the Corporation in the forthcoming arbitration in regard to the purchase of the Manchester Carriage and Tramway Co.'s undertaking in the district.

Atlin (British Columbia).—On Sept. 12, 1903, supply of electric current commenced in the Atlin mining district from the works of the British Columbia Power and Mfg. Co. (Ltd.). At Dec. 1 the company had 360 connections to the premises of 40 consumers, out of a population of 700 served by the works. It is considered that the prospects of the company are good, as water power is obtainable within easy distance, the only trouble being frost. There is plenty of water power throughout the country, and it is contemplated that a number of dredges will soon be employed for which electric power will be required.

A correspondent writes that there is a market in this district for dredges, copper wire, transformers, motors, pumps, hoists, &c., and electrical machinery and apparatus for water power only.

Bath.—The Bath electric tramway system was, as stated in our last issue, opened on the 2nd inst. When in full working there will be 40 cars, and all the cars are fitted with the Westinghouse magnetic brake, the meritorious features of which were demonstrated at the opening run.

Battersea (London).—On Wednesday the Council considered the recommendation of the Electricity committee to carry out extensions of the electricity undertaking at an estimated cost of £11,000, in order to meet the anticipated demand for electric current in the winter of 1904-5. The scheme was prepared by the borough electrical engineer (Mr. H. R. Forbes Mackay) and provided for the erection of a 750kw. turbo-generator condenser, two water-tube boilers, automatic stokers, &c., steam piping, switchboard extensions, cables, &c. It was decided to postpone decision until the estimates of the Finance committee have been considered.

During the past quarter the number of consumers increased from 404 to 470, and the equivalent 8 c.p. lamps connected from 29,797 to 35,423. The motors connected have increased from 323 to 368.

Beccles.—The Southern District Electricity Corporation have intimated to the Council that they are unable to proceed with their application for an electric lighting provisional order this year, but will probably do so next year.

Birkenhead.—For the position of manager of the municipal tramways, vacant by the appointment of Mr. Fearnley to Sheffield, there were 50 applicants, and these have been reduced by the Tramways committee to Messrs. F. Coutts (Ayr), Pilcher (Birmingham), Taylor (Birkenhead), Smith (Taunton), Wilkinson (Oldham) and Wyld (Doncaster). The salary is £450 per annum.

Bo'ness.—The agreement between the Council and the National Electrical Construction Co. for the erection and working of electricity works has been adjusted, and application has been made for sanction to borrow £25,000 for carrying out the scheme.

Boston.—For the position of borough surveyor and electrical engineer there were 48 applicants. This number was reduced to two—Mr. Geo. E. Clark of Sheffield and Mr. W. J. White of Cheltenham.

The Board of Trade have deferred for 12 months the question of the revocation of the Council's electric lighting order, 1900.

Bournemouth.—A ratepayers' meeting has sanctioned the promotion of the Corporation scheme for power to construct electric tramways to Southbourne and Christchurch at an estimated cost of £50,000.

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Brighton.—Tenders were accepted last week for the supply of boilers, &c., for the Southwick electricity works. The figures are given in another column.

Bristol.—The Local Government Board have sanctioned a loan of £10.000 for "free" wiring, and the Electrical committee has given instructions for the preparation of estimates, &c. Bristol has special statutory powers to undertake wiring. It is proposed to have the actual work done by local contractors.

Bromsgrove.—The District Council will oppose the application of the North Worcestershire electric lighting order in order to obtain protective clauses.

Buenos Ayres.—It is reported that the Transmarine Electricity Co., a German-owned undertaking, which recently absorbed the electrical department of the Primitiva Gas and Electric Lighting Co. at Buenos Ayres (after having acquired the works of the French Electric Lighting Co. in that city), has now concluded an agreement with the Anglo-Argentine Tramways Co. for the supply to that company's tramways of electric power for the period of its tramway concessions. It is further stated that, as soon as the City of Buenos Ayres Tramways Co. has obtained authority to convert its lines to electric traction, the Transmarine Company will supply power forl working these tramways.

Burslem.—Negotiations are proceeding between the Town Counci and the Tunstall District Council in regard to the supply of electricity to the latter, and alternative schemes are being prepared—one for supplying Burslem alone and the other for Burslem and Tunstall.

Canada.—In the Bedford (Quebec) district there is about 1,000 H.P. of water power available. Only a part of this power is at present utilised, but there is a likelihood of considerable extensions shortly.

Ingersole (Ontario) has been supplied with electric light and power for the past 15 years by the Ingersole Electric Power and Light Co., which has now 200 consumers on its books.

There is a small supply undertaking at Richmond (Quebec) the property of the Richmond County Electric Co. The plant is run entirely by water power, generated 6 miles from the town.

Cannock.—The District Council have provisionally consented to the application of Whittaker Bros. (Ltd.) for a provisional electric lighting order.

Canterbury.—On April 1 a revised scale of charges for electricity will come into operation. For private lighting the charge will be 7d. per unit for the first hour's maximum demand and 2d. after. For power the scale of discounts ranges from 5 per cent. for 1,000 units to 50 per cent. for 20,000 units per annum.

Cardiff-Penarth Tramways.—Owing to the opposition of Penarth Council the application by a syndicate for powers to construct this line will probably be dropped.

Cardiff Power Station Outrage.—The man Parkes, who recently disconnected the field circuit of a tramway generator at Roath power station, was sentenced to nine months' imprisonment with hard labour by the Recorder of Cardiff on Friday last. Particulars of the case were given in our last issue.

Chesterfield.—The Corporation bill, for further electric lighting and tramway powers, has been approved by a meeting of ratepayers.

Clevedon.—The Council have decided to support the application of the Western Electric Distribution Co. for a provisional electric lighting order.

Colchester.—The Council have approved a scheme for the free wiring of small properties in the Butt and Hamilton-roads district, which has been prepared by the electrical engineer, Mr. Sillar.

Croydon.—Croydon electric tramways (leased to the British Electric Traction Co.) carried 12,951,778 passengers during the year ended June last, and realised a profit of £11,639.

Devonport.—Messrs. Wm. Griffiths & Co. having declined to carry out the laying of the Harbour View and Camel's Head Embankment tramway routes at schedule rates, the Tramway committee recommend the Council to accept the offer of their consulting engineer (Mr. C. Chadwell) to carry out the work himself and to rescind a previous resolution to invite fresh tenders. Objections are to be lodged to Plymouth Corporation's application for an order for the construction of a light railway to Crown hill, as Devonport Corporation are making a similar application.

Dock Lighting.—Waterloo Dock, Liverpool, is to be lighted electrically.

Dorchester.—The Council have rejected a recommendation of the Electric Lighting committee to apply for sanction to a loan for electricity works. The Council recently decided to accept a tender for erecting and working a generating station for a number of years.

Dumbarton.—The County Council have decided to petition against the provisional order of Glasgow Corporation for the construction of tramways to Bearsdon and Milngavie and the applications by the Clyde Valley Electric Power Co. for three provisional orders for districts in the county. The Road board will report upon the advisability of the County Council applying for a provisional electric lighting order.

"Dumping."—An interesting report on the American iron and steel industry has recently been prepared by the German Department of the Interior, which reviews the industrial condition in the United States so far as the iron and steel trades are concerned. The subject of the imports of United States iron and steel at "low" prices is dealt with.

Dundee.—The work of improving the electric lighting cables in the centre of the city has been started, and the scheme, which is estimated to cost £9,844, involves the relaying of 8,300yds. of cable. The old rubber distributors are to be drawn out and the new cable will be placed in three-way porcelain ducts. Fewer connection boxes will also be required in the new system.

Ealing.—The Council propose to acquire 4 acres of land from the Great Western Railway Co. at £2,800 for extending the electricity buildings.

Edinburgh.—The Council have resolved to provide additional plant at Macdonald-road generating station at an estimated cost of £9,000.

Edmonton.—On Monday the Council considered the electric lighting schemes recently prepared by Messrs. R. Hammond and W. C. C. Hawtayne, and it was decided to adopt that of Mr. Hammond, which was estimated to involve an outlay of £44,000.

Electrical Standardising, Testing and Training Institution —As the result of the recent scholarship examinations, the examiners recommend the following awards :—

To H. S. Phillips, Oakham School, an exhibition of 40 guineas, tenable for two years; to L. W. Ballard, Dunheved College, Launceston, and G. E. Whitton, Wellingborough Grammar School, exhibitions of 30 guineas, tenable for two years; to H. R. Ainsley, Masonic School, a special prize of 20 guineas.

Exeter.—The arbitrator (Col. Sir C. Scott Moncrieff) recently appointed to assess the compensation payable in respect of the existing tramways, which the Council have decided to take over, has issued his award, and has fixed the purchase money at £6,749, each party to pay its own costs. The company claimed £14,900 and the Council offered £4,900.

Farnham.—The Council do not, we understand, propose to carry out the terms of their provisional electric lighting order at present.

Folkestone.—An unsuccessful attempt was made last week to rescind a resolution of the Council not to apply for powers to construct an electric tramway from the central station to the town hall. It was proposed to include in the order powers to construct tramways on the overhead system, but this was also defeated. By the provisional order the Council are bound, in accordance with a contract with Lord Radnor, to construct the tramways on either the underground or surface-contact system. An electrical engineer is to be engaged to advise on the G.B. surface-contact system.

Forthcoming Books.—Messrs. Archibald Constable & Co. will shortly publish Mr. James Swinburne's book on "Entropy," and Mr. F. Goodrich's "Refuse Disposal and Power Production."

"The Electrician" Printing and Publishing Co. will publish as usual, early in February, the Big Blue Book, "The Electrician" Electrical Trades' Directory and Handbook.

Gainsborough.—On Wednesday the Council unanimously decided to apply for a provisional electric lighting order.

Glasgow.—The Corporation have approved the recommendation of the Tramways committee to obtain 100 additional tramcars.

Greenock.—A report has been prepared by the burgh electrical engineer (Mr. J. A. Robertson) upon the financial aspect of the recent award by the Board of Trade arbitrator as to charges for current supplied by the Corporation to the tramway company.

The arbitrator decided that the company were bound to take electrical energy from the Corporation at the rate of 500,000 units per annum as from Aug. 1, 1901, and fixed $\frac{7}{16}$d. per unit as the price to be paid for all energy in excess of 500,000 units per annum. He further decided that £125 per annum was the amount to be paid for the cableways. The Corporation claimed May 15, 1901, as the date when the company were bound to fulfil their obligations, that it was inexpedient to make any reduction in the price to be paid for excess energy, and that the rent of cableways should be £150. Mr. Robertson now estimates the loss to the Corporation through supplying the company on the arbitrator's terms during the first year at £474. 10s., and during the second year £559. He considers it will be impossible to show any profit as a result of supplying the company with energy during the next two years, and that when the time comes for revision in 1905 every possible effort should be made to reverse the decision which will inflict a serious injustice on the Corporation.

Halifax.—Sanction to a further loan of £10,000 for extensions of the electricity undertaking has been applied for by the Corporation.

Hereford.—Sanction to a loan of £1,500, repayable in 30 years has been abtained by the Council for extensions of the electric lighting mains.

Hotel Lighting.—Arrangements have been made by the Glasgow and South-Western Railway Co. for Ayr Corporation to supply

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current for the electric lighting of Ayr station hotel at 3d. per unit up to 50,000 units per annum and at 2d. for any quantity beyond.

Hunslet.—Electricity supply will probably be available by the end of 1904.

International Telegraph Conference, 1903.—Messrs. Elliott and Fry have produced a fine photographic group of all the delegates at the recent International Telegraph Conference held in London, and copies can now be obtained.

Infirmary Lighting.—The Belfast Board of Guardians have decided to adopt electric lighting for the operating theatre and the corridors of their infirmary, examination room, &c.

Islington (London).—The Electricity committee recommend mains extensions estimated to cost £629, and also that further arc lighting be proceeded with.

Kirkcaldy.—In consequence of inadequate support, the Corporation have decided to stop running cars on the Public Park electric tramway route.

Leeds.—A ratepayers' meeting, held on Wednesday, to consider the Corporation's bill for consolidating their electric lighting and tramway provisional orders, &c., passed a resolution against proceeding with the bill.

The tramway traffic receipts during 1903 were £275,229, an increase of £19,735 over 1902. During three months of 1902 steam cars were running on one route.

Leek.—In addition to the flat rate of 6d. per unit, the maximum demand system has been introduced as an alternative—viz., 7d. per unit for the first hour and 3d. after. All applicants for current before the opening of the station are to be allowed a discount of 10 per cent. on the first quarter's account.

Leith.—The Board of Trade have formally consented to the sale to the Corporation of the Leith tramways of the Edinburgh Street Tramways Co.

Light Railways.—The Board of Trade have, after modification, confirmed the Middlesex and the Watford and District Light Railway Orders, 1903.

Inquiries will be held at Guildford on the 18th and at Woking on the 22nd inst. into the applications of the West Surrey Light Railways Co. for powers to construct light railways in these districts.

Hereford County Council have appointed a committee to inquire into the project for the construction of a light railway from Llangarren to Hereford.

Llandudno.—The Urban District Council have abandoned their electric traction bill.

London County Council Tramways.—Holborn Council decided on Wednesday to petition against the bill of the County Council to authorise the construction of an electric tramway along Tottenham Court-road.

Long Eaton.—At Monday's Council meeting it was stated that the total capital raised for the electric lighting undertaking was over £18,000, and the actual expenditure nearly £15,500. The gross revenue was £1,939 and the working expenses £1,064. After paying interest and sinking fund instalment there was a net profit of £96.

Lothians Power Scheme.—The Mid-Lothian County Council have decided to oppose the bill for the erection of generating stations for supplying electricity for power and lighting in the Lothians, &c.

Lourenco Marques.—At a meeting of the Goldfields of Matabeleland Limited the chairman announced that, during the past year, an interest had been taken in the purchase of the entire share capital of the company having the exclusive concession for the supply of electricity for public and private lighting and for power at Lourenço Marques. The demand for current was increasing, and the undertaking promised to be a most successful one.

Lowestoft.—The estimates of the Electricity department for the June half year were submitted to the Council on Tuesday. The total receipts were estimated at £4,260, and the total expenditure, including interest and sinking fund, at £5,118, leaving £858 to be provided from the next rate. There are at present 458 consumers, representing an equivalent of 2.501 8 c.p. lamps connected.

In presenting the estimates the chairman of the Electric Lighting committee (Mr. Fry) said the anticipated results of the past half-year's working had been greatly exceeded.

Manchester.—A town's meeting has approved the Corporation's bill for the construction of additional tramways, &c., and for the supply of electricity outside the borough.

Marylebone (London).—The Electric Supply committee of Marylebone Borough Council have duly considered the proposals contained in the two communications set out in our last issue (p. 465) from the Metropolitan Electric Supply Co. The following is an abstract of the committee's report presented last evening:—

By the company's first letter the Council are required to surrender entirely all the goodwill of the undertaking for the next 27 years. This was apparently valued by the arbitrator at about £1,000,000 sterling. In return for this concession the Council will gain only postponement of the payment of the capital sum under the award for 42 years. Further, the company is to be secured in an absolute monopoly of the whole supply during the lease. Consumers will practically be at the mercy of the company, as the only effectual check—that of possible competition—will be completely removed. The company further stipulates that the bonds to be given them in payment shall have a priority over any subsequent debt of the Council. This will practically mean that the Council will be unable for 42 years to borrow any sum whatever even for the most necessary local improvements. At all events, any such fresh loans would be of the nature of a second mortgage, and could only be obtained under most onerous conditions. The company propose only to pay a rent sufficient to cover the interest on the proposed stock. The Council would, therefore, have either to leave payment of the whole sum to their successors or to raise an annual sinking fund from the rates. The amount of the sinking fund necessary to redeem the capital in 42 years would, on the 2¾ per cent. tables, be £15,765. The committee understand that the sentence in the company's letter referring to capital to be provided in respect of the period from Jan. 1, 1902, until commencement of the lease means that the Council should issue similar stock for this amount, which is estimated by the engineer at £124,250. Nothing is said in the letter with regard to costs, and the committee take this to mean that the expenditure already incurred by the Council—about £60,000—will have to be at once provided from the rates. The Council will be bound on the termination of the lease, whether on Dec. 31, 1931, or earlier in the event of competition being admitted, to purchase at an agreed price the whole of the fresh capital expended by the company on so much of their Willesden works as the company thinks fit to say is suitable and sufficient for the supply of Marylebone. It is estimated by Mr. Wright from the figures supplied by the company in the arbitration, that by the end of 1931 the capital required for this purpose, after allowing for depreciation, will be not less than £800,000. The Council will be called upon to find this additional sum for buildings and plant in the design and erection of which they have had little or no voice, and would, further, be indefinitely tied to a system of supply which, as they have often reported to the Council, is in the highest degree uneconomical and undesirable in the interests of the borough.

When the councillors met last evening the first subject for consideration was the Council's proposed electric lighting bill, but it was found that this subject could not be discussed, and its consideration was therefore adjourned to the meeting on 21st inst., subsequent to the ratepayers' meeting on Tuesday. A desultory debate of a somewhat recriminatory character followed on the above report of the Electric Supply committee, and it was ultimately unanimously decided by resolution

That the Metropolitan Co. be informed that the Borough Council regrets its inability to accept the proposals contained in the company's letter of Jan 5.

During the proceedings the Mayor intimated that a circular was being issued to the ratepayers with the view to enabling the discussion at the important meeting, to be held on Tuesday, to be accurately understood, and in order that no time may be wasted in discussing matters foreign to the subject which the meeting is especially called upon to decide. It is intimated in the circular that the Mayor, who will preside, will recapitulate the circumstances which have led up to the present condition of affairs—in case anyone present should be unacquainted with the facts. Opponents of the proposed bill will, it is said, have full opportunity of stating their views, and, consequently, the proceedings promise to be of a lively nature, more especially as a body called the Marylebone Ratepayers' Committee are also issuing a circular in which an amendment to the approving of the bill will be moved, and, it is said, strongly supported. In spite of what has passed, this circular urges that the ratepayers should sign a petition asking the Council to come to an equitable arrangement with the Metropolitan Company for the cancellation, by mutual consent, of all arrangements with the Council in respect to electricity supply in Marylebone.

Middlesbrough.—Reports upon street lighting, prepared by the borough electrical engineer (Mr. H. M. Taylor) and the gasworks manager (Mr. D. Terrace), are under consideration by the Watch committee.

Mid-Yorkshire Tramways.—Bingley District Council have granted the Mid-Yorkshire Tramways Co. an extension of the concession for the construction and working of tramways to 42 years, provided that during the extra seven years an annual payment is made to the Council. The company propose to extend the tramway from its present terminus.

Municipal Telephony.—Bournemouth Telephone committee have been in negotiation with Mr. F. F. Bennett in regard to the erection of a municipal telephone exchange, and the committee have decided to interview Mr. Bennett in order to discuss—

(1) The question of modifying the proposed rates to suit local circumstances; (2) the establishment of sub-exchanges; and (3) the question of the company acquiring rights to use certain underground ducts belonging to the Corporation, which would save breaking up streets in the event of an agreement being come to, &c.

The National Telephone Co. have agreed to grant the same rates to Bournemouth as are at present in force in Portsmouth, and to adopt the party line system under which a subscriber pays £1. 5s. per annum to cover 600 free calls and afterwards 1½d. per call, inward calls being free.

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Musselburgh.—Prof. Kennedy has been retained to report upon the proposal to adopt the "G.B." surface-contact system of traction for the proposed tramways.

National Electrical Contractors' Association.—Meetings of the Northern section of this Association were held at Newcastle-on-Tyne on Saturday, under the chairmanship of Mr. E. C. Wallis (Leeds), supported by Mr. W. R. Rawlings (London), president of the National Association. A model specification is being drawn up and a system of registration of workmen is in use and is found useful to members. Many matters of interest to the industry are being brought forward by members of the association.

On the 8th inst. a dinnner was given by members of the Newcastle and District Association of Electrical Contractors to the delegates from the different towns in the North of England attending the meeting of the Northern section of the National Association held on Saturday. The president of the National Association (Mr. W. R. Rawlings) and the president of the London Association (Mr. Berry) were present. Mr. Cross (Falconar, Cross & Co.) presided, and about 20 covers were laid; there were present Messrs. Wallis (Leeds), McDermott and Steinthal (Manchester), Sutton and Harford (Liverpool), Tattersall (Middlesbrough), Andrews (Sunderland), Shaw (Stockport), Armstrong (Carlisle). T. G. Usher (vice-chairman), Gowdy, Andrews, Coleman, Beilby, C. Usher and R. Robson (hon. sec.) (Newcastle). To the toast of "The National Association," proposed by the chairman, Mr. Rawlings replied, and referred to the agreement with the Manufacturers' Association. Other toasts followed.

Newcastle-on-Tyne.—On Wednesday the City Council increased the salary of the tramways manager (Mr. A E. Le Rossignol) from £750 to £850, with an ultimate increase to £1,000 per annum.

Newport (Mon.).—The Council have resolved to construct a single-track tramway over Stowhill at an estimated cost of £7,300.

Northfleet.—The Council will support the Kent Electric Power Co.'s application for a provisional electric lighting order, on condition that all expenses are borne by the company, and that £250 be contributed towards the expenses incurred by the Council in obtaining the existing order. The Council will take current from the company for lighting the main streets, if the cost does not exceed that for gas lighting.

Outrage.—The youth Schutz, who is charged with feloniously wounding Mr. Willmot E. Lane, secretary of the Electric Lighting and Traction Co. of Australia (who is known to many of our readers as the energetic secretary of the Electro-Harmonic Society), was again brought before the magistrate at the Mansion House (London) police-court on Wednesday, and as Mr. Lane was not sufficiently recovered to appear, the prisoner was remanded until the 20th inst. It was stated that Mr. Lane was making favourable progress, and would most probably be able to attend at the next hearing.

Penzance.—An agreement has been entered into between the Corporation and the Penzance and District Electric Lighting Co. in regard to erection of electricity works and the supply of electric current for lighting and power in the district.

Plymouth.—Owing to increasing demand for electric current, the borough electrical engineer (Mr. E. G. Okell) has recommended the Electricity and Street Lighting committee to consider the question of providing additional plant to meet next winter's anticipated demands. Mr. Okell is preparing a report as to the extensions necessary and their probable cost. There are now over 500 consumers connected to the mains.

The salaries of the charge engineers have been increased from £120 to £132 per annum.

Poplar (London).—The Borough Council have acceded to the application of the Glangarnock Iron and Steel Co. for a supply of current for lighting and power after a threat of legal proceedings by the company's solicitors. This was one of the applications recently postponed owing to the full capacity of the plant at the station having been reached.

Portsmouth.—The Corporation have endorsed the action of the Tramway and Electric Lighting committee in appealing against the recent re-assessment of the tramway and electric lighting undertakings.

Prison Lighting.—The Commissioners of Prisons have agreed to take current from Hammersmith Council for lighting one wing (comprising 352 cells, with corridors, &c.) of Wormwood Scrubbs prison, and the Council have decided to extend the mains in the northern part of the borough to meet the demand.

Railway and Tramway Competition.—At the meeting of the Caledonian Railway Co. on Tuesday, the chairman said the directors were considering the desirability of asking Parliament to release the company from some of its capital obligations, and attributed the necessity for economy partly to "the development of electric traction and the very aggresive policy as regards tramways pursued by municipal bodies."

Saffron Walden.—The proposed generating station is to be erected on the waterworks site, and the estimated cost of the electric lighting undertaking is £8,500.

Salford.—In reply to questions as to the charges for electric energy for power, the chairman of the Electric Light committee (Ald. Shaw) stated last week that they had plant capable of supplying 30 million units per year, whereas the estimated consumption for the year ending March next was about 8 millions, of which the Tramways committee would take over 5 millions. The committee were anxious to dispose of the 22 millions surplus, hence the favourable terms which they had given to power users.

Scarborough.—Counsel's opinion is to be obtained as to whether the Corporation have power to supply electricity for the public lamps from the dust destructor works.

Sheffield.—The Corporation having decided to become their own insurers, wish to limit their liability for accidents on the tramways, and it has been decided to print the following notice on all tickets issued after March 25 next:—

Passengers are being carried at less than the maximum authorised charges, and every passenger is notified that, in consideration thereof, a passenger is only carried on the terms that the maximum amount recoverable from the Corporation, on account of any injury or damages suffered by a passenger, and for which the Corporation is legally liable, is £25. Except as above every passenger travels at his own risk. Passengers can only travel subject to being bound to observe the bye-laws for the time being.

Southwark (London).—The Local Government Board have confirmed the district auditor's decision in his audit of the accounts of the Council for year ended March 31 last as to the disallowance of £795. 1s. 1d. in respect of the Newington electric lighting undertaking, on the ground that the deficiency should be chargeable to Newington parish and not to the borough as a whole.

Stepney (London)—The Council have authorised the expenditure of £78,000 in extensions of the electricity supply undertaking, particulars of which were given in our last issue.

Stoke-on-Trent.—Sanction to a loan of £30,640 for electric lighting and refuse destructor works has been obtained by the Council.

In sanctioning this loan the Local Government Board state that the general question of municipal trading has recently been under the consideration of Parliament, and pending a decision on the question the Board were not prepared to sanction a loan in respect of the proposed mortar mills unless the Council gave a formal undertaking not to manufacture mortar for sale, but only to sell such surplus products of the plant as were not required for their own use.

A resolution embodying the suggested undertaking has been approved.

Suez Canal.—It is stated that the Suez Canal Co. contemplate lighting the Suez Canal banks with electricity from Port Said to Suez.

Sunbury.—The agreement with Edmundson's Electricity Corporation for the supply of electricity in this district has been sealed.

Taunton.—The assessment of the electricity works has been increased to £3,400. An appeal is to be entered.

Much correspondence has passed between the Corporation and Taunton Electric Traction Co. as to the repair of the tramway track. The Highways committee have been authorised to take proceedings against the company unless the track is repaired forthwith.

Tavistock.—At a recent meeting of ratepayers a resolution to support the Tavistock District Electric Supply Co.'s application for a provisional order was passed, with one dissentient.

Telephone in Russia.—The establishment of telephonic communication between Odessa and Kiew has been authorised, and the sum of 500,000 roubles (about £52,000) has been allocated by the Posts and Telegraphs Administration for this work, which is to be commenced in 1904, and is expected to be completed in 1906.

The Electrical Industry in Germany.—In a recent report by Mr. F. H. Mason, the U.S. Consul-General at Berlin, a review of the position of the electrical and engineering industries in Germany is made, under the title "Returning Prosperity in Germany.

Mr. Mason calls attention to the improvement in the market value of the stocks and shares of the A.E.G., the Siemens and Halske undertaking, and other principal manufacturing and supply companies of the German Empire. The top of the peak is represented by the condition of affairs in April, 1900, and comparison of that time and the end of 1903 forms the basis of Mr. Mason's comparative figures. He shows that from this standpoint there is a steady revival in the market value of the shares of these undertakings. In all 22 of the largest engineering and electrical companies come under Mr. Mason's comparison, and these nearly all show a steady return to the 1900 conditions. Mr. Mason points out that the recovery has been mainly of recent date, and he attributes the result to the more or less satisfactory negotiations that have taken place between Germany and several European Governments over commercial treaties based on the new German tariff. A further cause for the improvement is the fact that the principal German electrical manufacturing companies have secured large contracts for machinery, plant, apparatus, &c., for lighting and power plants, street railway construction and equipment, &c., in Mexico and South America.

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Tramway Accident.—An accident occurred on the London United Tramways at Brentford on Wednesday afternoon. One of the overhead wires broke and fell upon and killed a pair of horses belonging to a firm of coal merchants. The driver fortunately escaped.

Tramway Transfer.—Hurst District Council give notice of intention, subject to consent of Board of Trade, to lease the tramways constructed under the Hurst Tramway Order, 1900, to Ashton-under-Lyne Corporation.

U.S.-German Turbine Combination.—It is announced that the A E G. (Berlin) has concluded agreements with the European branch companies of the General Electric Co. (U.S A.), the Curtis Turbine Co., Profs. Riedler and Stumpff, and the German Inventions Introduction Co., and that other companies interested in a "turbine combine" include the Fort Wayne Electric Works, the Stanley Electric Mfg. Co., the Eddy Electric Corporation, the General Incandescent Arc Light Co , and the Northern Electric Co. (all U.S. undertakings). This united enterprise is said to have been established with the object of exploiting the United Steam Turbine Co., which is to acquire patent rights in the steam turbines of the American Curtis Co. and of Profs. Riedler and Stumpff. It is further stated that Messrs. Escher, Wyss & Co. of Zurich are about to exploit on a large scale the Zoelly type of turbine, of which they hold the patents.

Warrington.—Application has been made for sanction to a further loan of £5,000 for electric lighting extensions.

West Ham (London.)—At Tuesday's meeting the electrical engineer (Mr. J. K. Bock) presented a report to the Council on the arc lighting of the tramway routes :—

The report stated that the rectified system at present in use had proved very satisfactory, and he recommended that this system should be installed on the portions of the routes where mains for this purpose had already been laid, and also on five other roads. The estimated cost of cables was £435. Mr. Bock's report continues : Continuous-current arc lamps generally give better results than ordinary alternating lamps. There is one great advantage in using the continuous-current supply in this instance —namely, the saving in the cost of cables which may be effected by using the tramway rails to convey the return current. Certain difficulties had presented themselves, the most important being the trouble often experienced owing to the fluctuations in pressure on tramway circuits. Complications might also arise in the adjustment of the amount of current chargeable to arc lighting if the tramway mains were used. No trouble need, however, be anticipated, from these causes if independent feeders were used to supply the arc lamps (the rails being utilised to convey the return current) and by the use of a differential booster in conjunction with the storage battery at the generating station the variation in pressure would not affect the arc lighting. He, therefore, recommended the installation of continuous-current lamps on all the routes with the exception of those on which he had already advised rectified lamps. With regard to the type of lamps, the principal advantages in favour of enclosed lamps were low initial cost, small current consumption and long life of carbon. The disadvantages, in practice, were heavy maintenance cost and unreliability. Enclosed lamps, as originally installed in the borough, proved to be practically a failure and had to be removed. Many improvements had recently been introduced in the design of enclosed lamps, and seven of the latest type had been erected. These had a very small current consumption—375 watts as against 500 required by open-type lamps. They had also the advantage of burning about 50 or 60 hours without trimming, whereas the open-type lamp lasted about 32 hours. The disadvantages mentioned, however, applied also to these lamps and an additional trouble would be introduced, due to the vibration of the tramway poles, which in the case of enclosed lamps, would have the effect of shaking the carbons together and so extinguishing the light. The decision as to the type of lamp to be adopted resolved itself to a great extent into a question as to whether the saving in current and initial expenditure were sufficient to compensate for the trouble and annoyance due to lamps being frequently out. The saving, when considered, amounted to very little, owing to the increased cost of maintenance, the shorter life and the unreliability of enclosed lamps. Taking all the points into consideration and profiting by experience, Mr. Bock recommended the adoption of open type lamps throughout the borough. With regard to charges £16. 12s. was the estimated net cost to the electricity department to supply (at 1d. per unit) and maintain each arc lamp, this cost including a proper proportion of capital and management costs. The following were the charges in the more important metropolitan districts :—Islington 3½d. per unit (about £30 per lamp per annum), Hampstead £28, Hammersmith £22. 10s., Poplar £29. 3s. 8d., St. James' and Pall Mall Co. £30, City of London Electric Lighting Co. £26, Metropolitan Co. £30, Westminster £22, West Ham £20. Mr. Bock recommended that the present charge, £20, be made for these lamps, as the electricity department was entitled to show a fair trading profit, providing the price would not exceed that which might be charged by a private company.

The report was adopted.

Weybridge.—The Council have decided to object to the granting of a provisional order to the Urban Electric Supply Co. for Walton parish.

Whitby.—Sanction to a further loan of £2,000 for electric lighting has been received by the Council.

Willesden.—Correspondence has passed between the Metropolitan Electric Supply Co. and the District Council in regard to the company's right to supply electric current to residents in Willesden, and at Tuesday's Council meeting a letter was read from the company stating that they were unaware of anything in the Council's provisional order entitling them to demand an assurance that the company would not supply current from their works in Acton-lane to any person or company in Willesden requiring such supply.

It was resolved that in the event of the company supplying current in Willesden outside the area defined in their order, legal proceedings be taken; also that the London and North-Western Railway Co. and various authorities who may be affected be informed of this decision.

A sub committee was appointed to report as to the acquisition of a suitable site for a generating station in the event of its being deemed advisable at any time to terminate the agreement for bulk supply.

Wolverhampton.—Application has been made for sanction to a loan of £15,221, cost of reconstructing the Dudley-road tramwa route on the surface-contact system. A loan of £1,293 is also being applied for to construct the Snow-hill tramways Subject to this approval a single line of track will be constructed on a portion of Willenhall-road.

The ratepayers' meeting held on Wednesday to consider the Council's omnibus bill formally authorised its promotion.

Workhouse Lighting.—Mr. Watt, borough electrical engineer at Whitehaven, has been retained by the Guardians to superintend the wiring, &c., of the workhouse and infirmary for the electric light.

Annual Dinner.—The foremen employed by Messrs. Vickers, Sons and Maxim at Sheffield held their annual dinner on Saturday, when about 70 foremen and managers were presided over by Mr. S. Robinson, Mr. W. Blythe in the vice. Mr. M. Ibbotson, in proposing the toast of the firm, gave some interesting particulars of the development of this great business since its commencement in 1828. Mr. Kent, speaking on behalf of the directors, responded.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Manchester Tramways committee invite tenders for electric tramcar bodies, electrical equipment for cars and tramcar trucks. Specifications, &c., from the general manager of tramways department (Mr. J. McElroy), 55, Piccadilly, Manchester. Tenders to chairman by 5 p.m. Jan. 18. See advertisement.

South Shields Corporation invite offers for the lease of certain tramways authorised by the South Shields Corporation Act, 1903, to be constructed in the borough, together with tramway stables and depot. Further particulars are set out in an advertisement. A plan of the borough and full particulars and conditions of tender can be obtained from the town clerk (Mr. J. Moore Hayton), Court-buildings, South Shields, to whom tenders by March 12.

Whitby Urban District Council invite tenders for the supply and delivery of feeding and distributing mains. Specifications from the electrical engineer (Mr. L. H. King), to whom tenders by Jan. 25. See advertisement.

The Scottish Office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring the installations of May-Oatway compensated automatic fire alarms for direct connection with the fire brigades of Paisley and Dundee, as set out in an advertisement. Tenders by 20th inst., and further particulars from the managing director, 49, Queen-street, Glasgow.

Belfast Gas and Electric committee invite tenders for motor balancer and motor boosters. Specifications from the city electrical engineer (Mr. Victor H. M'Cowen). Tenders to the town clerk (Sir Samuel Black), Town Hall, Belfast, by Jan. 22. See advertisement.

London County Council invite tenders by Feb. 2 for roadwork and platelaying required for reconstruction for electrical traction on the conduit system of the existing double line of cable conduit tramways from Brixton-road to Streatham terminus, and for construction of a portion of the authorised tramways in High-street, Tooting, Merton-road, and Defoe-road.

Erith Urban District Council invite tenders for two Lancashire boilers, steam feed pump, pipes, &c.; surface condenser, with steam-driven air and circulating pumps; three-phase alternator and direct-coupled high-speed enclosed-type steam engine of 500kw.; and extensions to main switchboard and cable connections. Tenders to the clerk (Mr. Charles H. Fry) by noon Jan 18.

Brighton Corporation invite tenders for steel poles, trolley wires, bases and section pillars, cast-iron fittings, pole brackets, overhead line fittings, span and guard wire, switch gear, feeder, distributing

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and telephone cables, bonds, wood paving blocks and granite setts. Tenders to town clerk (Mr. Francis J. Tillstone) by 10 a.m. Jan. 18.

Hornsey Borough Council invite tenders for two dry-back or water-tube boilers, smoke-consuming apparatus, two 300kw. steam dynamos, one 100kw. steam dynamo and two motor generators. Tenders to town clerk (Mr. F. D. Askey), Southwood-lane, Highgate, London, N., by 10:30 a.m. Feb. 8.

Tenders are invited on behalf of the Municipality of *Johannesburg* for the supply of solid copper and flexible protected tramway rail bonds. Tenders to the consulting engineers (Messrs. Mordey and Dawbarn), 82, Victoria-street, London, S.W., by noon 18th inst.

Tonbridge Electric Lighting committee invite tenders for 50 electricity meters. Tenders to clerk to Council, Tonbridge Castle, Tonbridge, by noon Jan. 23.

Ilkeston Corporation invite tenders by 21st inst., for tramway stores for 1904.

Cleckheaton District Council invite tenders by 4 p.m. 18th inst. for distributing cables.

Cardiff Corporation require tenders by 21st inst. for about 400 tons of steel tramway rails, fishplates, bolts and nuts.

Prussian State Railway Authorities, Altona, invite tenders until 23rd inst. for 4,800 incandescent lamps and 300,000 arc-lamp carbons.

TENDERS RECEIVED AND ACCEPTED.

Brighton Town Council have accepted the tender of Babcock and Wilcox at £28,140 for

(1) Six water-tube boilers, two separately fired superheaters, economisers, induced draught fans and motors, steel chimney stack, feed pumps and exhaust heater, with foundations and brickwork for same. (2) A system of steam, exhaust, feed, blow-off and suction pipes, together with their valves. (3) Cast-iron storage tanks, hot-well tank and water purifier. (4) 30in. cast-iron circulating water pipes.

There were 7 tenders, varying from £20,901 to £38,578.

Brighton Council have also accepted the tender of the British Westinghouse Co. for substituting 75kw. exciters to three turbo-generators and switchboard (in place of the 15kw. and switchboard) at £810.

The May-Oatway Fire Appliances (Ltd) have accepted the following tenders for wiring premises for May-Oatway fire alarm installations for direct connection with the fire brigade headquarters:—

For Northern Co-operative Society, Aberdeen, Pratt and Keith.
For Eadie Bros. & Co., Paisley, J. Kilpatrick & Sons.
For Duncan Flockhart & Co., Edinburgh, Jas. Milne & Son.
For St. Cuthbert Co-operative Society, Edinburgh, W. Douglas.
For Shaw, Walker & Co., Glasgow, Allan Arthur and Ure.

Radcliffe District Council have accepted the tender of J. G. Statter & Co. for lighting and traction switchboard and accessories at £1,345. 12s. 6d., and that of the Forest City Electric Co. for rail bonds at £368. 1s. 6d.

Reigate Council have accepted the following tenders:—

Babcock and Wilcox, boiler, economiser, steam pipes, &c.
General Electric Co., steam alternator.
Cowans Limited, switchboard and instruments.
Wheeler Condenser and Engineering Co., condensing plant and cooling tower.

The British Westinghouse Co., are supplying (through Messrs. John Petrie, Son & Co) a number of "S B." direct-current enclosed type motors, direct-coupled, for driving an extensive wood-working plant at Christchurch, New Zealand.

The Metropolitan Asylums Board have placed an order with Belliss and Morcom (Ltd.) to supply generating plant at the Grove Hospital at £1,136, and have accepted the tender of Drake and Gorham for wiring the Fountain Hospital at £2,792.

Worthing Corporation have placed with the Hart Accumulator Co., Stratford, E, the contract for replacing the existing B.P.T. and L. battery at the electricity lighting works with 264 of the company's standard lighting type cells.

Battersea (London) Borough Council have accepted the tender of Callender's Co. for supplying and laying a feeder cable in St. John's-hill at £761. 16s. 8d., and that of the General Electric Co. for 110 arc lamp globes at 6s. 9d. each.

Hammersmith Borough Council have accepted the tender of the Fuller-Wenström Co. for a 30 H.P. electric motor at £130, that of Ferranti Limited for switchboard extensions at £242. 10s., and that of the Gilbert Arc Lamp Co. for nine alternate current arc lamps at £9. 10s. each.

Blaydon Council have accepted the offer of Priestman's Colliery Co. for supplying and erecting poles, wires, &c., for the electric lighting of Whinfield.

Great Yarmouth Council have placed an order with G. C. Milnes, Voss & Co. for a car pit bogie at £37. 10s., and with Selig, Sonnenthal & Co. for a turning lathe at £77.

Dartford Council have accepted the tender of S. W. Gibson & Co. for wiring consumers' premises for one year, and that of W. T. Henley's Co. for mains extensions and house-service cables.

Preston Corporation have placed an order with Dick, Kerr & Co. for four single-truck tramcars, in place of four bogie cars, at an extra cost of £228 per car.

Hammersmith (London) Guardians have accepted the tender of Mr. Winn for electric light fittings for the board room and offices.

Heckmondwike Council have placed an order for a mechanical stoker for the electricity works with Meldrum Bros.

Croydon Corporation have accepted the tender of E. J. Saunders for electricity station building extensions at £3,600.

BUSINESS NOTICES.

We learn that Messrs. F. W. Potter & Co., of Phipp-street, Great Eastern-street, London, E., have acquired the business of Bedford, Steer, End & Co. (Ltd.), Long-lane, Borough, S.E., and are erecting works at the latter address, where, when the works are completed, the whole of this business will be conducted. Messrs. Potter & Co. have in course of manufacture, we understand, a new type of motor, which promises to come into successful competition with other makes on the market for small and medium powers.

Messrs. J. H. Bartlett and D. H. Ogden, trading as Perry & Co., electricians, 17, Grafton-street, and 12A, Avery-row, London, have dissolved partnership.

Messrs. G. R. Marson, H. W. Burbury and J. Marson (trading as Marson Bros. and Burbury), electrical engineers, &c., Coventry, have dissolved partnership. Debts by Mr. G. R. Marson.

Messrs. Robinson and Horsfall, consulting electrical engineers, have removed to 13, Castle-street, Liverpool.

LIQUIDATIONS, BANKRUPTCIES, &c.

The adjourned meeting of the creditors of A. E. Hodgson, 94, Victoria-street, London, and formerly of York and Halifax, was held last week. Debtor formerly had a motor car business in Halifax, and sold it, together with the business of the Eclipse Brass and Copper Co. (Ltd), which he promoted, to the British Power, Traction and Lighting Co. (Ltd). The latter went into liquidation, and debtor states that most of his liabilities are in respect of guarantees given by him on its behalf. Mr. W. S. Ogle, C.A., winds up the estate.

The trustee in the bankruptcy of A. P. A. Hunt, electrical engineer, 49A, Lord-street, Southport, and lately trading at 62, South Castle-street, Liverpool, has been released.

A meeting of the North-Eastern Telephone Co. (Ltd.) will be held at 12, West-street, Gateshead, on Feb. 11, to receive an account of the winding-up.

A meeting of Howell's Simplex Anti-Inductive Telephone Syndicate (Ltd.) will be held on Feb. 19 at 33, St. Swithin's-lane, London, E.C., to receive an account of the winding-up.

The South-Western Electrical Co. (Ltd.) is to be wound up voluntarily. Mr. C. E. Peebles, 31, Kenilworth-court, Putney, is liquidator.

The Electrical Supplies, Rubber and Ebonite Co. (Ltd.) is to be wound up voluntarily. Mr. C. Elles, 1, Oxford-court, London, E.C., has been appointed liquidator.

Sale by Auction.—By order of the Court, Messrs. Fuller, Horsey, Sons and Cassell have been instructed to offer for sale by auction (in one lot) at the Mart, London, E.C., on Tuesday, Jan. 26, at 1 o'clock, the valuable freehold engineering works known as the Trusty Engine Works, Cheltenham, occupying an area of about 4 acres, with sidings to the Midland Railway. The whole of the fixed plant and machinery, and the goodwill of the business will be included. Orders to view from the auctioneers, and particulars (when ready) of Messrs. Mackrell and Ward, solicitors, 1, Walbrook, London, E.C., Messrs. Rodgers & Co., solicitors, 30, Bank-street, Sheffield, Mr. R. Hooper Radford, 15, St. James's-row, Sheffield, Mr. Howard Field (receiver), 38, Mincing lane, London, E.C., and of the auctioneers, 11, Billiter-square, London, E.C. An advertisement contains additional particulars.

Plant for Sale.—Two Lancashire and two Cornish boilers and two sets of Willans engines, coupled direct to Siemens dynamos, are for sale. Applications to Mr. A. Underwood, 3, Queen-street, London, E.C. See advertisement.

The Corporation of Launceston (Tasmania) have for sale alternate-current plant and direct-current arc lighting plant. Some particulars are given in an advertisement. Further information from the city electrical engineer, Town Hall, Launceston, Tasmania.

Two Parker dynamos, a booster, and a shunt-wound charging dynamo are advertised for sale on another page.

Works, &c., for Sale.—Some modern well-equipped car-building works, occupying a covered area of 8¾ acres, with 25 acres available for future extensions, are advertised for sale in another column. Applications to Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C.

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Some manufacturing premises are advertised for sale or letting on lease, without restriction and with or without steam power. The premises adjoin Laindon station, Essex, 22 miles from London. Particulars from Messrs. I. Levy & Son, 62, Albany-road, Old Kent-road, London, S.E.

Metallic Packing.—We have received from Messrs. Newton and Nicholson, of Tyne Dock, South Shields, some examples of Taylor's patent corrugated metallic packing, as supplied to the Admiralty, to the Spanish navy, and to a very large number of home and foreign shipbuilders, engineers and other large users of packing material. This list of users includes a number of leading firms in the electrical industry. The samples to hand consist of metal rings and oblongs cut from very thin sheets of brass and corrugated for the purpose of being placed in the joints with cement for the joining together of metal pipes and other metal articles, ensuring their steam and water-tight condition. In making the joint, one of the corrugated rings is laid along with the cement on the inner surface of the flange, clear of the bolts, and in screwing up the joint the ridges of the corrugation yield and take the impressions of all the surfaces of the flanges, making it impossible for any high-pressure or other steam or water to penetrate the joint. These rings, oblongs and squares are made of various inside diameters, and can be supplied to all requirements. They are manufactured in brass, copper and gunmetal.

"Unica" Noiseless Pinions.—Messrs. J. B. Hamilton & Co., 145, Cannon-street, London, E.C., are placing on the market pinions of a special composition, said to be more durable than, and equally silent as, raw hide. They are claimed to be unaffected by oil and not to require side plates, shrouds, or bushes. Amongst the uses they have been put to, so far, may be mentioned electric motors, pumps, printing machines, calenders, &c.

Burnand Transformers—We learn that the Burnand Transformer Co., of 6, Oxford-street, Regent-street, Salford, have just completed delivery of a large order for Burnand transformers for Launceston, Tasmania, comprising approximately 100 transformers with a total capacity of 1,450kw. These transformers have all been tested and passed by Prof. Fleming without a single rejection.

Metal-Rolling Machinery—Some fine examples of improved rolling machinery for rolling sheet lead, leadfoil, tin, tinfoil, pewter plates, sheet zinc, brass, copper, aluminium, &c., are listed in a set of sheets which reach us from Messrs. John Wilson & Sons, of Vulcan Works, Johnstone, Scotland. The machinery illustrated in the list has been actually installed, and gives an excellent idea of the capabilities of the firm for turning out the largest required units of machinery for this class of work. Messrs. John Wilson & Son manufacture a very large variety of machines, engineering tools, &c., and a list of these is now ready and can be obtained on application. The special machines for covering telegraph and telephone cables and electric light conductors in long lengths without joins from ⅛in. to 4in. diameter, and any desired thickness of covering, have been supplied to the principal manufacturers of these cables at home and abroad, and are made under the personal supervision of the patentee, Mr. Alexander Wylie.

Admiralty Contract.—For the 18th year the United Asbestos Co. (Ltd.), Dock House, Billiter-street, London, E.C., have been awarded by the Lords of the Admiralty the contract for asbestos goods for use in the Royal Navy. The contract includes the following:—United asbestos carded fibre (special Italian), twine, "Victor" metallic packing and metallic joints and "Salamander" mattresses.

Willing's Press Guide—The 31st annual issue of this useful guide to the world's press is to hand. We have frequently spoken in terms of praise of this compact and useful annual, and have only now to repeat that the book gives, in the concisest manner possible, an immense amount of information which, so far as we are able to check it, is accurate and reliable. It is published, price 1s, by Messrs. James Willing, jun. (Ltd), 125, Strand, London, W.C.

"London Manual, 1904"—The new edition of this manual, edited by Mr. Robert Donald, is to hand. The book is published, price 1s. 6d., by Messrs. Edward Lloyd (Ltd.), of Salisbury-square, London, E.C. This is the eighth year of publication of a useful Manual, which contains a good deal of information concerning public bodies not to be found so concisely assembled, we think, in any other publication. The Manual appears, so far as we have been able to check it, quite up to date, and, moreover, gives evidence of more careful editing than many works of a more pretentious character. In the map on p. 162, Stoke Newington is shown white, indicating the possession of municipal electricity works in operation. This is hardly correct. It is true that this borough has powers to purchase electricity in bulk from the adjoining boroughs of Hackney and Islington, and does, in fact, purchase current from the former. Generally the information in this Manual will be found both reliable and complete.

Half-tone Process Work.—The engineering trades have been interested in the development of half-tone process work, and have taken every advantage of this development. The process is one which has a direct interest for the manufacturing branch of the industry, and therefore the third edition of "The Half-tone Process," by Julius Verfasser, which has just been published by Messrs. Iliffe & Sons, London, price 5s. net, will meet with some demand amongst engineers. The new edition has been entirely re-written, and is now a volume of nearly 300 pages, with numerous illustrations. The practical side of photo process work is the book's chief recommendation, and those who desire to make themselves fully acquainted with this branch of industry may be advised to consult Mr. Verfasser's work. If we may make one comment concerning the illustrations, we do not think the examples shown on the pages following p. 32 do full justice to the subject. The book would have been improved by more numerous examples of the gradation of screen, especially examples of machines and apparatus which would appeal to engineers and machine builders.

Catalogues, &c.—The Synchronome Co., of 32 and 34, Clerkenwell-road, London, E.C., have prepared a list of all the time circuits in the United Kingdom, except a very few. Mr. F. Hope-Jones, the manager and patentee of this company's system, calls attention to the apathy which prevails in this country regarding this branch of electrical work. He bewails the limited competition that exists here in comparison to that prevailing on the Continent and in the United States of America, and infers that his company would welcome rivals who would assist in bringing before the public and our large manufacturers the benefits of uniform and accurate time. A well-got-up catalogue of the apparatus and instruments forming the Hope-Jones system of electric time service, as owned by the Synchronome Co., is just issued, and this is accompanied by a good list of large firms who have adopted the "synchronome" time service. These include electrical engineering and engineering works, insurance offices, banks, railways, institutions, schools, large business premises in various branches of industry, private establishments, &c., totalling in all over 1,200 dials. The list is accompanied with a set of instructions for the management of the apparatus, and a number of unsolicited testimonials.

The British Prometheus Co., 18, London-road, Kingston-on-Thames, have ready a new "Radiator" pamphlet illustrating and describing the latest types of this company's electrically-heated radiators, to which attention has been called on several occasions in these columns. It is pointed out that every Prometheus radiator is sold with a 12 months' guarantee, and that so far the makers have not had a single case of complete breakdown. Trifling defects which have occurred have been simply and promptly repaired. A special system of heaters for tramcar and railway carriage heating is listed, to which particular attention is called. Numerous ornamental and plain designs of radiators are given, and a table of general information concerning current consumption, cost of installation, &c.

The Britannia Co., Colchester, have ready a new list of the Britannia oil engine (Nicholson's patent), for which several advantages are claimed. The company have some new price lists ready of lathes, drilling and shaping machines, &c.

From Acoustic Patents Limited, 20, Bucklersbury, London, E.C., we have received two pamphlets describing the electrical acoustic inventions of Mr. Miller Reese Hutchinson. The apparatus is claimed to form a complete electrical system for the treatment and cure of deafness.

A new list of roller bearings is issued by the Empire Roller Bearings Co., 1, Delahay-street, Westminster, London, and contains very useful information concerning roller bearings generally and the company's manufactures of this class of goods in particular. There is a new series listed for plummer blocks for shafting.

Messrs. Hunt and Hess, makers of litholite, have ready a new (No. 3) sheet of litholite handles, bushes, &c., giving some of the latest patterns now being made in these goods. The list is accompanied by a certificate from the Westminster Electrical Testing Laboratory of satisfactory tests made for insulation resistance and dielectric strength of litholite.

Messrs. Robert W. Blackwell & Co., 59, City-road, London, E.C., have ready a new list of "Arkless" fuses.

The latest calendar to hand is published by Messrs. Crompton & Co., and is described as an "Arc Lamp Calendar" for 1904. A view of Messrs Crompton's works at Chelmsford is affixed to the cover, and good photographic views are given of installations of Crompton arcs at Plymouth, Edinburgh (2), Aberdeen, Newport, Cork, Glasgow (2), Carlisle, Birmingham, Crystal Palace and Avonmouth.

Exports and Imports of British Produce.—The value of telegraphic cable and apparatus *exported* from Great Britain in the month of December, 1903, was £43,237, compared with £106,591 for the same month in 1902 and with £37,572 for December, 1901. The exports for the year were £1,808,136, compared with £2,838,641 for 1902 and £3,147,985 for 1901. [The Pacific cable project is probably responsible for the chief difference in these figures.] The *imports* of these goods for the month of December was £1,379, compared with nil for the same months in 1902 and 1901. For the whole year 1903 these imports were £57,360, compared with nil for 1902 and 1901.

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Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Jan. 6 to 12 with the ports of destination:—

Africa—Cape Town, £142; Durban, £5,132 (including £2,165 telegraph material); East London, £727. *Argentina*—Buenos Ayres, £148 (telegraph material); *Australasia*—Adelaide, £44; Auckland, £120; Brisbane, £361; Hobart, £86; Melbourne, £233; Perth, £208; Sydney, £731; Wellington £3,834 (including £1,849 telegraph material). *Belgium*—Antwerp, £234. *Brazil*—Rio Janeiro, £575 (including £550 telegraph apparatus). *British Guiana*—Demerara, £96. *Ceylon*—Colombo, £230. *Channel Islands*, £69. *China*—Shanghai, £84. *Columbia*—Santos, £196. *Gibraltar*, £269 (including £70 telegraph material). *Holland*—Amsterdam, £40; Rotterdam, £48 (telegraph material). *India*—Bombay, £146; Calcutta, £437 (including £301 telegraph material); Madras, £599. *Japan*—Yokohama, £36. *Malta*, £135. *Norway*—Christiania, £132 (telegraph apparatus). *Russia*—St. Petersburg £18 (telegraph material). *Straits Settlements*—Singapore, £28. *Sweden*—Gothenburg, £21; Stockholm, £152 (telegraph wire). *Uruguay*—Monte Video, £108. Total £15,499, against £6,558 in the corresponding week last year (Jan. 7 to 13).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

November 14, 1903.

24,797 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
24,798 B.T.-H. Co. (G.E. Co., U.S.) Electric vehicles.
24,799 B.T.-H. Co. (G.E. Co., U.S.) Electric motor systems.
24,800 B.T.-H. Co. (G.E. Co., U.S.) Braking systems.
24,806 F. Hinz. Electrolytic manufacture of peroxides of magnesium and zinc.
24,808 A. T. M. Thomson. Facilitating communication through exchanges.
24,833 A. Wydts and J. Klopfenstein. Spark intensifier for electric igniters.

November 16, 1903.

24,847 M. G. Waggott. Birmingham. Electro-mechanical automatic switches.
24,848 Sherard Cowper-Coles & Co. and Sherard Cowper-Coles. Electro-deposition of zinc.
24,854 F. A. Chandler and B. Bonniksen. Coventry. Electric clocks.
24,905 A. G. Haddock. Electrolytic cells.
24,909 C. P. Steinmetz. Electric lamps and making same. (Date applied for, Nov. 17, 1902, date of application in U.S.).*
24,912 J. I. Ayer. Utilising electrical energy in heating, lighting, &c.*
24,914 W. Reuter. Magnetic lifting device for cranes.*

November 17, 1903.

25,006 E. W. Lewis and Daimler Motor Co. Coventry. Electric ignition.
25,812 A. S. Adler. Systems of electrical regulation.*
25,016 T. E. Cornwell. Storage batteries.
25,020 F. M. Staunton. Automatical governing of electric motors of vechicles when given speed is exceeded.
25,022 A. McMurtrie. Couplings for conduits. (Date applied for, Nov. 21, 1902, date of application in U.S.)*
25,026 A. P. Warner and C. H. Warner. Magnetic tachometers.*
25,023 M. H. Galsworthy and London Electrical Fittings Co. Adjustable electric light pendants or fittings.*
25,047 A. G. Bloxam. (J. Goffin, Belgium). Brackets for telegraph and like posts.
25,053 G. G. Milne. Electric lighting and power systems.*
25,074 G. W. L. Case and Reason Mfg. Co. Electrical demand or rebate indicators.

November 18, 1903.

25,087 J. Gardner. Manchester. Preventing interference in wireless telegraphy.
25,098 J. S. Foley. Birmingham. Terminal fittings for electric cables.
25,110 J. H. Airey. Sunderland. Trolley-pole attachments.
25,114 J. Allen. Coin-freed electric meters.
25,122 J. B. Fournier. Arc lamps.*
25,127 W. Aitken. Liverpool. Telephone exchange systems.
25,132 E. A. Ashcroft. Electrolytic cells.
25,133 E. A. Ashcroft. Plates for storage batteries.
25,146 G. Laird and J. P. Todd. Controllers for electric motors.
25,157 G. Honold. Magnetic ignition device.*
25,153 L. Cibié. Arc lamps.
25,162 Metals Corporation and Sherard Cowper-Coles. Electrolytic refining of copper.

November 19, 1903.

25,189 M. H. Barber and G. H. Larmuth. Manchester. Electric switching devices.
25,197 W. R. V. Marshall. Glasgow. Dynamo-electric machines and motors.
25,199 C. T. B. Sangster. Birmingham. Switches for electric ignition.
25,222 H. H. Hornsby and E. W. Auger, jun. Protective device for electric circuits.*
25,228 L. P. Asbury. Bexley Heath. Fuse head, and manufacturing same.
25,235 C. Smart. Commuting currents passing through combined arc and incandescent lamp circuits.
25,244 W. P. Thompson (E. L. Frenot, France). Electric lamp.
25,245 W. P. Thompson. (E. L. Frenot, France). Electric lighting system.
25,230 L. H. Strain. Electric sparking devices for internal combustion motors.
25,284 E. T. Ruthven-Murray. Support for cables.

November 20, 1903.

25,305 T. C. Perkins and F. W. Massey. Burton-on-Trent. "Frog" for making connection between line wires at places where line is not continuous in conductors used for overhead wiring for electric tramcars.
25,313 C. Owens. Manchester. Fire alarms and extinguishers.
25,322 P. M. A. Matthews and H. P. Houghton. Manchester. Resistances.
25,341 L. W. Huber and G. B. Mercer. Liverpool. Electric ignition for gas, petrol and like engines.
25,343 E. M. Goldburgh. Self-testing sparking plug for motors.
25,349 J. A. Stevens. Reflector for incandescent lamps.
25,381 Marconi's Wireless Telegraph Co. and A. Gray. Circuit breakers and closers for wireless telegraphy.
25,382 J. A. Fleming and Marconi's Wireless Telegraph Co. Signalling keys.
25,383 J. A. Fleming and Marconi's Wireless Telegraph Co. Transmitting instruments for wireless telegraphy.
25,386 B. Becker. Electro-magnetic tremblers.
25,389 A. G. Bloxam. (A. Schoeller, Germany.) Magneto-electric induction apparatus.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1902.

22,732 Zani. Switches.
23,066 Leitner. Systems of electric lighting.
25,149 Berry. Apparatus for distributing alternating currents.
25,522 Crompton & Co. and MacIntosh. Boosters for charging and discharging storage batteries and regulating the pressure of the 'bus bars.
25,554 de Kandó. Electric contacts.
25,731 Routin. Electro-chemical regulators.
25,757 Carolan (G.E. Co., U.S.). Electric heaters.
25,954 Lorrain (E.A.G. vorm. Schuckert & Co.). Process and furnace for obtaining metals, metalloids and compounds of the same.
26,040 Carolan (G.E. Co., U.S.). Systems of electric motor control.
26,764 Leitner and Lucas. Regulating electric generators.
27,301 Lake (Stone). Method of applying electromagnetic signal waves.
27,760 Carolan (G.E. Co., U.S.). Magnetic core structures of reactance coils.
27,767 Carolan (G.E. Co., U.S.). Arc lamps.
27,770 Carolan (G.E. Co., U.S.). Arc lamps for constant potential circuits.
28,509 Lake (Stone). Transmission of electromagnetic signals without wires.
28,515, 28,521, 28,549 and 28,550 Lake (Stone). Electric wireless telegraph systems.
28,551 Lake (Stone). Oscillators for wireless telegraphy
28,728 Macgregor. Fusible cutouts.
28,761 Piscicelli. Motor despatch boxes and overhead lines for use in electric postal service.
28,820 Mann and Goebel. Electrodes for primary batteries.

1903.

47 Heap. Transformers used with instruments measuring energy.
70 Siemens Bros. & Co. and Ferreira. Electromagnetic switches.
329 Lang. Regulating electric motors.
415 Rodebourg. Negative electrodes for secondary batteries.
455 Javaux and Barbou. Control of direct-current dynamos and motors.
695 Pieper and L'Hoest. Electric lighting of railway trains.
752 Milburn. Sparking plugs for vapour engines.
896 B.T.-H. Co. and Murphy. Arc lamps.
1,057 Carolan (G.E. Co., U.S.). Thumb pieces for switches.
1,058 Carolan (G.E. Co., U.S.). Switches.
1,059 Carolan (G.E. Co., U.S.). Hangers for overhead conductors.
1,060 Carolan (G.E. Co., U.S.). Fuses or cutouts.
1,051 Carolan (G.E. Co., U.S.). Switches, and making the same.
1,062 Carolan (G.E. Co., U.S.). Arc lamps.
1,064 Carolan (G.E. Co., U.S.). Switches.
1,065 Carolan (G.E. Co., U.S.). Electric couplings.
1,066 Carolan (G.E. Co., U.S.). Combined switches and cutouts.
1,069 Carolan (G.E. Co., U.S.). Conductor connections on third-rail or like electric railways.

ISSUE OF CAPITAL BY THE A.E.G.—The A.E.G (Berlin) is said to be about to increase its capital by the issue of new shares amounting to £1,150,000, the object being to complete the absorption of the Union Electricity Co., with whom recently working arrangements were made. The A.E.G. is said to have subscribed largely to the share capital of the General Electricity (Thomson-Houston) Co., which has been recently formed with a capital of £240,000.

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NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

H. J. CASH & CO. (LTD.)—Reg. Jan. 9, capital £10,000 in £1 shares, to carry on business as electrical, mechanical, heating and ventilating engineers, manufacturers of and dealers in electrical appliances, electrical contractors, fitters, &c. The first subscribers are H. J. Cash, electrical engineer, H. T., H., S. and H. T. Holloway, jun., C. Thomson and C. J. Byworth. First directors are H. T. Holloway, H. Holloway, S. Holloway, C. Thomson, C. J. Byworth and H. J. Cash (all permanent). Reg. office, 1, Belvedere-road, Lambeth, S.E.

A.E.G. ELECTRICAL CO. OF SOUTH AFRICA (LTD.)—Reg. Jan. 6, capital £50,000 in £5 shares, to carry on business as electrical and mechanical engineers, electricians, suppliers of electricity for light, heat, motive power or other purposes, manufacturers of and dealers in any apparatus, machinery, appliances for the generation, distribution, supply, &c., of electricity, constructors, owners and managers of railways, tramways, generating stations, &c., manufacturers of and dealers in lamps, fittings, electric elevators, carbons, motors, engines, &c., in South Africa or elsewhere. The subscribers are J. Stottner, S. A. Simon, C. Giestränger, G. Ambach, A. Hirschberg, P. Listner and M. Schlönberger. First directors, Felix Deutsch (Berlin), Prof. Klinberger (Berlin), Franz Deutsch and C. F. de Nordwall. Reg. office, 125, Charing Cross-road, London, W.C.

ELECTROGRAPH LIMITED.—Reg. Jan. 4, capital £10,000 in £1 shares, to acquire interest of E. G. Craven in an invention known as "Electrograph," to acquire patents, &c., relating thereto, and to carry on the business of manufacturers of and dealers in "electrographs" and electric instruments or apparatus of any kind, electrical and mechanical engineers, electricians, &c. Reg. office, Donington House, Norfolk-street, Strand, W.C.

MECHAN & CO. (LTD.)—Reg. in Edinburgh Jan. 8, capital £200,000 in 10,000 preference shares of £10 each and 100,000 ordinary shares of £1 each, to acquire the undertaking of Messrs. Mechan & Sons and to carry on the business of electrical, mechanical, hydraulic and general engineers, machine and engine tool makers, engine and carriage builders, &c. First directors, H. Mechan, S. Mechan and A. Mechan. Reg. office, Scotstoun Iron Works, Scotstoun, Renfrewshire.

MORTGAGES AND CHARGES.

CHELMSFORD ELECTRIC LIGHTING CO. (LTD.)—Trust deed, dated Dec. 21, 1903, to secure £20,000 debenture stock, has been registered. Property charged: Company's personal property, including uncalled capital and unpaid calls, goodwill, trade debts and other choses in action, and certain freehold lands and hereditaments at Chelmsford. Trustees, Lieut.-Col. R. E. B. Crompton, C.B., and B. Gibson.

COSTA RICA ELECTRIC LIGHT AND TRACTION CO. (LTD.)—A principal trust deed, dated March 30, 1898, to secure £130,000 debentures created March 14, 1898, and a supplemental trust deed, dated Dec. 23, 1903, to secure £100,000 further debentures created Nov. 25, 1902, have been registered. Property charged, contracts or concessions for using the waters of the rivers Maria Aguilia, Tiribi, Varilla, Torres and Cartago, having an available horse-power of about 1,360, with power houses and other works used in connection therewith, land at Anonos, San José and Cartago, and the company's undertaking and property, present and future, including uncalled capital. Trustees, City Safe Deposit and Agency Co.

ROSS ELECTRIC LIGHT AND POWER CO. (LTD.)—£1,500 debentures, created and dated Dec. 17, 1903, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 27$\frac{5}{8}$d. per oz. (Jan. 14). Consols 88$\frac{1}{16}$—88$\frac{3}{8}$ for money, 88$\frac{1}{8}$—88$\frac{1}{4}$ for account; 2$\frac{1}{2}$ per cent. annuities 87$\frac{1}{2}$—88 (Jan. 14). Consols Pay Day, Feb. 3; Stocks and Shares Continuation Days, Jan. 26 and Feb. 9; Ticket Days, Jan. 27 and Feb. 10; Pay Day, Jan. 28; Mining Share Carry-over Days, Jan. 25 and Feb. 8.

CHILI TELEPHONE CO. (LTD.)—The directors have declared an interim dividend at the rate of 6 per cent. per annum for the six months ended Sept. 30.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have declared an interim dividend of 3s. per share, tax free (at rate of 3 per cent. per annum), for the quarter ended Dec. 31, payable 30th inst., setting aside £8,000 to reserve, and carrying forward about £2,479. The transfer books are closed from Jan. 12 to 26 inclusive.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)—The interest on this company's 4 per cent. mortgage debenture stock for the half-year ended Jan. 31 will be paid on Feb. 1. The 4 per cent. mortgage debenture stock register will be closed from 27th to 30th inst. inclusive.

GLOBE TELEGRAPH AND TRUST CO. (LTD.)—A quarterly interim ordinary dividend of 2s. per share is announced.

LIVERPOOL OVERHEAD RAILWAY CO.—At a special meeting on Tuesday the issue of £60,000 additional share capital in £10 5 per cent. preference shares was authorised. The chairman (Sir Wm. Forwood) said the new capital was to enable them to pay for the extension to bring their railway into connection with the Lancashire and Yorkshire Railway at Seaforth. The cost would be about £14,000, and other expenditure would be involved in the laying of the new third rail from Seaforth station to the southern end of the line at a cost of £12,000. Increase of plant at the generating station would cost £7,900, a total of £33,900. In addition they wished to make good their capital account. The new shares would be offered to all the shareholders.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—An extraordinary meeting will be held on 22nd inst. to authorise the creation and issue of a second £50,000 debenture stock.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed Jan. 20 a special settling day in and have ordered to be quoted £200,000 5 per cent. debenture stock of the *Buenos Ayres Electric Tramways Co. (1901) Ltd.* The Committee have been asked to appoint a special settling-day in, and to grant a quotation to a further issue of 5,763 fully paid ordinary £1 shares and 5,763 fully-paid 6 per cent. cumulative preference £1 shares of the *West London and Provincial Electric Supply Co. (Ltd.)*, and also to allow a further issue of 17,500 fully-paid 5 per cent. cumulative preference £10 shares of the *London United Tramways (1901), Ltd.* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Jan. 9	1,240	+ 421	32	39,858	+ 7,342
Ayr Corporation	,, 2	216	- 10	33	10,348	+ 71
Barnsley	,, 1	176	- 11	52½	9,399	- 69
Bexley District Council	,, 8	123	...	14	2,267	...
Birkenhead	,, 10	982	+ 36	1	982	+ 36
*Birmingham Tramways	,, 9	5,046	+ 123	1	5,046	+ 123
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 7	295	- 24	§10	88,213	- 222
Blackpool and Fleetwood	,, 11	188	- 4	2	250	- 48
Blackp'l, St. Anne's & Lytham	,, 7	134	+ 111	†10	1,454	+ 929
Bolton Corporation	,, 10	1,065	+ 105	41	75,517	+ 8,424
Bournemouth Corporation	,, 6	857	+ 209	1	857	+ 209
*Bradford Corporation	,, 10	3,302	+ 190	89	154,421	+ 20,346
Brighton Corporation	,, 10	743	...	40	87,754	+ 2,590
Brisbane Tramways	Nov. 25	2,295	+ 101	21	49,135	+ 476
*Bristol Trams & Carriage	Jan. 8	4,448	+ 102	7	31,957	+ 1,162
*Buenos Ayres & Belgrano	Dec. 13	3,269	+ 33	8	25,829	+ 951
Burnley Corporation	Jan. 9	815	+ 140	41	41,045	+ 7,154
Burton Corporation	,, 10	294	...	23	8,156	...
Calcutta Tramways Co.	,, 9	R39,092	+R3,853	2	R79,522	+ R17,460
Camborne-Redruth	,, 11	98	...	10	7,242	...
Cardiff Corporation	,, 9	1,823	+ 237	41	80,512	+ 20,880
Carlisle Tramways Co.	,, 9	175	+ 23	§1	249	+ 30
Central London Railway	,, 9	7,054	+ 87	2	13,615	- 5
Chatham & Dist. Lt. Rys.	...	...	...	...	...	...
City & South London Rly.	,, 10	3,133	- 273	2	6,405	- 442
Cork Electric Trams Co.	,, 7	415	...	1	415	...
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 1	457	+ 79	52½	24,268	+ 1,844
Dover Corporation	,, 9	171	- 11	†41	9,349	+ 53
Dublin & Lucan Railway	,, 10	126	...	¶2	126	- 4
Dublin Southern District	,, 8	685	+ 17	1	685	+ 24
Dublin United	,, 8	3,717	+ 50	1	3,717	
Dudley—Stourbridge	,, 1	866	+ 66	52½	43,549	+ 3,852
Dundee Corporation	,, 6	1,125	+ 64	1	1,125	+ 64
East Ham Council	,, 9	585	+ 102	†41	27,863	+ 7,715
Gateshead & Dist. Trams	,, 1	1,008	+ 86	52½	46,272	+ 5,494
Glasgow Corporation	,, 9	14,619	+ 2,594	32	439,805	+ 45,685
Gravesend—Northfleet	,, 1	221	+ 27	52½	12,602	+ 1,390
Greenock & Port Glasgow	,, 1	520	- 2	52½	28,388	+ 2,823
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 1	293	+ 45	52½	14,175	+ 994
Huddersfield	,, 9	1,093	+ 80	...	...	...
Hull Corporation	,, 9	2,037	+ 275	†41	77,732	+ 5,290
Ilkeston Corporation	,, 6	106	...	8	961	...
Ipswich Corporation	,, 9	340	...	1	340	...
Isle of Thanet Co.	...	...	...	...	...	...
Kidderminster & District	,, 1	126	+ 16	52½	6,605	+ 188
Kirkcaldy Corporation	,, 6	343	...	44	7,916	...
Lanarkshire Trams Co.	,, 7	873	...	1	873	...
Leeds Corporation	,, 9	4,795	+ 224	41	225,523	+ 13,630
Liverpool Corporation	,, 2	9,696	- 11	1	9,696	- 11
*Liverpool Overhead Rly.	,, 10	1,593	+ 96	2	3,161	+ 163
*London County Council	,, 2	8,860	+ 784	†41	403,144	+ 72,279
	,, 9	9,326	+ 1,234			
Lowestoft	,, 9	136	...	†25	5,781	...
Manchester Corporation	,, 9	10,749	+ 2,560	30	350,236	+ 170,970
Mersey Railway	,, 9	1,450	+ 383	1	1,450	+ 383
Merthyr	,, 1	214	+ 31	52½	10,456	+ 51
Middleton	,, 1	278	+ 6	52½	16,389	+ 1,951
Newcastle-on-Tyne Corp.	,, 9	3,468	+ 523	1	3,468	+ 523
*Newport (Mon.)	,, 9	421	+ 222	14	6,118	+ 3,168
Oldham, Ashton & Hyde	,, 1	542	+ 14	52½	20,582	+ 1,643
Perth (W. A.) Elec. Trams.	,, 8	1,426	+ 226	1	1,426	+ 226
Peterborough	,, 1	134	...	49	7,608	...
Poole and District	,, 1	256	- 6	52½	15,565	+ 2,087
Portsmouth Corporation	,, 9	1,371	+ 51	†41	72,719	+ 4,635
*Potteries	,, 1	1,549	+ 3	52½	83,559	+ 3,722
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 1	56	- 17	52½	7,047	+ 1,590
Salford Corporation	,, 9	3,569	+ 690	41	157,185	+ 44,675
Sheerness	Dec. 30	57	...	38	3,109	...
Sheffield Corporation	Jan. 10	4,038	+ 223	2	8,058	+ 589
*Southampton Corporat'n	,, 7	845	- 30	1	845	- 80
Southend Corporation	,, 6	189	+ 19	40	13,226	+ 2,080
Southport Tramways	,, 1	239	- 19	52½	16,109	+ 2,710
S. Staffordshire Trams.	,, 1	1,186	+ 389	52½	48,636	+ 9,288
*Sunderland Corporation	,, 10	1,035	+ 126	41	50,327	+ 2,328
*Swansea Trams	,, 1	554	+ 61	52½	27,192	+ 2,192
Taunton Trams	,, 1	56	- 4	52½	3,129	- 204
Tynemouth and District	,, 1	239	+ 11	52½	15,876	+ 733
Tyneside Trams Co.	,, 6	253	+ 23	1	253	+ 23
Wallasey District Council	,, 9	584	+ 44	†41	28,399	+ 3,427
Weston-super-Mare	Dec. 30	26	- 11	52	5,757	- 587
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	Jan. 1	423	+ 31	52½	20,285	+ 7,627
Wrexham	,, 1	125	...	39	5,403	...
Yorkshire Woollen District	,, 1	605	...	45½	18,267	...

(a) These comparisons are with the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Jan. 13.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS WEEK TO JAN. 13. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
£	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4¾—5	4 17 6	April, Oct	4¾	..
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	127¾	127
10	10/0	Barcelona Tramways Ord.	7⅞—8¼	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
£	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
£	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	† Do. Cum. Pref. (fully paid)	10½—10¾	3 15 11	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 —82	3 12 9	..	79½	..
St.	5%	Do. Pref. Ord. Stock	91 —94	5 6 2	..	93	..
10	4/2½	Do. 5% Cum. Perp. Pref.	10½—10¾	4 13 0	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅞	4 6 7	..	103	102⅝
100	4%	Do. Vancouver Power Debs.	100 —103	4 9 4	..	..	..
10	6/0	British Electric Traction Ord.	11¾—11¾	6 16 2	..	11⅞	11¾
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—11¾	5 2 2	Feb, Aug	11⅝	11⅝
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	122½	..
£	..	Buenos Ayres and Belgrano Ord.	3 —3¼	..	..	3⅜	3⅜
£	3/0	Do. 6 per Cent. "A" Cum. Pref.	5¼—5¾	5 4 0	..	5⅞	..
£	3/0	Do. "B"	4¾—5¼	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	100	99⅜
£	2 6	Calcutta Tramways	6⅜ —7	4 12 10	..	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 —107	4 4 2	..	105⅛	..
1	1/0	Cape Electric Tramways Shares	1⅜—1⅝	9 1 4	..	1⅜	..
St.	4%	Central London Ordinary Stock	91 — 94	4 6 7	June, Dec	95	95⅛
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	4 0 4	..	99½	98⅜
St.	4%	Do. Deferred Stock	91 —94	4 8 11	..	92½	..
100	4%	Do. 4 per Cent. Debs.	115 —118	3 7 11	..	..	..
£	2/6	City of Birmingham Trams.5% Cm. Prf.	5 —5½	4 10 11	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	47 —50	6 5 0	Feb, Aug	48⅜	47
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 —129	3 18 7	Feb, Aug	..	..
St.	5%	Do. (1896)	123 —126	4 0 4	..	..	..
St.	5%	Do. (1901)	120 —125	4 1 1	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	102 —105	4 16 5	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13¼	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
£	6/0	Electric Lgt. & Tract.of Aust.6%Cm.Prf.	3¾—4¼	6 13 4	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 —8	3 15 0	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	††Do. 6 per Cent. Pref.	14½—14¾	4 2 10	Mar, Sept	..	..
St.	4½%	††Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
£	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3¼—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4¼—5	2 10 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10¼—10¾	4 13 0	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	97 —99	4 0 9	Jan, July	..	..
1£	5,0	London United Trams. 5% Cum. Pref.	11 —11¼	4 6 11	..	11¼	11⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	102 —104	3 16 11	..	103½	..
St.	..	Mersey Con. Ord. Stock	8 —11	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1⅛	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1⅛	4 8 11	..	1	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	102 —104	4 16 2	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 4 1	..	..	..
£	..	New General Traction Ord.	⅛	..	..	..	..
£	..	Do. 6 per Cent. Cum. Pref.	1¼—2¼	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1st Mt.Db.Stk.	99 —102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8¼ - 9¼	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 —94	3 9 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2¼—3¼	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	49 —52	6 1 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	92 —94	6 8 3	F,My,Ag,N	94	93
St.	1/0	Do. Deferred	7⅛—8	0 13 0	F,My Ag,N	7⅛	7⅛
100	£2	Commercial Cable Capital Stock	175 —185	4 7 0	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —92	4 7 0	Jn Ap,Jy,O	90	89⅛
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	7⅛	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3¼	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	7⅜	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝—101⅞	4 9 1	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10¼	6 3 10	Ja,Ap,Jy,O	10⅛	..
100	4½%	Direct West India Cable 4½% Rg.Db.(rd.)	98 —101	4 9 1	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	121 —126	5 11 1	Ja,Ap,Jy,O	123	..
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 18 5	Ja Ap,Jy,O	..	..
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	106	..
10	2/6	Eastern Extension	11 —11½	6 1 9	Jn,Ap,Jy,O	11⅝	11
St.	4%	Do. 4 per Cent. Deb. Stock	106 —109	3 14 4	Feb, Aug	106¼	..
100	4%	* Eastern & S. African 4% Mrt. Deb.1909	99 —102	3 18 10	Feb, Aug	100¼	99
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102%	3 18 11	May, Nov	..	..
10	5,0	Great Northern of Copenhagen	24½—25½	4 18 1	Jan, July	..	..
100	4½%	Halifax & Bermudas4½% 1st Mt.Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	12/6	Indo-European	37 —40	6 5 0	May, Nov	39½	..
100	6%	London Platino-Brazil. 6% Debs., 1904	98 —102	5 18 3	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 —6	3 6 8	..	..	..
2½	..	West Coast of America	⅛—⅜	..	..	⅛	..
100	4%	Do. 4 per Cent. Debs.	96 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	6⅜	6
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	99	..
10	3,0	Western Telegraph	11¾—12½	5 14 3	Mr,Jn,O,D	12	11⅞
100	5%	* Do. 5% Debs. (2nd Series, 1906)	99 —102	4 18 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 3	..	..	..
		FINANCIAL, INVESTMENT, &c.					
£	8/0	†Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8½—8¾	4 11 5	Ja Ap Jy O	8¾	8⅞
10	3/0	Do. 6 per Cent. Pref.	12½—13	4 12 4	Ja Ap,Jy,O	12⅞	12⅝
5	4/0	Reuter's	6½—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	118 —123	4 18 9	April, Oct	119	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Jan. 13.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS WEEK TO JAN. 13. Highest.	Lowest.
		TELEPHONES.					
£	6/0	Chili Telephone (fully paid)	4¾—5¼	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	102 —104	5 18 0	..	103½	102
St.	5%	Do. Def. Stock	77 —80	6 2 10	..	77¾	77
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	..	..
10	6,0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	..	..
£	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5¼	4 15 3	Feb, Aug	5¼	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 —97	3 12 2	June, Dec	..	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	100 —102	3 18 5	..	..	..
1	0/7½	Oriental	⅞—1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
£	3 0	United River Plate	5¼—6	5 16 8	July.....	..	..
£	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 – 105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝—¾	..	..	..	..
1	..	Do. 7 Cum. Pref.	1⅛—1⅜	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	114 —117	3 17 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13⅛	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
£	4/6	Brompton & Kensington Elec. Sup. Ord.	10 —10½	4 5 9	..	..	..
£	3/6	Do. 7 per Cent. Pref.	9⅜—10½	3 8 4	Mar, Sept	..	..
£	3.0	Calcutta Electric Supply Ord.	6½ - 7½	4 6 8	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	105 – 108	3 13 11	..	..	..
£	4/0	Charing Cross & Strand Electric Sup..	8¾ - 9½	5 8 1	Feb, Aug	9½	9⅛
£	2/3	Do. 4½ per Cent. Pref.	5¼—5¾	3 18 3	Feb, Aug	..	..
£	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 —105	3 16 3	..	..	..
£	2 0	Chelsea Electric Supply Ord.	5½—6	4 3 4	March ..	5⅝	..
St.	4½%	* Do. 4½ per Cent. Deb Stock (red.)	105 —108	4 3 3	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¼—10¾	6 19 6	Feb, Aug	10¼	10¼
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13½	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7½ - 8½	4 14 2	..	8	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	11⅞	11½
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 1 10	..	107	..
St.	27.6%	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	101½	100
£	2 0	Folkestone Electricity Supply Co. Ord	5½—6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
10	..	Havana Electricity Co. Shares (£8 paid)	7⅛—8½	..	..	..	..
£	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
£	5/0	Kensington & Knightsbridge Ord.	10½—11½	4 6 11	..	..	..
£	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck.(red.)	101 —104	3 16 11	..	..	..
8	..	London Electric Supply Ord.	1¾—2¼	..	..	..	..
£	3/0	Do. 6 per Cent Pref.	5¼—5¾	5 4 4	..	5¼	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 —100	4 0 0	Mr,Jn,S,D	98⅛	..
10	8 0	Metropolitan Electric Sup. Ord.	17—18	4 6 1	April, Oct	17½	17⅛
5	..	Do. 4½ per Cent. Cum. Pref.	5¼—5¾	..	..	5⅛	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	109 —113	3 19 6	Jn, Dec ..	110½	110
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 4	..	..	..
100	4½	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
1£	6 0	Notting Hill Electric Ord.	12½—13½	4 8 11	March....	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
£	2 6	Oxford Electric Ord.	5¼—5¾	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 —101	4 0 6	..	..	..
1	..	Rand Electric	⅝—1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
£	5 0	St. James's and Pall Mall Electric Ord.	14½—15½	4 13 9	Feb, Aug	14⅞	14⅝
£	3 6	Do. 7 per Cent. Pref	8 —9	3 17 9	Feb, Aug	8⅛	8⅛
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —101	3 10 4	..	..	..
£	2/6	Smithfield Markets Electric Sup. Ord.	3 —3¼	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
£	1/9	South London Electric Supply Ord.	3¼ - 3⅝	4 13 4	..	3⅝	..
£	2,6	Urban Electric Supply Ord.	4½ 5¼	4 17 7	..	..	..
£	2,6	Do. 5% Cum. Pref.	4¾—5¼	4 17 7	..	..	..
£	6/6	Westminster Electric Supply Ord.	12 —13	5 0 0	Mar, Sept	12⅝	12⅛
£	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6⅝	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref...	½—¾	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅜—⅞	..	Mar, Sept	..	..
£	4 0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
£	3 0	Do. 6 per Cent. Pref.	5¼—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
St.	4½%	British Thomson-Houston 4½% 1st Mt. Db.	103 —105	4 5 8	..	..	..
£	3/0	British Westinghouse 6% Pref.	4 —4½	6 13 4	..	4½	4
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 8 4	..	..	..
£	..	Brush Electrical Engineering	¾—1¼	..	March ..	..	..
£	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1¾	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	75 – 80	5 12 8	Jan, July	..	..
£	5,0	Callender's Cable Construction Ord.	11 —12	6 5 0	Jan, July	..	..
£	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 6 11	Jan, July	5¼	5¼
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	104 – 108	4 3 3	Nov, May	..	..
£	7/d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	90 —95	4 15 3	..	..	..
£	0,7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..
£	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2¼	6 13 4	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	97⅞—100%	5 0 0	Jan, July	..	..
£	..	Dick, Kerr & Co. Ord.	8¼—8¾	..	..	..	..
£	..	Do. 6 Cum. Pref.	5½—5¾	..	..	..	..
St.	4½	Do. 4½ Deb. Stock	103 – 105	4 5 9	..	..	..
£	..	Edison & Swan United("A" sh.) (£3 pd.)	..	..	Feb, Aug	..	..
£	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	71 —76	5 5 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
£	4/6	Edmundson's Elec. Corp. Ord.	6 —6½	5 7 8	H'lf-yearly	6½	6⅜
£	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	..	6	6
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 – 107	4 5 4	..	106	..
2	1/2½	Electric Construction Co.	1⅜—1⅝	6 8 0	Jan, July	1½	..
2	2 9⅜	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	2⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	98 —101	4 0 9	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	½—¾	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	½—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	9½—10	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 – 98	4 2 6	..	..	..
£	6/0	Henley's Telegraph Works Ord.	13½—14½	6 17 11	Feb, Aug	14⅜	13⅛
£	2/3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	5⅛	5
St.	4½%	Do. 4½ per Cent. Mort Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33 —36	6 13 4	Mar, July	35⅜	34
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 —103	3 17 8	Jan, July	..	..
£	3/0	Willans and Robinson Ord.	4½—5½	5 18 2	Apr, Oct	5⅛	..
£	3,0	Do. 6 per Cent. Cum. Pref.	5¼—6	5 0 0	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs	98 —102	3 18 5	May, Nov	..	..

*In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

THE progress of the electric power companies, as set forth in the sheet which we publish as a supplement this week, is, it must be confessed, disappointing. The Newcastle-upon-Tyne Electric Supply Co. is developing rapidly and is conferring benefits on the various industries in its area of operation by the supply of cheap electric power; the South Wales Electric Power Distribution Co. has been fairly rapid in getting to work, and has a promising future before it; and the Cleveland and Durham County Electric Power Co. will also soon be in active operation. But the majority of the remaining companies are extremely slow in realising the schemes of their promoters. The Midland Electric Corporation for Power Distribution, owing, we believe, to lack of capital at the outset, missed the opportunity of starting with a good power load, and has not added to its connections during the year as much as might have been desired. The County of Durham Electric Power Supply Co. and the North Metropolitan Electrical Power Supply Co. have excellent districts to work in, but are still supplying from small temporary stations. Among the newer companies, the Yorkshire and Lancashire Electric Power Companies are actually building their works, but the remainder have done remarkably little during the year. The "tightness" of the money market is probably one of the chief causes of these delays, and we trust that when the political horizon is clearer things will advance with greater rapidity. Electric power supply has, however, been by no means at a standstill in this country, for in addition to the progress made by the fortunate minority of the companies promoted mainly for power supply, the motor load of all the electric lighting undertakings has enormously increased, and the advantages of electric driving are being better appreciated by power users day by day.

AT the Leeds Local Section of the Institution of Electrical Engineers last night, Mr. H. BOHLE presented for discussion an interesting Paper on the conditions necessary for the paralleling of alternators. He has apparently absorbed and digested all the numerous and voluminous German writings on the subject during the last two or three years, and shows how the famous figure of $\frac{1}{300}$ for the limiting inequality of speed of an engine may be arrived at theoretically. He considers, however, that this is the inferior and not the superior limit of allowable speed variation during a revolution of the engine, and that in certain circumstances the fraction may be increased to $\frac{1}{250}$, $\frac{1}{150}$ or even $\frac{1}{100}$ without endangering satisfactory parallel running. This conclusion is at variance with current practice, or, at all events, with that indicated by typical English and American specifications for steam alternators at the present day, and some experimental verification would be welcome. In spite of absence of this, the Paper is a valuable one, however, for much of the recent work in Germany has been carried out with the particular object of investigating the suitability of gas engines for driving alternators, a question much to the fore at present. Some time is necessary to engrave the large number of diagrams with which Mr. BOHLE'S Paper is elucidated, but we hope to publish the Paper in our columns at an early date.

IT is impossible to credit a ridiculous statement published in the *Elektrotechnischer Anzeiger* a fortnight ago and reproduced in yesterday's *Standard*. The announcement is to the effect that the Swiss Federal railways have under consideration a project for the application of electricity to their railways not in the ordinary manner but by the application of electrical heaters within the boilers of the existing locomotives. Our

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German contemporary even sketches the position of the heaters within the locomotive boiler, and gives a sectional drawing to show how they can be attached, pointing out, moreover, the enormous gain in capital expenditure by equipping trains in this manner instead of furnishing them with motors and auxiliary apparatus. When it is considered that, on account of the inefficiency of the steam engine as a thermal engine the efficiency between boiler and crank shaft is even less than 10 per cent., the absurdity of the proposal is manifest.

THE method of dealing with the serious gas fire which occurred in Piccadilly on Wednesday of last week was very ingenious and interesting. It will be remembered that three mains, having diameters of 18in., 6in. and 4in. respectively, were broken, and the gas carried by them ignited. To shut off the supply at cocks would have produced disastrous results as, owing to the withdrawal of pressure, a highly-explosive mixture would have formed in the pipes. Two points were, therefore, selected as close to the break as possible, one on each side, and the ground excavated until access to the pipes was gained. Holes were then drilled in the mains and gas bags inserted. These bags were then inflated from the outside until they allowed only a very little gas to pass, thus reducing the flame to almost insignifiant proportions. Finally, the firemen turned the hose on the broken mains, and the flames were extinguished by concussion. Just over six hours were required to bring about the desired result, and it is interesting to note, by way of comparison, that if a main carrying electrical energy happens to get broken it does not belch forth a huge volume of flame requiring the combined efforts of a gas company and a fire brigade, exerted for half a day, to extinguish it. The gas journals are always anxious to give prominence to accounts of electrical breakdowns, and it is, therefore, not out of place to remind them that a conductor disconnects itself automatically in the event of a break or short-circuit, and thus causes a minimum amount of trouble.

THE proceedings at the statutory meeting of the Marylebone ratepayers on Tuesday, reported elsewhere in this issue, show a healthy departure from the apathy with regard to municipal matters which characterise the average London citizen. The non-voting ratepayers having allowed their "elected" representatives to muddle along in their own way, and considering, probably, that the few pence which might be saved in the rates would not justify the mental effort of studying reports of Council meetings or the physical effort of walking to the polling booth triennially, these non-voting ratepayers have now suddenly realised that they are called upon to contribute their share towards the raising of over a million of money for the purpose of municipalising their electric light, which has hitherto burnt with sufficient brilliancy although supplied by a joint stock company. So far the majority have not even yet studied the facts of the case, but they are sufficiently awakened to adopt the Irishman's proverbial political creed: "Agin the Government." It is, therefore, not unlikely that the poll which will now be taken as a sequel to the meeting last Tuesday, will be a vote against the Electric Lighting Bill of the Marylebone Borough Council, although it is doubtful whether a tithe of those who vote against it will have perused the Bill itself.

AT present the Marylebone Borough Council are bound by an Act of Parliament passed last session to purchase the Metropolitan Electric Supply Co.'s Marylebone undertaking for one-and-a-quarter million pounds. If the Bill which the Council are now promoting receives the approval of the ratepayers, and subsequently the assent of Parliament and HIS MAJESTY THE KING, they will be able to borrow this sum at the usual rate of interest. On the other hand, if the ratepayers will not allow the Bill to proceed, the Company can legally demand payment of the sum in question at the end of next month. In fact, the Bill in question is merely to correct the bad drafting of the main clauses of the Act passed last year. The best policy for the ratepayers would be to allow the Bill to proceed, and to insist on the whole matter being placed in the hands of competent business men, capable of remedying the mistakes of their predecessors and of making the best terms possible with the Metropolitan Company. Such a course is all the more desirable as it will be seen that proposals have already been received from the British Westinghouse Co. and the (English) General Electric Co. for carrying out the Council's scheme, the latter offering, in addition, to take over the whole management of the undertaking; and there is also a sporting offer by Mr. ARTHUR WRIGHT to accept one-sixth of the profits in lieu of his commission. But we fear that what we suggest as the best policy will not be followed; and the irate inhabitants of Marylebone can hardly be blamed if they simply vote against every proposal of their present Borough Council on the electric lighting question without looking forward to the ultimate issue.

Rugby Engineering Society.—A Paper entitled "Notes on Cupolas and Cast Iron," was read by Mr. C. Morehead before this society last night.

New Chancellor of Glasgow University.—By the death of the Earl of Stair, the Chancellorship of Glasgow University has been rendered vacant; Lord Kelvin, Lord Elgin and Mr. Haldane, M.P., have been nominated, and a vote will be taken.

Italian Railways.—The Mediterranean railway contemplates the extension of the electric system with a third raid over the Verese-Laveno-Gallarat-Sesto Calende-Arona lines, so that Milan will be directly connected with the upper Italian lakes by four electric standard railways.

Electrical Engineers Volunteers.—On Wednesday next, the 27th inst., the tablet erected at the headquarters of the corps of Electrical Engineers in Regency-street, Westminster, in memory of the members of that corps who died in South Africa during the late war, will be unveiled by Col. Pett, R.E. The ceremony will take place at 8:30 p.m.

The City of Liverpool and its University.—On January 15th a deputation appointed by the Liverpool University, and consisting of the Chancellor, Lord Derby, Vice-Chancellor Dale, Sir J. Brunner and Mr. A. F. Warr, waited upon the finance committee of the Liverpool Corporation to call attention to the claims of the new University to municipal support. As a result of the meeting, it is reported that the committee will recommend that a vote in aid of £10,000 a year be made.

Fire at Salford Generating Station.—A fire occurred at Salford electricity works at about 8 o'clock last Sunday morning. It appears to have originated in the balancer room and then to have spread to the main switch room, immediately above. The tramway feeders suffered very severely and those supplying energy for lighting to a lesser extent. By 1 p.m.

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the latter were repaired, but the tramways were only partially operated in the afternoon and evening, and that by energy obtained from the Manchester overhead system which adjoins the Salford system. We are informed that Messrs. W. T. Glover & Co.'s patent fire-resisting cable was immediately ordered to replace that which had been damaged by the fire.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903 ..	—
St. Vincent—Grenada	Dec. 29, 1903 ..	Jan. 15, 1904
Gibraltar—Tangier	Jan. 18, 1904 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—

Communication to the Channel Islands is now restored.

An Unseasonable Thunderstorm.—At Tonbridge, in the course of a severe thunderstorm on January 13th, a two-storey house was struck by lightning, which passed through four out of the five rooms in the house, and did considerable damage. The lightning entered the building where the chimney joins the tiled roof, passed through the bedrooms, stripping the plaster from the walls, and down to the front door. It there took a sharp curve to the left, passed through the kitchen, burning large holes through two metal trays standing there, and passed on into an outhouse, where it entered the earth through a bucket of water. Plaster was peeled from the walls of the house, umbrellas and walking sticks were burned and furniture damaged. The inmates of the cottage, however, were quite unharmed.

Electrical Pumping.—A few weeks ago, when the basements of a number of newspaper offices in the neighbourhood of Tudor-street were flooded owing to the heavy rains, the City of London Electric Lighting Co. offered to equip the sewers running under the Thames embankment with electric pumps. This offer was, however, refused by the London County Council, and since the City of London Company have established a supply station in Tudor-street the latter have kept a portable pump in readiness in the event of any more floods occurring. By telephoning to the company the use of this pump may be obtained at a few minutes' notice, current being taken from the supply mains. It is said that the company are considering the establishment of a portable fire engine to be worked in a similar manner.

Electrical Engineers' Ball.—We are asked to announce that it is proposed to hold a dance on a large scale at the Hotel Cecil on Monday, February 15th. The following gentlemen form the committee :—

H. Alabaster, T. Browett, T. O. Callender, Thos. Cushing, E. C. De Segundo, S. T. Dobson, R. S. Erskine, S. Z. de Ferranti, T. E. Gatehouse, J. Gavey, W. Geipel, F. Gill, R. Kaye Gray, G. Grindle, F. E. Gripper, R. Hammond, H. Hirst, H. R. Kempe, J. V. Money Kent, J. E. Kingsbury, W. L. Madgen, W. G. McMillan, Sir H. C. Mance, W. H. Massey, W. M. Mordey, F. H. Nalder, J. S. Raworth, J. H. Rider, M. F. Roberts, Sir David Salomons, Sidney Sharp, Alex. Siemens, A. M. Sillar, Fredk. Smith, G. Sutton. G. H. Verity, R. Wallis-Jones, Major-Gen. Webber. Executive Committee, J. E. Kingsbury, W. Geipel, M. F. Roberts, R. Wallis-Jones. Hon. Treasurer, R. Hammond. Hon. Secretaries, A. M. Sillar, H. Alabaster.

Improvements on the Paris Underground Railway.—The British Westinghouse Company informs us that the officials of the Paris Metropolitan Railway have decided to abandon the use of power cables carrying large currents through the train, and have awarded a contract to the French Westinghouse Company for the supply of 100 complete equipments of their electro pneumatic turret type control apparatus to replace the present system. One of the chief features of the electro-pneumatic control system (which was described in detail in our issue of April 24, 1903) is that compressed air is employed for actuating the controllers on all motor cars, and that the control is effected by very small currents in wires throughout the train at the harmless pressure of 14 volts.

The Motor Car Act.—The President of the Local Government Board has appointed a Departmental Committee to inquire and report with regard to any regulations which should be made under sec. 6 of the Locomotives on Highways Act, 1896, and sec. 12 of the Motor Car Act, 1903, as respects any class of vehicle for the purpose of increasing the maximum weights of 3 and 4 tons mentioned in sec. 1 of the former act, and with regard to any conditions as to the use and construction of the vehicles which should be made by any such regulations. The members of the Committee are the Right Hon. Henry Hobhouse, M.P. (chairman), Sir William Arrol, M.P., Mr. H. C. Monro, C.B., Mr. H. H. Law, M.Inst.C.E., Mr. George Deacon, M.Inst.C.E., and Mr. H. Graham Harris, M.Inst.C.E. Mr. R. J. Simpson, of the Local Government Board, will act as secretary.

Electric Light in Hartlepool.—On January 9th the electric lighting installation at Hartlepool, carried out and owned by the Northern Counties Electricity Supply Co., was started. A provisional order was obtained by the Corporation in 1899, and recently transferred to the company. Current is generated at a pressure of 460 volts by a 100kw. Westinghouse continuous-current dynamo driven by a 165 H.P. Crossley gas engine. A battery, consisting of 250 Chloride cells with a capacity of 300 ampere-hours, is provided. Approximately, 1,500 incandescent and 40 arc lamps have, so far, been installed. They are fed on the three-wire system. Three miles of British Insulated and Helsby bitumen cables have been laid on the solid system in wood troughing. Current for lighting purposes is charged for at the rate of 4½d. per Board of Trade unit. The price of gas in the district is 2s. 3d. per 1,000 cubic ft.

Tramway Accident.—An accident occurred on the Batley electric tramways on Saturday afternoon. It seems that a car, carrying six or eight passengers, started on the Thorncliffe-road section, for Batley, at about 4 p.m. Too great a speed was attained on a piece of straight track, and the driver, in applying the hand-brake, locked the wheels, and the car left the track at a sharp bend in the road. Its momentum carried it through a brick wall, and it finally came to rest in a private garden. The driver was rather badly injured, and one of the passengers, a lady, sustained a serious scalp wound beside other injuries. As soon as the car had been brought back to the rails, and before any part of the mechanism had been touched, a test was made of the working of the Westinghouse magnetic brake, to the failure of which the accident was first attributed. Despite the facts that the controller was dislocated, and the front platform of the car badly broken up, the brake acted perfectly.

The Victoria University.—At an extraordinary general meeting of the Yorkshire College Council, held at the Philosophical Hall, Leeds, on Wednesday, the following resolution was brought forward :—"That the Bill to merge the Yorkshire College in the Victoria University of Yorkshire and to transfer all the property and liabilities of the Yorkshire College to the Victoria University of Yorkshire, and for other purposes, which has been deposited in the Private Bill Office of the House of Commons, be approved, subject to such additions, alterations, and variations as Parliament may think fit to make therein." In the event of the draft charter, now before the Privy Council, being passed by His Majesty the King, the above Bill would provide for the abolition of the existing Yorkshire College as an individual college and its resuscitation as a part of the Victoria University of Yorkshire. Mr. A. G. Lupton moved the resolution, which was seconded by Mr. W. Rowley, and afterwards carried unanimously.

Obituary.—The death is announced from New York of Mr. G. F. Train, who was the pioneer of tramways in this country. The system which he patented and constructed in many places throughout the kingdom consisted of light rails, similar to railway rails, laid upon the surface of the roadways. Among other lines which he constructed upon this principle was one from Marble Arch along the Bayswater-road, another from Westminster to Victoria and a third from Westminster Bridge to Kennington Park. Similarly in the provinces, Mr. Train built such lines at Blackpool, Burslem and Darlington. But the obstruction to the ordinary vehicular traffic of the roadways which this system created led to a great outcry and the lines were soon removed. The construction of these tramways took place about the year 1861, when Mr. Train patented his system and entered into agreements with

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the local authorities, after being refused the necessary statutory powers by Parliament. His first efforts to introduce tramways in England were made as early as 1851.

Radium.—The Paris correspondent of the *Standard* states that the difficulty of finding M. Curie a new laboratory has been solved by the action of the Council of the Pasteur Institute, who have agreed to place the necessary rooms at his disposal.——The New York correspondent of the *Yorkshire Post* states that a Dr. W. J. Morton, of New York, has announced that he has succeeded in effecting cancer cures with the aid of radium. He has operated on three proven cases of cancer, and he says his patients are now cured. Dr. Morton's treatment consists in administering internally a solution of sulphate of quinine, and then holding near the body a minute quantity of radium. The solution fluoresces, and the process, by working on the malignant growth, kills it.——The New York correspondent of the *Morning Post* says that M. and Mme. Curie are shortly to visit the United States to give lectures on radium, and incidentally to investigate several substantiated reports that deposits of pitchblende, in paying quantities, have been found in several parts of the United States. The most important of the deposits are in Utah and Idaho, and were found by Capt. James Lawrence, a prominent geologist. It is said that an assay has been made of samples of the mineral in New York, and that they have been pronounced unusually rich.

Birmingham Corporation Electric Tramways.—As announced in our issue of January 8th, the Birmingham Corporation has put into operation a short section of electric tramway, consisting of 1¼ miles of single track and 2½ miles of double track. The line runs from the top of Steelhouse-lane to the city boundary in Aston-road, and is the first move towards carrying out the avowed policy of the Corporation that all tramway lines within the city shall eventually be municipally owned and worked. The lines have hitherto been leased to various companies, but, as the leases fall in, the Corporation intends to acquire the lines and convert them to electric traction. One lease expired last year, and all the remaining ones will have lapsed by 1911. The line which has just been opened is a new one authorised by the Corporation Act of 1903, and has been constructed under the supervision of Mr. A. Baker, the tramway manager, late of the London County Council. It is of 3ft. 6⅜in. gauge, the rails being of the girden type, weighing 105lb. to the yard. Fixed stopping places have been arranged every 200yds. The maximum gradient is 1 in 22, and the sharpest curve 35ft. radius. The side trolley system is employed, the conductor being 000 gauge with one wire on each side of the road. The feeders are Callender, 0·4, 0·3 and 0·2 sq. in. section laid "solid" under the footpath. There are at present 20 cars of the double-truck, double-deck type, weighing 10½ tons and having a seating capacity of 56 passengers. Hand and electric brakes are fitted. For the time being, the Birmingham Corporation is purchasing its current from the Aston Manor Corporation for working these lines, and it pays 1½d. per unit. Of the companies at present working tramways in Birmingham, the City of Birmingham Co. alone has an electric system. This consists of 3¼ miles of double track worked on the overhead trolley system, to which it was converted in May, 1901. Prior to that, it was worked by means of accumulators on the cars. On the other routes steam, cables and horses are employed.

Engineering Standards Committee: Electrical Conference.—We are informed that arrangements have been concluded to hold a conference of consulting engineers to large power schemes and electrical manufacturers to meet the members of the committee dealing with the question of standardising generators, motors and transformers at 2 p.m. on Tuesday and Wednesday, January 26th and 27th, in the theatre of the Institution of Civil Engineers, Great George-street, Westminster. The above sub-committee have for a long time been hard at work upon the question of the standard rating of electrical machinery. They have issued several carefully drawn-up circulars to the manufacturers, the replies to which have been collated and very fully discussed, and these have proved of the greatest assistance to the sub-committee in the difficult task they have in hand. Certain questions, however, relating to the standardisation of direct and alternating-current motors have lately arisen, upon which great diversity of opinion appears to exist, as evidenced by the replies received. The sub-committee, after carefully considering the replies sent in, came to the conclusion that the most practical course of action, and that best calculated to lead to the most satisfactory results to all concerned, would be to confer with the leading consulting engineers and manufacturers and investigate to the fullest extent the different points at issue. In view of the criticisms which have arisen as to the wisdom of adopting 25 and 50 periods per second as the standard frequencies, the Sub-committee on Generators, Motors and Transformers have also deemed it advisable to invite the consulting engineers and those interested in large power schemes to be present at this conference and discuss this very important question of standard frequencies with them. It is to be hoped that this conference will be well attended by representative men, with the result that, by carefully discussing these difficult questions in detail and from every point of view, the best interests of standardisation may be advanced by a distinct and substantial step.

Sir William H. White has been nominated by the Institution of Civil Engineers as one of its representatives upon the Engineering Standards Committee, in place of the late Sir Frederick Bramwell.

Underground Cables to the North.—*The Times* on Monday gave some particulars of the work which has been carried out by the Post Office to improve the communication between London and the North of England. Between the years 1897 and 1900, the Post Office engineering officials were engaged upon the work of laying an underground telegraph line from London to Birmingham. Shortly after it was completed there occurred one of the most serious breakdowns of the overhead system that has ever been known in this country, and the underground line, during that breakdown, was found of great utility, as the telegraph service between London and Birmingham was uninterrupted at a time when Liverpool and Manchester were quite isolated from the metropolis. Owing to the serious inconvenience thus caused, the Postmaster-General was approached by several members of Parliament and chambers of commerce, and urged to extend the underground wires in other directions, and deputations which waited upon the department were informed that it was intended to do so. Effect was given to this promise last year by the laying of an experimental cable between Birmingham and Warrington, and this cable was in use till May, 1903. Since that date gangs of men have been engaged in taking out the experimental wires and putting in a main permanent cable between the Midlands and Lancashire. The cable, which is laid in a 3in. cast-iron pipe, contains 103 wires, enclosed in a leaden sheathing; 74 of the wires are twisted in pairs, and the remainder are single wires. The pairs of wires may be used for telephonic purposes, but it is believed that their primary use will be for high-speed telegraph circuits. The route from Birmingham is via Walsall, Cannock, Stafford, Eccleshall, Woore and Nantwich. At the present time the cable has been completed to Eccleshall. It is hoped to have the cable completed to Warrington before the end of next March. At Warrington lines connecting Liverpool and Manchester can be tapped. It will then be possible to work from London to those cities by means of underground wires. During the department's next financial year probably the section between Warrington and Carlisle will have attention. A line is also being laid north-east from Manchester to serve the large Yorkshire towns.

St. Louis Exhibition.—The contract for lighting the St. Louis Exhibition, which has been awarded to the General Electric Co., provides for supplying the exhibition with 300,000 incandescent lamps at 13·6 cents each, or a total outlay of $40,800. This contract for lamps followed the completion of sketch plans for lighting the exhibit places, grounds and architectural features belonging to the exhibition proper, but is exclusive of state, national and private concession buildings. The detail plans are now being drawn. It is stated that 12,000 are to be placed on the Palace of Education alone. The classical outline of that building eliminates brilliant colour effects, but furnishes a splendid setting for night effects pro-

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duced by electric lights. It has been decided to place on each of the monumental standards, which dot the main avenue of the exhibition on the border of the waterways, 24 incandescent lamps. Each of these standards has four cast-iron pendants, on each of which there will be six lights. Each of the standards along the central avenues will hold 24 lamps, so distributed that 12 will hang on each arm of the supporting post. The lamps contracted for will be used exclusively for exterior lighting. The interior of the exhibit buildings, which will be closed at sunset, will be lighted with arc lamps, the chief object of this lighting being for patrol purposes. The western half of the north façade of the educational building has been equipped with lamps. This is merely a test section installed for the purpose of trying the effect of lights between the columns. Results of the tests have proved satisfactory in every way. Regarding the matter of electric service to be available in the Electricity Building during the time of the exhibition, arrangements have been made to supply the following service for commercial use in the above building—namely, 104-volt, 25 ∿, alternating current, one and three-phase; 104-volt, 60 ∿, one and two-phase; 6,600-volt, 25 ∿, one and three-phase; 2,200-volt, 60 ∿, one and two-phase; 2,200-volt, 60 ∿, one and three-phase; 110-volt, 220-volt, and 500-volt, continuous current. For distribution of the above service the following plans have been adopted:—104-volt, 25 ∿, 300kw. available and distributed over entire building; 104-volt, 60 ∿, 100kw., available and distributed over entire building 110-volt, 220-volt and 500-volt, continuous current, 100kw., available and distributed over building; 6,600-volt, 25 ∿, 100kw., available at transformer space only; 2,200-volt, 60 ∿, 50kw., available at transformer space only; 2,200-volt, 50∿, 50kw., available at transformer space only. Should any exhibitor require service covered by the last three items it will be necessary for him to wire from his space to the transformer space, located in the north-west corner of the Electricity Building. In addition to the service mentioned above, there will be at the transformer space a limited quantity of 340 volt, 25 ∿, one and three phase, and 400-volt, 25 ∿, one and three-phase. These two items are for supplying current to rotary converters and motor-generators installed in the transformer space.

The Carnegie American Engineering Building.—Some time ago a committee of fifteen persons was appointed to consider and report on the proposal to erect an engineering building in New York, the necessary money, £200,000, having been offered by Mr. Carnegie. The American Society of Mechanical Engineers has just issued a circular on the subject, one item of which is a report of the organisation committee composed of Dr. A. R. Ledoux, C. W. Hunt, and Dr. S. S. Wheeler. Having considered legal advice and taken note of all suggestions received, the committee unanimously advise as follows:

1. The total amount offered by Mr. Carnegie shall be administered as two gifts: one to the Engineering Societies and the other to the Engineers' Club, each to be held and administered independent of the other. The allocation of the fund to be made at once, but the buildings to be designed and erected as one operation; thereafter the respective titles and administrations to be entirely independent.

2. The property represented by land, buildings and equipment of the engineering societies, shall be held and administered by an executive corporate body, preferably under a special charter, to be obtained from the State of New York, each of the constituent societies being entitled to name from its membership three persons to act as incorporators and thereafter as directors.

3. Each society annually to elect or appoint, as their bye-laws may prescribe, one of their voting members to serve on the board of directors of the executive corporation for a term of three years; a vacancy in said board to be filled by an appointment made by the society the retirement of whose representative causes the vacancy.

4. The land and property being held for the societies by an executive corporation, the said corporation may, to pay for the land acquired, issue certificates of indebtedness or bonds bearing interest at 4 per cent., and redeemable on six months' notice, the buildings being a gift from Mr. Carnegie.

5. Each of the constituent societies may purchase and hold an equal amount in value of the said bonds or certificates, but the board of directors of the executive corporation may authorise any of the constituent societies to hold an additional amount; that is, in excess of its portion, but such excess shall be subject to recall at its par value at any time that the directors of the executive corporation may so order, to the end that each society shall have an equal interest in the property of the corporation if it so desires. The certificates held by each society shall be inalienable unless they are offered to the executive corporation at their par value, and such tender shall not be accepted by the board of directors within one year thereafter.

6 The property of the executive corporation shall be used perpetually as a meeting place and headquarters for the constituent societies, and for such other scientific associations as may be temporarily admitted by the consent of the Board of Directors of the Executive Corporation. Such associations may pay a pro rata share in the expenses of the headquarters, but no profit shall be made from such use.

7. Each of the participating societies shall be entitled to rooms and space in the property adequate to its need, paying its share of the running expenses in accordance with the amount of space occupied, said space to be assigned and a proper assessment therefor determined by the board of directors of the executive corporation.

8. The excess of receipts over expenditures, if any, shall be used for reducing the subsequent contribution of the several societies for maintaining the building, and for the advancing of engineering arts and science, by and through the participating constituent associations. No dividends shall be declared or profits divided, but a reasonable repair and rebuilding fund may be established.

9. If the income of the Executive Corporation shall be less than the expenditure, the deficiency shall be made good by an assessment on each of the constituent societies, so allocated as to be in proportion to the number of voting members of each society. An excess of receipts over expenditures may be allocated to the societies in like manner to reduce their annual assessment.

10. Should any of the constituent societies fail or refuse to appoint directors, the remaining members of the board of the Executive Corporation shall administer the property with all the force and effect as though the board contained its full quota of members.

11. Finally, your committee, in offering the above suggestions, has had in mind the setting aside of the money used for a building for the Engineers' Club, so that on the completion of the said building the relations of the club and of the engineering societies will terminate. Thenceforward, the constituent societies are to carry through the Executive Corporation the administration of the building and its accessories, leaving the scientific, professional, intellectual and financial activity in each organisation entirely independent of the others, and free to develop to any extent and along any line that may be determined each for itself.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) **FRIDAY, January 22nd.**

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, South Kensington. Agenda: (1) "The Photographic Action of Radium Rays," by S. Skinner. (2) "Astigmatic Aberration," by W. Bennett. (3) "Some New Cases of Interference and Diffraction," by Prof. R. W. Wood. (4) Exhibition of Instruments by Messrs. Crompton & Co.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel, when Mr. Fletcher Moulton, K.C., F.R.S., will deliver his Presidential Address.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by the Rev. Walter Sidgreaves on "Spectroscopic Studies of Astrophysical Problems at Stonyhurst College Observatory."

WEDNESDAY, January 27th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

7:30 p.m. Meeting in the University. Paper to be read: "Energy Distribution to Sub-stations," by C. A. Smith. The discussion will be followed by a short demonstration on "Some Uses of the Oscillograph," by Dr. D. K. Morris and J. K. Catterson. During the afternoon a party of members of the Birmingham Local Section will pay a visit to the West Bromwich Electricity Works.

LIVERPOOL ENGINEERING SOCIETY.

8 *p.m.* Meeting at the Royal Institution. Paper to be read: "Induction Motors, by Prof. E. W. Marchant.

THURSDAY, January 28th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. The adjourned discussion on Mr. W. Hibbert's Paper, "The Edison Accumulators for Automobiles," will be opened by Dr. J. A. Fleming, F.R.S., after which the adjourned discussion on Dr. Hans Behn-Eschenburg's Paper "On the Magnetic Dispersion in Induction Motors and its Influence on the Design of these Machines" will be taken.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting at the Royal College of Science, when the discussion on Mr. W. Brew's Paper, "Three-phase Working, with Special Reference to the Dublin System," will be taken.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

8:30 p.m. Meeting at the Society of Arts. Paper to be read: "Rating of Tramways and Light Railway Undertakings. The present practice and how it might be improved," by W. G. Bond.

FRIDAY, January 29th.

ASSOCIATION OF TECHNICAL INSTITUTIONS.

Annual Meeting at the Leathersellers' Hall, London, Sir John Wolfe Barry, F.R.S., in the chair. An address will be delivered by the president elect, the Right Hon. Sir John E. Gorst, M.P.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, Westminster. Lecture by Mr. A. P. Head on "Metallurgy as Applied in Engineering."

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LONDON COUNTY COUNCIL TRAMWAYS.

(Concluded from page 479.)

As has already been mentioned, the sub-stations are all equipped with synchronous motor-generators, an illustration of one of which was published in our last issue. These motor-generators are all Dick-Kerr machines, and of a uniform size—300kw.—the difference in the output of the sub-stations being according to the number of sets installed—five, four and three respectively. The motor part of the set receives three-phase current directly at 6,600 volts, and its revolving field has 10 poles; the generator is six-polar and is of the ordinary tramway power-house type. The speed of the set is 300 revs. per min. A feature of it is the central bearing with a coupling on either side, so that either field system may be lifted independently.

In order to gain the advantages of a strip winding of the field magnets on the alternating sides, which necessitates low-pressure excitation, each machine carries its own exciter, and this exciter, moreover, acts as a motor for starting the set. Being a synchronous machine it is necessary that the set is run up to synchronism before it is switched on to the high-tension

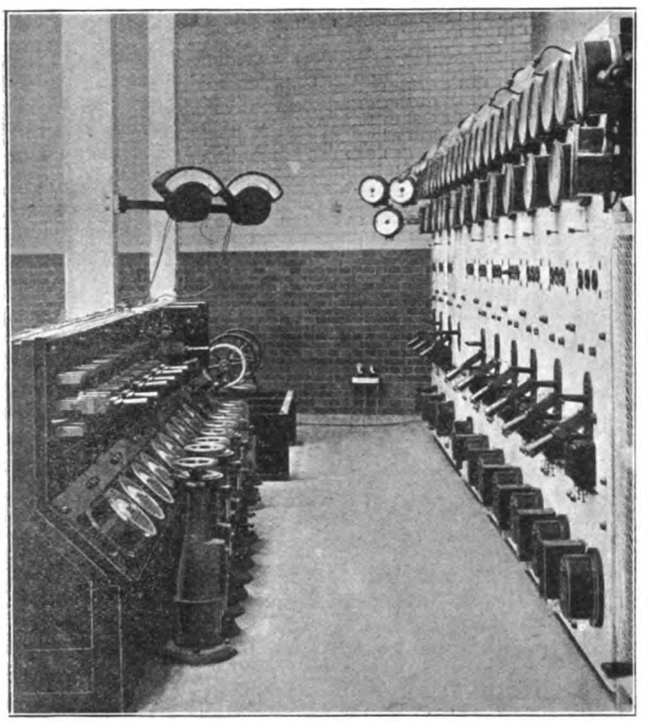

Fig. 4.—High-tension Switchboard, with Exciter and Starter Gear Opposite. New Cross Sub-station.

'bus bars, and as the sub-stations have no batteries, this cannot always be done by running up the continuous-current generator as a motor. A small 50kw. induction motor-generator is therefore provided. This is first started, and its continuous-current generator side is then connected, through a circuit-breaker on each pole. to the exciter and the field of the large set in parallel. On switching on, all the resistances are out of the exciter field, and all resistances in the exciter armature and the alternate-current motor field. This starts up the exciter as motor, and its field resistances are switched in and the armature resistances out until the alternator side is in synchronism with the 'bus bars. After switching in the alternate-current motor, the field of the exciter is again strengthened until the ammeter in series with it reverses and shows that it is acting as a generator and not as a motor, and when it generates the full exciting current the small induction motor-generator is switched off.

Each main motor-generator is provided with a switch, placed on a bracket on the machine, enabling the continuous-current side to be connected with a common starting resistance for use when other machines are running, and the motor-generator is started by running up the continuous-current side as a motor. A contact on this switch also provides for short-circuiting the series windings of the continuous-current machine, should this be necessary for any reason, and as an equaliser switch for parallel running.

The little induction motor-generator also provides current for lighting the sub-station, but this can also be done from any one of the exciters on emergency, and provision is also made for exciting any of the alternating current motors from the exciter on any other.

As seen in our illustrations, the switchboard is divided into three parts, the alternating-current side, with the exciter and starting switch gear opposite (Fig. 4), and the continuous-current side (Fig. 5). On the left are the high-tension panels, accommodating the feeder from the generating station and the two interconnecting high-tension cables from the nearest sub-stations. The panels on the right are for the main circuit of the motor side of the motor-generators. The main switches on these two sets of panels are of a new pattern. Their contacts are immersed in oil chambers behind the switchboard, and the handles and maximum and return-current tripping gear are in

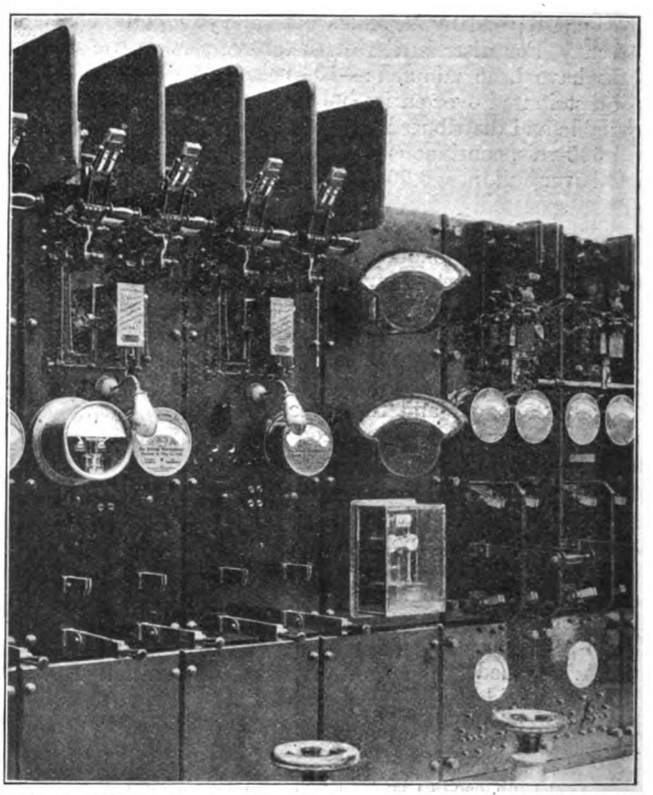

Fig. 5.—Two Generator and Two Circuit Panels of the Low-pressure Switchboard. New Cross Sub-station.

front. In the position seen in the figure the first three switches are off, the fourth is on, and the fifth is off. To switch on, the handle is lifted, and a catch in it engages in the projecting trigger seen in the figure, which is at the end of the actual switch lever. This is pulled down, and in its lower position the catch within the handle is again free from the trigger, so that the maximum and return-current tripping gear can act even if the handle is held down. To switch off, a button at the end of the handle is pressed, and causes the catch to engage in the trigger. The maximum and return-current release coils are energised through small transformers, and the return-current gear is polarised, one coil receiving current from a primary battery of dry cells.

In addition to the ordinary ammeters, voltmeters and watt-meters, the switchboard is equipped with a "synchroscope" as a supplement to the ordinary synchronising lamps, and there are two pairs of "ground detectors." The latter instruments are electrostatic, and contain two segments connected to two conductors of the main respectively, the needle being fixed to an earthed segment. A fault on either main causes the needle to deflect from its central position.

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The operations which are carried out at the exciter and starting board have already been explained. Beyond this board in Fig. 4 are seen the pulleys over which the ropes to the water resistance for charging the cables pass. This is controlled from a panel of the high-tension board opposite, between the feeder and motor-alternator panels, as it is, of course, a part of the feeder-circuit apparatus.

The low-pressure switchboard is in two parts, and Fig. 5 shows two panels of each. On the left are the generator panels of the motor-generator, which include time element circuit-breakers; and to the right are the circuit panels, which

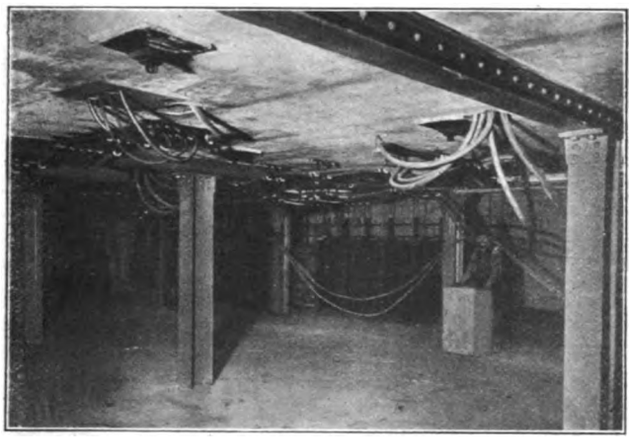

FIG. 6.—GENERAL VIEW OF THE BASEMENT AT NEW CROSS SUB-STATION.

throw over reversing switches, so that the polarity of the conductor rails in the conduit can be reversed in case of need. This matter was fully gone into in our first series of articles on the London County Council tramways. A test board is placed at the extreme right of the row of switchboard panels, and stands out at the end at right angles to the others, and the connections and general arrangement of both circuit board and test board are similar to those described with a diagram in this former article (*The Electrician*, Vol. LI., p. 159). At

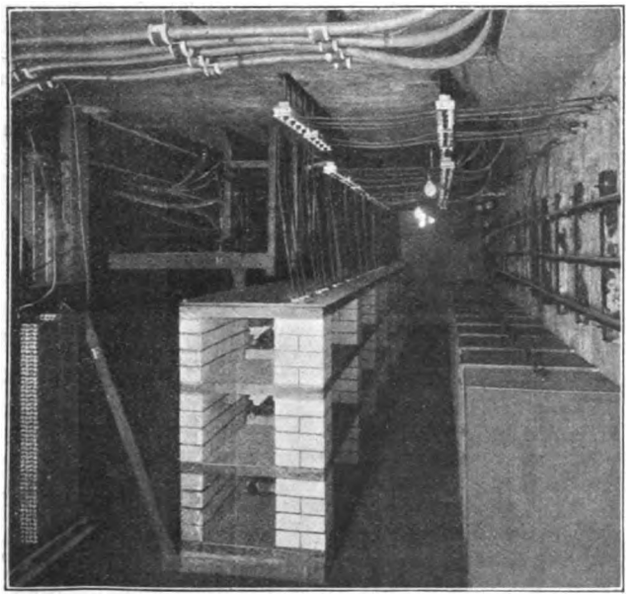

FIG. 7.—BASEMENT, BELOW SWITCHBOARD. NEW CROSS SUB-STATION.

the New Cross and Camberwell sub stations these boards have been supplied by Mr. Bertram Thomas, at the other sub-stations by Cowans Limited. The high-tension switchboard and the motor-generator panels of the low-tension board have been supplied by the British Westinghouse Co.

The motor generators are simply bolted down to concrete beds on the floor of the sub-stations, and have not separate foundations. As there is no reciprocating machinery, this support is considered amply sufficient, the floor being supported by strong girders. The advantage of this is that it affords space for a large basement, in which the transformers and live parts of the switch gear and connections are placed, while the remainder of the basement is utilised for stores. Fig. 6 is a general view of the basement at New Cross, in which the method of supporting the floor is clearly seen, and also the bottom of some of the holding-down bolts of the motor-generators. In fairness to the London County Council electrical engineer, it should be stated that the sub-station was not quite finished at the time the photograph was taken, and that the cables had still to be tidied up. Fig. 7 shows the arrangement beneath the high-tension switchboard. The brick cubicles seen in the centre contain the main 'bus bars, and the boxes in a row to the right of them are the transformer chambers for the various instrument transformers, &c.

The building of the Greenwich generating station is being rapidly pushed forward and the foundations for the generating sets are already down. A few particulars with regard to it will be found in the supplement table of electric railways and tramways in the United Kingdom which will be published in our next issue, and we may add that one of the most interesting features of the power house will be the employment of combined horizontal and vertical engines of 5,000 I.H.P. for driving the generators. As the engines are not yet built, it would be premature to publish a detailed description of them, but a few words as to their general arrangement will not be without interest at the present time. Each set is practically two compound engines working on the same crank shaft, the generator being between them, and each has a vertical high-pressure cylinder and horizontal low-pressure cylinder. The main dimensions, &c., are: High-pressure cylinder 33½in. diameter, low pressure cylinder 66in. diameter, stroke 4ft., speed 94 revs. per min., piston speed 750ft. per minute, steam pressure 180lb. per square inch, condenser vacuum 26in. Both vertical and horizontal cylinders will work on to the same crank pin, and the two cranks are 135deg. apart. Another feature of the power house will be the employment of "remote control" switch gear, the switches being placed at convenient points and all being controlled from a small keyboard to which the main current is not brought. We hope to give our readers further particulars with regard to the projected board at an early date. The Greenwich lines were opened to the public on Sunday last, in accordance with our previous announcement.

ELECTRIC POWER IN QUEENSLAND RAILWAY WORKSHOPS.

The industrial applications of electricity have of late been attracting much attention in Australia, and the recent opening of the Government railway workshops at Ipswich, Queensland, have accordingly excited much interest. The plant in these shops exemplifies the electric drive at its best, the plant being of the most modern type, and the arrangement of the works convenient to a degree impossible with the use of any other form of power. The fact that the entire plant is new, and is not a sort of conglomeration of annual additions, is another important factor in economical production.

The power house is 112ft. long, and is partitioned off into engine and boiler rooms, 38ft. and 45ft. wide respectively. The engine room contains three 200kw. units, each consisting of a Westinghouse single-acting compound engine directly connected to a Westinghouse two-phase alternator. From here the power is distributed underground to the 14 different shops, covering an area of about 5 acres. These comprise the boiler, machine and erecting shops, where the greater proportion of the power produced is utilised for driving metal-working tools, also the carriage and waggon shops, paint shop, two saw mills, pattern makers' shop and forge.

The boilers are four in number, of Babcock and Wilcox make, each having a heating surface of 2,823 sq. ft., and capable of evaporating under normal circumstances 7,380lb. of water per hour at 150lb. pressure. Mechanical chain-grate stokers, each with a grate area of 65 sq. ft., are employed, all driven by a Westinghouse 4½in. by 4in. single-acting two-

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cylinder "Standard" engine. The speed of travel of the grate may be regulated so as to give complete combustion with varying qualities of fuel and depth of fire. The coal and ashes are handled by a Hunt gravity bucket conveyor, with a capacity of 40 tons per hour. The coal passes by gravity from the bunkers outside the boiler house into the buckets, which elevate it and tip it into the required hopper above the boilers.

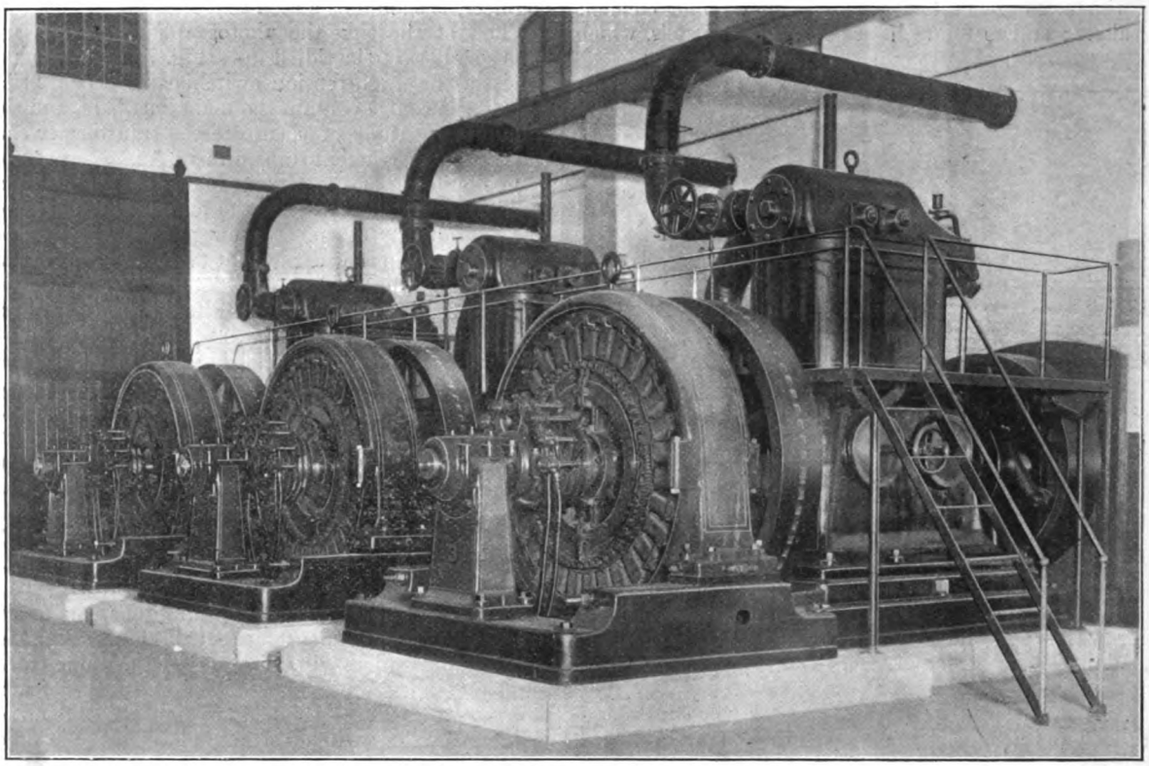

FIG. 1.—GENERATING UNITS.

Each hopper has a capacity of 10 tons, and discharges by gravity through a 12in. cut-off valve into the stoker hopper.

The engines are of the single acting compound type, with cylinders 18in. and 30in. diameter by 16in. stroke. The valve gear consists of a single piston valve operating on the top of the cylinders, and actuated by an eccentric on the engine shaft. This valve controls the admission and exhaust ports of both cylinders. Steam is supplied at 150lb. per square inch, and the engines exhaust into a Worthington condenser. The engines run at 250 revs. per min., and are lubricated by the cranks splashing up the oil contained in the crank chamber.

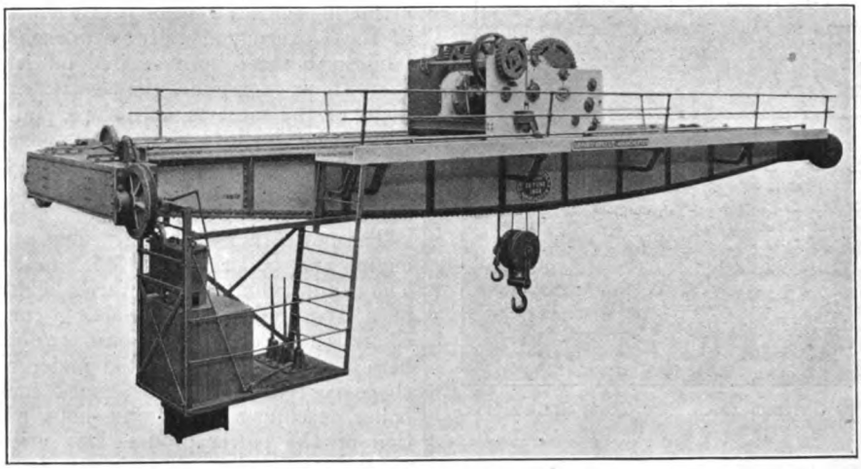

FIG. 2.—ONE OF THE CRANES.

The generators are each of 200kw., delivering two-phase alternating current at 60 cycles and 220 volts pressure. They are of the Westinghouse rotating armature type, the armature consisting of laminated mild steel punchings built up on a cast-iron spider. Slots parallel to the shaft carry the windings, and radial openings extending round the armature allow of ventilation. The winding is of the bar type, and consists of copper bars carefully insulated and slipped into the slots from one end, being held in place by the overhanging tips of the slots. No band wires are employed, hard fibre wedges being driven in above the conductors. The field is horizontally split, and may be moved away from the armature in a direction parallel to the shaft. The field poles are of laminated steel, and the coils are machine wound upon formers. The exciting plant consists of a 17½kw. Westinghouse engine-type generator, directly coupled to a Westinghouse 8½in. by 8in. "Standard" engine, making 350 revs. per min. This exciter supplies field current to the three large generators. Foundations are provided for a duplicate exciting set.

The switchboard is of standard Westinghouse pattern, and consists of seven panels of white Italian marble. The general arrangement of the board is of the double-throw type—that is, two sets of 'bus bars are provided, and all switches made double-throw. By this means the three generators may be operated in parallel on the one set of bars, or, if desired, any feeder circuit or group of feeders may be operated from any generator running independently of the others. Three of the panels are for the control of the three main generators, one for the control of two exciter sets, and the remaining three for six-feeder circuits—two to each panel.

The condensing plant consists of a Worthington condenser, combined air and circulating pump and cooling tower. The

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condenser can treat 36,000lb. of steam per hour; the tubes are 1in. in diameter and 12ft. ¼in. long, and number 1,175, giving a total cooling surface of 3,600 sq. ft. and a horse-power rating of about 1,800. The cooling tower is capable of cooling the circulating water from, say, 160°F. to about 75°F. or 85°F., according to the atmospheric conditions. It is 14ft. 6in. in diameter and 32ft. in height, and is built of steel plates, coated inside with non-corrosive paint, and fitted with 17,000 interlocked tubes. The tubes give a cooling surface of 79,500

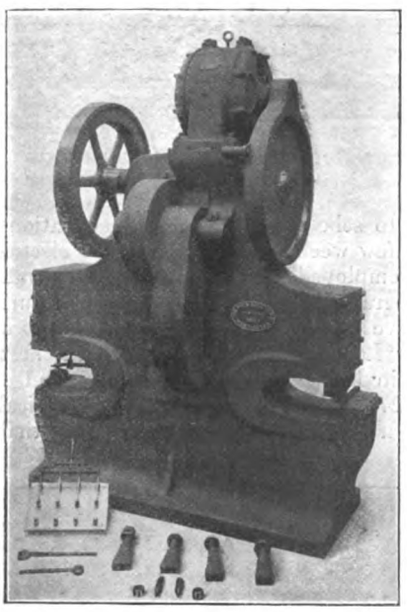

FIG. 3.—COMBINED SHEARING AND PUNCHING MACHINE.

sq. ft. A 120in. Seymour fan, with adjustable blades which can be regulated to any pitch, provides 180,000 cubic ft. of air per minute for cooling purposes. This fan is driven by a 30 H.P. Westinghouse motor.

The cables, which are laid underground from the power house to the shops, are of Callender's make, lead-sheathed, with a dielectric of fibrous bitumen, and an insulation resistance of

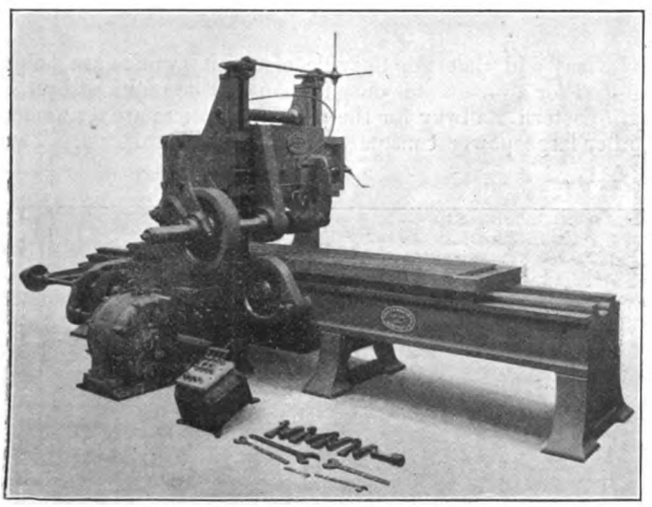

FIG. 4.—MILLING MACHINE.

600 megohms per mile. They are laid on the solid system, 18in. below ground. Each feeder circuit, comprising four cables, is laid separately in a strong iron-bark trough, the timber of which is treated with Stockholm tar to exclude moisture. After the troughing is laid, a thin layer of hot bitumen is poured upon the bottom, in which, at intervals of 18in., are placed small hardwood bridges to support the cables in a central position. The troughing is then filled entirely with melted bitumen and the cover screwed on. Vulcanised rubber-covered cables of the 600-megohm class are used for the interior wiring of the various shops. They are carried overhead, and supported on large glass insulators, which are clamped to the structural steelwork of the roof.

The motors installed vary from 1 H.P. to 75 H.P., and are all of the Westinghouse polyphase induction type, the majority with squirrel-cage rotors. The number at present installed is about 170, and the aggregate power over 1,200 H.P. Where speed regulation is required, the squirrel-cage rotor is replaced by a wound and insulated secondary, connections from which are made by means of collector rings on the shaft to external resistances. Thus the motor is enabled to exert full load torque at a number of speeds less than full speed, depending on the number of notches in the controller. For crane work, however, suitably designed squirrel-cage motors can be used.

The shop equipment includes 11 cranes, each operated by three motors, one for hoisting, one for cross-traversing and one for travelling. They are controlled from a cage (see Fig. 2) suspended from one end of the crane, and all three motions may be used at once, thus enabling material to be handled with the utmost dispatch. In addition to the cranes there are in the works numerous examples of large tools driven by individual motors. Figs. 3 and 4 representing respectively a combined punching and shearing machine, and a milling machine, are notably compact arrangements.

All these tools were made by Messrs. Craven Bros. of Manchester. A large number of tools, especially for wood-working purposes, were also supplied by Messrs. J. Robinson & Son of Rochdale.

The entire electrical equipment of the works was carried out by Messrs. Noyes Bros., the agents of the British Westinghouse Co. in Australasia.

THE NORTH-EASTERN RAILWAY.

Progress continues to be made with the electrical equipment of the Tynemouth lines on the North-Eastern Railway and the new power house which the Newcastle-on-Tyne Electric Supply Co. is building at Carville, near Wallsend, where power to work the lines will be generated. From the map which we published in *The Electrician* (Vol. XLIX., p. 721) at the time the specifications were issued and tenders invited for the "electrification," it will be remembered that the line is a loop between Newcastle and Tynemouth, and that it includes about 40 miles of route and an equivalent of some 80 to 90 miles of single track.

By the courtesy of the consulting engineer, Mr. C. H. Merz, we are now able to publish a drawing showing the arrangement of the conductor rails on the track (Fig. 1). It is seen that a distance of 3ft. 11½in. has been chosen between the centre of the track and the centre of the conductor rail (which is placed in the 6ft. way), the top of the conductor rail being 3ft. above the top of the track rail. This position, we may mention, is identical with that which has been adopted on the Lancashire and Yorkshire Railway, so that it will be possible to run trains—motor cars and all—from one line on to the other. The lines in and about London have not adopted this gauge, and the track of the Mersey Railway is also arranged in a different manner, but as the latter are lines of a special character, in which also an insulated return conductor was deemed essential, the "break in the gauge" is not so serious as it might at first sight appear. The collection of similar sectional drawings for the other third, and third and fourth-rail, electric railways, given by Mr. Stevens elsewhere in this issue, affords an interesting comparison. A modified pattern of the "Crown" Chicago bonds has been employed for establishing the electrical continuity of the track rails which form the return path for the current. At points and crossings the conductor rail has necessarily to be interrupted, but each motor car is provided with four contact shoes, so that the circuit is never broken. Fig. 2 shows the lower part of the motor car cab, and one of

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the shoes is seen, as also a portion of the conductor rail and an insulator.

In an article which we published last May (*The Electrician*, Vol. LI., p. 237) we gave general technical particulars with

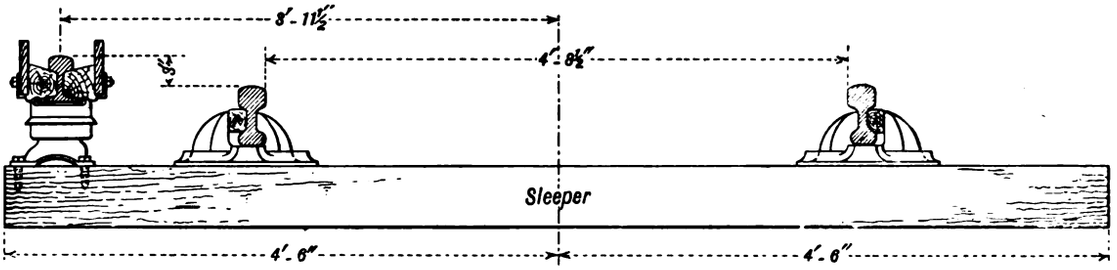

FIG. 1.—SECTION OF TRACK, SHOWING POSITION OF THIRD RAIL.

regard to the system adopted for the "electrification" of the line, and published drawings of the Carville power house and the sub-stations that are being erected, and we refer our readers to this for further information. It will be remembered

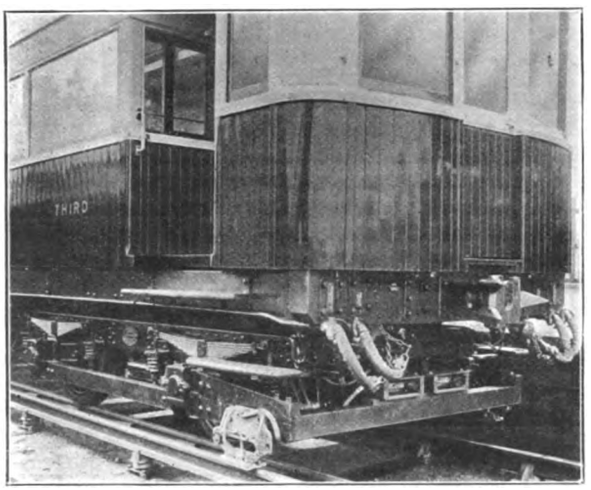

FIG. 2.—FRONT OF MOTOR CAR, SHOWING CONTACT SHOE AND ARRANGEMENT OF THIRD RAIL ON THE TRACK.

that the Thomson-Houston multiple-unit system is employed, and Fig. 3 shows the position of the resistances, "contactors," and reversing switch on the motor cars. The arrangement of these is similar to that adopted on the trains of the Metro-

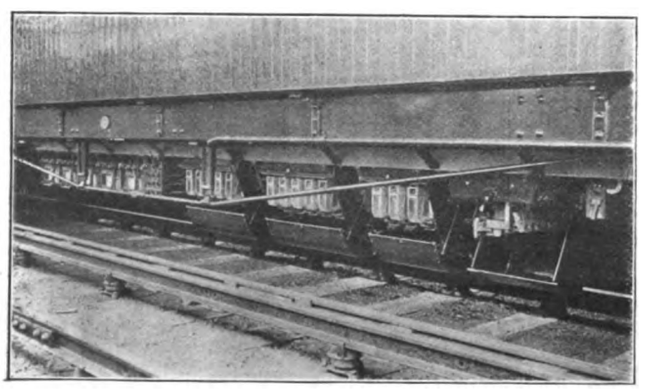

FIG. 3.—CONTACTORS, &c., ON MOTOR CAR.

politan District Railway, fully described in *The Electrician* last April (Vol. LI., p. 64), with the differences necessitated by the use of the track rails as a return instead of the insulated fourth rail of the new District lines.

The Carville power house not yet being in operation, current for trial runs has been supplied from one of the other generating stations of the Supply Company. In about a fortnight from now the North-Eastern Railway Co. proposes to run some trains to schedule time for the education of the motormen, and a few weeks later some of the electric trains may possibly be employed for regular passenger traffic. Fig. 4 is from a photograph of one of the trains taken during one of the runs that have already been made, and Fig. 5 is the historic locomotive "Locomotion" that drew the first public passenger train in England between Stockton and Darlington on September 27, 1825. The first trial electrical run on the North-Eastern was on the last anniversary of that day.

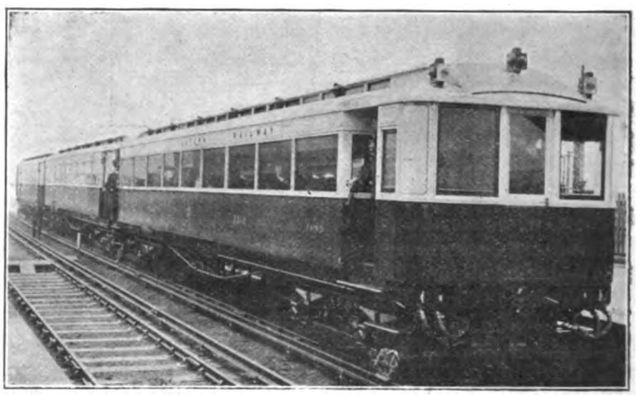

FIG. 4.—ONE OF THE TRAINS.

We may add that the Carville electricity works are being equipped for a far greater output than will be required by the North-Eastern Railway for the present, as there are a number of other large power consumers in the neighbourhood. Two

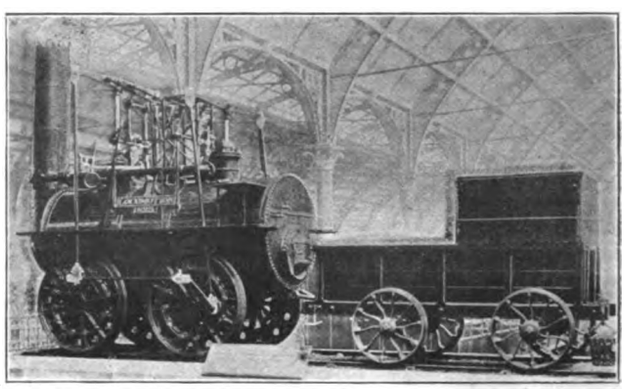

FIG. 5.—"LOCOMOTION, 1825."

2,000kw. and two 3,500kw. Parsons turbo-alternators are being put down, and these will be supplied with steam from Babcock and Wilcox marine type of boilers, each with an evaporative capacity of 20,000lb. per hour.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 495.)

The Conservation of Radio-Activity.—The simple law of radio-active change—that in N atoms of any type of radio-active matter λN change per second, where λ is a constant characteristic for the type of matter considered and unalterable by any known agency—leads to some general deductions of a far-reaching character. Radio-activity is derived either (1) from the slow break-up of some "permanent" radio-element—*i.e.*, an element changing excessively slowly, so that the amount does not perceptibly alter from year to year; (2) the more rapid break up of transition forms of matter which are maintained in existence because they are continually being reproduced by (1). The radio activity due to (1) must be constant over ordinary periods of time. With regard to (2), a little consideration shows that the quantity of each transition form in existence is also constant and must bear some fixed relation to the quantity of the parent element, for it is that quantity at which so much has accumulated that the quantity breaking up per second exactly balances the constant quantity produced per second. Therefore, each transition form contributes a fixed proportion of the radio-activity, so that the sum total of radio-activity is a constant. All that is effected by the chemical separations that have been discussed is to remove one or more of the transition forms. But the sum of the activities is still the same as before separation. This is the principle of the conservation of radio-activity, and holds true under all conditions that have yet been investigated. If it were otherwise the value of λ would suffer alteration, and this is contrary to experience, so far as our present experimental knowledge is concerned. After very long periods, probably comparable with the age of the earth, the radio-activity of any given quantity of one of the parent radio-elements, uranium or thorium for example, must diminish, it is true, unless there is some upward process of evolution not yet recognised which is re-forming the heavy elements out of the lighter ones, and so maintaining their quantity. But the principle of conservation applies rigidly only when some fixed amount of radio-element is considered, and this is spontaneously growing less. The change is, however, so slow that it may be neglected for ordinary periods of time.

Ultimate Products.—The question arises, since all radio-active matter must be changing, What are the final products resulting from the disintegration of the radio-elements when they at length assume a stable—*i.e.*, a non-radio-active—form? Obviously no evidence can be obtained in this direction by direct experiment, at least for the feebly-active elements uranium and thorium, except by operating with very large quantities over long periods. This has, fortunately, been done for us by Nature in the minerals containing these elements, for we must suppose, having no evidence to the contrary, that the changes have been proceeding continuously over geological epochs in these elements as they occur in the crust of the earth, and that, therefore, the ultimate products of the change tend to accumulate in the radio active minerals in quantities sufficient to be detected by ordinary chemical means. They should appear in the minerals as invariable companions of the radio-elements. If one examines the minerals containing uranium and thorium, many of which, as we now know, contain radium also, there are usually present a very large number of elements in larger or smaller quantities. The frequent presence of one—viz., helium—is, however, very remarkable. When Sir William Ramsay discovered this element for the first time in terrestrial sources, he drew attention to the curious fact that it only occurs in those minerals which contain uranium or thorium—*i.e.*, as we know now, are radio-active. On this account the case of helium is very suggestive. For the element belongs to the family of inert gases which are incapable of combining with any known element, and once separated from the mineral, by heat or solution, cannot be made to re-combine with it again. If, however, it were liberated by radio-active change through the mass of the substance, it is possible that it might be mechanically prevented from escaping. Rutherford and Soddy discovered (*Phil. Mag.*, 1903, VI., 5, p. 453) that this is the case with the gaseous emanations which, under certain circumstances, remain stored up in the compound producing them, and do not escape, and suggested that helium might be a disintegration product of one of the radio-elements. Thanks to the great advances made of recent years in gas manipulation by Sir William Ramsay and his colleagues in their work on the rare gases of the atmosphere, which necessitated the handling of vanishingly small quantities of gases, this prediction has been verified experimentally in the case of radium (*q.v.*).

This completes the theoretical consideration of the nature of radio-active change. For the sake of simplicity, and to avoid confusion, the case of thorium has been mainly taken, this being the element for which the theory was first worked out, but it applies equally to every case so far as is at present known, and the treatment of the remaining cases is much simplified by the consistent application of the theory.

A few points remain still to be cleared up in the case of thorium, however. Owing to the frequently complex nature of radio-active change, the parent element producing in turn several products, each of which is radio-active, the simple laws arrived at by considering each change by itself without reference to the effect of the subsequent changes, are not often strictly applicable without modification. Thus, the experimental curves obtained (Fig. 28) in the determinations of the rate of decay of the activity of thorium X, and the rate of recovery of the activity of thorium exhibit for the first two days divergencies from the the normal course afterwards followed. These are at once capable of explanation, if the other products of the change besides thorium X—viz., the emanation and the matter causing the imparted activity—are taken into account. Before the separation of thorium X, the activity of a thorium compound is due to the several activities of (1) thorium, (2) thorium X, (3) emanation, (4) matter causing imparted activity. By the chemical operation (2) is separated, leaving (1), (3), (4). The emanation (3) being very short-lived, loses its activity within a few minutes after the separation, and need not be practically considered. But (4), the matter causing imparted activity, requires 11 hours for the activity to fall to half value. Hence the recovery of activity due to the regeneration of (2), thorium X, will be offset by the simultaneous decay of the activity of (4). Thus the activity of the thorium compound does not commence to recover at once, but at first diminishes,

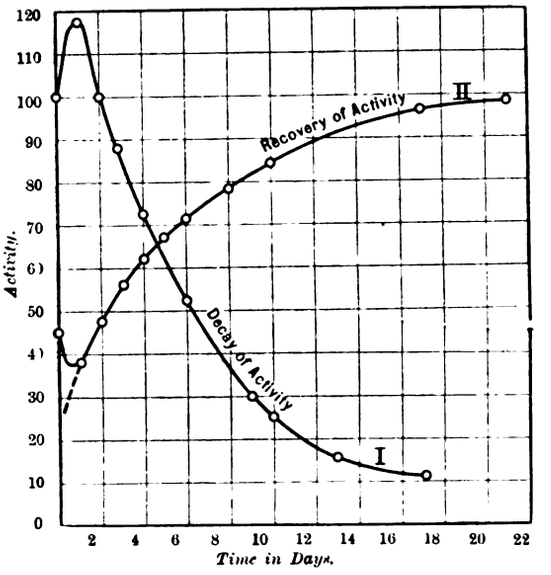

FIG. 28.

* These articles are based on a series of 12 lectures which Mr. Soddy has delivered at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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owing to the decay of the imparted activity present. The truth of this conclusion was tested by separating thorium X a great many times at short intervals from the thorium, so as to give the imparted activity produced by the thorium X, originally present before the first separation, time to completely decay. Under these circumstances, it is found the recovery curve commences to rise immediately in the normal manner from a 25 per cent. minimum, and the initial irregularity is completely absent. The same considerations hold good for the decay curve of thorium X. At first the imparted activity produced in the further change of thorium X causes the activity of the latter to increase, until the point is reached in about two days at which the amount of imparted activity produced balances its decay with time. Then the augmentation of the activity stops, and the steady decay of the activity of thorium X, to half-value in four days, proceeds after the second day according to the simple geometrical progression.

Another point which will repay discussion before leaving the element thorium, is the great variation in the emanating powers of different compounds, and of the same compound under different conditions. For the law that λN atoms change when N atoms are present, necessitates equally with a definite and unalterable radio-activity a correspondingly definite rate of production of new matter. Now, although the activity of thorium compounds is proportional to the quantity present, and is not affected by chemical or physical means, it is found that the emanating power of a compound often bears little relation to the amount of thorium contained in it. Certain compounds, like the oxide, but more particularly the hydroxide and carbonate, give off a large amount of emanation, while others, like the nitrate, oxalate, &c., give off very little indeed. It is found however, that when dissolved in aqueous solutions, all compounds of thorium are equally effective in this respect, and the emanating power may be taken to be at its maximum in solution. Rutherford noticed that if the oxide is intensely heated the emanating power is permanently reduced to a few per cent. of its original value, and preparations so treated are frequently referred to as "de-emanated." But if the de emanated oxide is subjected to a series of chemical processes, and again converted into a soluble compound, it is found that the normal maximum emanating power is possessed by the solution, showing that the phenomenon of de-emanation is to be associated with a particular physical state. The emanating power of a given thorium preparation is much affected by temperature, being very small at temperatures of about $-100°C.$, and being increased by rising temperature up to the point—about a red-heat—at which the process of de-emanation sets in The power of a thorium compound to impart activity to its surroundings varies correspondingly with its emanating power.

All these variations are satisfactorily accounted for by the view that the rate of production of the emanation is, as theory requires, constant and proportional to the quantity of thorium (or more strictly of thorium X) present, but that the *rate of escape* of the gaseous emanation from the compound producing it is much affected by temperature, solution, and the chemical and physical state of the compound. De-emanation for example, is brought about by an alteration in the physical state of the oxide, which retards the escape into the surrounding atmosphere of the emanation, which is formed uniformly through the mass of the compound. Owing to the rapid decay of the activity of the thorium emanation, a relative slight decrease in its rate of escape will greatly affect the value of the emanating power. In consequence, the radio-activity of the emanation appears as a part of that of the solid, and the imparted activity is produced in the compound instead of on surrounding bodies. Hence the radio-activity of a highly emanating compound like thorium hydroxide should be increased by strong ignition, and the increase should reach a maximum about two days after the process, when the imparted activity produced by the imprisoned emanation obtains its equilibrium-value. This was found to be the case. The activity of a sample of thorium hydroxide rises slowly during the first two days after ignition to a maximum about 120 per cent. of the former value. The converse experiment is to take a non-emanating compound and suddenly convert it into a highly emanating one. This was accomplished by keeping the highly emanating hydroxide in liquid air for some days, so that the emanation is condensed and does not escape, and its radio-activity and the imparted activity it produces is added on to the activity of the compound. On removing it from the liquid air the activity slowly decays about 20 per cent. during the first few days, owing to the emanation now being free to escape from the system, and to carry away the imparted activity to surrounding objects.

No simple general treatment is possible of the disturbing effects of subsequent changes. The following cases may be qualitatively recognised. If a body, A, changes into B, and B changes into C more rapidly than A into B, the decay curve of A will show a preliminary increase in activity, and then a decrease to zero at the rate of change of A into B. If, however, B changes into C at a slower rate than A into B, the decay curve will exhibit a normal course down to a certain point, and if this point is calculated as zero, the rate of change may be considered without error as the true rate of change of A into B. From this point the activity decays to zero at a rate slower than before—viz., that of B into C. These cases are complicated experimentally when one of the stages consists of a gaseous type of matter, like the emanation, but each case can be worked out for itself from first principles.

(To be continued.)

LAMME'S SINGLE-PHASE MOTOR PATENT.

The following is the complete specification of the British patent for "Improvements in Electric Motors," granted to B. G. Lamme, of the Westinghouse Company. The number of the patent is 26,746 of 1902 :—

My invention relates to electric motors, and has for its object to construct an improved series-wound motor for use with single-phase alternating currents. Hitherto alternating currents have been applied to operate series-wound motors, but considerable difficulties have arisen in the form of undue heating, excessive sparking of the brushes and low efficiency, together with want of due regulation. According to my invention, I overcome these defects, not by merely modifying the arrangement of parts of the ordinary series-wound motor, but by providing that certain definite proportions and relations shall subsist between such parts, together with various novel features in the construction of the motor. Since the self-induction of the field-magnets and the counter E.M.F. set up by the armature are both dependent on the strength of field, a relation subsists between them which is proportional to the speed of rotation of the armature, the relative ampere-turns and the frequency. A higher speed, a low frequency and few turns on the field-magnets compared with those on the armature, will give a lower ratio of the field self-induction to the armature counter E.M.F. Both the field strength and the armature magnetic lines of force increase with the current supplied to the motor, and if saturation is not approached each of these will increase directly as the current, and, therefore, the torque which is produced by them jointly will increase as the square of the current, which would be a highly advantageous condition for electric traction work. Increase in strength of field, however, is accompanied by augmented self-induction which, when working with alternating currents, must be reckoned with. Inasmuch as the resultant of all the E.M.F.s is equal to the applied E.M.F., increase in self-induction would result in a fall of speed, and if the self-induction of the motor becomes relatively high, the speed will fall very rapidly, and zero will be reached when the self-induction is equal to the applied E.M.F. Conversely, if the strength of the field be kept constant its self-induction will be constant, and, consequently, the armature speed will not fall unless its own induction be very high.

In the two cases above stated the first is that in which the strength of field is approximately proportional to the strength of the current, and in the second case the field magnetic strength is constant. As previously pointed out, the first case provides favourable conditions for electric traction, but it is limited by the fact that the maximum torque which can be developed may be insufficient for maximum requirements. In the second case the torque is not so limited, but on the other hand the general characteristics of the motor may not be suited to given conditions of working. It is therefore advantageous to so proportion the motor as to combine the two cases and thus secure conditions through a certain range of working, in which the field strength is approximately proportional to the current, and have the motor capable of developing the required torque. It has been pointed out that the limitation in the torque developed when the field magnetic strength increases in proportion to the current, is due to the rapidly increasing self-induction of the field as the current is increased, so that the self-induction soon becomes nearly equal to the applied E.M.F. It is desirable, therefore, to provide means for limiting the self-induction so that it does not normally absorb an undue proportion of the applied E.M.F., and when a heavy torque is required, the self-induction of the field shall not limit the current, but shall permit

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a sufficient current to flow to produce the required torque. As the cross-induction of the armature through the poles acts with the self-induction of the field in limiting the flow of current, it is desirable that this should also be kept within proper limits. It follows, therefore, that the self-induction of the motor, as a whole, in normal working, should be relatively small with relation to the applied E.M.F., and should also have a limiting value which is less than the applied E.M.F., even when the motor is operating under maximum conditions of torque. The relations between the field self-induction and the armature counter E.M.F. may be expressed as follows: Self-induction of field = alternations × field turns in series × induction per pole × constant. The counter E.M.F. of the armature = revolutions × the number of armature wires × induction per pole × constant. The constants used are dependent upon the characteristics of the supply circuit and upon the units in which the different terms are expressed; their values are determined in any given case according to well-established laws, and the armature winding is assumed to be of the usual parallel type.

$$\frac{\text{Field self-induction}}{\text{Armature C.E.M.F.}} = \frac{\text{Line alternations} \times \text{field turns in series} \times \text{induction per pole}}{\text{Revolutions} \times \text{armature wires} \times \text{induction per pole}} \times \text{constant},$$

since armature wires $= 2 \times$ poles $\times$ armature-turns in series

$$\frac{\text{Field self-induction}}{\text{Armature C.E.M.F.}} = \frac{\text{Line alternations}}{\text{Poles} \times \text{revolutions}} \times \frac{\text{field ampere-turns}}{\text{armature ampere-turns}} \times \frac{\text{constant}}{2}.$$

In a direct-current motor the armature alternations are equal to the product of the revolutions multiplied by the number of poles, and, since this relation may be assumed to obtain in a series alternating-current motor the foregoing formula may be further simplified by substituting the term "armature alternations" for the term "poles × revolutions." It has been pointed out that the self-induction of the motor should be relatively low as compared with the applied E.M.F., since the resultant of the self-induction of the motor and the counter E.M.F. is approximately equal to the applied E.M.F., and it follows that the self-induction should be low in proportion to the counter E.M.F. of the armature in normal working. The relation between the two is expressed in the foregoing formula, and it is now apparent what relations must hold between the elements of the motor itself and between the motor and the external conditions.

In order that the ratio between the field self-induction and the counter E.M.F. of the armature may be low, it is clear that there must be a small number of line alternations, a large number of poles and a high speed, and a small number of field ampere-turns and a relatively large number of armature ampere-turns. The absolute values and the ratios between these several elements which are admissible and suitable for practical design and operation will now be considered. The ratio of field ampere-turns to the armature ampere-turns has, generally, a minimum value which is fixed by the proper operation of the motor itself. If the field ampere-turns are too small as compared with the armature ampere-turns, the magnetic field will be distorted and good commutation will be difficult. The minimum ratio of field ampere-turns to armature ampere-turns is dependent upon many factors in the design, but, in general, it may be said that this ratio should be greater than 0·5 and may sometimes be as high as 0·75.

Therefore, when definite limits have been assigned to two of the ratios in the last equation—namely, the ratio of field self-induction to armature counter E.M.F., and the ratio of field ampere-turns to armature ampere-turns then there is also a definite limit fixed for the remaining term in the equation—*i.e.*, a definite relation between the alternations in the supply circuit, the number of poles of the motor, and its rate of revolution, or, in other words, between the line alternations and the armature alternations. It may be noted that an average working value for the last-mentioned ratio is approximately 0·625, and it has been found that the expression $\frac{\text{constant}}{2}$ in the foregoing formula closely approximates the reciprocal of 0·625—*i.e.*, 1·6. It follows, therefore, that the last two ratios of the formula cancel out, leaving only the ratios of field self-induction to armature counter E.M.F. and line alternations to armature alternations, for which definite limits are fixed, as hereinbefore pointed out. With a given number of revolutions, the number of poles must be directly proportional to the alternations in the supply circuit. Thus, for instance, if an eight-pole 700-revolution motor of a certain capacity is required for 2,000 alternations per minute, 3,000 alternations per minute will require a 12-pole motor at 700 revs. per min.

The foregoing considerations indicate the conditions required for securing a relatively low self-induction of the field of the motor. It has been stated that a limiting value of the self-induction of the motor can be secured by suitably proportioning certain parts of the motor. A method of doing this will now be described. The field self-induction and the armature self-induction may both be limited by special construction of the pole-pieces. For instance, slots or holes may be cut in the body of each of the field pole-pieces from end to end transversely to the direction of rotation, the amount of iron left at the back of the slots being that which is required for the desired induction. The teeth or narrow portions between the slots or holes are of such cross-section that the desired induction through them may be obtained. The slots or holes may be closed, or nearly closed, at the pole faces, and usually this is preferred, as open slots increase the magnetising power required in the field winding which, in turn, necessitates more field turns, and results in greater field self-induction. The cross-section of iron in the poles is preferably such that but little magnetising power is absorbed in addition to that required for the air-gap until the current exceeds the normal rated amperes of the motor. Beyond this normal current, the teeth between the pole slots rapidly approach saturation. In order to secure this result, the parts in which the cross-section of the magnetic circuit is reduced should be of comparatively short length, but should, of course, be worked at a high induction. It is not necessary or desirable to subject the whole yoke to a high induction, as the desired results can be obtained by having a short length of small cross-section, whereas, if the whole yoke be subjected to a high induction, the losses due to reversals in the core will be objectionably large, and also the magnetic leakage into the surrounding frame and through the field windings will be objectionable.

The self-induction of the armature which results from a cross-induction through the poles, in which the magnetic lines enter at one edge or side of the pole and pass through the core to the opposite edge or side, is also reduced and limited by the arrangement of slots or holes which has been described and which would not be obtained in the same degree if the whole yoke were saturated, provided the field cores in the two cases required the same number of ampere-turns in the field for magnetising them. The cross-induction of the armature is due to the magnetic flux which passes through the field poles, the path for any given pole being through the teeth at one side, then across the slots and also across the pole back of the slots and then along the teeth at the other side of the pole and back to the armature. The smaller the section of the teeth and the more highly they are saturated, the less will be the cross-induction with a given current in the armature. As it is desired to have the induction in these teeth quite high, it is, as above pointed out, desirable to have the teeth as small as possible, and, therefore, the magnetic reluctance of the field circuit is concentrated near the pole-face instead of being distributed through the whole yoke. The total useful flux through the armature and field sets up no effective E.M.F. of self-induction in the armature windings, as it will add to the counter E.M.F. at one part and subtract at another part of such winding. But the E.M.F. set up by the cross-induction does not neutralise itself in the same way, and thus becomes an E.M.F. of the same character as that set up in the field windings. The cross-flux from the armature may be further limited by the suitable interposition of a secondary circuit, if desired. For example, if a slot at the middle of the pole contain a conducting plate or closed coil, it will oppose the magnetic flow which would tend to cross the slot. If the ends of a conductor placed through the middle slot be connected with the outer frame of the machine at each end, or if the conductor be closed around the outside of the yoke, then the secondary circuit thus formed will oppose the flow of the cross-induction which tends to pass through the section of iron back of the slots.

The armature winding of the motor is of the closed coil type and is closed upon itself before being connected to the commutator, relatively high resistance leads being inserted between the winding and the respective commutator bars. As the magnetic field of the motor is alternating, any short-circuited turn through which the magnetic flux from a field-pole passes will have a secondary current set up in it. By the well-known laws of the transformer the ampere-turns in such short-circuited secondary will approximate the ampere-turns in the primary winding, which is, in this case, the field-magnet winding. Certain coils of the armature winding are short-circuited through the brushes when the adjacent commutator bars to which the ends of the coils are connected are bridged by the brushes, and when the latter are located in neutral positions or without lead, the short-circuited turns surround the paths of the magnetic flux and are, therefore, good secondary circuits in which relatively large secondary currents are set up by induction. This is the principal cause of the excessive sparking in series motors of ordinary construction, when it is attempted to operate them upon an alternating-current circuit. In order to obviate destructive sparking, the current in the short-circuited turns of the armature coil should be limited to an amount materially less than what would normally flow. I have found that by inserting a definite amount of resistance in each of the leads between the closed winding and the commutator bars, it is possible to so limit the secondary current due to the alternating field flux as to prevent injurious sparking. The working currents in the armature winding will not pass through these resistances except at the bars in contact with the brushes, because the armature winding is closed on itself inside or beyond the resistance leads. Consequently, the loss in the winding due to the introduction of the resistance can be relatively small, and when the armature is rotating, this loss is distributed successively through all the resistances, thus making the average loss per resistance lead very small. Various ways of introducing such a resistance will be described in connection with the accompanying drawings.

With a given current in the motor, the turn of each armature coil which is short-circuited by a brush will tend to have the same E.M.F. set up in it irrespective of the E.M.F. applied to the motor. Therefore, the resistance in the leads may be such that the short-circuited current developed will be limited in amount, and, generally speaking, with full-load current in the motor; the resistance should be such that the short-circuited current will not exceed, say, twice the value of the full-load current. The resistance in each short-circuit will include the resistance of the turn itself plus the resistance of two of the leads, plus also the resistance of the brushholders and brushes. As will appear from what has already been stated, the conditions for suitably low self-induction and for a proper ratio of field ampere-turns to armature ampere-turns practically determine the number of poles the motor should have with a given rate of alternation and speed. This motor will require a relatively larger number of poles as compared with direct-current motors of corresponding size. Moreover, the conditions of good commutation are that the armature circuits of the motor be connected in parallel, and that the number of turns between consecutive armature bars be small. It follows, therefore, that the voltage of the motor is definitely limited, and it is found that the actual voltage is low relative to that for which direct-current motors

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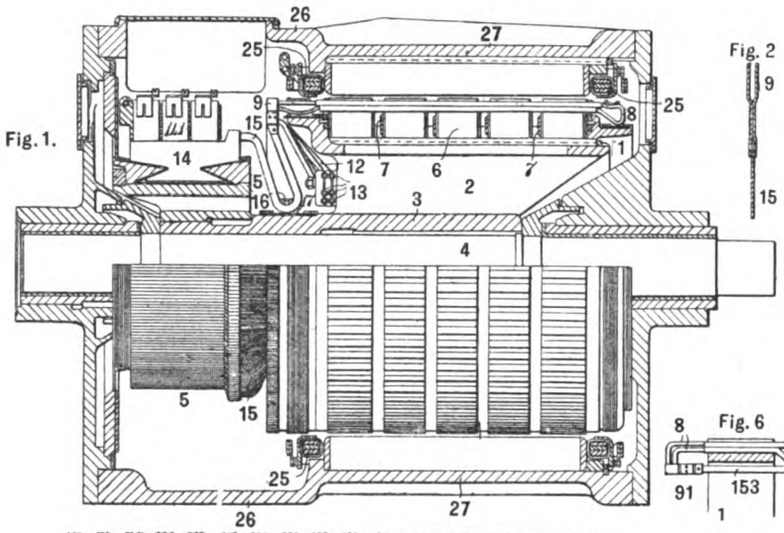
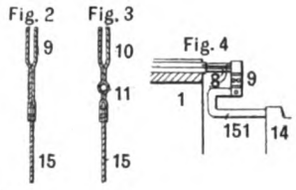
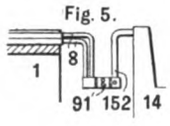
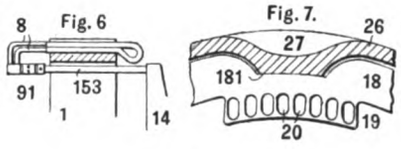
may be wound—such, for example, as motors employed in ordinary electric traction. While this characteristic would be a serious limitation in connection with the distribution of energy for direct-current traction motors, it is of minor consequence in connection with alternating-current motors, since transformers may be interposed between the supply-circuit and the motors, which may be designed to receive practically any voltage from the line and to deliver any desired voltage to the motors. In service, a motor may require either a constant voltage or a variable voltage. For variable speed work the variable voltage is usually desired. A variable voltage may be obtained by the introduction of resistance or self-induction into the circuit or, preferably, by means of a transformer in which the rate of transformation is suitably changed. The several elements which are involved are the motor, the controller, the supply circuit and the transformer. The motor, as has been pointed out, has inherent limitations as to the voltage for which it can be wound, which are independent of the transformers, the controller and the voltage of the supply circuit. The current and the voltage which can be most advantageously handled by the controller may be entirely different from those of the motor. For example, it may be advantageous to design the controller for one-third of the current and three times the voltage which are required by the motor. The line voltage may, in turn, be entirely too high to be introduced directly into the controller or the motor. It follows, therefore, that the voltage of the motor, the voltage of the controller and the voltage of the supply circuit, and their respective currents, which may be most advantageously utilised, may be widely different. It is possible, however, by means of one or more transformers, to operate a motor adapted to any voltage by a controller adapted to any voltage from a supply circuit of any voltage. A convenient method of control consists in connecting a main transformer across the supply circuit, its secondary being included with the motor circuit but having included in series the secondary of a series transformer, the primary of which derives current either directly or indirectly from the main circuit and is capable of adding to or subtracting from the E.M F. developed in the secondary of the main transformer.

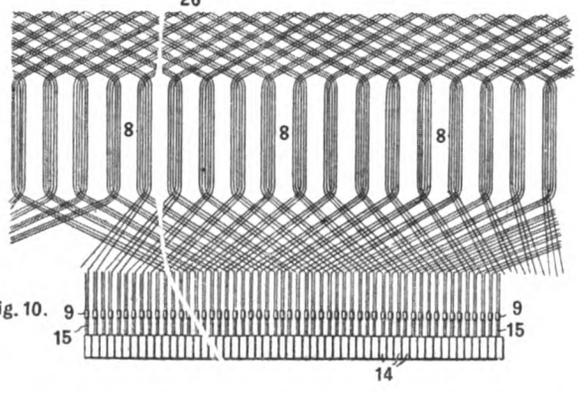
This invention is applicable in cases where frequent starting is required, as, for instance, in electric traction systems. It is now the common practice in operating electric cars to have two or more electric motors upon each car, and for the purpose of securing varying speeds means are usually employed for connecting the motors either in series or in parallel, and for introducing more or less ohmic resistance into the circuits of the motors. With single-phase motors constructed according to my invention, it is possible to dispense with practically all ohmic resistances for regulating purposes, and it is not necessary to connect the motors successively in series and in parallel for the purposes of regulation, but the motors may be permanently connected either in parallel or in series and all the benefits of the usual series parallel control, as employed with direct-current motors, may be obtained by varying the E.M.F. applied to the alternating-current motors. In some instances, it may be desired to connect the motors permanently in series—for instance, in cases where the reduced current will be more suitable for the controllers, or where the increased voltage presents advantages such as would be secured if this voltage were equal to that of the supply circuit. The method of control by means of variable ratio of transformation in the transformer is one which provides a very much higher degree of economy in starting and at low speeds than is obtained in the usual method of operating direct-current motors where the voltage is reduced by means of rheostats, either with or without the series parallel method of control. In electric traction work, in which starting is frequent, a very large per cent. of the power delivered to the car may be lost in rheostats, thus greatly reducing the efficiency and increasing the cost of operation. It is to be understood, however, that the rheostatic method of control may be used with the form of alternating-current motors herein described, if desired, but usually the advantages of operating by means of transformers with variable E.M.F. ratio without rheostats are very great. The voltage delivered by the transformers is that required by the motor, so that there are practically no losses except those inherent in the transformers and motors, both of which are capable of being so designed as to have high efficiency. With this system, full load torque or several times full load torque at starting may be developed with a very small amount of energy from the supply circuit. It also follows that with a given torque developed by the motors, the power taken from the circuit is substantially proportional to the speed of the motors, which is not the case with direct-current motors.

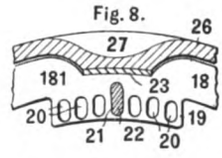


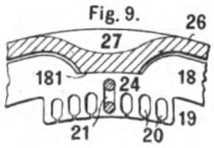












In the accompanying drawings, Fig. 1 is a view, partially in side elevation and partially in longitudinal section, of a motor constructed in accordance with my invention. Figs. 2 and 3 are detail sectional views of two of the combined resistance leads and connectors between the armature conductors and the commutator segments. Figs. 4, 5 and 6 are detail views illustrating modified arrangements of resistance leads for connecting the armature conductors with the commutator segments. Figs. 7, 8 and 9 are detail views of different forms of field-magnet core construction. Fig. 10 is a diagrammatic development of a portion of the armature winding and connections between the same and the commutator segments. As here shown, the armature 1 comprises a skeleton open-work frame or spider 2, the hub 3 of which is in the form of a sleeve mounted upon and suitably keyed to a shaft, 4, this sleeve being extended, at one end, to receive a commutator cylinder, 5, which is also suitably keyed to it. The core 6 of the armature is built up in the usual manner of thin plates or laminæ, properly spaced apart at intervals by ventilating spaces 7 and provided with slots, which, in the present case, are 72 in number, in which are mounted the insulated conductors 8 constituting the coils of the armature winding. These coils or conductors, as shown, are of strap copper, the turns of which are located side by side in the slots, forming three separate coils, which span the core from the first to the ninth slot, and so on around the core. The coils are properly joined together at one end of the armature by means of suitable connectors, 9 and 10, so as to form a closed parallel winding. The connectors 10 are provided with sockets 11, in which are fastened the outer ends of suitable connecting wires or strips, 12, the inner ends of which are connected to balancing rings, 13, in a well-known manner.

For the purpose of reducing the secondary currents that are generated by the alternating magnetic field in the coils which are short-circuited at the brushes to substantially non-sparking limits, I join the connectors 9 and 10 to the several commutator bars 14 by means of relatively high resistance leads 15, there being in the present case 216 commutator bars and the same number of leads. As employed by me, these leads are in the form of strips of German silver, and their dimensions are accurately determined, in view of the specific resistance of the material, so as to reduce the secondary current, above referred to, to the desired limits, and the form and arrangement of the leads are also such as to be properly accommodated by the space available and so as to be properly ventilated and securely supported independently of each other. The commutator brushes, 141, are arranged in sets in the holders or arms, and, in the present instance, the arms or holders are eight in number. The brushes and arms may be of usual material and construction and connected in the usual manner to properly co-operate with the commutator cylinder and the supply circuit. As indicated in Fig. 1, the leads 15 are bent into substantially the form of U-shaped loops,

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the inner ends of which are held in place by means of a suitable winding, 16, an insulating band, 17, being interposed between the leads and the sleeve 3 of the armature spider. As illustrated in Fig. 4, the resistance leads 151 are shown as having a substantially U-shaped form, one arm of which extends beyond the other for connection to the commutator bar and the two arms of which are approximately parallel to the armature axis. In Fig. 5 the resistance leads 152 are shown as having each a main body postion substantially perpendicular to the armature axis and an outer end which extends approximately at right angles to the body portion for connection to the commutator bar. In this case, the end of the armature conductors project inwardly, approximately parallel to the body portions of the leads, for connection to the connectors 91, which are also substantially at right angles to the body portions of the resistance leads. In Fig. 6 the resistance leads 153 are connected to the ends of the armature conductors, at the end opposite the commutator, and project through the spider to the commutator and, substantially parallel to the axis of the armature. Other forms and arrangements of resistance leads may, perhaps, be devised which will be adapted for the purpose. These, I have shown, are such as I have been able to devise to most satisfactorily provide the necessary resistance and, at the same time, be economically and safely disposed in the available space in the motor.

As has already been pointed out the number of field magnet-poles of the motor must be directly proportional to the rate of current alternation in the supply circuit, and other conditions, which have been heretofore pointed out in detail, render it desirable, and, in fact, necessary, for successful operatson that the rate of line alternations shall be low, and that the rate of armature alternations shall be relatively high. The motor here illustrated and described was designed for a frequency of 2,000 line alternations per minute, and the motor which is adapted to this number of alternations and the other conditions has eight field-magnet poles. The field-magnet core 18 is in the form of a hollow cylinder and is built up of thin plates or laminæ, the laminated construction being necessary by reason of the fact that the magnetic flux, due to the field-magnet winding, is alternating.

The polar projections or pole-pieces 19 are provided with holes or perforations 20 extending through the same, transversely to the direction of armature rotation, and located in close proximity to the ends of the polar projections or pole-pieces, and the depth of the body portion of the core is reduced at the rear of each polar projection, as shown at 181, in Figs. 7, 8 and 9, in order to aid in reducing the cross-magnetisation and, consequently, the armature self-induction, The slots 20 are made comparatively shallow in order to keep the iron loss low and at the same time to ensure the desired saturation of the adjacent iron when the current materially exceeds the rated amperes of the motor. These slots may be entirely closed at the pole-faces, as indicated in Figs. 7 and 8, or they may have narrow openings, as shown in Fig. 9, but in every case where open slots are employed the openings should be small. As shown in Fig. 7 there are eight of the holes 20, which, as above stated, are of such dimensions and so spaced as to provide a cross-section of metal between them which will become quickly saturated when the current in the field magnet windings materially exceeds the rated amperes for which the motor is designed. In Fig. 8 are shown six holes, 20, and at approximately the middle of the pole-piece is a hole, 21, which is of materially greater depth than the holes 20. In this hole 21 is located a bar or plate, 22, of copper or other good conducting material, for the purpose of serving as a closed secondary circuit to reduce the armature self-induction due to the cross-magnetisation. In Fig. 8 is shown a plate, 23, of copper or other good conducting material, which also acts as a secondary closed circuit to oppose any cross-magnetising flux which tends to pass outside of the core 18 of the field-magnet. In Fig. 9 the construction is the same as that shown in Fig. 8, except that a single turn, 24, of wire constituting a closed coil is placed in the middle slot 21, instead of the bar or plate 22, and the plate 23 is omitted. Other forms of conductors suitably disposed to act as secondaries and thus oppose the cross-magnetising flux might be employed, if desired, those shown being set forth merely as examples that I have found well adapted for the purpose. The field magnet winding 25 is here shown as comprising eight coils of strap copper, bent edgewise and connected in series and so insulated and supported as to perform the functions desired, and, at the same time, be effectively insulated and occupy a minimum amount of space. In the present case the winding comprises 20 turns, one-half of the coils having three turns and the other half having two turns, and the coils of the two sets are alternately disposed around the core. A greater number of turns may be employed, if desired, provided they are so connected that the number of turns in series does not materially exceed that specified above.

The field magnet core and coils are mounted in a casing, 26, which is provided with extensions at its ends to enclose also the armature and commutator. As shown, this casing projects inwardly, at the backs of the pole-pieces, to constitute supports for the core 18, and is correspondingly hollowed out as regards its exterior, as indicated at 27, so as to lessen the weight of the structure. This form may be varied from what is shown, if desired, and the points of support between the core and the casing may be otherwise located. The casing may also be made of open-work skeleton construction, if desired, since its office is mainly that of a support for the field-magnet.

Various methods of controlling motors, constructed in accordance with this invention, may be employed, it being preferable, as above stated, to vary the E.M.F. applied to the motors. For this purpose a transformer may be interposed between the motor and the supply mains, and the E.M.F. of the secondary may be varied by varying the number of windings of the primary or secondary, or varying their magnetic relationship in a manner well known in the art. Either a two-coil transformer or an auto-transformer may be employed. Another very convenient means consists in the employment of a three-coil transformer, the third coil of which is connected with the primary coil of a second transformer, the secondary coil of which is in series with the secondary coil of the main transformer, as above described. Rheostats or similar adjusting means may obviously be employed in addition to or instead of the means for varying the voltage. It will be understood, however, that the invention is not limited to the method of control or restricted to any precise method.

The claims are:

1. A single-phase alternating-current series-wound motor, in which the ratio of the field-magnet self-induction to the armature counter E.M.F. is approximately equal to the ratio of the line alternations to armature alternations, substantially as described.

2. A single-phase alternating-current series-wound motor having a closed-coil parallel-wound armature with relatively high resistance leads connecting the armature coils with the several commutator bars, and a field-magnet the poles of which have slots transverse to the direction of rotation of the armature and with or without a closed conductor inserted in one of the slots and extending through approximately the central portion of the pole, substantially as described.

3. For use with single-phase alternating electric currents, a series-wound motor having the ratio of the number of field poles to the number of current alternations per minute approximately as 1 to 250, and having a ratio of field ampere-turns to armature ampere-turns approximately as 20 to 27.

4. Electric motors for use with single-phase alternating currents constructed substantially as described with reference to the accompanying drawings.

ON THE MAGNETIC DISPERSION IN INDUCTION MOTORS, AND ITS INFLUENCE ON THE DESIGN OF THESE MACHINES.*

BY DR. HANS BEHN-ESCHENBURG.

I.—On the Dispersion-coefficient σ.

As is known, in the theory of induction motors, a dominant part is played by the coefficient of magnetic dispersion which may be defined by the expression

$$\sigma = 1 - \frac{M_1 M_2}{L_1 L_2}; \quad \ldots\ldots\ldots \quad (1)$$

wherein M_1 and M_2 denote the coefficients of mutual induction, L_1 and L_2 the coefficients of self-induction of the corresponding winding elements of the inducing and induced systems. The coefficient σ is most simply obtained experimentally as the quotient of the magnetising current by the short-circuit current at equal terminal potentials. If we neglect the relatively small correcting terms which depend on the ohmic resistance and the no-load losses, the dispersion coefficient may be approximately stated by the expression

$$\sigma = \frac{J_0}{J_k}; \quad \ldots\ldots\ldots \quad (2)$$

where J_0 denotes the no-load current and J_k the short-circuit current, reduced to equal terminal potentials.

Here at the outset, for fixing the limits of accuracy which in this investigation will be assumed as convenient, let it be laid down that the values of σ experimentally obtained for motors of equal size and precisely similar winding, differ amongst themselves frequently from 10 to 20 per cent., probably because the dimensions of the air-gap, of the slots, of the winding pitches, &c., which determine the magnitude of σ, cannot, in different examples of the same type, actually be turned out alike with mathematical precision. The experimental values deduced in the following investigations to determine the coefficient σ are mean values selected with great precaution from a large series of machines of similar type, or from observations made on some individual motor in which the separate dimensions could be varied. The distinct importance of the coefficient σ lies, as is known, in the limitation by it of the maximum power-factor, and of the capacity for overload of the motor. As is known, we have the approximate relation

$$\cos \phi_{max.} = 1 - 2\sigma;$$

and the maximum torque, relatively to the torque which exists at the maximum power-factor, is

$$\nu = \frac{1}{2\sqrt{\sigma}};$$

Let it be assumed that σ lies between the limits 0·1 and 0·02, and that the accuracy of the values of σ for a motor of known dimensions does not exceed 10 per cent., then the accuracy in the predetermination of the maximum power-factor will attain about 1 per cent., and that of the capacity for overload about 6 per cent. But these are

* The researches described in this communication were imparted in April, 1903, to Prof. Silvanus P. Thompson, on whose suggestion they were communicated in their present form to the Institution of Electrical Engineers in the summer, and have since been translated into English. The Paper was read in abstract by Prof. Thompson at the meeting of the Institution on January 15, 1904.

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degrees of accuracy which quite equal the accuracy of the experimental determination of these qualities attainable in practice.

In accordance with these limits of accuracy, it seems convenient to confine an investigation into the dispersion coefficient to a qualitative separation of the most important factors which in any general consideration are the determining ones, and to an experimental fixing of the order of magnitude of these factors. The coefficient σ appears to be made up of a series of single terms and factors, to which in the various theories different degrees of importance are attributed. So long as these individual quantities cannot be systematically separated experimentally one from the other, one may easily find a concordance between the total values of σ as ascertained by experiment and as calculated by theory, even though the theoretical composition of the total value out of the individual considerations were false.

II.—Theory.

In order not to complicate inconveniently the theoretical part of this investigation, consideration will from the outset be confined to a three-phase motor the primary and secondary systems of which possess equal numbers of windings, which are arranged in the same manner in an approximately equal number of similar slots, so that the dispersion-ratios in the two systems may be approximately equal, or at least capable of being expressed by a mean value. In due course, in the experimental part, it will be considered what is the influence which any departure from this hypothetical uniform arrangement of windings will exert. Moreover, this assumption, while making for simplicity, is useful in demonstrating relations which depend upon σ, and it will be shown that within the above-stated limits of accuracy it is of general validity.

Further, in what follows, we make the assumption generally that the so-called magnetic resistance in the iron parts of the motor is small in comparison with the magnetic resistance of the air-gap. This condition may obviously always be fulfilled if we confine ourselves to such degrees of saturation that the magnetising current is proportional to the terminal voltage.

In formula (1), giving the definition of σ, it is primarily to be noted that σ must practically be a quantity smaller than 0·1; and that, having regard to the degrees of accuracy required in practice, quantities smaller than 0·1 are negligible relatively to unity. For a motor with stator and rotor windings that are alike, we may substitute

$$M_1 = M_2 = M;$$
$$L_1 = L_2 = L;$$

whence
$$\sigma = \frac{L^2 - M^2}{L^2} = 2 \times \frac{L - M}{L}. \quad \ldots\ldots\ldots \quad (3)$$

In what follows we will apply the coefficients L and M to the winding of one group of coils, constituting one phase in one pole-pitch of the motor. Let w be the number of turns of this group of coils, and let the group consist of $\frac{N}{3}$ single coils, which are disposed in $2\frac{N}{3}$ slots. For the three-phase motor, N is, therefore, the number of slots per pole-pitch. Then $\frac{L}{w}$ denotes the magnetic flux which intersects the windings w when these same windings are traversed by a current of strength = 1. Also $\frac{M}{w}$ is the magnetic flux which intersects the windings of one system when the windings of the other system are traversed by a current of strength = 1.

§ 1.—The Winding-coefficient.

In every motor there necessarily exists a difference between the self-induction of the winding of one system and the mutual-induction between corresponding portions of the windings of the primary and secondary systems, even if there were no so-called magnetic leakage to influence the relation.

To simplify the exposition, let us consider a motor in which both systems possess a precisely similar number of slots, and in which the iron teeth lying between the slots are of precisely similar form Let both systems be wound in the usual manner; in fact, let one system contain a primary winding which is arranged in the manner of the three-phase motor in one-third of the slots within the pitch of one pole, while the induced system consists of a number of conductors regularly distributed in all the slots. It will be assumed that no leakage is present in the two systems. Then let us distinguish two extreme positions in which the two systems may be placed opposite to one another—i. the teeth of one system stand exactly opposite the teeth of the second system; ii. the teeth of the one system stand exactly opposite the slots or holes of the second system. In both positions let the same number of magnetic lines be generated by the primary winding, and pass over from the teeth of the first system into the teeth of the second system. It is self-evident that in the former position the mutual-induction will be exactly equal to the self-induction, since the secondary conductors are surrounded by exactly as many magnetic lines as are the primary. In the latter position, on the contrary, a portion of the magnetic lines will enclose a smaller number of secondary conductors than they do in the former position.

The total amount of the mutual-induction may be measured in a simple way as the sum of a set of products, each product being the amount of a branch of the magnetic flux proceeding out of a primary tooth multiplied by the number of secondary conductors which this branch of the flux surrounds until it again returns into the primary system. The difference between the amounts so reckoned of the mutual-induction in the two extreme positions gives the loss of the mutual-induction which occurs in the second position. This loss is equal to the difference between the self-induction and the mutual-induction in this second position. But now, since during the operation of the motor, in consequence of the slip, the teeth of the two systems glide past one another in their relative positions, it follows that half the difference of the mutual-inductions in the two extreme positions will indicate the mean value of this difference while running. If one exchanges the respective rôles of the primary and secondary systems, the estimate so made of this difference will apply equally to the stator system as to the rotor system of the motor. Strictly speaking, in this regard the windings of all the slots in their actual and complete relations ought to be taken into consideration All the phases of the winding of the one system act successively and together upon all the phases of the winding of the second system. In consequence there occur in general at definite places in each system the known distortions and inequalities of the magnetic field, and these are bound up with the practical limitation of the number of current-phases to two, three, four or six phases. In the case of three-phase windings this inequality may amount to 15 per cent. But this complete investigation would entail difficulties out of proportion to its usefulness, having regard to the desired limits of accuracy. The principle of the phenomenon, and also the magnitude of the determining relations, admits of being expressed to a sufficiently close approximation in a simple investigation which takes into account one phase only of the primary winding of a three-phase motor.

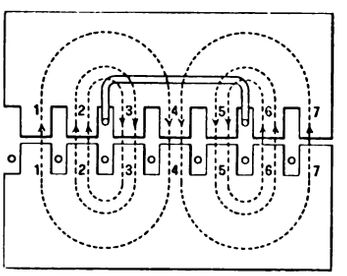

Fig. 1.

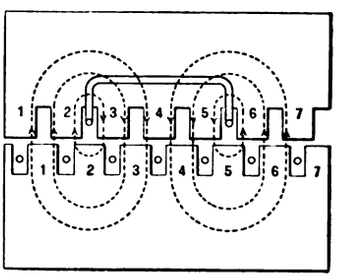

Fig. 1a.

Let us assume, as the first and simplest case, a motor possessing in its primary and secondary systems three slots and three teeth per pole-pitch. The primary winding in one phase may be represented by a single turn, which lies in the slots 2 and 5 (see Fig. 1) of the primary system. The secondary system has one conductor, L, in each slot. The slots and teeth of each system are numbered progressively from left to right. Doubtless the schematic representation of the figures will be intelligible without further explanation. Let the arrow-heads indicate the course of the magnetic lines, and let each arrow denote a portion of the magnetic flux amounting to the value f.

From the figure the amount of the mutual-induction may now be read off in the following manner—namely, that each separate partial re-entrant magnetic flux of amount f will be multiplied by the number of secondary conductors L which it embraces. From the middle tooth 4 there emerge to left and right two magnetic fluxes each of value f, each of which surrounds three conductors. Therefore the tooth 4 contributes toward the mutual-induction an amount equal to $2 \times f \times 3 \times L$. From each of the teeth 3 and 5 there emerge two fluxes f, each of which surrounds one conductor—namely, conductors 2 and 5 respectively. These fluxes, therefore, contribute the amount $2 \times 2 \times f \times 1 \times L$. The total mutual-induction of this system in this position may therefore be stated as of the value

$$2f \times 3L + 2 \times 2f \times 1L = 10\,(f \times L).$$

In Fig. 1a the same system is depicted in the second position, in which the teeth of one system stand opposite the slots of the other. Let the same total magnetic flux as before pass over from each tooth of the primary system into the secondary system; but it must now divide itself between two teeth of the secondary system. But a mere superficial observation makes it evident that a part of the flux now no longer encloses any secondary conductors, and that, on the other hand, the secondary conductor No. 3 is not surrounded by any flux.

Let us count up, as for Fig. 1, the amount of the induction; then we find for the fluxes which emerge from the middle tooth 4 the induction values $2f \times 2L$ for the fluxes of teeth 3 and 5 the values

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$2f \times 2L + 2f \times 0L = 2 \times 2f \times L$. The sum of these is now $8f \times L$; that is to say, only 80 per cent. of the mutual-induction as it was in the first position. In other words, we therefore lose in this position 20 per cent. of the total flux for the mutual-induction.

If we carry out the similar investigation for a primary and a secondary system with six slots per pole-pitch, in which the winding of the primary system consists of two windings lying in two (pairs of) slots, we then obtain, according to Figs. 2 and 2A, in the first position a total of $36f \times L$, in the second position $33f \times L$. In the second position we therefore lose about 10 per cent. of the mutual-induction, or in the mean between the two positions about 5 per cent.

In a similar way we get for two systems with nine slots per pole-pitch, and a primary winding of three windings distributed in three (pairs of) slots, in the first position a total of mutual induction of $119f \times L$; in the second position, $114f \times L$. (In this case there is assumed for calculation a flux of $3f$ in each tooth of the primary system that is entirely surrounded by three primary windings.)

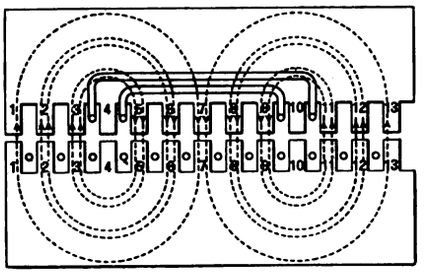

FIG. 2.

For systems with 15 slots per pole-pitch and five primary windings one gets, in the first position, $545f \times L$; in the second position $538f \times L$. (In this case there is assumed a flux of $3f$ in a primary tooth which is surrounded by all five windings.)

If now, in place of the two systems having equal numbers of slots, we examine the case of two systems with unequal numbers of slots, then the distribution of the magnetic fluxes through the individual teeth takes a rather more complicated form in the different positions. But the character of the phenomenon is quite like that of the cases above considered. In general there can be found two positions in which the value of the mutual-induction is respectively a maximum and a minimum. The maximum value agrees approximately with the value of the induction in the first position of the system with equal numbers of slots. But in this the values are to be compared with the primary system for equal numbers of slots, and with the secondary system as to equal numbers of conductors. For example, if a secondary system with nine conductors in nine slots is to be compared with a system of 15 conductors in 15 slots, then the value of the induction in the first case must be raised in the proportion 15 : 9, since in each slot 15/9 of a conductor will be assumed.

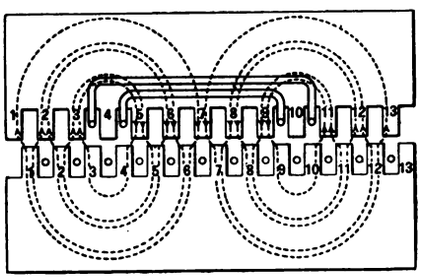

FIG. 2A.

Also in the cases of systems with different numbers of slots the action on one another of all the phases of the primary current, strictly stated, must be taken into consideration. Then the influence of the inequality of the field will have a predominant effect. Further, the distribution of the winding, and the winding-pitch in the two systems, must be accurately set out for each particular case. These influences, however, involve very detailed expressions, and yet they exercise on the character of the phenomenon and on the magnitude of the relations involved so little change, that they may be passed over in the scope of this inquiry, the difficulty of which lies rather in its experimental part.

As an example we consider, as in Figs. 3 and 3A, the mutual-induction of two systems of which the primary system has six slots per pole-pitch, with two winding as in Fig. 2, and the secondary system nine slots per pole-pitch with nine conductors. In the first position, Fig, 3, the amount of the mutual-induction is $54f \times L$; in the second position, $52f \times L$. If the secondary number of conductors 9 is for comparison with Fig. 2 reduced in the proportion 6:9, then in the first position we have the value $54 \times \frac{2}{3} \times f \times L = 36f \times L$, exactly as in Fig. 2. In the second position, Fig. 3A, the amount is $34{\cdot}6f \times L$, while in Fig. 2 the amount $33f \times L$ was obtained.

A similar calculation was made for a primary system with nine slots and three windings, and a secondary system with 15 slots and 15 conductors. Here there was found in one position the value $199f \times L$, in a second position the value $196f \times L$. For comparison with the values which were given above for two systems with equal number of slots, nine per pole-pitch, these values must be reduced to equal numbers of conductors. Thus one obtains for the systems

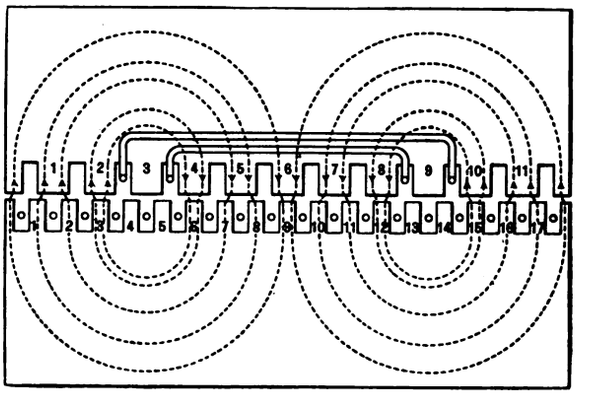

FIG. 3.

with nine and 15 slots in the first position the value $119{\cdot}5f \times L$; in the second position, $117{\cdot}5f \times L$; for the system with nine slots in both primary and secondary we have earlier found in the first position $119f \times L$, in the second position $114f \times L$.

These considerations have been set out with this completeness, because they afford an insight into an essential element of the so-called dispersion-coefficient σ which does not arise out of ordinary magnetic leakage, but which must also occur in an ideally leakage-free motor; and in general the magnitude of this element will be greater than the so-called peripheral leakage.

In order to obtain a view into the order of magnitude of this effect, which we shall denote as the effect of the distribution of the winding, or effect of the *winding-coefficient*, let us assemble in a table the numerical values above obtained. As a measure of the influence of the winding coefficient, we may regard the quotient of the difference

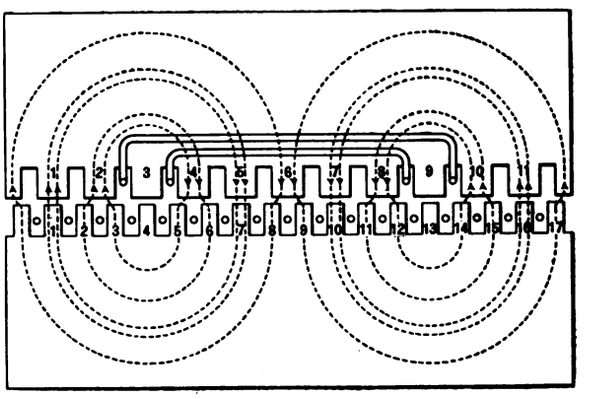

FIG. 3A.

of the maximum and minimum values of the induction divided by the maximum value. In order to be able to assign beforehand to these coefficients a mean value for all possible different positions of the two systems, we insert in the quotient the *half* of the difference between the maximum and minimum values.

Number of slots.		Induction.		Half-difference / Maximum value = Winding-coefficient.
Primary.	Secondary.	Maximum.	Minimum.	
3	3	10	8	10 per cent.
6	6	36	33	4·2 ,,
6	9	36	34·6	2·3 ,,
9	9	119	114	2·1 ,,
9	15	199	196	0·75 ,,
15	15	545	538	0·6 ,,

(To be continued.)

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GAS ENGINE ELECTRICITY WORKS.

Judgment in the action, "Knight *v.* The Isle of Wight Electric Light and Power Co.," which was delivered by Mr. Justice JOYCE on Wednesday, is reported in another column of this issue. Quite from its inception the scheme has been beset with difficulties and troubles well-nigh overwhelming, and now it has received the worst blow of all. An illustrated description of the offending works at Ryde appeared on p. 10 of *The Electrician* for October 23, 1903, and, in the same issue, a brief history setting forth the disadvantages under which it laboured was given in an editorial note. It will be remembered that the station is equipped with Tangye three-cylinder vertical gas engines, supplied with fuel by two producers manufactured by the same firm. The works were formally opened on October 1st, seven months having been occupied in the erection, but before the trials were completed an action had been commenced to restrain the Company from working, and so objectionable were the nuisances alleged to be that an interim injunction was applied for, but refused by Mr. Justice JOYCE on October 21st.

The plaintiff, Miss KNIGHT, carries on a school for young ladies, and her property is in proximity to that of the defendants; she complained that the operation of the works interfered with the enjoyment of her property by reason of noise, smells and vibration. The defendants denied the nuisances alleged, and also pleaded that they were authorised to carry on the works by their Provisional Order, and that such temporary annoyance as might have been caused by the erection and starting of the works was speedily abated. The hearing of the case was fully reported in our issues of November 27th, December 4th, 11th and 18th. In his considered judgment, Mr. Justice JOYCE has come to the conclusion that the nuisances complained of actually did exist, and that the company are not entitled by their Provisional Order to continue the operation of the works in these circumstances; he also pointed out that as the contractor's workmen were still engaged at the works, it was evident that the engines were not running to the defendant's satisfaction. The injunction was, therefore, granted, but execution was stayed for a period of six weeks. It now remains to be seen what steps the company will take to abate the nuisances. They are only allowed six weeks to do this, and of course it would not be possible during so short an interval to replace the gas plant by steam plant.

Before plans were drawn out, considerable difficulty was experienced in obtaining a suitable site The first position chosen, which was quite far enough from inhabited houses to prevent complaints being made, proved entirely out of the question, owing to the impossibility of sinking proper foundations. The Corporation of Ryde objected to the con-

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struction of the works on the second site selected; and residents in the neighbourhood of the present site threatened strenuous opposition if the promoters proposed to erect a tall chimney, and under the terms of their lease the company were debarred from doing so. Thus, the company were "between the devil and the deep sea"—they had already made three attempts at securing a site and now they were in such a position that they must either erect the station without a chimney or erect no station at all. They chose the former alternative and put down gas plant. Now it is patent to all engineers that every such installation on anything like a large scale must, owing to its very nature, cause a certain amount of noise and commotion, and the Ryde installation proved no exception. Indeed, the company admit that during the preliminary runs certain objectionable vapours were allowed to escape, and that the engines did not run quite as noiselessly as they have done subsequently. Naturally, a certain amount of time is required to bring such an undertaking to a state of maximum efficiency, and there is no doubt that everything is being done to effect this. During our visit to the works we carefully examined them while running and while shut down. On entering the station while the engines were at work, it was difficult to believe that they were not operated by steam, so quietly did they run. The exhaust is water-cooled, and by the time it reaches the atmosphere there is little or no noise or vapour. However, the decision of the Court is against the Company, who have our most sincere sympathy.

Considered from a general point of view, the application of gas engines to electricity works has not yet proved itself an entire success. We have consistently advocated in these columns the theoretical fitness of such engines for the purpose, but have at the same time pointed out certain difficulties which were inevitable. These prognostications have, unfortunately, turned out to be only too true; but it does not follow that the gas engine is doomed on this account. On the contrary, there is every reason to believe and hope that the inventive genius of manufacturers will be so stimulated as to overcome the troubles which now present themselves in so formidable a shape. The gas-engine industry has made gigantic strides in Europe within the last decade. Several Papers on the subject have been read before engineering societies in this country during the last few years and duly reported in our columns. The last Paper of this nature was one read by a Mr. J. R. BIBBINS before the American Institute of Electrical Engineers which draws particular attention to progress in the United States. He takes his figures from 15 installations, having an average capacity of 315 H.P., in 12 of which the generators are belt-driven, and the remaining three directly coupled to the engines. In the latter the generators supply three-phase current for industrial purposes and run in parallel, which is somewhat unusual and marks a distinct step forward in gas engine design and operation. The author comes to the conclusion that for 1,000 H.P. equipment the respective first costs for steam and gas plants are about equal—that is, when producers have to be put down, and this again depends to a certain extent on the capacity of the gas storage provided. In addition to these facts, it should be borne in mind that the labour required for the actual operation of gas plant is much less than that required for steam plant of the same capacity, it being maintained by some engineers that the ratio is as great as 1 to 2. Some interesting figures relating to fuel economy are given by Mr. BIBBIN in his Paper. Assuming the steam consumption of an engine to be 11lb. per B.H.P.-hour, and taking coal having a calorific value of 14,000 B.Th.U., one pound of which will evaporate 10lb. of water, it is found that 1·1lb. of coal or 15,400 B.Th.U. are consumed for every B.H.P.-hour. On the other hand, a modern gas engine requires at full load, 10 to 11 cubic feet (900 to 1,000 B.Th.U. per cubic foot) for every B.H.P.-hour, and this is equivalent to 10,000 to 11,000 B.Th.U. per B.H.P.-hour. There are, however, many other points of superiority claimed for the gas engine over the steam engine. The light load efficiency of the former is greater than that of the latter, and this is a point too important to be neglected by electricity works engineers. The cost of operation and maintenance is said to be lower. There are fewer auxiliaries required, energy can be stored at times of light load without serious loss of efficiency, and possibly at a lower capital cost than with secondary batteries, thus tending towards a higher all-day efficiency. There are also cases in which the cylinder jacket water is used for heating offices and buildings, and there does not appear to be any serious objection to this. When gas engines are employed for operating alternating-current generators, the principal conditions are that the frequency should be as low as possible and the revolving part of the generator should have a high peripheral velocity. Anything tending, therefore, to impede the construction and working of pioneer gas engine stations of moderate and large size is to be regretted, and we trust that Mr. Justice JOYCE'S decision will not have the same effect in retarding large scale experimental work in this direction as the famous Leyton injunction case did.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Bending of Magnetometer Bars.—C. Chree deals with the source of error found in the bending of magnetometer deflection-bars. In magnetometer measurements, the deflecting magnet is carried by the deflection-bar at an appreciable height above the centre of gravity of the cross-section, and the bending of the bar when in use, under its own weight and that of the magnet with its carriage, results in an increase of the distance between the deflecting and the deflected magnets. To keep the instrument properly level, there ought to be a counterpoise on the other arm of the deflection-bar, at the same distance as the deflecting magnet from the centre. In the absence of such a counterpoise, supposing the instrument originally level, the weight of the magnet and carriage causes a slight tilting. In consequence of this, the point of suspension of the deflected magnet moves towards the deflecting magnet, thus reducing the horizontal distance between them. Measurements of the bending effect have been made on over 20 magnetometers at the National Physical Laboratory, and it is now the regular practice to take the effect into account in framing the certificates. The author fully describes the testing method.

[C. CHREE, *Phil. Mag.*, January, 1904.]

Rotation of Lines of Force.—The question as to whether the lines of force of a magnet revolve with it has been answered by Hoppe in the affirmative. He found that the lines of force show a slight drag in the direction of rotation. K. Düsing has endeavoured to reply to the further question as to whether the lines of force revolve with a rotating armature when the magnets remain fixed. Here, also, he found a slight drag. He laid a flat iron ring between the poles of a permanent magnet, covered it with paper, and dusted iron filings upon it. With a proper field-strength he obtained a slight tracing of the lines of force within the ring, in spite of its shielding action. He then substituted a piece of photographic paper for the ordinary paper, and made the ring revolve about its own axis. The tracing of the lines of force obtained during the rotation was fixed by holding a lighted match over the paper. The tracing showed a distinct but slight inclination of the lines of force both within the ring and outside it in the direction of the rotation. The ring must, therefore, have dragged the lines of force with it to some extent.

[K. DÜSING, *Ann. der Physik*, No. 13, 1903.]

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An Oscillator with Variable Capacity.—The measurements hitherto made on the constants of electric oscillations have shown that the dielectric constant and the damping ratio depend not only upon the medium in which the oscillations are produced and transmitted, but also upon the principal wave-length emitted by the oscillator, which in turn depends upon the arrangement and dimensions of its various parts. E. Castelli has designed an oscillator in which the various systems of electric oscillations can be produced, and their wave-lengths varied continuously within wide limits. The primary and secondary plates consist of sheets of tinfoil suspended by pulleys and counterpoised, so that they are in equilibrium at any level. They can also be slid forward or backward, so that their distance apart and the amount of surface in direct opposition can be varied at will. In the course of his measurements with this oscillator, the author made an observation which he believes to be new. If a vacuum tube is used for discovering the nodes, and is gradually shifted beyond the node, it remains alight even in places where it would not light up if it approached it from the outside. The author compares this result with the fact that the distance between the carbons in an electric arc can be increased while the arc is playing to lengths at which an arc cannot be ordinarily formed.

[E. Castelli, *Nuovo Cimento*, July-August, 1903.]

Calorimetry with Platinum Thermometers.—In the course of their previous determination of the water value of a Berthelot combustion calorimeter in electrical units, W. Jaegers and H. von Steinwehr obtained a limit of error of 0·1 or 0·2 per cent. On that occasion they used mercury thermometers, and they expressed the hope that with platinum thermometers it would be found possible to reach a far higher degree of accuracy. This expectation has been fulfilled, and they now report upon the method adopted. The platinum thermometer owes its advantage chiefly to the fact that it is possible to operate with intervals of temperature as small as 1 or 2deg., which means that it is possible to use large quantities of water and that Newton's law of cooling is strictly fulfilled. A point to be considered is that the thermometer must have as large a cooling constant as possible, in order to render the heating due to the measuring current harmless. The authors used a platinum wire 30cm. long and 0·01mm. in diameter, drawn through a capillary glass tube bent into a straight loop, the two ends being fastened side by side in a block of ebonite. The loop was surrounded by a guard of wire netting. The temperature inertia was only about one-twentieth of that of a mercury thermometer. The authors used 10kg. of water, so that the water value of the metallic masses was only 1 per cent. of the total, and only had to be known to within 1 per cent. The electric energy introduced was about 250 watts per second. The results did not differ among themselves by more than one part in 5,000.

[Jaegers and von Steinwehr, *Verh. d. Physik Ges.*, May 20, 1903.]

Magnetism of Volcanic Rocks.—P. David gives some further results of his observations on the permanence of the magnetism of volcanic rocks, and on the inferences which may be drawn therefrom. He studied various building materials dating from the Gallo-Roman epoch, which had been in their places for two thousand years. They showed all kinds of magnetisations, thus showing that the long period during which they had been under the influence of the earth's magnetic field since they were put in their places, had not sufficed to give them a uniform magnetisation. It was, of course, impossible to deduce anything from their magnetisation as to the magnetic conditions which obtained at the epoch of their formation, since their original situation was quite unknown. The author, therefore, turned his attention to some flagstones in the ancient Temple of Mercury on the summit of the Puy-de-Dôme, which also dates from the Gallo-Roman epoch. He had some cubes cut out of the flagstones and determined their direction of magnetisation. He found that the declination was different in every stone, but the dip had the same numerical value, though positive in one case and negative in two cases. The obvious explanation of this is that the flagstones all had the same magnetisation, but that on laying them down they were oriented in various directions horizontally. But vertically, they could only be laid in one direction, though they might be inverted and thus produce the inversion of the sign. The dip observed was about 55deg. The author hopes that these observations will shed some light on the quarry from which these enormous stones were cut.

[P. David, *Comptes Rendus*, January 4, 1904.]

Physiological N-rays.—A. Charpentier has discovered some remarkable differences between the various kinds of rays given out by the human body according to their muscular or nervous origin. The rays emitted by the nerves have the remarkable property of being intercepted to a greater extent by aluminium than by lead. "A thickness of half a millimetre," says the author, "suffices to appreciably obscure the beam emitted by a point of the brain. As regards the portion which traverses the plate, it is not absorbed by further thicknesses of aluminium, even of 2cm. or 3cm. It, therefore, consists of pure N-rays proper." On the other hand, the rays emitted by the heart, by the diaphragm, and by the muscles generally are hardly appreciably affected by the interposition of aluminium, and what minute effect there is may be attributed to the nerve-endings embedded in the muscles. Another difference between nerve-rays and muscle-rays is that the former are greatly increased by the slightest compression. Yet another distinct mark of the nerve-rays is found in their pronounced action upon phosphorescent sulphide heated to 40 or 45°C. In reply to the complaints as to the difficulty of discovering the rays, the author gives some practical directions. He spreads a quantity of phosphorescent sulphide on black cardboard, in amount sufficient to give a very thin surface 2cm. in diameter, and fixes it with collodion. It is exposed for a short time to sunlight and observed in a moderately darkened room. The plate must be observed by indirect vision and without strained attention. It should be remembered especially that the increase in luminosity after the impact of the new rays is gradual. But the observations are by no means difficult.

[A. Charpentier, *Comptes Rendus*, January 4, 1904.]

COAL CONSUMPTION IN CENTRAL STATIONS.*

BY ALFRED S. GILES.

At the present time central station engineers are constantly brought face to face with the question of the price at which they can supply power to factories and workshops, in competition with isolated steam power plants. It may be assumed that the question at issue will, perhaps, be most studied in Lancashire, where such large powers are being used in connection with the staple industry of the country, and where fuel is comparatively within easy reach of the numerous manufacturing towns.

In order to study the question of fuel economy, no better example could be taken than the coal consumption in the weaving and spinning mills of Lancashire, and the figures obtained may be compared with such items as agree with modern central station practice. We may take it that weaving and spinning mills can produce an indicated horse-power-hour for about 2lb. of good coal, and these figures can be translated from indicated horse-power into units by taking, say, 600 watts per indicated horse-power. Taking coal at 7s. per ton in Lancashire, we arrive at what we may call our ideal figure of 0·125d. per unit for coal consumption.

Now let us look into the conditions of power generation in the weaving and spinning mill. Generally the plant consists of Lancashire boilers, hand or mechanically stoked, an economiser, and a compound condensing Corliss engine. The load-factor is, of course, very high, practically 33 per cent., and the losses from condensation in steam pipes are a minimum, whilst the power taken by the auxiliary machinery, feed pumps, &c., is a very small percentage of the output, yet we find the ordinary cotton mill working with a poor vacuum at certain times of the year, comparatively low pressure, and without any superheat, except in isolated cases. The fuel economy in the cotton mill may, therefore, be accounted for entirely by the load-factor. Many generating stations in this country could obtain the fuel economy of the cotton mill if they had the same load-factor, and those stations which are suitably situated for coal and water supplies could show better figures. In order to see in which items possible economies could be made, let us consider them point for point.

* Abstract of a Paper read before the Manchester Section of the Institution of Electrical Engineers on Tuesday.

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Table A.—*Blackburn Fuel Tests.*

No. of tender.	Name of slack.	Actual working test. Weight of coal. tons cwt. qrs.	Percent. of ashes.	Loads of ashes.	Units generated.	Cost. per unit.	Calorimeter test. Temp. before test. C.	Temp. after test. C.	Temp. rise. C.	B.Th.U.	Price.
1	Arley slack	163 6 1	20·8	34	40,769	0·360d.	6·9°	13·0°	6·1°	11,662	7/4
2	Bickershaw rough	260 5 3	11·9	31	78,001	0·317d.	8·5°	15·8°	7·3°	14,118	7/9
3	Park-lane Wigan slack	261 3 2	19·1	50	70,746	0·339d.	8·6°	14·6°	6·0°	11,507	7/6
	Rose Bridge	..	..	..	..	..	7·16°	13·4°	5·8°	11,120	7/8
4	Pearson & Knowles' Moss slack	..	..	..	..	..	8·7°	15·8°	7·1°	13,538	8/8
	West Leigh rough slack	231 19 1	18·5	43	63,231	0·359d.	9·0°	15·2°	6·2°	11,797	8/0
	Pearson & Knowles' washed slack	35 7 1	14·3	5	9,984	0·345d.	9·6°	16·1°	6·5°	12,474	8/0
	Crompton Shawcross Ince slack	..	..	..	..	..	9·1°	15·4°	6·3°	11,990	8/1
	Ellerbeck slack	..	..	..	..	..	9·5°	15·2°	5·7°	10,927	7/9
	Duxbury Park	..	..	..	..	..	7·6°	13·2°	5·6°	10,733	7/0
5	Arley slack	..	..	..	..	..	9·2°	15·2°	6·0°	11,507	7/2
6	Haydock Collieries slack	..	..	..	..	..	9·4°	15·2°	5·8°	11,313	8/5
7	Meadow slack	237 0 0	16·8	40	68,142	0·297d.	9·5°	15·8°	6·3°	11,990	7/0
8	Trencherbone hard slack	283 0 0	15·2	44	75,118	0·379d.	No sample with tender.				8/3

Table B.—*Coal Consumption in Electricity Supply Central Stations. Year 1902-1903.*

Town.	Quality and calorific value.	How fired. Mech. or hand.	Steam or elec. auxiliary machinery. No. of units used.	Condensing or non-condensing.	% of output non-condensing.	Superheat in degrees Fahrenheit.	Price per ton.	Lbs. per unit generated.	Cost per unit generated. d.	Load-factor on feeders.
Aberdeen	S. Hetton, Wearmouth, Wilson & Clyde, &c.	hand and mechanical	both	both	13·4	none	11/6 11/10 11/9 12/6	..	0·47	17·49
Blackburn	Wigan slack 11,900	mechanical	both	both	..	none	7/3	10·0	0·38	17·45
Blackpool	Lancs. slack and nuts	both	steam	N.C.	..	very little	10/- aver.	15·4	0·826	14·32
Bootle	Lancs. slack	mechanical	both	C.	..	none	7/6	9·02	0·357	28·44
Bradford	11,700 to 13,000 B.Th.U.	mechanical	both	both	20·0	partially	9/9 about	4·1	0·214	20·93
Bristol	Rhymnly washed peas 13,500 to 14,000									
	Hanham slack 12,500 to 13,000	mechanical	mostly steam	C.	..	partly 500°—560°	11/10—7/6	8·6	0·54	13·75
Burnley	Small lump 13,290	both	electric	C.	..	none	10/3	5·2	0·28	15·59
Croydon	Best Welsh	hand	nearly all 372,140	C.	..	partly up to 500	24/6	5·3	0·66	16·81
Derby	Small peas 14,103	both	both	C.	..	50	7/8	13·2	0·543	13·36
Devonport	Welsh	hand	steam	C.	..	35	14/2	9·6	0·72	19·02
Dundee	Fife small about 11,000	both	225,000 almost all	C.	8	very little	9/6—7/-	7·7	0·35	13·63
East Ham	Hucknell steam and slack	hand	..	C.	..	60° above	19/9—12/6	6·2	0·6	12·95
Edinburgh	Washed nuts 12,500	almost all mechanical	both	N.C.	..	slightly	6/11—7/6	6·35	0·247	14·31
Glasgow	Washed nuts 11,000	mechanical	all purposes 745,801	C.	..	500	7/-	6·05	0·227	14·01
Halifax	Nuts and slack	mechanical	both 409,015	C.	..	430 to 450	7/6	9·6	0·39	16·98
Huddersfield	Slack	both	both	C.	..	none	5/5	11·02	0·296	10·47
Hull	Yorkshire steam 14,700	hand	steam	C.	..	none	12/4	7·05	0·465	9·96
Leeds	Smudge 10,000—11,000	mechanical	steam	C.	..	Portn to 460	5/-	8·4	0·224	12·31
Nottingham	Part large, part pea nuts 9,000—10,000	both	steam chiefly	N.C.	..	none	9/— 9/6	6·5	0·37	16·31
Salford	Slack	mechanical	elec. 554,381	C.	..	50 to 100	8/4	4·3	0·244	21·84
Sheffield	Engine slack 12,000	mechanical	..	C.	..	none	7/9	7·8	0·32	11·92
Southport	Slack	hand	both 95,377	C.	..	60 to 100	7/-	7·7	0·289	15·31
South Shields	Small	hand	steam	C.	..	none	9/6	6·3	0·32	15·82
St. Helens	Lancs. slack	hand	both	C.	..	460	6/9	5·0	0·18	19·78
Sunderland	Durham bean and small 13,480	mechanical	both	both	40	none	9/10	10·0	0·535	17·87
West Ham	Best Welsh Derby pea nuts	both	steam	C.	..	slightly	20/6 13/8	..	0·75	12·82
		hand	both	..	10	none	7/3 9/1	7·9	0·43	18·38
	Tredegar best Welsh 13,500	hand	both 180,177	both	..	none	22/4½	5·2	0·637	17·38
	Engine slack	mechanical	both 427,351	both	16	100	7/8	7·0	0·281	18·87
	Tramway Generating Stations.									
Glasgow	Washed singles 10,000	mechanical	elec. 988,000	C.	..	390—400	6/8	3·64	0·13	47·7
Sheffield	Treeton washed and screened nuts 13,700.	hand	partly	C.	..	none	8/8	4·3	0·2	37·15
Hull	Hickleton Main washed slack	mechanical	partly 93,861	C.	..	none	12/4	8·9	0·58	29·5

Table A gives the results of calorimeter tests recently made at the author's works before placing the annual coal contract. It will be readily observed from this table that the coal contracted for, No. 7, though neither so high in calorific value, nor so clean as the other coals, is the cheapest per unit generated, and the difference in the cost is so large as to nullify the advantages of the other coals.

As regards the question of handling coal, it may be said that if the central station is a small one, burning, say, 50 tons per week, mechanical stokers will show very little gain over hand-firing, unless it is necessary to avoid all smoke or to burn a very small low-class fuel. In large central stations, however, mechanical stokers are most satisfactory, for not only can a cheaper coal be used than with hand-firing, but the economy of labour in employing these machines in conjunction with coal elevating and conveying plant, may reach sometimes 30 to 40 per cent, over hand-firing.

We know that the main object in all boiler firing should be to produce as much CO_2 as possible and as little CO. The proper supply of oxygen admitted to the furnace through and above the grate bars and at the bridge, and whether the air shall be supplied hot or cold, is what we have to study, and the importance of this is best illustrated by the fact that if carbon be consumed to CO_2 it produces 14,650 B.T.U. per pound, if consumed to CO it produces 4,400 B.T.U. per pound.

The following table shows the per cent. loss of heat for different per cent. volume of CO_2 in the flue gases :—

Percentage CO_2 in flue gases by volume	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Percentage loss in heat ..	90	60	45	36	30	26	23	20	18	16	15	14	13	12

It has been considered by many good authorities that the amount of excess air required for good combustion should not exceed 50 per

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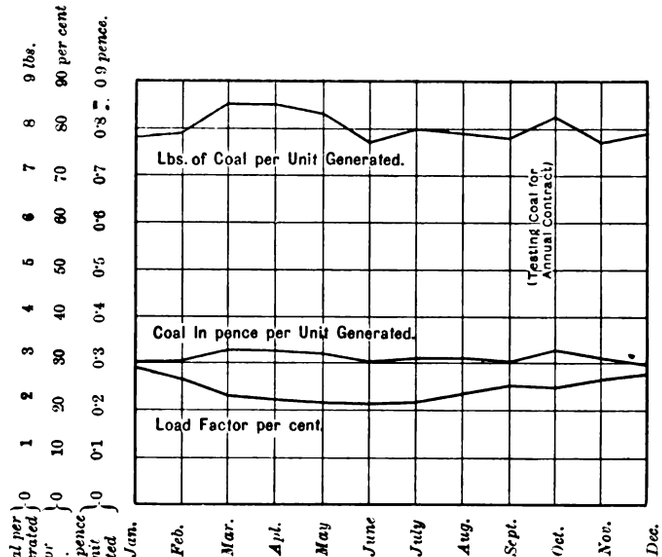
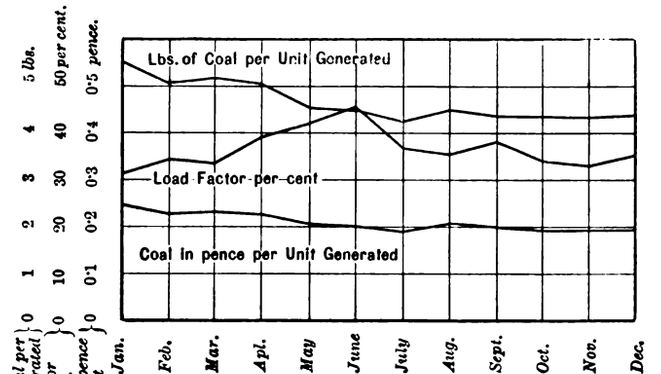
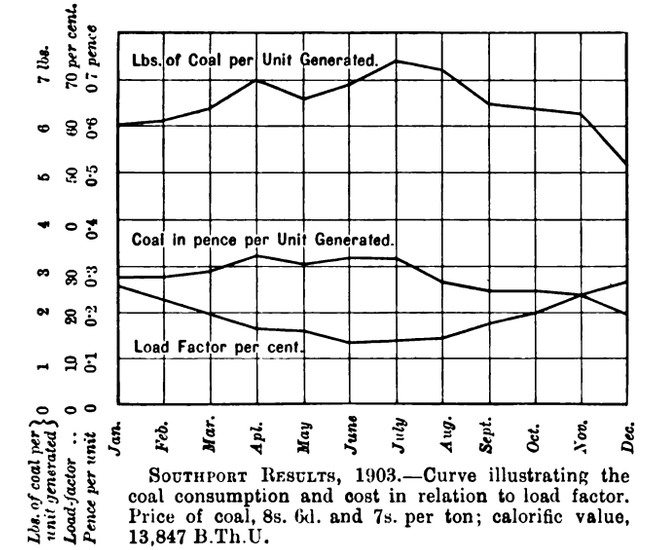
cent., and be not less than 25 per cent. by volume; but as there is such a marked difference between different coals, the thickness of the fire, and the amount of draught, it is evident that reliable data can only be obtained by individual tests.



BLACKBURN, 1903.—Curve illustrating the coal consumption and cost in relation to load-factor. Price of coal, 7s. 3d. per ton; calorific value, 11,900 B.Th.U. Load-factor each month per cent.



SALFORD, 1903.—Curves showing lbs. of coal per unit generated, coal in pence per unit generated. Load-factor on 'bus bars per cent. Price of coal, 8s. 4d. per ton; calorific value in B.Th.U. per lb., 12,800.



SOUTHPORT RESULTS, 1903.—Curve illustrating the coal consumption and cost in relation to load factor. Price of coal, 8s. 6d. and 7s. per ton; calorific value, 13,847 B.Th.U.

Experiments appear to have been most exhaustively carried out on the Continent in connection with the heat transmission through the boiler plates to the water, and the results obtained prove that the cleanliness of the surfaces of the metal between the furnace gases and the water affects the efficiency from 10 to 15 per cent., or even more.

The loss of heat by radiation is a serious item; for instance, from the standpoint of the naked boiler or pipe we see that the loss by radiation, from most careful experiments, have been shown to be 903 B.Th.U. per hour per square foot of external surface on a pipe at a steam pressure of 135lb. A similar test made on a pipe with a good non-conducting composition reduced this loss to 150 B.Th.U. per hour.

Trials carried out by expert authorities prove that with compound condensing engines a saving of 22 per cent. in coal can be attained by using steam superheated to 500°F. instead of saturated steam. A discussion would be interesting as to the best practical degree of superheat for central stations. At the author's works, using flue-fired McPhail and Simpson's superheaters connected with 8ft. 6in. by 33ft. Lancashire boilers steaming to a 1,200 I.H.P. Willans engine, a maximum of over 100deg. of superheat is obtained at the engine at full load, the steam pressure being 170lb. at the engine.

Some little time back figures were quoted to the author by nearly every engine builder in the country for three 775kw. sets. With steam at a pressure of 170lb. at the engine, superheated to 470deg., a guarantee of 20·51lb. of steam per kilowatt-hour was given at full load and 22·15 at half-load for the high-speed type of engine, whereas. the best Corliss engine builders gave 19·6 and 22·1 respectively

Prof. Kennedy considers the following figures ideal for a centra station :—

10½lb. of water evaporated per lb. of coal.
8½lb. of steam at engine per lb. of fuel burnt.

Let us work on this basis the coal consumption of a modern 775kw. combined plant, with the following guarantees :—

Steam pressure at engine	170lb.
Steam consumption per kilowatt-hour (full load) ..	21·92lb.
Vacuum	24in.
Temperature of steam at engine	450°F.

Then the coal consumption will be 2·58lb. per kilowatt-hour, and at 7s. per ton will cost 0·097d. per kilowatt-hour.

In practice the author has endeavoured to arrive at the equivalent results, and for this purpose has carried out trials on the peak load at his station on one of the 775kw. sets. The coal was carefully weighed, and the output of the generators was metered by a reliable B.T.-H. recording wattmeter, recently calibrated. The figures obtained were as follows :—

PARTICULARS AND DIMENSIONS OF PLANT.

Lancashire boilers (2), 33ft. by 8ft. 6in.
Green's economisers.
McPhail and Simpson superheaters (2), flue-fired.
E.S.E. mechanical stokers.
Heating surface per boiler, 1,150 sq. ft.
Grate area per boiler, 38 sq. ft.
Triple-expansion condensing 1,200 I.H.P. Willans engine.
180 R.P.H. with Korting condenser.
775kw. Dick, Kerr continuous-current generator.

OBSERVATIONS TAKEN.—Time, 5 p.m. to 9 p.m. = 4 hours.

Mean steam pressure at boiler by gauge, 183lb.
Mean absolute steam pressure, 197·8lb.
Mean temperature of steam, 380°F.
Mean temperature of feed water to economiser 80°F.
Mean temperature of feed water to boilers, 190°F.
Mean load 1,420 amperes 493 volts = 700kw.
Total coal used in lbs., 8,845.
Price of coal per ton, 7s.
Calorific value in B.Th.U., 11,990.
Total units generated in B.Th.U., 2,640.
Mean draught, ⅛in.
Mean temperature of steam entering superheaters, 370°F.
Mean temperature of steam leaving superheaters, 500°F.
Mean temperature of steam at engine, 460°F.
Mean vacuum at engine, 23in.

ANALYSIS OF GASES LEAVING BOILER.

Carbonic dioxide, CO_2, 10·2 per cent. volume.
Carbonic oxide, CO, 0 per cent. volume.
Oxygen, 9 per cent. volume.

RESULTS.

Pounds of coal per square foot of grate area, 29·2.
Pounds of coal per B.Th.U. generated, 3·35.
Cost of coal per B.Th.U., 0·125d.

In order to obtain information on this important subject of coal consumption in central stations, the author sent out inquiries to a number of central stations of over an output of one million units, and he now takes this opportunity of again thanking those engineers who so kindly replied to his inquiries on this subject. The statistics in Table B, as far as the author knows, have not been tabulated in this way before.

If we can increase our load-factor we can reduce the coal consumption per unit. This is shown by the accompanying curves, which have been made from figures kindly supplied to the author by Mr. Taite and Mr. Downe. A third curve showing this relation of load-factor to the cost of coal in Blackburn, is also given.

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THREE-PHASE WORKING, WITH SPECIAL REFERENCE TO THE DUBLIN SYSTEM.*

BY WILLIAM BREW.

Introductory.—In bringing this subject before you at the request of our local secretary, I am at the outset met with difficulties. In the first place, the Dublin system of three-phase generation and distribution being unique in this country, I fear a great deal more will be expected from me than it will be possible in the scope of a short Paper and the little time at my disposal to deal with. In the second place, I cannot help feeling that any reference to the Dublin system will be wholly incomplete unless the elaborate arrangements for the change-over of the city electrical supply from single-phase to three-phase be fully described. When it is remembered that the change-over of this supply from the 2,000-volt, 83-period single-phase station at Fleet-street to the 5,000-volt, 50-period three-phase station at the Pigeon House, situated over 3 miles distant, could be comfortably effected by the Corporation staff in something like 20 seconds, whereas the arrangements for accomplishing this result had been maturing for something over two years, it will be agreed, I think, that the plan shaped by the consulting engineer had been well conceived. Much as I should like to describe at length the numerous difficulties which were encountered and the manner in which they were overcome I am, unfortunately, compelled in the present short Paper to deal merely with a few electrical points, which I can only hope may prove of interest to you.†

Generating Plant.—The three-phase generator is essentially suitable for power transmission. Its prime cost and weight are usually about 30 per cent. less than a single-phase machine of the same output; whilst with star winding and earthed neutral point the pressure tending to break down the insulation of the machine is only 57 per cent. of that between the line wires transmitting the power.

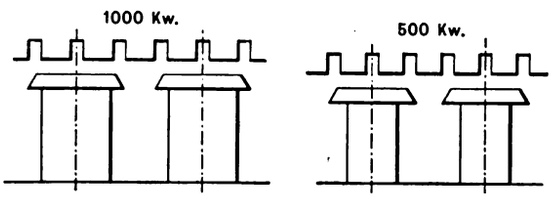

FIG. 1.

In three-phase transmission systems at extra high pressure, the line-voltage at which step-up transformers become advisable at the generating station is thus much higher (with resulting economy as regards plant and working losses) than would be the case if single-phase generators were used earthed at one pole in the usual manner.

It was urged at one time that generating direct at extra high-pressure at the Pigeon House station, which is so near the sea, would be out of the question, and that step-up transformers would have to be employed. The 5,000-volt three-phase alternators have, however, been working continuously now for seven months without giving any intimation that the sea air disagreed with them.

Mesh wound generators of large size have been found to give trouble from harmonics and idle currents circulating in their closed windings, which, in addition, are subject to the full line pressure. In the case of Dublin we have four star wound Oerlikon generators; two of 1,000kw. and two of 500kw. output, driven directly by marine type compound engines with Corliss valve gear. The principal data of these machines are as follows:—

	1,000kw. sets.		500kw. sets.
Speed revs. per min.	84	....	94
No. of magnet poles	72	....	64
No. of coils per phase	36	....	32
Weight of flywheels and magnets in tons	44	....	33
Diameter of wheels in feet	18·3	....	14·2

The arrangement of pole-pieces and stator slots in these sets is shown in Fig. 1, from which it will be seen that there are six slots per pair of poles. We should thus expect to find harmonics of the fifth and seventh order in evidence upon the fundamental wave of 50 ~ per sec. under favourable circumstances. The electrical characteristics of these machines are illustrated by Figs. 2 and 3. The curves marked A give the relation between exciting current and terminal pressure. The curves marked B give the short-circuit current of the machines for various values of the exciting current. The synchronous impedance of these machines or the relation between terminal volts on open circuit to short-circuit current at the same speed and excitation can be read at once from these curves; it will be seen that the short-circuit stator current with an excitation which would produce full terminal P.D. of 5,000 volts is in the case of the 500kw. sets =148 amperes, and in the case of the 1,000kw. sets 240 amperes. These quantities are of importance in connection with calculations on resonance,* and will be referred to later.

It is well known that the excitation of an alternator necessary to maintain full terminal pressure varies for the same armature current according to the power-factor of the load. On open circuit or with small armature current the demagnetising effect of a lagging current or magnetising effect of a leading current upon the magnet poles will be inappreciable, and a rise in pressure will either indicate resonance or the neutralising of the armature self-induction by the capacity of the cable. The curve (Fig. 4) is interesting in this respect, and shows how the exciting current necessary to maintain full terminal pressure of 5,000 volts on one of the small Dublin sets varies.

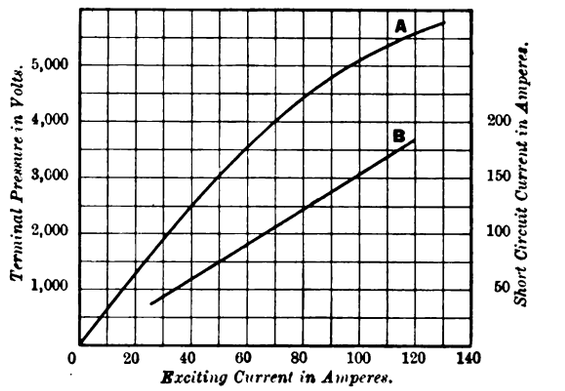

FIG. 2.—DUBLIN 500KW. GENERATOR. 93·5 R.P.M. 50 ~.

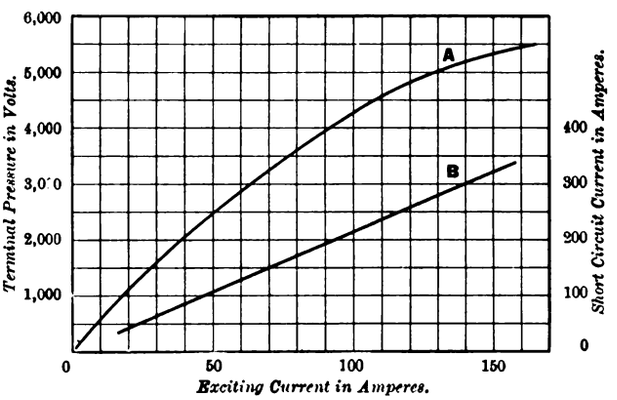

FIG. 3.—DUBLIN 1,000KW. GENERATOR. 84 R.P.M. 50 ~.

Trunk Mains.—Transmission schemes are considerably handicapped with restrictions regarding high-pressure overhead wires, and the great difference between the cost of the underground high-pressure cable and the overhead line as used abroad. Although plenty of data have been published regarding Continental overhead lines, the writer is not aware that tests of the impedance and charging currents, &c., of British power lines are much in evidence. This is probably due to the fact that, with short lines and pressures of a few thousand volts, the quantities in question do not affect the station instruments. The impedance of cored low-pressure distributor cables is, however, of importance, and should be taken into account in the laying out of a three-phase distributing system.

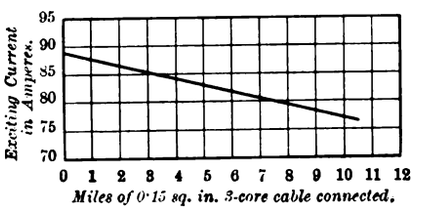

FIG. 4.—DUBLIN 500KW. GENERATOR. 5,000 VOLTS AT TERMINALS. 94 R.P.M.

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers.

† For a full description of the new electricity works at Dublin, and the change in the system employed there, reference may be made to *The Electrician*, Vol. LI., pp. 920, 958 and 996.

* An interesting Paper on this subject by Mr. Field will be found in the *Journal* of the Institution of Electrical Engineers, Vol. XXXII., Part 4.

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The writer may, perhaps, here be pardoned if he briefly reminds you of the elementary principles underlying the impedance of symmetrically cored polyphase cables.

The value of H, the intensity of magnetic field in C.G.S. units at a point outside the conductor 1 (Fig. 5) and at a distance from it, l, is $H=2C_1/l$, where C_1=current in conductor 1. If N=total number of lines of force in the space d between the surface of 1 and the centre of 2,

$$N=\int_r^d \frac{2C\delta l}{l}=C\log_e\frac{d}{r},$$

where r=the radius of conductor (1). Again, considering the interior of conductor (1), it is readily shown that if N′=the number of lines of force linked by the current itself, $C_1N'=C_1/2$. The self-induction of the conductor (1) per unit length is therefore—

$$L_1=(2\log_e\frac{d}{r}+\tfrac{1}{2})\times 10^{-9}.$$

Now, in the ordinary case of two conductors acting as flow and return the return conductor will just double this value L for the circuit. In the case of polyphase cables, the number of lines of force N linking any conductor will depend upon the resultant field, due to the currents C_1 C_2 and C_3 in the conductors and the induction coefficients L_1 L_2, &c., between them.

For a symmetrical three-phase cable we shall have

$$N=L_1C_1+L_{1\cdot2}(C_2+C_3). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For a symmetrical five-phase cable, it will be evident, upon drawing a figure, that we shall have

$$N=L_1C_1+L_{1\cdot2}(C_2+C_5)+L_{1\cdot3}(C_3+C_4), \quad . \quad . \quad . \quad . \quad (2)$$

and so on.

Now, in the case of the three-phase cable we have

$$C_1=C\sin\theta,$$

$$C_2=C\sin\left(\theta+\frac{2\pi}{3}\right),$$

$$C_3=C\sin\left(\theta-\frac{2\pi}{3}\right),$$

and

$$(C_2+C_3)=C\left(2\sin\theta\cos\frac{2\pi}{3}\right)=-C\sin\theta,$$

$$=-C_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

It will be evident from expressions (1) and (3) that the currents in conductors (2) and (3) will jointly combine to give a resultant field, which is equivalent to an ordinary return to conductor (1).

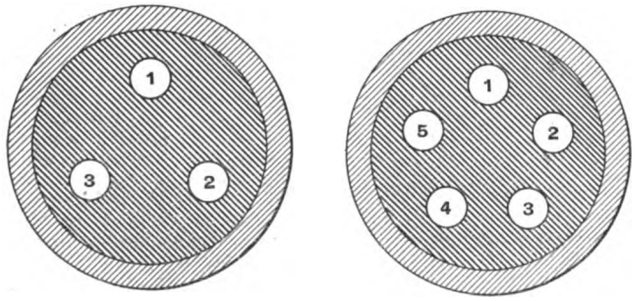

Fig. 5.

The test given in Table I. of the impedance of 6·2 miles of 0·15 three-core feeder may be of interest. The pressure V_1 and V_2 across two phases of the cable and the currents C_1 and C_2 in two of the cores were measured at the sending end, whilst all three cores were bunched at the other end. It will be seen from these tests that the impedance of this cable per mile=0·324. The measured resistance per mile of core =0·282.

Table I.—*Test of Impedance of 6·2 miles of (3 core 0·15) E.H.T. Feeder at 50 ~ per second.*

P.D between phases at sending end.				Current per core at sending end.			Impedance per single core.
V_1	V_2	Mean.	Mean/$\sqrt{3}$	C_1	C_2	Mean	
89·0	88·5	88·0	51·2	26·0	25·0	25·5	2·01
90·0	90·5	90·5	52·2	26·0	25·5	25·75	2·03
99·0	99·0	99·5	57·2	28·5	28·0	28·25	2·02
108·0	108·0	108·0	62·5	31·5	31·0	31·25	2·0
116·5	116·0	116·5	67·2	34·0	33·5	33·75	1·99
119.0	119·0	118·5	68·6	34·2	34·0	34·1	2·01
						Mean = 2·01	

One phase was disconnected, and the readings in Table II. were taken :—

Table II.

P.D. between phases at sending end.		Current per core at sending end.			Impedance per single core.
V_1-V_2.	V/2.	c_1.	c_2.	Mean.	
92·0	46·0	22·5	22·0	22·25	2·07
100·0	50·0	25·0	24·0	24·5	2·04
99·5	49·75	25·5	24·0	24·7	2·02
110·5	55·25	27·5	26·5	27·0	2·04
122·0	61·0	31·2	30·5	30·8	1·98
123·5	61·75	31·5	30·7	31·1	1·99
140·0	70·0	35·7	34·5	35·1	2·0
141·0	70·5	35·8	35·0	35·4	1·99
				Mean = 2·01	

Between the generating station at Pigeon House Fort and the central distributing station at Fleet-street, a distance of 3·1 miles, three trunk mains have been laid. Each of these mains consists of a three-core lead-covered British Insulated and Helsby paper cable, the section of each core being 0·15 sq. in. Capacity tests made upon these feeders after they were laid gave the results in Table III.

Table III.—*High-tension Feeders, 0·15 sq. in. Three-core E.H.T. Paper-cable, Lead-covered.*

——	Feeder No. 1.		Feeder No. 2.	
	3·13 miles.	Per mile.	3·13 miles.	Per mile.
One core against two other cores bunched to lead sheath	0·96mfd.	0·303	0·95	0·303
Three cores bunched against lead sheath	1·53mfd.	0·49	1·53	0·49

The corresponding capacities of the 0·04 sq. in. three-core E.H.T. paper insulated lead-covered cables per mile are :—One core against two other cores bunched to lead sheath, 0·25mfd. Three cores bunched against lead sheath, 0·46mfd.

These capacities correspond to a Y capacity of 0·373mfd. per mile for the 0·15 sq. in. three-core cable and 0·298mfd. per mile for the 0·04 sq. in. three-core cable. The pressure charging these cable condensers is 2,880 volts with 5,000 volts between phases. The minimum charging current per mile will, therefore, be for the 0·15 sq. in. three-core=0·337 amperes and for the 0·04 sq. in. three-core=0·272 amperes.

Resonance or deviation from the sine wave of E.M.F. may, however, considerably increase these values. In order to test this point experimentally two phases of one of the 500kw. sets were disconnected from the earthed neutral bar and an electro-dynamometer and Kelvin balance were inserted between these phases and the neutral, as shown in Fig. 5. With the generator coupled to two trunk feeders in series the readings in Table IV. were obtained. It will be noticed that the charging current per core considerably exceeds the theoretical minimum value. This current, however, includes leakage from two large switchboards one at either end of the line and newly erected.

Table IV—*Test of Charging Current of Trunk Feeders, Three-core, 0·15 Cable, 6·26 Miles; 50 ~ per second*

P.D. between cores.	P.D. to neutral point.	Charging current, amperes.		Equivalent capacity of one core.
		Electric dynamom't'r.	Kelvin balance.	
1,600	924	2·09	2·2	0·813
2,100	1,212	2·88	2·74	0·735
2,500	1,442	3·37	3·24	0·745
3,200	1,850	4·12	4·14	0·713
3,700	2,135	4·47	4·5	0·667
4,200	2,430	4·85	4·79	0·637
4,900	2,830	5·34	5·19	0·62
5,180	2,990	5·6	5·48	0·597

Before leaving this question of the charging current taken by these feeders, it may be of interest to consider for one moment the relation of the alternator self-induction to it. Taking the alternator E.M.F. wave as being made up of a fundamental wave, $e=\sin 2\pi nt$: where $n=50\sim$ per second, and a number of harmonics of frequency $=q$ times n, where q has successive integral values, we may express the E.M.F. wave as $e=\Sigma E_q\sin(2\pi qnt+C^q)$, C_q being a constant fixing the relative position of any particular harmonic with regard to the fundamental.

Now, if resonance occurs with any particular harmonic, it has been found that the current flowing is exactly that due to the fre-

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quency of the harmonic in question. Hence the current (C) charging the cable will be $C_K=2\pi qnKV$, and the short-circuit current of the alternator $C_L=V/2\pi qnL$, where K=capacity in farads and L=self-induction in henries of one leg of the system. When these two currents are equal, we have the well-known condition for resonance.

Applying this condition to the case of a 500kw. Dublin set coupled to the three trunk mains (9·3 miles of 0·15 cable, $C_K=0{\cdot}337\times9{\cdot}3=3{\cdot}14$ amperes, and $C_e=145$ amperes when q is unity. The value of q, therefore, which will make $C_K=C_e$, is $q=\sqrt{145\ 3{\cdot}14}=6{\cdot}77$. We might, therefore, expect to get resonance with the seventh harmonic, or a frequency of about 338.

(To be concluded.)

THE CITY AND SOUTH LONDON RAILWAY: WORKING RESULTS OF THE THREE-WIRE SYSTEM APPLIED TO TRACTION, &c.

The following is an abstract of the conclusion of the discussion which took place on January 14th on Mr. P. V. McMahon's Paper upon the above subject read before the Institution of Electrical Engineers on December 17, 1903. The Paper and first part of the discussion appeared in our issues for December 18th and 25th.

Mr. McMAHON asked Prof. Carus-Wilson to explain more fully his statement at the last meeting that the three-wire system as used on the City and South London Railway could only be applied to lines upon which the rails were used as the return, and that it could not be used if two insulated rails were employed. So far as he (Mr. McMahon) could see, the three-wire system and the method of changing over from one side of the system to the other was equally applicable to any case in which an insulated return conductor was employed.

Prof. Carus-Wilson not being present, the discussion was continued by Mr. T. STEVENS, who referred to Mr. McMahon's arrangement of circuit-breakers. The circuit-breaker does not entirely break the circuit, but when a short-circuit occurs throws in a resistance which limits the current to the maximum load for which the feeder is designed. Mr. McMahon's diagrams did not show all the circuit-breakers with the resistance shunted, and it appeared to him that if Mr. McMahon did have a resistance shunting all his circuit-breakers he would have the condition which obtained on the Paris Metropolitain at the time of the fire. Upon this line there were practically no sections in the third rail, and at each feeding point a 4,000-ampere circuit-breaker was connected, so that it was possible, he believed, to get 8,000 amperes into a fault midway between two sub-stations and to keep that 8,000 amperes flowing without the circuit-breakers tripping. Mr. McMahon's diagrams showed a second circuit-breaker in series without the short-circuit, and he took it that this second breaker was set somewhat higher than the first, so that, if a short-circuit came on which was persistent, the second one took care of the open circuit and prevented any continuous flow of current. The report which had recently been issued with regard to the Paris Metropolitain fire (*The Electrician* of December 25, p. 359) had particularly interested him. No doubt everyone had seen the recommendations contained in it. The one that the driver should be able to lift the shoe from his position in the cab was certainly copied from Mr. McMahon's practice, as his shoes were designed in that way. Another recommendation was that the third rail should be divided into sections, and each section protected by an overload cut-out. The electric railways in England had the line divided into sections in this manner, and it gave the maximum of safety. This arrangement had now been installed in Paris. Diagrams (p. 537) of the cut-out and sectioning arrangements on the various lines were exhibited. Another suggestion by the committee which enquired into the Paris Metropolitain accident was that between stations there should be switches to cut off the current without the necessity of tel-phoning. Personally, he had never designed a switch for short-circuiting purposes only, and it would appear that there would have to be a good many spares. No doubt this could be done, however, and, moreover, it was a very desirable thing to be able to do it in order for the passengers to be able to walk through the tunnel. This Paris committee also recommended that provision should be made for cooling the motors. He did not like the addition of blowing machinery to the other apparatus which it was necessary to put on to the trains, and he thought it was sufficient to put in a motor which would not overheat under ordinary circumstances. Prof. Carus-Wilson, at the previous meeting, had raised the point that it was better to have two insulated rails than a single one, and in the following week the papers published a report of a death in South Africa which, although on a tramway system, certainly appeared to him to have a bearing on this question. This was the death of a gentleman stepping into his bath and completing the circuit between the water supply from the shower and the drain pipe which went to earth. That shower was in contact with a trolley standard which was not earthed, and a defective insulator on that trolley standard made it alive, so that it was a case of one fault waiting for another to make a short-circuit (see *The Electrician*, December 25, p. 380). For this reason, wherever possible, it was very desirable to have one side earthed, and his diagram showed that the 5,000-volt Central London circuit at Shepherds Bush was earthed and the transformer cases were earthed also. Incidentally this gave the lowest possible voltage to earth, and it ensured the breakdown of the system when one fault appeared. This was not advantageous to the system, but it was a precaution against accident to passengers, and he thought it was a very desirable precaution. It had also been suggested that cables running under the cars were not the most advantageous part of the equipment. Nowadays it was possible to build the motor cars encased in iron, as was the case on the Central London Railway, but when a cross-over road was reached they must connect the two shoes, which bridged the gap, by a cable under the bottom of the car. He had never heard of an accident due to such cables, and he would like to know if Prof. Carus-Wilson had ever heard of one. It seemed to him that the nearer they get to the Board of Trade regulations in this matter the nearer did they get to the ideal. The suggestion made by Mr. Trotter that these connections under cars should be made rigid, and either bare or enamelled, or inside iron pipe insulated by non-combustible rings, and wherever flexible that hinges or knuckle joints should be provided, was an excellent one. The speaker had also prepared the diagram on p. 536, showing the third-rail and fourth-rail arrangements on the various electric railways in this country.

Mr. W. H. BOOTH, speaking on the steam side of the question, which he thought he was entitled to by the "&c." in the author's title, referred to the coal consumption mentioned in the Paper—viz., 3½lb.—which he took as a good result in an electric station; 3½lb. of coal per killowatt would not have been looked upon 20 years ago as a particularly good result. He was aware of the effects of load-factor in raising the coal consumption, but he would like to call attention to an old engine which was even 30 years old when he encountered it 20 years ago. It was an old-fashioned engine of which they were accustomed to say that it revolved occasionally. There were two horizontal engines exhausting into two beam engines, and two vertical engines exhausting into two marine engines, and the coal consumption for the month of September, which was the best month in the year, was 2·23lb. per horse-power. If that were multiplied by 1·34 and divided by 0·85 for the over-all efficiency—assuming that this engine had driven generators—the coal consumption worked out to the same as was at present the case on the City and South London Railway. The steam pressure of these old engines was 60lb., and in the case of the City and South London Railway it was about 150lb., so that it seemed to him that sufficient was not obtained out of high-pressure steam compared with what was obtained years ago. Steam at 150lb. had a density something like double that a 60lb., and he thought that steam of this density carried considerably more water. He thought that if these old engineers with their cumbrous system of cylinders could get such results from steam of 60lb. pressure, there must be something wrong with present-day steam practice. According to the Paper, the steam used by Mr. McMahon was tested by a Carpenter calorimeter, and showed 4·5 per cent. of wetness. But he would not believe that any man could take a true sample of steam out of the piping. If a proper sample could be obtained, it was possible to test it; but he was confident that no man knew what was inside the pipe or that he could get a true sample out. There was no way of telling how wet steam was, but there was a method of telling how dry it was. If steam were superheated 5 per cent., it was possible to try it with a thermometer and know it was hotter than the steam in the boiler. The author had stated he had found out that the Willans engine was not so economical as the Corliss engine. He did not wish to say anything against the Willans or any high-speed engine, but it did seem to him that, unless they used superheated steam with high-speed engines, they were not going to do much good. It hardly seemed fair to compare high-speed engines with wet steam with slow-speed engines of smaller internal surfaces. With an engine with a large internal surface and wet steam a much larger portion of the initial steam condensed—up to 40 per cent. This was due entirely to condensation and re-evaporation in the cylinder. But it would not occur to the same extent if the steam were thoroughly dry to begin with. A good deal had been heard in that room about entropy. He supposed there was not one in 10 of them who understood anything about it. Engineers had not the time to study it, and if they did understand it they did not have the time to work it out. But he would like to point out that steam engines for the last 20 years had been drawing a diagram with which it was possible to show the wetness of steam. If there were steam engines with adiabatic cylinders some good might be done, but we did not get such engines and, therefore, why trouble ourselves with thermo-dynamics? Until they got steam dry throughout the whole of the stroke—which was practically impossible—it was useless to argue the question. Mr. Sayers had kindly given him some figures relative to the Maybank power station in Staffordshire. The coal consumption was 4·37lb. per kilowatt, cost 0·195d.; oil, water and engine-room stores, 0·0203d.; repairs and maintenance, 0·0277d.; salaries and wages, 1·377d. Total cost per unit 3·807d., an exceedingly good result considering the weight of coal used was 4·37lb.

Mr. HERBERT JONES said it seemed a very great drawback that the generating station at Stockwell was so situated that all the coal and stores had to be carted into the works. The cartage of something like 15,000 tons of coal per annum must be a heavy item of expenditure. Mr. McMahon had overcome so many difficulties, however, that perhaps he had some scheme for getting over this one. Mr. McMahon stated that "an all-round satisfactory water meter was not to be found that would work with hot water under boiler pressure," but he would like to know why it was necessary to have such a water meter at all. There were many meters which would work in a satisfactory manner in the suction of the feed pumps. For instance, on the Waterloo and City Railway there was a Kennedy water meter which had been at work for five years in the suction of the feed pumps, and had always been found to be within 1 per cent. He noticed that the author did not seem to favour motor-driven pumps for condensing plant and boiler-feed purposes, as he had not used them extensively. From his own experience, however, there was great economy to be obtained from using motor-driven pumps both for condensing plant and boiler-feed purposes, but, of course, having a

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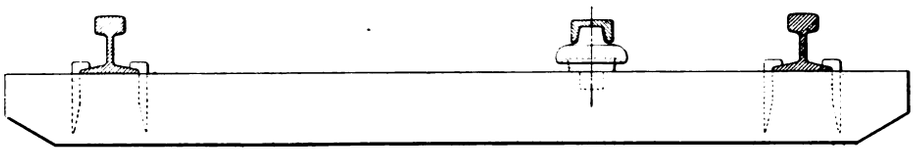
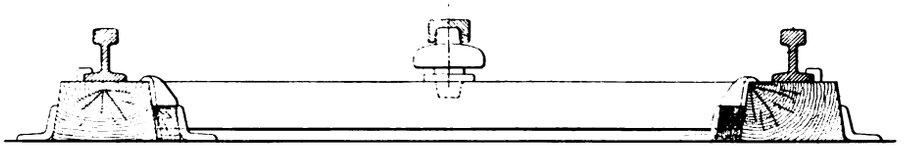
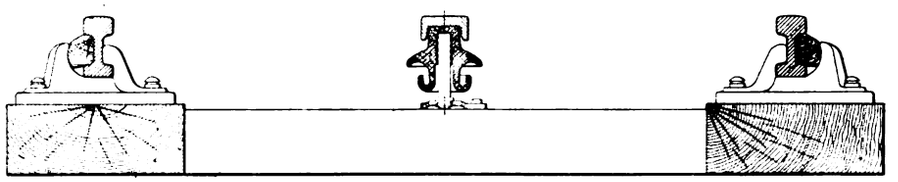
steam pump as a stand-by for boiler-feed purposes. The point with regard to resistances across the circuit-breakers had already been raised. The method of completely breaking the circuit, he thought, was the safer. There were certainly great advantages in the system, adopted by the author, of putting a resistance in each circuit, especially from a generating point of view; but, in the case of a cable going to earth and the circuit-breaker opening, the fault was fed with a considerable current, which maintained the arc and probably did a large amount of damage. He would like to know how the flexible rail bonds mentioned in the Paper were fixed to the bottom flange of the rail. He himself had carried out some tests on flexible bonding and on the bonding of rails generally, and had found that the greatest loss was at the point of contact between the rail and the terminal. The great point was to have the track well riveted. On the Waterloo and City Railway this was done by means of a hydraulic riveter, and each rivet was closed with a pressure of 40 tons. The line had been running for 5½ years, and he had never yet found a slack rivet. The author's figures at the end of the Paper were so remarkably good that he did not like to draw comparisons between these results and those obtained on the Waterloo and City Railway, which was such a small line in comparison. Perhaps, however, some figures might be useful. For the half-year ending June, 1902, Mr. McMahon's coal consumption was 3·9lb. per unit generated, the total units generated being 3,781,000. During the last half-year ending December, 1903, the units generated on the Waterloo and City Railway were only half a million—less than one-seventh—whilst the coal burned was 5·6lb. per unit. Of course, the cost per unit on the Waterloo and City also came out much higher on account of the smaller number of units generated. As regards coal, it was 0·53d. as against 0·31d. The only figure in which he was lower than the City and South London was for oil, waste and other stores, which he put down to the use of high-speed engines. The expenditure in wages per unit generated was 0·306 on the Waterloo and City against Mr. McMahon's remarkably low figure of 0·036. The total works cost per unit generated in the Waterloo and City for half a million units per half-year was just a penny (1d.). Mr. McMahon gave his units per ton-mile as 0·0552, on the locomotive. From other figures given in the Paper this worked out at about 0·0608 at the switchboard. This figure was higher than on the Waterloo and City Railway. His own figure for the units per ton-mile at the switchboard was exactly the same as Mr. McMahon's figure at the locomotive—viz., 0·0552 units per ton-mile. Probably this was due to trains on the Waterloo and City running 1½ miles without an intermediate stop. His coal per ton-mile worked out at 0·313, against Mr. McMahon's 0·237. Of course, it should be remembered in considering these figures that the units generated were seven times as great on the City and South London line, and also that the load on the latter was practically a steady one compared to that on the Waterloo and City Railway. It did not vary more than about 25 per cent. on either side the mean, whereas his own varied 75 per cent., or from 150 to 1,050 amperes in about 30 seconds, and this went on about 200 times a day. Mr. McMahon had given some remarkably good figures as to freedom from failure, and stated that the trustworthiness of the locomotives expressed as percentage of the time lost through armature failures was 0·16 per cent. While admitting that he had a shorter line, he had a better record even than that, on the Waterloo and City line. The time lost over the whole of the year 1903 on breaksdown, worked out at only 0·135 per cent. from all causes, signalling and all others. From electrical causes only this was less than 3 minutes delay a week. The last figures given by Mr. McMahon were given as pence per train-mile. If these were converted into pence per



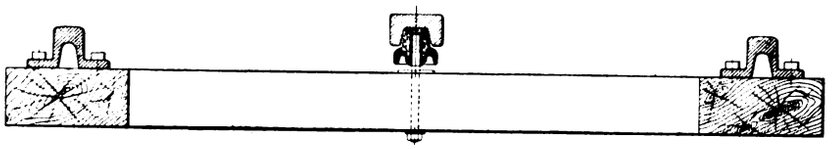
City and South London Railway.



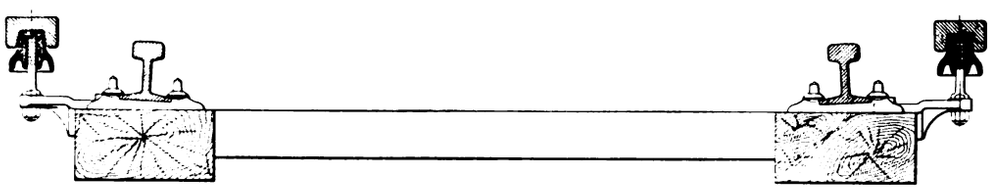
Liverpool Overhead Railway.



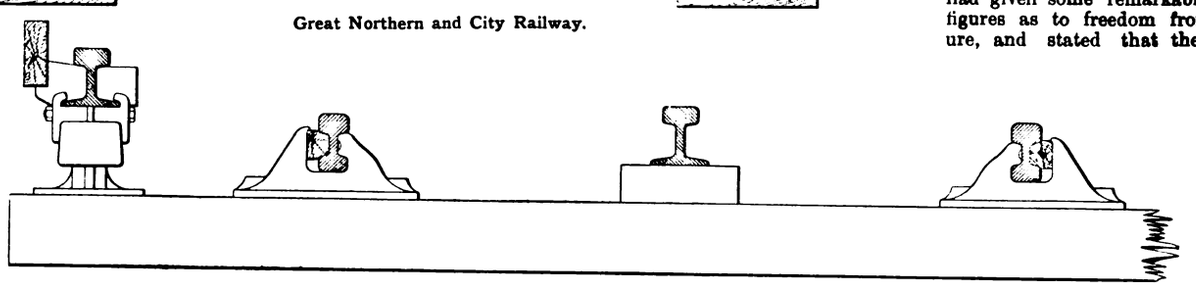
Waterloo and City Railway.



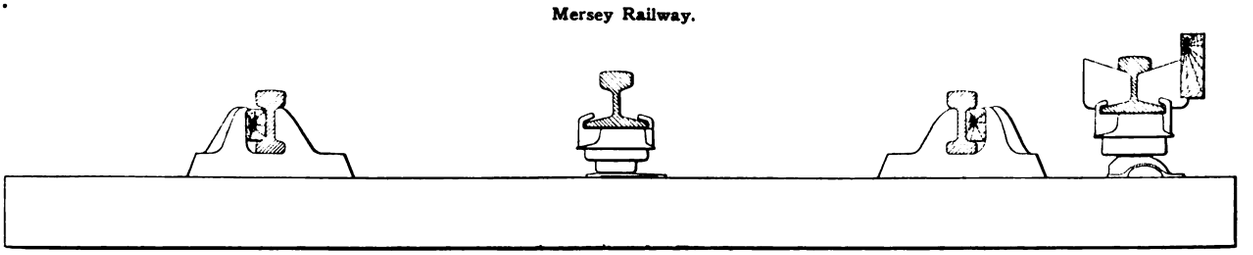
Central London Railway.



Great Northern and City Railway.



Mersey Railway.



Scale: ¾ of an inch = 1 foot.

Metropolitan and Metropolitan District Railway.

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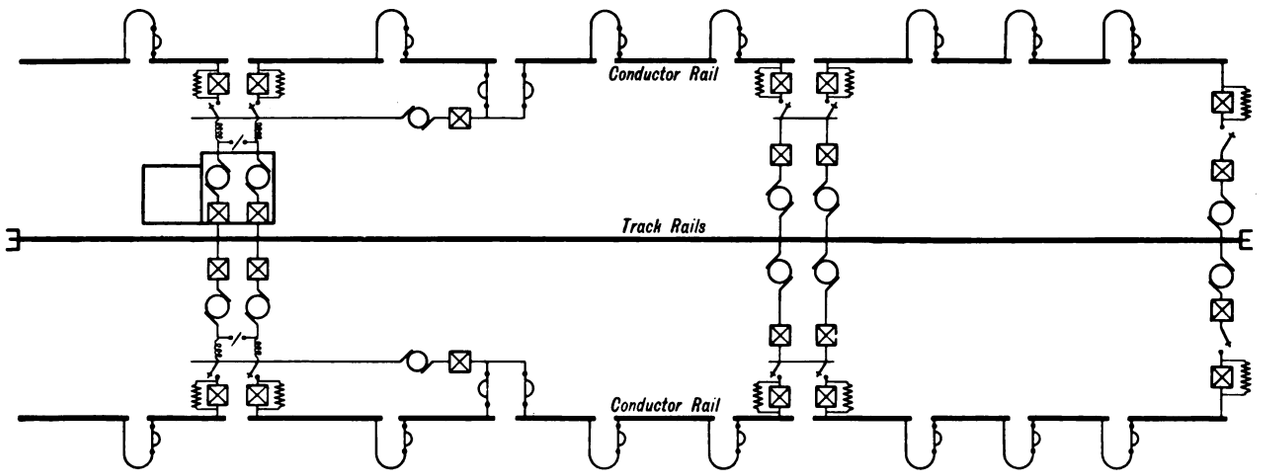
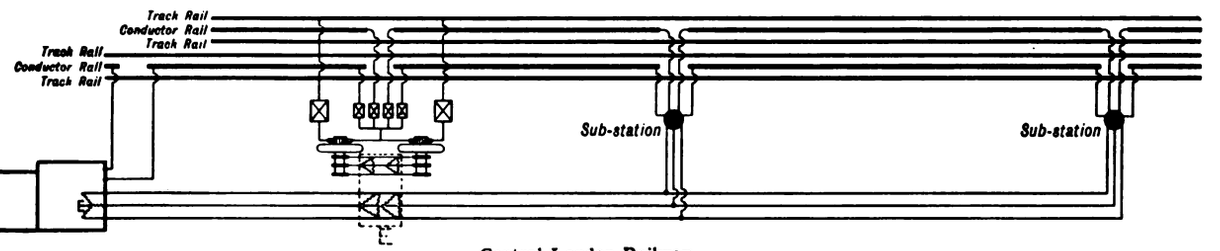
ton-mile, the last figure of all—total cost per train-mile, including salaries and wages—would come out at $\frac{1}{10}$d. per ton-mile roughly. The figure for the Waterloo and City Railway came out, of course higher—viz., 0·16d. per ton-mile. The figures Mr. McMahon gave for maintenance and running costs per train-mile looked remarkably low until the weight of the train was taken into consideration.

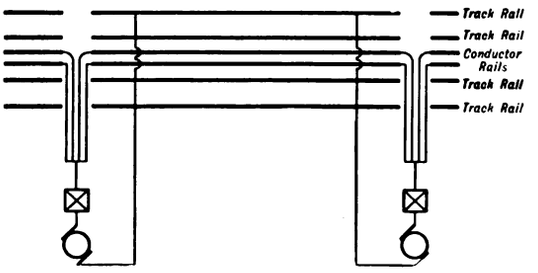
Mr. E. V. CLARK said that Mr. Booth's remarks concerning the effect of superheated steam on high-speed engines perhaps accounted for one peculiarity in the figures of the Paper—viz., the difference in the competative tests of the Corliss and Willans engines, under their guarantee tsets and under the three hours, working test. When it was considered hat during their guarantee trials the Willans engine was working with 23½in. of vacuum and the Corliss with 25¾in., it would be seen from the figures of steam consumption that the economy in the Corliss engine was only measured by a very few per cent. in excess of the Willans. In the three-hour tests, which were more trustworthy, the increased economy was 25 per cent. over the Willans engines—a very different figure. It seemed, however, that Mr. McMahon had phrased the description of these tests in such a manner as made the Willans engine come out in too bad a light. It was stated that "During the tests of the Willans sets the average load on the 125kw. sets was about full normal load, while the 300kw. sets were also up to full normal load—*i.e.*, 600 amperes per machine. The average load on the Corliss sets during the test was 900 amperes each, or about 56 per cent. of the normal full load." The specification of the Corliss engine, given in the early part of the Paper, showed that it was designed to have a most economical normal working load of 600kw., giving 800kw. with late cut-off, and the tests showed that this Corliss engine was most economical at the lower load. On the other hand, the Willans engines, which were designed to be most economical at 320kw., were required to work up to 400kw. without pulling up, and as their governing was on the throttle, it turned out that they were 7½ per cent. more economical at their overload than at their normal load, and it also was probable that the 125kw. sets would similarly be more economical at their overload. It would, therefore, be expressing things in a truer fashion to say that at the time of these comparative tests both the Willans and the Corliss engines were working at 75 per cent. of their net economical load. No doubt the fact that the Corliss engine was governed on the expansion valve made it more suitable for traction purposes. For a lighting station that was reasonably loaded, the Willans engine might be designed to work for a great part of its time at its most economical point. He thought it would be a great benefit if Mr. McMahon would state, with regard to the three-hour tests, what were the boiler pressures and the average vacuum in the two cases. Presumably, from the Paper, they were similar, but there was no definite statement to this effect. Also, in connection with the all day test, April 8, 1903, would Mr. McMahon give some information as to the load on the station during the different hours of the day, and as to what engines were running at the various times. The steam per unit, including condenser, was 23·88lb., which was practically the same as was obtained on the Corliss engine in the special three-hour test, and this appeared to prove that the Corliss engines must have been working at times much more economically than in the three-hour test. With regard to the electric and hydraulic lifts, the figures as to the working cost were very suggestive, but he had looked in vain in the Paper for figures which would tell him how much capital charges should be debited to the hydraulic and the electric lifts. If these were added, the electric lift would possibly come out in a much poorer light than the present figures showed. The Central London Railway had abandoned electric lifts for hydraulic in the extension of the Shepherds Bush Station. The author had mentioned, in the early part of the Paper, that it might be considered advisable by some to have a few large sets generating, say, 1,000 volts across the outers instead of so many small sets as was now the case, and had pointed out that such an arrangement would not work. But he would be glad to know if there were any reasons why two generators,



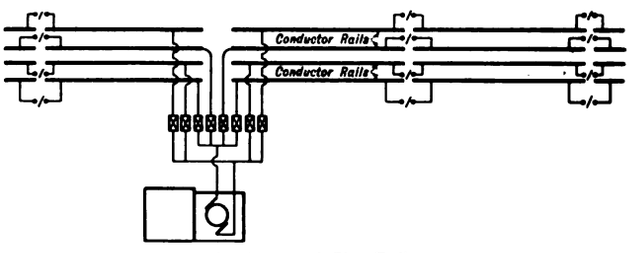
City and South London Railway.



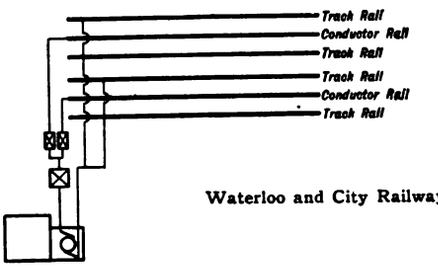
Central London Railway.



Paris Metropolitain Railway



Great Northern and City Railway.



Waterloo and City Railway.

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or one double-wound generator, should not have been put on the one engine shaft. For instance, if the 800kw. dynamos driven by the Corliss engines had been double wound, with two commutators generating500 volts on each side, it would have simplified the plant in the station a good deal. At the present time, whenever the high-tension feeders were in use there must be four generators running in the station, either steam or motor driven, and this certainly looked somewhat extravagant. If each of these 800kw. sets were double wound it would not mean very much complication at the switchboard, and in any case, the extra trouble and cost in this direction would have been justified by the simplification of the working plant. It was a pity, he thought, that so little had been said in the discussion upon the one point which prevented any general adoption of the three-wire system for surface tramways. This, of course, was the difficulty of balancing and the question of earth drop. The Board of Trade limit of 7 volts in the negative rail return was difficult to keep within, and the Board specially stipulated that the trolley line must be connected to the positive terminal of the dynamo and the earth return to the negative. If anyone proposed to connect the rail return to the positive pole, the Board of Trade would probably limit them to 2 or 3 volts drop in the rail, as there would be much more danger from electrolysis, and of course in a three-wise system, normally balanced, the e must be times when the rail is acting as a positive return, wi h heavy currents in it. Then, again, the Board of Trade specially stated that at no point on the rail return must there be a difference of more than 4½ volts between the rail and adjacent pipes if the rail was positive to the pipes, or more than 1½ volts—only one-third the amount—if the rail was negative to the pipes. Mr. McMahon, he presumed, was free from that stipulation because his tube was metal sheathed, and he was away down well below any pipes; but it would be interesting to hear whether, when he was designing the line, he had any trouble to obtain the Board of Trade approval. Perhaps he was not under the ordinary Board of Trade regulations. It appeared that one could only work a three-wire tramway system by obtaining a very special condition, and perhaps the author had hit upon the idea which would allow of a tramway system being thus worked—viz., the use of battery sub-stations with a Highfield booster to take charge of the peaks. These latter were the great trouble in tramway working, as the normal rail drop at full load could be calculated and kept within limits. It appeared to him that, by having several battery sub-stations distributed along the line, it would be quite possible to keep within the 3 volts drop when the rail was acting as the positive return. The system could be adjusted to have normally a negative drop of 2 volts, which would allow of a variation of 4 volts up or down when the peaks were first on one side and then on the other. But one thing came out from Mr. McMahon's curves—viz., that the Highfield booster did not seem able to keep pace with the fluctuations of the load. The variation of the generating load was much more rapid than the battery discharge. The latter appeared to be a smooth curve, though very undulating, one minute discharging, and in a couple of minutes charging again, but it had not got the very rapid fluctuations of the motor and generator load. He believed the Highfield booster which Mr. McMahon was using was one of the earliest constructed, and possibly they could now be built to follow up the fluctuations much more rapidly; but it appeared from the curves in the Paper that there was plenty of scope for their improvement, although at present they did a very great deal. Prof. Carus-Wilson had spoken as to the impossibility of the use of the three-wire system with insulated return, but it seemed to him that the objection to this was, supposing an earth should be developed on the negative rail, there would at once be a difference of potential of 1,000 volts between the positive rail and earth, which might, of course, cause considerable trouble to the controllers and motors unless the latter were specially designed to withstand 1,000 volts between their working parts and earth, although there were only 500 volts across their terminals. But surely this requirement could be met, and need not prevent the use of the three-wire system with an insulated return rail.

(To be concluded.)

EXPERIMENTS ON EDDY CURRENTS.

The following is an abstract of the discussion which took place at the Newcastle Local Section of the Institution of Electrical Engineers on Monday, January 18th, in connection with Dr. Thornton's Paper on the above subject. The Paper itself was published in our issues of January 1st and 8th.

Mr. EUGENE BROWN said that in designing electrical machinery the losses due to eddy currents were not calculated, but allowed for empirically; the Paper, however, clearly pointed to the fact that these were of considerable importance and should in future be carefully considered by designers. The losses due to the eccentricity of the armature showed that this matter also should have attention. He had repeatedly found that the losses in continuous-current machines were far greater than those anticipated, and it was quite possible that they were due to eddy currents. He had not looked for eddy currents in magnet yokes. In conclusion the speaker thought the subject so complex that it would be some time before any definite results could be obtained from observations. He wished to ask whether the disturbances would not be greater in a two-polar than in the four-polar machine on which the tests were made.

Mr. A. W. HEAVISIDE thought, looking at the question broadly, that the main point brought out by Dr. Thornton's Paper was the importance of symmetry. He had found this to be the case also in overhead line work for telegraphy, and especially for telephony.

Mr. LAWS was interested to see that the oscillograph was likely to be quite as useful with continuous as with alternating-current machines. He too, had frequently noticed that eddy losses in machines were considerably higher than those anticipated.

Mr. G. STONEY said that in practice it was exceedingly difficult to separate the various losses in a dynamo or motor, and it seemed likely that a great deal might be done by Dr. Thornton's method of looking for oscillating magnetism in various parts of the machine. In the case of alternators especially, it was likely to be of value, and it was quite possible that we might see much further lamination of the field magnets. The damping necessary for parallel running might be obtained by damping coils instead of, as in many instances, by more or less solid poles. It would be interesting if Dr. Thornton, by the use of the oscillograph, could find the limit of the number of commutator segments to give the best results for a given voltage, as the number often varied greatly, some designers appearing to have too many and others too few.

Dr. THORNTON, in replying, said that he was of the same opinion as Mr. Brown, inasmuch as he also thought the disturbances would be increased in two-pole machines. He might say that the whole *morale* of the Paper was "symmetry." If the construction of a machine were perfectly symmetrical there would be no eddy currents.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, January 14.

Sir DOUGLAS FOX said that in London two classes of traffic must be considered—viz., that travelling, say, 2 miles and upwards and that travelling ½ mile and upwards. For the former tube railways would be suitable, and for the latter motor omnibuses and electric tramcars on the surface would answer the purpose, although, in the congested parts, shallow subways could be constructed if the cost was not too excessive. But he considered the construction of shallow subways in congested streets would be prohibitive from the point of view of cost, and he disagreed with the evidence of the London County Council as to the desirability of such routes. Under new streets it was a different matter. With regard to possible increase of facilities during the next few years, he mentioned the electrification of the Inner Circle. This would be a great accession to travelling facilities, but if the original plan of having the Circle as a continuous route without junctions had been adhered to, a much larger amount of traffic could be dealt with than was now possible. He believed the time was coming when a 1½-minute service would be run upon electric railways, and the existence of junctions would, therefore, be impossible. With regard to providing further means of communication in London by tube railways, he said the north-eastern portion of London was greatly in need of new lines. Extensions by electric railway to the south-east of London, where further facilities were needed, would have to be on the surface, as, owing to the nature of the strata, it was impossible to tunnel. Routes from Victoria to the neighbourhood of Sydenham were necessary, and he approved of the routes taken by the lines which were deposited last session but withdrawn. On engineering matters connected with tube railways he expressed the same opinions that he has frequently expressed in Parliamentary Committee rooms. As to legislation he complained of the burdening of tube railway companies with clauses and onerous conditions as had been frequently done in recent bills, and any clause as to purchase by the London County Council would destroy the prospect of raising the capital. Generally speaking, substantial justice was done to the tube companies in the Parliamentary Committee rooms, but he regarded it as a mistake that practically the whole of the capital should be guaranteed before the bill was passed. If this policy were persisted in, it would result in a monopoly either to the existing companies or one or two powerful financial groups. The special tribunal which he suggested should insist that 5 per cent. of the capital should be guaranteed only. His idea of a traffic tribunal was that it should be a permanent paid body (with the exception, perhaps, of the chairman) consisting of five members, the chairman being of judicial capacity, one member a barrister of Parliamentary experience, another a civil engineer with railway, tramway and Parliamentary experience, a representative of the municipal authorities and a representative of the Board of Trade. The tribunal could, for its own guidance, give preliminary consideration to existing modes of communication and probable requirements of the future, and as far as possible adhere to a fixed policy with reference to its mode of dealing with the proposals brought before it. The standing orders of Parliament should be simplified as much as possible. Witnesses should be called and heard on oath. A public inquiry should be held where all who could show interest in the works proposed should be heard, if a petition were entered, either by counsel or personally. The tribunal should also have the power to award costs against promoters or opponents where the opposition was considered frivolous. Questions of competition should be entered into and clauses inserted as to capital, &c., and also for the protection of persons interfered with. The tribunal should be required to personally view the railway or tramway proposed. There should be no appeal to the Board of Trade, but the orders granted should be reported to Parliament and lie on the table for a fixed period. In the case of opposition it would be desirable that it should be dealt with by a joint committee of the two Houses. At present there was a great lack of continuity of policy in Parliamentary procedure.

Friday, January 15.

Mr. A. C. MORTON, chairman of the Streets committee of the City Corporation, gave evidence supplementary to that which he put before the Commission on April 3, 1903. (*The Electrician*, Vol. L., pp. 1008 and 1020. Whilst adhering to the views then expressed, he further was of the

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opinion that the members of the proposed tribunal should be paid. No local authorities should be represented upon it. The tribunal should report, not less than once a year, on the subject of the traffic and locomotion in London generally. But it should not have the power to order improvements to be carried out, nor should it be responsible for any works carried out as a consequence of its annual reports. All tramway schemes should come before, and be settled by the tribunal, subject to the rights of the local authorities, and in connection therewith the tribunal should be empowered to confer compulsory powers for the acquisition of property. New works should be enforced upon existing companies. In connection with this tribunal, also, a settled policy of action should be decided upon with the object of securing continuity of principle. Road authorities should have complete control with regard to the opening of streets, but the tribunal should apportion the cost of improvements according to the advantages derived from particular districts, and also to others contiguous to those in which the improvements were made. Another duty of the tribunal should be the settlement of all disputes between local authorities and promoting companies. Finally, the area of the jurisdiction of the tribunal should correspond with the Metropolitan Police area and not be confined to the county of London. With regard to subways for passengers, he said the result of the opening of the subway at the Mansion House had been disappointing. Three years ago the percentage of the total pedestrian traffic at that point using the subways was only 8½ per cent. and at the present day only 10 per cent., exclusive of the passengers using the tube railways. Probably as time went on this percentage would increase, but hitherto the subway had not fulfilled the expectations of the Corporation.

Alderman Sir HENRY KNIGHT, of the City Corporation, suggested that all omnibuses should be motor driven, and that he favoured something akin to compulsion in this matter. With regard to the congestion caused by heavy goods traffic, he thought this could be obviated by the construction of two zones or ellipses of underground electric railways, one about half a mile north or south of the river and a second about a mile or a mile and a half further out both for the conveyance of goods only. On the question of tramways, although these were very useful in wide thoroughfares, they would be absolutely impossible in the City. He would prefer a system of motor cars. With regard to tramways crossing the bridges, he was against this, as he failed to see that any good purpose would be served. He also advocated the prohibition of the use of coal for heating purposes, which would obviate much cartage of dirty materials, in favour of gas, and the construction of suspension bridges for busy crossings such as Ludgate circus, Oxford-circus, &c., was also suggested.

Thursday, January 21.

Ald. CROSBY, of the City Corporation, said that in his judgment the introduction of tramways into the City would enormously increase the difficulties of congested traffic which now had to be contended with owing to the narrow streets. Tramways over the bridges were clearly impossible, and omnibuses should be excluded from the centre of the City. He put in a plan to show that by the construction of more tube railways, and by connecting these by omnibuses, the present obstruction could be largely obviated. The centre portion of the City should be reserved for pedestrians as far as possible. He would leave it to private enterprise to construct suitable tubes or underground railways.

Mr. W. R. PRYKE, a member of the Court of Common Council and chairman of the Bridge House Estates Committee, referred to the efforts of the City Corporation to provide adequate communication across the Thames bridges within the jurisdiction of the City Corporation. With regard to tramways in the City, he said the introduction of these would nullify the benefit now derived from the expenditure of £6,000,000 which had been spent by the Corporation during the past 50 years in widening existing and building new thoroughfares. He would welcome any means of through communication.

Mr. ANDREW MURRAY, the surveyor to the City Corporation, made the following general observations and suggestions with regard to the problem of traffic regulation and improvement in London. He advocated greater powers being given to the local authorities to prevent the breaking up of streets in the City and other parts of the metropolis. With regard to the suggestion that tramcars should run over Blackfriars and Southwark Bridges, he was of the opinion that the effect of this would be to nullify the benefits intended by the re-widening of Southwark Bridge. The fact seemed to be that the London County Council's advisers, who had made this suggestion, had in view the desirability of affording greater facilities for travelling to the working population which gained a living in the City, but which lived in the suburbs, and were oblivious to the necessities of vehicular traffic which was a great trouble to regulate. So long as the City was an area devoted to business of various kinds, so long must there be carts and vans constantly delivering or receiving goods, and these must of necessity be ranged next to the curbs. With this state of affairs it seemed to him that the task of the police in the regulation of traffic would be most seriously hampered if the central parts of the City were to be specially reserved for the use of tramcars. Pedestrians in the City had at the present time ample means of getting quickly from one part to another in it, and also to other parts of London.

The Commission adjourned until to-day (Friday.)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Five-figure Tables of Mathematical Functions." By J. B. Dale. (London: Edward Arnold.) 3s. 6d.

"Light Railway Procedure: Reports and Precedents," Vol. II. By J. Stewart Oxley, M.A., assisted by S. W. P. Beale, B.A. (London: P. S. King & Son.) 21s.

THE "MIDGET" INSULATION TESTING SET.

An extremely compact insulation testing set, most appropriately called the "Midget," has just been put upon the market by Messrs. Nalder Bros. & Co. As shown in the accompanying illustration, which is half scale, the set is circular, being only 5in. in diameter and 2in. high. It is intended for carrying out insulation tests on the direct-deflection method, and consists of a sensitive moving magnet galvanometer (with an arrangement for lifting the magnet off its pivot, and a mirror to avoid parallax in reading), a resistance of 10,000 ohms and a set of $\frac{1}{10}$, $\frac{1}{100}$ and $\frac{1}{1000}$ galvanometer shunts. The key contacts are beneath the ebonite top of the instrument, there being five buttons projecting from the top. The battery is connected to the terminals C and Z and the insulation resistance to be tested between the terminals L and E. On depressing one of the three keys corresponding to the shunt and the key marked "constant," a deflection of the galvanometer through a resistance of 0·01 megohm is obtained, and then the test key, together with one of the shunt keys (if necessary) is depressed for the actual insulation test. The instrument is extremely compact, and, although sold at a very low price, shows evidence of good workmanship and finish.

One-half actual size.

Its weight is only 18oz., and it is carried in a leather case of convenient size and shape. We may add that the insulation of the instrument will allow the use of 200 volts for the test, and the makers state that resistances up to 350 megohms may be measured with this pressure, and of course, 175 megohms with 100 volts pressure. They supply secondary batteries of 50 cells or dry batteries of 75 cells in convenient cases to give 100 volts. It may be noted that the galvanometer of the instrument is also suitable to use with Messrs. Nalder Bros.' fault localisers, and also as an ordinary detector. It is safe to predict that the set will become popular.

Suspension Ferry over the Loire.—The United States Consul in Nantes describes an interesting structure called a "Pont Transbordeur," or overhead ferry, connecting the old quays on the north side of the Loire with the new ones on the south side, where the State railway is about to construct a large freight depot. It is a stately and graceful structure consisting of two tall steel towers, one on each bank of the river and joined together by a horizontal bridge or railway track 490ft. long and 165ft. above the surface of the water. An inverted steel carriage or car travels along the rails, and suspended from this by steel cables is the platform, or ferry, which has two divisions—one for horses, vehicles and railway cars, and the other for foot passengers. Electric motive power operates the car from which the platform is suspended, and the crossing is thus quickly and easily effected. This "pont transbordeur" in no manner interferes with navigation, since, owing to the great height of the track from which the ferry is suspended, ships possessing the tallest masts may pass under it; moreover, it does not involve the ascents and descents of the ordinary bridge approaches. The cost of this structure was a little more than £40,000, and the projectors believe it will be a paying venture. There is a similar "pont transbordeur" at Bilbao, Spain, and others at Rouen and Martrou, France, and Bizerte, Tunis.

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CORRESPONDENCE.

CUT-OUTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am interested to learn from Dr. Garrard's letter in your issue of the 15th that he has succeeded in designing a permanent-magnet reverse-current cut-out that does not lose its sense of direction when traversed by an abnormally heavy reverse current. It appears, however, that even if this relay is as perfect as is claimed, all it can do is to close a local circuit through a shunt coil connected across the 'bus bars. But Dr. Garrard's argument against the use of a compound-wound direct-acting device is that "its action depends upon the value which the voltage across the shunt coil may have when the accident occurs." As the drop of voltage is liable to be so great as to render the compound-wound device inoperative, it is evident that the pressure across the operating coil in Dr. Garrard's system may be much too weak to release the cut-out. Of course, this coil may be excited from an independent source, as suggested in my letter in your previous issue, but if independent excitation is necessary, it is difficult to see what is to be gained by using a relay when a simple direct-acting device can be guaranteed to operate under any circumstances that may arise.—Yours, &c.,

Manchester, Jan. 18. LEONARD ANDREWS.

M. BLONDLOT'S "N" RAY EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It would be interesting to know whether anyone has succeeded in confirming the above, as described in your columns and elsewhere. Personally, I have repeated most of M. Blondlot's experiments, but I have not been able to discern the slightest trace of any of the remarkable phenomena that he describes. This is also the case with Mr. J. C. M. Stanton and Mr. R. C. Pierce, who have assisted me in the investigations. In order to get away from personal physiological idiosyncrasies we have also applied delicate photographic methods of observation, but without result, and as a general conclusion I am inclined to think that M. Blondlot's observations must be due, not to physical, but to physiological processes, and, further, that these are not operative in the case of all persons. Perhaps others may have tried the experiments and may have met with greater success.—Yours, &c., A. A. CAMPBELL SWINTON.

London, S.W., Jan. 19.

THE RECENT MAGNETIC STORM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may perhaps interest some of your readers to learn that the magnetic storm which caused so much trouble in Europe and America on October 31st and November 1st was also felt on the circuits out here on exactly the same days. No disturbances to the ordinary working of the cables were, however, experienced, we using sending or receiving condensers. By reading all the accounts of the troubles experienced at home, it seems to me that matters might, in many cases, have been remedied by disconnecting the earth and using a return wire. Most people seem to think that we have especially to look out for these magnetic storms when the sun spots are passing the central part of the sun's disc. Is it not more probable that they are due to the breaking out of sun spots? This will, of course, explain the occurrence of disturbances when no particularly big spots are noticed on the near side of the sun, the outbreak having taken place on the far-off side.—Yours, &c. W. SCHÖNAV.

Great Northern Telegraph Co., Shanghai, Dec. 18.

"THURY" POWER-TRANSMISSION SYSTEM.

[TRANSLATION.]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It was with great pleasure that we read in your issue of January 1st the description of our power transmission between St. Maurice and Lausanne, but we were rather surprised to note that you think a transmission on the series continuous-current system to be "hopelessly out of date," and to be regarded rather as "a curiosity than as an example to be followed." Such a system cannot be out of date, because we alone, so far, have applied it to large power transmissions. On the contrary, we believe we can affirm that, since the experience, so conclusive, of the town of Lausanne, it is more up to date than ever. In fact, since the day of putting the installation into service in July, 1902, until this day, the transmission *has not been interrupted one hour* for reasons of failure of the electric plant, while the secondary distribution, which is carried out with alternating currents at a pressure of 3,000 volts only, has had to be stopped several times on account of failures of the transformers or of the line.

We beg to draw your attention also to the fact that the town of Lausanne decided to adopt our system only after a profound study. The town had the choice of two projects, one with three-phase current, the other on the series continuous-current system. These projects were submitted to five experts, chosen amongst the best qualified engineer specialists, and this is their conclusion:—

The experts, after having studied the projects for the power transmission from St. Maurice to Lausanne by continuous and three-phase current, do not hesitate in recommending the series continuous-current system, carried out in accordance with the contract entered into with the St. Maurice power undertaking. This decision was dictated to them especially by reasons of the security of the working and considerations regarding the regulation of the light, and was, moreover, influenced by the economy of construction."

We do not want to abuse the hospitality of your esteemed journal by setting forth the great advantages which the series continuous-current system possesses—*for large power transmissions and for long distances*—over alternating current systems, especially since the experiences made at St. Maurice have shown that the earth may be used as the return conductor. We may add, however, that in the case of Lausanne, the alternating current project was about 1,000,000fr. dearer than the one based on the series continuous-current system, and that, since then, the large transmission schemes which are being studied at present in France provide for the use of the series continuous-current system.

We do not doubt that if you would do us the honour of visiting our installation in St. Maurice you would speedily recognise your error.—Yours, &c.,

COMPAGNIE DE L'INDUSTRIE ELECTRIQUE.

Geneva, Jan. 12.

PARLIAMENTARY INTELLIGENCE.

On Saturday last, January 16, the time expired for depositing memorials alleging non-compliance with standing orders in respect of private and local bills. Since then private bill examiners have sat daily to take proof of the compliance with Standing Orders. Among others, the following measures have been passed as having complied with the Standing Orders:—Lincolnshire and Yorkshire Electric Power, Baker Street and Waterloo Railway, Charing Cross, Euston and Hampstead Railway, North and South Woolwich Electric Railway, St. Marylebone Electric Lighting, Middlesbrough, Stockton and Thornaby Tramways, Tyneside Tramways, Metropolitan District Railway, and the Lancashire Electric Power Bill.

The London County Council Tramways Bill was petitioned against by the Holborn Borough Council and Messrs. Shoolbred with respect to the proposed tramway down Tottenham Court-road, on the ground that the requisite consent of the petitioners had not been obtained. Consequently the bill was referred to the Standing Orders Committee for decision on this point.

The American Institute of Electrical Engineers.—The *Electrical World* of New York announces that in order to celebrate the twenty-fifth anniversary of the introduction and commercial development of the incandescent lamp, the friends and associates of Mr. Thomas A. Edison have taken steps to found a medal which will be entrusted to the American Institute of Electrical Engineers, and which it is proposed to award annually to graduating students in electrical engineering. It is proposed that the medal shall be awarded each year to the graduating student who shall present the best thesis on some original subject, from the universities and colleges of the United States and Canada which have regular courses in electrical engineering.

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LEGAL INTELLIGENCE.

Knight v. Isle of Wight Electric Light and Power Co.

In the Chancery Division on Wednesday, Mr. Justice Joyce delivered his reserved judgment in this case, which was for an injunction to restrain the defendant company from committing a nuisance by the working of their electricity works at Ryde, Isle of Wight. The facts were reported in our issues of Dec. 4, 11 and 18.

In the course of his judgment Mr. Justice JOYCE said that in 1899 Ryde Corporation obtained a provisional order authorising them to supply electric energy within the borough. Clause 69 of the order provided that nothing in the order should exonerate the undertakers from any indictment, action or other proceeding for nuisance in the event of any nuisance being caused or permitted by them. Subsequently the Corporation entered into arrangements with defendants for the erection, maintenance and working of a generating station within the borough, and defendants in the early part of 1903 acquired as a site for the proposed works a piece of land adjoining the garden of plaintiff's house. The engines were driven by gas produced on the premises by the Dowson process. One of the terms under which defendants held their site precluded them from erecting a tall chimney shaft thereon. The formal opening of the works as completed, or supposed to be completed, took place with some kind of municipal ceremony on Oct. 1, 1903, and from that date, he supposed, if not before, the works had been supplying electric energy. It was hoped by defendants, and it was to be expected, that the demand would constantly and greatly increase, and that, consequently, from time to time, additions to and extensions of the plant and machinery would have to be made. Before the formal opening, the manufacture of gas for working the engines and machinery generally had been in operation, and in particular on one occasion in September, for a period of nine hours, the engines and dynamo working without intermission. Plaintiff complained of serious annoyance to the inmates of her establishment by noise, vibration and offensive smells produced by the operations at defendants' works, and she instituted an action on Sept. 29, claiming an injunction and damages in respect of the alleged nuisance. A large body of evidence was adduced before him at the trial, and, to his mind, the result of it had been that, having regard to the positive testimony of plaintiff and her witnesses, whose veracity and substantial accuracy he saw no reason to doubt, and the facts admitted by some of defendants' witnesses, and having regard also to the correspondence and pleadings and arguments addressed to him by counsel for defendants, he considered it to have been almost virtually admitted, and at all events to have been sufficienily proved before him that at various times during September, and for a not inconsiderable period afterwards, the works of defendants were so carried on as, by noise, offensive smell and in some degree vibration, to occasion serious interference with the ordinary comfort of plaintiff and the inmates of her house and the carrying on of her business. The annoyances were not, in his opinion, trivial, or of a kind to be expected from any ordinary and reasonable use of the land acquired by defendants, nor were they by any means of such a kind as would be complained of only by unreasonable and fastidious persons. No doubt it was the fact that since the commencement of the action defendants had, by the adoption of various expedients known to mechanical engineers and men of science, and perhaps under the pressure of these proceedings, by measures of a special character, greatly diminished the intensity and frequency of the annoyances complained of. The engines and machinery were not now working later than 11 p.m. There was, he thought, still reason for further improvement at the cost of further expenditure, and the most skilful and careful management were necessary to prevent the nuisance complained of from constantly recurring. At times there was no annoyance to complain of. Still, at the date of the trial such an annoyance had repeatedly and constantly recurred. Even then the works were not in such perfect order, if such perfection were obtainable, as to remove altogether plaintiff's just grounds of complaint. The engines did not do their work to the satisfaction of defendants themselves, and the workmen of the firm which erected them had still to be in attendance. He held that repeated and not merely momentary annoyances caused to plaintiff did amount to an actionable nuisance unless defendants could make out they were, in point of law, justified in causing such an interference with the comfort of plaintiff's premises. Defendants contended that they were to be so excused, and relied upon the judgment of Lord Justice Vaughan Williams in "Harrison *v.* the Southwark and Vauxhall Water Co." After reading the portion relied upon his Lordship said it must be observed that the annoyance or nuisance complained of in the present case did not arise from acts of the kind referred to in the passage he had read from Lord Justice Vaughan Williams' judgment. The plaintiff had submitted to the inconvenience, if any, that arose from the mere construction of the defendants' works. What she complained of was what she had suffered and was from time to time suffering from the working of the generating station and the works there carried on, and which would be continued to be carried. That he held not to be an ordinary user of defendants' property, or in any sense reasonable if serious annoyance were thereby occasioned to the occupiers of the adjoining house and gardens. It was also urged that the annoyance was only temporary and occasional, but it must be borne in mind that what was being done here was not, in his opinion, an ordinary user of defendants' land. Defendants did not allege, nor had it been shown, that those works could have been established and set permanently in operation without causing a nuisance if necessary and reasonable precautions had been taken in the first instance. He held that the acts complained of had from time to time and frequently up to the trial materially interfered with the ordinary and comfortable existence of the plaintiff in her house; and, secondly, that those acts were such that, having regard to the circumstances and surroundings of the defendants' property, were in excess of the natural and ordinary use and enjoyment of her property. There must be an injunction during the continuance of plaintiff's lease restraining defendant company, their directors, servants and agents from using or working or causing or permitting to be used or worked in or upon the generating station and their works adjacent to plaintiff's gardens any engines, dynamos or other machinery, and from so carrying on the manufacture of gas, or any other process as by the production of noise, obnoxious or offensive smells, vibration or otherwise, to cause a nuisance to plaintiff.

His Lordship granted an inquiry as to damages and reserved the cost of the inquiry. He also directed that defendants should pay the costs of the action. On the application of Mr. Younger, K.C., suspended the operation of the injunction for six weeks.

Lloyd's Packing Warehouse Limited v. Veritys Limited.

On Friday last, in London, Mr. Justice Jelf resumed the hearing of this case, which commenced at Manchester and was reported in our issue of Dec. 4 (p. 264). The plaintiffs' case was that by letters which passed between the parties from Oct., 1901, to Jan., 1902, plaintiffs agreed to buy and defendants to supply certain electrical generating plant for £1,187. It was a condition of the contract that the plant should be capable of dealing with the maximum load required by plaintiffs for driving the machinery installed, or to be installed, at their works. The power was to be produced at a cost not exceeding 1d. per unit of electrical energy per hour. The plant was supplied and plaintiffs paid £890. 15s. on account. They alleged that the plant was not in accordance with the conditions and was not capable of dealing with the maximum load and would not produce sufficient power to satisfactorily run their motors and plant. They therefore rejected the plant, and asked defendants to remove it. Plaintiffs claimed the return of the money paid, and also asked for damages for increased cost of plant and production.

The defence was a denial that defendants agreed to the conditions alleged. Defendants said it was an express condition that the plant should be capable of producing 51kw. from the dynamos, and that this condition was fulfilled. They denied that plaintiff's made known to them that the plant was needed to produce sufficient power to satisfactorily run the motors, and they counter-claimed for extra work and materials supplied.

Mr. C. H. WORDINGHAM, said he was called in by plaintiff company at the end of 1902, in consequence of the generating plant supplied by defendants not working satisfactorily. He found no trace of negligent use of the motors by plaintiffs' workmen. With a number of machines performing different cycles of work in different periods they would, of course, get periods of heavy load on different machines, sometimes by synchronising and sometimes not. If they did not synchronise the tendency would be to equalise the load, and when they did synchronise the irregularity of the load on an individual machine would be greater. In the report which he made following his inspection he criticised the average which Messrs. Verity adopted as the standard load. A gas engine was not capable of working at its full horse-power continuously and efficiently. If they attempted to work a gas engine of the type of plaintiffs' continuously at its full power, that was to say, exploding every cycle, it would become too hot. It should miss once in every seven or eight cycles. When the full possible horse-power was 100 it should not be worked above 75.

The hearing was again adjourned and the judge hoped the case would be finished at Manchester.

Wilson v. Easton & Co. (Ltd.).

In the Chancery Division on Saturday, Mr. Justice Byrne heard a motion for judgment in default of defence in a debenture-holders' action. Counsel said the company was incorporated in December, 1900, to take over the business of Easton, Anderson and Goolden (Ltd.) electrical and general engineers. The security became enforceable amongst other events on winding-up, and the company had gone into liquidation. Mr. Justice Byrne made the order, and directed the usual inquiries, and continued the receiver (who had been appointed as manager) until March 25.

Dennis & Co. v. Glover.

In the City of London Court on Monday, Messrs. W. F. Dennis & Co. sued defendant for £19 for the conversion of goods. It appeared that plaintiffs were robbed of goods, some of which were afterwards bought by defendant, who subsequently re-sold them to another firm. Defendant was thus liable for conversion, although he had acted bona fide and had paid the ordinary price. It was submitted for defendant that there had been no demand for the return of the goods and that there had been no conversion.

Judge Rentoul found for plaintiffs and costs.

Prepayment Meters.

Three summonses were heard by Mr. Curtis Bennett at Marylebone (London) Police Court on Friday last. The summonses were issued at the instance of the Gas Light and Coke Co. against workmen living at Westbourne Park and Kilburn for the recovery of 10s. 2d., 7s. 11d. and 4s. 8d. respectively for gas supplied through automatic meters. It appeared that in two of the cases the money was collected by a sham

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collector, who represented himself as in the employ of the company, but it was urged that the defendants were, nevertheless, responsible, according to the terms of their agreement.

The Magistrate thought it was very hard upon defendants, but held that under the agreement they had signed they were clearly responsible for the safe custody of the money in the meter until the company collected it. He made orders for payment, with 3s. costs.

In the third case, the meter had broken into and the contents stolen, and a similar order was made.

National Telephone Co. v. Samuel.

This case came before Mr. Justice Wills and Mr. Justice Kennedy on Monday, on an appeal by plaintiffs against a decision of the deputy-judge of Marylebone County Court who had entered judgment for defendant on the finding of a jury. Particulars appeared in *The Electrician* for July 17, p. 553. It was originally an action brought by plaintiffs against defendant, to recover a year's rent of a telephone due in January, 1903, and under the usual agreement, at a rental of £10. 5s. a year, payable in advance, for five years. This agreement provided that the company should maintain the telephone in good working order. For the first two years all went well, but in 1903 defendant refused to pay, and the company took proceedings against him in the County Court. The defence was that the efficient service was not maintained as agreed, and he claimed that he had received no consideration for the agreement. As plaintiffs had failed to perform their part, he asked that it might be rescinded. The jury found for defendant on all points, and the Judge made an order rescinding the contract.

It was contended that the judgment was wrong, as it had not been shown that there was total failure of the service. In order to justify his decision there would have to be a finding of the jury not only that the company had failed to keep the instrument in good working order, and to supply an efficient service, but that they had acted so as to show an intention to repudiate or abandon or refuse to perform the contract. That was not, however, suggested.

Mr. NIELD, for defendant, urged that the judgment be affirmed.

In giving judgment, Mr. Justice WILLS said that he did not think a jury would hesitate to find that a service that had to be remedied over and over again in 1902, and which broke down altogether at last, was an inefficient one. He thought the County Court Judge was right in rescinding the contract.

Mr. Justice KENNEDY agreed, and the appeal was dismissed, with costs. Leave to further appeal was refused.

Watson v. Corporation of Sunderland.

In the Divisional Court, before Justices Wills and Kennedy, yesterday, defendants appealed from a judgment of the judge at the Sunderland County Court. It appeared that plaintiff, while travelling on a Corporation electric tramcar, received an electric shock from an overhead wire, which fell upon her, and she had obtained a verdict and judgment for £25 as damages for her personal injuries. At the trial defendants submitted that there was no evidence of negligence on their part to go to the jury, but the judge ruled otherwise. Evidence was given that the tramways had been inspected and approved by the Board of Trade, that there was a proper weekly inspection by Corporation employés and that the breaking of the wire had not occurred through negligence. The jury, however, found that there was negligence, and returned a verdict for plaintiff.

For appellants, Mr. C. A. RUSSELL, K.C., submitted that the judge ought not to have allowed the case to go to the jury, and that, even if there was a case, the evidence for defendants rebutted any suggestion of negligence, and that judgment should have been entered for defendants. He also submitted that the Judge should have told the jury specifically what it was in respect of which it could be said the Corporation had failed in their duty.

For plaintiff Mr. W. G. CLAY contended that, having made out a prima facie case, no such evidence was given in rebuttal as would make it the duty of the judge to practically direct a verdict for defendants. The explanations given by defendants of the accident left the cause of it a mystery, and the jury were entitled to come to the conclusion they had.

In dismissing the appeal, Mr. Justice WILLS said it was an accident as to which one might, in popular language, say that if everything had been right it had no business to have happened. These overhead wires were not expected to tumble down of themselves, and if there was to be a liability to that kind of accident Parliament would be very slow to grant the powers which they had granted; therefore it seemed to him it was a case in which, from the accident, if nothing else occurred, a very reasonable conclusion would be that there must have been something wrong in the construction of the wire, or in the way in which it was joined, or that there was some mismanagement of it in some way or another. Therefore, it was quite clear that there was a case to go to the jury. What happened before the case was finally left to the jury was that the defendants were wholly unable to suggest any explanation of how the accident happened. Under these circumstances they satisfied the tribunal not merely that they were unable to explain it, but that such an accident could happen without there being any explanation at all. The jury were justified in saying that no explanation was no explanation, and they thought the fact that the accident happened was quite inconsistent with due care having been exercised. The summing up of the learned judge was fair and impartial.

Mr. Justice KENNEDY concurred, and the appeal was dismissed with costs, leave to further appeal being refused.

ELECTRIC LIGHTING IN MARYLEBONE.

RATEPAYERS' MEETING, JAN. 19.

A crowded meeting of parochial electors was held in the Queen's Hall, Langham-place, W., on Tuesday evening, to decide upon the promotion or otherwise of the bill proposed by the Marylebone Borough Council to be presented to Parliament to amend the Council's Electric Lighting Order Confimation Act (No. 1), 1901. At the doors a printed statement was circulated prepared by Mr. Arthur Wright the Council's consulting electrical engineer. This was referred to in the course of the proceedings.

The MAYOR (Rev. Russell Wakefield) presided, and in opening the proceedings gave a detailed history of the facts leading up to the present position of affairs which (he said) would help the electors of the borough to come to a decision in the matter before them. There was no question as to the fairness of the award of the arbitrator who had inquired into this matter. He did not intend to defend either the award or the arbitration, but would leave that to those who were responsible for the purchase. There were two courses open to the meeting—one was to accept the bill unconditionally, and they would then have a great municipal undertaking on their hands, or they must reject the bill and let the consequences be what they may. The promoters of the bill claimed that the undertaking in the hands of the Council (even at the cost at which they had to obtain it) would pay. There was expert opinion of a very important character in favour of the carrying out of the Council's scheme. Against the idea, there was, first of all, the objections to municipal trading altogether. In many respects he held with this view, but it was rather late in the day to deal with the matter now. At any rate, the bill could not be initiated without the ratepayers' consent. Secondly, there was the doubt as to borough councils being the best bodies to carry on business undertakings. On this point it might be said that there were certain members of the Marylebone Council who conducted or managed businesses as big as the Metropolitan Electric Supply Co. The promotion of the bill did not necessarily mean the taking over of the undertaking, but it was felt that it would help the Council in negotiating with the company. These negotiations, however, so far had certainly been a failure. If the bill was rejected, would the position be an immoral one? For the Council it might be; but for that meeting he could not say that it would be. It was a very serious responsibi ity, however, for the award was made and the money had to be found. It was conceivable that a Court of Justice would say that the money would have to be paid out of five, six or seven years' rates. The matter was entirely in the hands of the ratepayers, and he was pleased to see so enormous an attendance. Ratepayers had shown but little interest hitherto in the affairs of their Council and that body was inclined to sleep.

Mr. E. R. DEBENHAM (chairman of the Electric Supply committee) explained why it was necessary to promote the new bill, and hoped the electors would consider the matter free from all prejudices. In the arbitration proceedings the company's claim was nearly £3,000,000 and this had been reduced to £1,212,000. In 1900 the Council had come to an agreement to purchase the Metropolitan Company's undertaking in the borough for £910,000, and they were blamed for not doing so. He could not himself see much difference between the original agreed amount and the amount of the award, taking into consideration the increased profits of the company from their lighting in the borough. But there was an Act of Parliament which laid it down explicity that the Council must buy and that the company must sell. The purchase price had been settled by arbitration, and had been confirmed by the High Court. The only result, if the electors threw out the bill, was perfectly clear from the judgment of Mr. Justice Buckley—that there would be a mandamus to the company sequestrating the rates for the whole sum due. In one form or another the amount would have to be paid. The chief object of promoting the bill now before them was that the Electric Supply committee considered this was their only chance of coming to an agreement with the company. There were those who would reject the bill and trust to the mercy of the Courts. Well, they had had an example of the mercy of the Courts, and had been ordered to pay the company £60,000 forthwith. Mr. Debenham then explained Mr. Wright's figures and estimates, and outlined generally the scheme of the Electric Supply committee. Every dependence, he said, could be placed upon these estimates. He had always been convinced that, by paying a certain premium for insurance, they could obtain a guarantee of the correctness of Mr. Wright's figures, and in this connection he desired to inform the ratepayers that the British Westinghouse Co., of Norfolk-street, W.C., had indicated that they would be prepared to put up the necessary station, instal the whole system in fact, and guarantee that the undertaking would produce current at the price stated by Mr. Wright. Further, the General Electric Co., of Queen Victoria-stre t, E.C. had written undertaking, if the Council carried through their bill, and subject to their receiving the order for the plan and materials required, to take over the management of the electric lighting undertaking for six years, and would undertake to pay all interest and sinking fund charges, &c., on the condition that, if the losses had not been recouped to the company at the end of six years the arrangement should be continued for 10 years. Beyond this Mr. Wright had expressed his willingness to forego his commission and to take in lieu thereof one-sixth of the profits of the undertaking. Mr. Debenham then formally moved—

"That this meeting of electors of the Metropolitan Borough of St. Marylebone are in favour of the promotion of the St. Marylebone Electric Lighting Bill, 1904."

The EX-MAYOR (Ald. E. R. Elgood) seconded, and said he did so because he could see no other possible way out of the difficulty with which they were faced.

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Mr. HERBERT GIBBS disagreed with Mr. Debenham. A compromise with the company should be made. It was said that, at the price demanded, the undertaking could be worked with a profit. Mr. Wright's first calculation was on the basis that the money could be borrowed at 3¼ per cent. Now that it was found that the money could not be obtained under 3¾ per cent. a fresh set of figures was put forward which actually showed a greater profit than the first estimate. It was unlikely that the repayment of the whole sum would be allowed to be spread over 42 years. The scheme was impossible and compromise was rejected. He recommended the rejection of the motion. If the ratepayers rejected this bill, a bill would be immediately promoted by him and his friends to sweep away the whole network of difficulties in which the borough council had entrapped them. The case from the ratepayers' point of view had never been put before Parliament or the Courts. They would say that, as the project was entered into without the ratepayers' consent or knowledge, it was an injustice, and that such injustice was intolerable.

Col. Maude supported the rejection of the bill, as did also Mr. Edwin White.

At this stage no further hearing for the speakers could be secured, and the mayor put the motion to the meeting, which, on a show of hands, was declared rejected.

BOROUGH COUNCIL MEETING, JAN. 21.

At the meeting of the Borough Council last evening, among the payments on the agenda paper to be passed by the Council was the item of £60,000 ordered by Mr. Justice Buckley (in his recent judgment in the action brought by the Metropolitan Electric Supply Co. for specific performance by the Council of their obligations under the famous arbitration award) to be paid by Jan. 31.

Mr. E. WHITE opposed the payment on the ground that the steps taken by the Council to obtain the 1901 bill were illegal. The ratepayers were (he said) no parties to the electric lighting undertaking. He was convinced the whole of the proceedings in regard to this matter were *ultra vires*.

Ald. DENNIS supported Mr. White's action and created a sensation in adopting this course. He did not, he said, support the proposal on the same grounds as Mr. White, but because he felt that the meeting on Tuesday clearly indicated that the ratepayers were determined that the matter should not be proceeded with, let the consequences be what they may.

Ald. ANGLIM supported Ald. Dennis.

Mr. E. R. DEBENHAM said it would be a very serious matter if the Council refused to pay the amount in accordance with the order of the Court. There was no alternative but to pay the money on the date mentioned.

Councillor SANDS supported Mr. Debenham.

A lengthy discussion ensued and ultimately it was decided unanimously that "The consideration of the payment be adjourned till Thursday (28th inst.), and that the mayor, in the meantime, approach the company on the question of the postponement of the payment of the £60,000 until after a poll of the ratepayers."

The meeting was then made special to consider and determine upon the expediency of confirming the promotion of the proposed bill in accordance with the resolution passed at the meeting of the Council on Oct. 29, 1903, but by general consent this matter was adjourned to a special meeting to be held three weeks hence.

Mr. E. R. DEBENHAM then said it was the logical result of the resolution with regard to the payment of the £60,000 that a poll of the ratepayers with regard to the promotion of the Electric Lighting Bill should be taken, and he therefore formally moved that the poll be taken in accordance with the Act of Parliament.

This was opposed by Councillors Lee-Smith, E. White and Sir Edwin Galsworthy, but was carried by 39 to 13 votes, and it was decided to proceed forthwith to take a poll.

Mr. E. R. DEBENHAM then moved as an urgent motion: "That the Electric Supply committee be empowered to enter into a provisional agreement with the General Electric Co. or with any other firm of standing, and that proper legal advisers be employed." The point of this proposal (he said) was to get the Council a guarantee against any loss in the scheme outlined by Mr. Arthur Wright. The company had (he understood) submitted Mr. Wright's estimates to Mr. E. Manville, a consulting engineer of high standing in the electrical profession, and it was on that gentleman's favourable report that the company made their offer. He (Mr. Debenham) did not suggest that the matter be definitely decided, but asked that the committee be empowered to enter into a provisional agreement in order that it might be put before the ratepayers before the poll. Mr. Debenham intimated that the Electrical Co., Messrs. Siemens Brothers & Co., and Messrs. Dick, Kerr & Co. would also be approached with a view to their submitting a scheme which the committee could consider.

Sir EDWIN GALSWORTHY said the letter of the General Electric Co. needed careful consideration. He therefore moved that the debate be adjourned to a special meeting on Monday next (25th inst.), and this was carried practially unanimously.

COMBINATION OF AMERICAN WIRELESS TELEGRAPH INTERESTS.—The "Financial News" states that the De Forest Wireless Telegraph Co., a consolidation of the De Forest Wireless Telegraph Co. and the International Wireless Telegraph Co., has been incorporated under the laws of the State of Maine with a capital stock of $15,000,000, of which $3,500,000 is 7 per cent. cumulative preferred and $11,500,000 common stock.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Leicester Tramways committee require an assistant electrical and mechanical station engineer, a power station shift engineer, switchboard attendants, engine drivers, engine fitter and spare engine driver, foreman for maintaining and repairing overhead work, linesmen for overhead work, chief motor inspector, motor inspectors and motor instructors. Further particulars are set out in an advertisement, and applications, addressed to the chairman of the committee at the offices of the borough engineer, Mr. E. George Mawbey, M.Inst.C.E., Town Hall, Leicester, by Feb. 2.

Tyne Improvement Commissioners require an electrical superintendent at their Northumberland and Albert Edward Docks and Staiths. Salary £150 per annum. Applications to the assistant secretary (Mr. J. McD. Manson) by Jan. 30. See advertisement.

An assistant lecturer and senior demonstrator and electrical engineer is required for the Royal Technical Institute, Salford. Salary £130 per annum. Application to town clerk (Mr. L. C. Evans), Town Hall, Salford, by 27th inst. See also advertisement.

A junior English master capable of teaching evening classes in theoretical and practical physics is required immediately for the Merchant Venturers' Technical College, Bristol. Applications to the Registrar by January 27. See advertisement.

A motor and meter inspector is wanted, conversant with direct-current motors, Hookham and prepayment meters. Applications to city electrical engineer (Mr. C. A. Midgley), 18, Collier Gate, York. See advertisement.

Bexley Electric Lighting and Traction committee require an engineer and manager of the Council's electric lighting and tramways undertakings. Salary £300 per annum. Applications to Mr. Thos. G. Baynes, Council Offices, Bexley Heath, Kent, by noon 23rd inst.

Wimbledon Urban District Council have a vacancy for a mains superintendent. Salary £125, rising by annual increments of £25 to £175 per annum. Applications to chief electrical engineer, Mr. H. Tomlinson-Lee, by noon 25th inst.

Two assistant superintendents of telegraphs are required for the Government of Ceylon. Salary R.3,500, rising to R.5,000 by biennial increments of R.500, with certain travelling allowances. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to Jan. 30.

A principal is required for Swindon and North Wilts Technical School, Swindon. Applications by 30th inst.

Stockport Corporation require a manager and a senior clerk for their tramways. Applications by 25th inst.

Mr. T. Robert Smith, A.M.I.E.E., chief electrical and mechanical assistant to the borough engineer of Leicester, has been unanimously appointed by Leicester Tramways committee resident electrical engineer of the Corporation electric tramways, to take charge of the working and general repairs and maintenance of all completed electrical plant and equipment of the power station, car depots, overhead work, cars and feeder system. Salary £250, rising to £350 per annum. There were 129 applicants for the appointment. Mr. E. George Mawbey, M.Inst.C.E., is engineer-in-chief, and Mr. E. Manville, M.I.E.E., is consulting engineer for Leicester electric tramways.

Mr. W. Wyld, of Doncaster, has been appointed manager of the Birkenhead electric tramways at £450 per annum.

Mr. E. Briggs has been appointed clerk of works in connection with the electric light installation at Fulham-road workhouse of the St. George's (Hanover-square) Guardians.

Mr. A. A. Day, borough electrical engineer at Bolton, has also been appointed general manager of the electric tramways. Mr. C. C. Howard is traffic superintendent.

Aberfeldy (N.B.).—The Marquis of Breadalbane has been invited to support a scheme for supplying electricity to the burgh.

Basingstoke.—The ratepayers have rejected the Corporation's bill providing for "free" wiring of consumers' premises, &c.

Bermondsey (London).—The Council have decided to take legal proceedings to recover £3. 3s. from the Premier Electric Lamp Co. It appears that in October last the company sent a cheque for £3. 3s. for a specification and form of tender. The latter was returned and the company stopped payment of the cheque, explaining that when they applied for the form of tender they were under the impression that they were at liberty to quote for incandescent lamps only, and that when they found this was not the case they immediately returned the form of tender.

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Bexhill.—A poll of ratepayers is to be taken on the omnibus bill of the Corporation, which seeks powers to let motors on hire, to do wiring work, &c.

Boulder (W.A.).—The Municipality recently took over the electricity works from the contractors. The plant includes a 150kw. steam dynamo and two 130 H.P. boilers. Current is supplied on the continuous-current three-wire system, with a pressure of 460 volts between the outers.

Bridgnorth.—The District Council have lodged their objections to the Shropshire and Worcestershire Electric Power Co.'s application for an electric order for Bridgnorth.

Brixham.—The agreement with the Urban Electric Supply Co. for supply of electric current from their Dartmouth works to Brixham has been sealed.

Buenos Ayres.—La Capital Tramways Co. have obtained a concession for an extension of their lines from Parque Patricios to Puente Alsina.

The Municipal Council offer to grant a 55 years' concession to Buenos Ayres Grand National Tramways Co., with sanction to an extension, provided the company carry out their scheme for conversion to electric traction, and that the undertaking shall become the property of the municipality at the end of the term without pecuniary consideration.

Calais.—In the report of the directors of the Calais Tramways Co. for the past year it is stated that the company's application for an extension of the concession and the conversion of the lines to electric traction is still under consideration by the authorities in Paris,

Canada.—Southampton (Ontario) is provided with a water-power-driven electric lighting service, and in 1902 a charter was granted to the Huron and Ontario Railway Co. to build an electric railway, over 100 miles long, from Kinsar Drive, through Winterton, &c., to Toronto, but the promotors, while still negotiating, have not secured capitalists to take up the construction of the line. There is water-power available in this district from a watershed 1,000,000 acres in extent, and equivalent to 500 to 600 H.P. under a 12ft. head. The owners of the water-power works in the district are the Sampson Electric Light and Power Co.

At Annapolis Royal, Nova Scotia, with a population of 1,200, the municipality own a water-power electric generating plant, supplying current on the three-wire alternate-current system to 125 subscribers. A 200 H.P. Crocker turbine is installed. Supply commenced in March, 1903, and there is now the equivalent of 2,200 8 c.p. connections.

Canadian Electric Railways.—At the end of 1902 returns were received relating to 44 electric railroads in the Dominion of Canada, operating 421·39 miles of single track and 188·09 miles of double track. These lines earned gross in 1902 £1,374,000, the gross expenses being £829,000. The total capital paid up (including bonded debt) was £8,352,000. The miles run were 36,711,130, passengers carried 146,000,000. The rolling stock consisted of 1,895 motor cars and 326 trailers. The total employed staff on these 44 lines was numbered nearly 5,500.

Cardiff.—The report upon the cost of the electric lighting of a number of suburban streets was considered by the Lighting committee on Monday, and it was decided to adopt electric lighting in certain streets in which mains are already laid at an initial expenditure of £1,561. 12s. 6d. and an annual cost of £1,610. It has been decided to ask the Bute Estate authorities to grant permission for carrying electric lighting cables over their property.

Cardiff-Penarth Tramways.—The Board of Trade have dispensed with the consent of the local authorities to the promotion of this provisional electric tramway order.

Chester.—On Wednesday the Corporation decided to increase the salary of Mr. F. Thursfield to £550 per anuum, increasing by annual increments of £50 to £700.

Cheshunt.—The North Metropolitan Electrical Power Distribution Co. have replied to the Council's request for the insertion of a clause in their agreement providing for the laying of mains within 18 months that, owing to the present state of the money market and the political situation, it would not be prudent to undertake to do what the Council desired. The company would not guarantee to do this work under three years. Negotiations are proceeding.

Clacton-on-Sea.—The Council's provisional order has been extended for another year.

Coatbridge and Airdrie Tramways.—It is expected that this line will be opened for traffic the first week in February.

Devonport.—With regard to the note which appeared under this heading in our last issue, it should be mentioned that Mr. C. Chadwell is only consulting engineer for the electric tramways, and that the short line which is to be constructed will be executed by the Corporation themselves under Mr. Chadwell's supervision. Mr. Chadwell has purchased, in the name of the Corporation, the necessary materials, and has made arrangements for engaging the necessary labour.

Demerara (British Guiana).—Georgetown is lighted by electricity, and has an overhead electric tramway service of about 10 miles of track, these undertakings being owned by the Demerara Electric Co. (Ltd.).

The imports in 1902-3 of electric lighting plant and apparatus was valued at £4,360, of which only the odd £60 came from Great Britain, the balance being supplied by the United States.

The telephone service of British Guiana was reconstructed during 1903.

Dublin.—Arrangements have been approved by the Board of Works for supply by the corporation of electric current for nearly 3,000 lights in the State apartments at Dublin Castle.

Dunedin (N.Z.).—The new municipal electric tramways, equipped by Noyes Bros., Sydney, N.S.W., were opened last month.

Edinburgh.—At last week's meeting of the Corporation, Mr. Mackenzie, convener of the Electric Lighting committee, referred to his statement made at the previous meeting of the Corporation (see *The Electrician*, Jan. 1, p. 428), and said he desired to modify this statement, and to add that the objection to the use of iron tubing in house wiring was entirely confined to unscrewed tubes, and in no way applied to screwed tubes and other fittings.

Electric Train Lighting in Australia.—The New South Wales Railway Commissioners are experimenting with a new system of electric train lighting on the Melbourne expresses.

Electricity in Mining.—Electric lighting and haulage plant is being installed at Long Tunnel Extended mine, Walhalla, Victoria.

Fatal Accident.—An inquest was held by Dr. Danford Thomas, at Paddington, London, on Saturday into the death of Herbert Laurence Newton, aged 25, who died from injuries received by being run over on the Metropolitan Railway.

Deceased was an assistant electrical engineer to the British Insulated and Helsby Cables (Ltd.), who are laying a cable for the Metropolitan Railway Co. between Willesden and Neasden. On Tuesdry night last week he left Neasden station to see to some work in progress down the line, and a goods train passed. Directly afterwards the workmen heard cries for help. Deceased was found lying on the line badly injured, having been knocked down and run over by the train. He died two hours after admission to St. Mary's Hospital.

The driver of the train said if deceased had had a lamp he (witness) would have seen him and have been able to pull up. Other witnesses said it was usual for the railway authorities to provide workmen with a flagman, but this was not done on this occasion.

For the railway company it was urged that deceased had not given notice that the men would be engaged working late, or a flagman would have been provided.

The jury returned a verdict of accidental death, and added a rider recommending that in future a flagman or signalman should be engaged at night.

Fulham (London).—The Council have decided to institute proceedings against the National Electric Wiring Co. in connection with the claims arising out of the fatality at Fulham baths in 1902.

The electric lighting mains are to be extended to serve wharves and other premises in the neighbourhood of Crab Tree-lane, and a 200kw. sub-station is to be constructed and equipped, in the first instance, with 100kw. plant at an estimated cost of £950.

Glasgow.—A petition signed by 813 inhabitants of Milngavie has been presented to Glasgow Tramways committee to extend the Corporation tramway system to Milngavie. The Corporation have, however, decided not to proceed with this line as well as the projected route to Barrhead.

Hartlepool.—The public buildings were electrically lighted last week for the first time. The street electric lighting is to be inaugurated this week.

Heavitree.—An offer by the National Electric Construction Co. to erect electricity works and supply electrical energy for lighting and power in the district is under consideration by the Council.

Hornsey (London).—It is proposed to hold an exhibition of electrical fittings, apparatus, &c., between March 1 and 4.

Hull.—The Hedon-road tramway route was officially inspected on Tuesday.

Ilford.—The District Council's proposal to promote a bill for the extension of tramways, &c., has been defeated at a ratepayers' meeting.

Islington (London).—Last week some extensions of the low-tension distributing mains were authorised. It was also decided to proceed with the lighting of a portion of Grosvenor-road.

Kettering.—A towns meeting recently approved, with only two dissentients, the promotion of a bill by the District Council for further powers connected with electricity supply, &c.

Lampeter.—The Town Council have, owing to the complaints of the bad gas lighting, referred the matter of electric lighting to the Finance and General Purposes committee for report.

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Leeds.—In consequence of the adverse vote of the ratepayers at a meeting last week, the City Council have decided to take a poll in regard to their bill for consolidating their electric lighting and tramway orders, &c.

Leith.—Edinburgh Council have decided to petition against the Leith Corporation tramway provisional order.

Leyton.—The solicitors to the National Electrical Contractors' Association (Messrs. Turner & Co.) threaten to oppose the Council's omnibus bill unless certain clauses relating to the wiring of consumers' premises, &c., are withdrawn or modified. The matter has been referred to the Legal and Parliamentary committee.

In the discussion upon the subject, Councillor Golightly claimed that the Electric Light committee were as capable as anyone to carry out wiring work, and he hoped the committee would stick to the bill in its entirety.

Linlithgow.—Bathgate District committee of the County Council have adopted electric street lighting in the Uphall district.

Liverpool.—During 1903 the Corporation electric tramways carried 113,057,234 passengers, the receipts being £524,509, an increase of 3,721,649 passengers and £17,883 in receipts.

London County Council Tramways.—Lewisham Council have decided to contribute one-third of the cost of street widenings in connection with the proposed London County Council tramways from New Cross to Lee Green, from Greenwich to Catford, from Lordship-lane to Forest Hill and from Lewisham High-road to Forest Hill. Deptford Council will similarly contribute to the cost of widening Lewisham High-road to Forest Hill.

The new electric tramway from the Thames bridges to Greenwich were opened on Sunday last.

Maidstone.—The Corporation propose to wire the smaller houses in the district and to charge an extra ½d. per unit for electric current.

Manchester.—A poll, demanded by the local master carriers, will take place on 29th inst. on the proposed tramways bill of the Corporation.

Margam.—Six months' extension of time has been granted for carrying out the terms of the Council's provisional electric lighting order, obtained in 1898.

Motor Car Licences.—At West London Police Court on Tuesday Mr. W. Crowdus, an American gentleman residing at Barkston Gardens Hotel, Kensington, was summoned for keeping a carriage without a licence.

For the defence the point was raised that the carriage, which was an electric motor car designed by defendant and termed the "Crowdus" motor car, was not liable to duty because it was only a sample car. Defendant brought it from America for the sole purpose of selling the patents connected with it. A syndicate took the car for eight months with the option of purchasing the patent, but the syndicate, which took out a licence for the time that they used it, decided not to purchase. Meanwhile defendant had incurred certain expenses at the hotel, and he arranged with the landlord that the latter should hold the car as security for his hotel bill. Since then the only occasion on which Mr. Crowdus had "used" the car was for showing it for sale. It was submitted that the car was not "used" in the legal sense, but was in the same category as carriages kept for show by coachbuilders, and, further, that if anyone was the keeper or user of the car it was the landlord of the hotel. The magistrate (Mr. Rose) said the case was too full of doubt for decision against defendant, and the summons must be dismissed.

Municipal Telephony.—In reply to a statement that certain subscribers of the Glasgow Corporation telephone department had discontinued the service, the general manager (Mr. A. R. Bennett) emphatically denies the statement. The very converse of the statement is the fact (Mr. Bennett continues), as the Corporation telephone subscribers continue to increase at a very rapid rate, and practically no instruments are discontinued except in the cases of death, bankruptcy, or giving up business. A widespread organisation exists for the purpose of depreciating Corporation telephone enterprises, and so deterring other municipalities from touching them. This organisation floods the country with mendacious literature in the shape of pamphlets and circulars, mostly anonymous, and utilises the columns of the press freely under all sorts of signatures.

Hull Telephone committee have outbid the Post Office for a single line from Springhead station to Willerby reservoir. The work is to cost £120, and is to be carried out under the head of contingencies, as the amount has not been included in the recent loan. The rental was £15 per year for 10 years.

The charge for telephone second instruments to a subscriber has been fixed at 20s. for wall instruments and 25s. for table stands.

Musselburgh.—On the recommendation of the consulting engineer, Prof. Kennedy, Edinburgh Corporation has decided to allow the promoters of the Musselburgh tramways to adopt the G.B. surface-contact system.

Nernst Lamps.—The Electrical Co., 121-125, Charing Cross-road, London, W.C., send us the following copy of a letter received from Mr. E. E. Hoadley, borough electrical engineer, Maidstone, concerning Nernst lamps for street lighting:—

I have just received the figures for the life of the last 100 ½-ampere Nernst burners which we have used for street lighting, and I thought you would be pleased to know that the average life of this last 100, under street lighting conditions, works out at 598 hours.

The company's communication continues:—"We may mention that Mr. Hoadley is using a few hundred Nernst lamps for public street lighting, and the results are so satisfactory that large extensions are being made. Over 20 other towns in the kingdom have made experiments with Nernst lamps for street lighting, and the results in almost every instance have been highly satisfactory."

Northampton Institute.—Lord Kelvin will present the certificates and prizes at the annual distribution and conversazione of members and students at the Northampton Institute, Clerkenwell, London, E.C., on Friday, February 26.

Outrage.—The lad Schutz, who is charged with committing a dastardly outrage upon Mr. Willmot Ernest Lane, secretary of the Electric Lighting and Traction Co. of Australia, was on Tuesday, at the Mansion House, London, committed for trial.

Perth.—Messrs. Kincaid, Waller, Manville and Dawson have been appointed consulting tramway engineers.

Presentation.—The Sheffield staff of the National Telephone Co. have presented a tea service to Mrs. Northam, and an umbrella and handbag to Mr. Northam, upon his retirement after 20 years' service. The district manager, Mr. Bennett made the presentation.

Provisional Order Transfer.—Chichester Corporation give notice of intention to transfer their powers, duties, and liabilities under their 1898 electric lighting order to the Chichester and District Electric Supply Co. (Ltd.) for £500. The Council reserve the right to purchase at 14, 21, 28 or 35 years at its fair market value, or at any other time on terms to be settled by arbitration should the company fail to work the undertaking as required by the Electric Lighting Acts or the Chichester order.

Romford.—Owing to opposition the Empire Electric Light and Power Co. have withdrawn their bill for the construction of additional tramways.

Shoreditch (London).—In reply to a communication from the London County Council as to the formation of a reserve or renewal fund in connection with the electricity undertaking, the Borough Council have intimated that steps are being taken to form such a fund, but that up to the present renewals to plant, &c., have been paid for out of revenue.

Stafford.—An inquiry has been held here into the application of the Corporation for permission to borrow £6,600 for electric lighting extensions, including the laying of mains in the Castle Church district outside the borough. Opposition was offered on the ground that there was not a sufficient guarantee that the supply of electric current outside the borough would not be a burden upon ratepayers within the borough.

Stepney (London)—In a lengthy report by the town clerk (Mr. G. W. Clarke) on the East London and Lower Thames Power Bill it is stated that:—

The promoters are seeking for powers which are in conflict with the principle laid down in the Electric Lighting Acts of 1882 and 1888, and that, even in regard to bulk supply, it was doubtful, having regard to the progress made in connection with the Stepney electricity undertaking, whether it would ever be necessary to have to recourse to the assistance afforded by such supply; but if such were the case, the Charing Cross and City Electric Co. are already in a position to give supply in bulk by means of their mains through the borough. £189,564 had already been expended on the Stepney electricity undertaking, and for the year ended March 31, 1903, the net profit was £5,145; 1,759,349 units of electricity were sold, including 1,321,353 to private consumers.

It is pointed out that sections 2 and 3 of the 1888 Electric Lighting Act (as to purchase of electricity supply undertakings) are excluded from the company's bill, and it is submitted that an endeavour should be made to get inserted in the bill provisions similar to those in the London County Council (Electric Supply) Bill, 1903. Objection is further made to clause 42, which would enable the proposed company to distribute electricity in the borough for lighting and power.

The Electric Lighting committee and the Finance committee have, in consequence of this report, decided to petition against the bill.

Sunbury.—The Council recently sealed the agreement with Edmundson's Electricity Corporation for a supply of electric current

Sunderland.—Agreements have been entered into between the Corporation and Messrs. S. P. Austin & Son and R. C. Thompson & Sons (shipbuilders) for supply of electric current to these firms for power for three years, on condition that pontoon or dock motors are not used, except by consent of the borough electrical engineer, during Mondays, Tuesdays, Thursdays and Fridays, between 4 p.m. and 7 p.m. from Nov. 1 to March 1 in each year.

Land has been acquired at Hendon for a sub-station.

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Thames Ditton.—The Council will oppose the application of Edmundson's Electricity Corporation for an electric lighting order on the ground that its granting would be prejudicial to the Council, that there is no demand for electric current, and that powers to supply part of the district are held by the London United Tramways (Ltd.).

Torquay.—Friction has arisen between the Council and the Dolter Electric Traction Co. in regard to Sunday traffic on their proposed electric tramways, and a conference is to be held between the parties.

Venice.—The utilisation of the waters of the River Celina for the generation of electrical energy has been taken in hand by a company for some two years past, and has resulted in an improved supply of electricity being available in Venice. This improvement has led to a considerably increased demand for apparatus, fittings, accessories, material, &c., used in electrical installation work in Venice and neighbourhood.

Wallasey.—A poll is to be taken on 30th inst. upon the Council's Tramways and Improvement Bill.

Wandsworth.—The County of London Electric Lighting Co. notify the Council that they cannot accept the conditions of the Council attached to their approval of the laying of electric conduits on the Heaver Estate, Balham, including (amongst others) that the whole width of the tar-paved footpaths shall be re-topped. The Council have decided to adhere to their conditions.

Woolwich (London).—This Borough Council obtained Parliamentary authority in 1903 to undertake wiring and electrical installation work of all kinds, and in January, 1904, decided to take advantage of this authority. The old scheme of assisted wiring was not a success and has been abandoned, and arrangements have been made by which consumers can have their premises wired on easy terms—repayment of the cost being made by equal quarterly payments spread over from one to eight years, according to the size of the installation and the standing of the consumer. The scale is generally as follows :—Rising up to £20 payment is spread over six years, £20 to £25 seven years, £25 to £30 eight years, more extensive installations on terms to be agreed. Motors and arc lamps are let out on hire at a rental of about 10 per cent. of the total cost of the installation. These terms apply to the Woolwich, Eltham and Plumstead undertakings of the Borough Council. The price of electric current for lighting in the district is 4d. per unit, less 5 per cent.

Yarmouth-Gorleston Tramways.—Negotiations are proceeding for the transfer to Yarmouth Corporation of the horse tramways of the Yarmouth and Gorleston Tramways Co. Last week the Corporation considered a report in which the borough surveyor urged the advantages of overhead as opposed to sub-aqueous cables for conveying current across the river for working the lines after their purchase and conversion to electric traction. The consulting engineers (Messrs. Preece and Cardew) also favour the overhead method.

E.E. (R.E.) Volunteers' Concert.—A Bohemian concert will be given at the headquarters of the Electrical Engineers (R.E.) Volunteers on Saturday, Jan. 30, at 8 p.m., under the presidency of the officer commanding. Tickets can be obtained from the Sergeant-Major at Headquarters, Regency-street, London, S.W., or from Second-Lieut. E. Graham Sheppard, hon. secretary of the Entertainments committee.

Electro-Harmonic Society.—A smoking concert will be held this evening in the Crown Room, Holborn Restaurant, London, W.C., at 8 o'clock. Mr. Mervyn O'Gorman will preside.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

South Shields Corporation invite offers for the lease of certain tramways authorised by the South Shields Corporation Act, 1903, to be constructed in the borough, together with tramway stables and depot. Further particulars are set out in an advertisement. A plan of the borough and full particulars and conditions of tender can be obtained from the town clerk (Mr. J. Moore Hayton), Court-buildings, South Shields, to whom tenders by March 12.

The Scottish Office of the *May-Oatway Fire Appliances (Ltd.)*, invite tenders for wiring installations of May-Oatway compensated automatic fire alarms for direct connection with the fire brigades at Govan and Dundee. Further particulars from the managing director, 49, Queen-street, Glasgow. Tenders by Jan. 27. See also advertisement.

West Ham Corporation invite tenders for various engine-room stores, cable, recording wattmeters, house cutout boxes, transformers, incandescent lamps and coal. Further particulars are given in an advertisement, and tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E., by 4 p.m. Feb. 11.

Canterbury Drainage committee invite tenders for the supply and erection of four motor-driven centrifugal pumps for lifting sewage at their sewage farm. Specifications from the city electrical engineer (Mr. C. A. Blascheck), and tenders to the town clerk (Mr. Henry Fielding) by 10 a.m. Feb. 8. See advertisement.

Islington (London) Borough Council invite tenders for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple-core high-tension feeders and low-tension distributors, and pilot cable with feeding junction and service boxes. Specifications, &c., from the borough electrical engineer (Mr. Albert Gay), 50, Eden-grove, Holloway, N., after Feb. 1. Tenders to the town clerk (Mr. Wm. F. Dewey) by noon Feb. 24. See also advertisement.

Hastings Electricity committee invite offers from manufacturers and others with respect to the supply of alternating motors to consumers on hire-purchase agreements. Proposals are to be sent to the town clerk (Mr. Ben. F. Meadows) by Jan. 30. See also advertisement.

Edinburgh Corporation invite tenders for an engine (Willans or Belliss type) and dynamo. Specifications, &c., from resident electrical engineer (Mr. F. A. Newington), Dewar-place, Edinburgh, and the specifications and drawings may also be seen at, but not obtained from, the office of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street. Westminster, S.W. Tenders to the town clerk (Mr. Thomas Hunter, W.S.), City Chambers, Edinburgh, by Feb. 22. See also advertisement.

Kirkcaldy Corporation invite tenders for seven motor cars complete to run on the Corporation tramways. Forms of tender from the burgh electrical engineer and tramways manager (Mr. O. F. Francis), electricity works, Victoria-road, Kirkcaldy. Tenders to town clerk (Mr. Wm. L. Macindoe) by noon Feb. 1. See also advertisement.

Bristol Corporation are desirous of receiving from manufacturers detailed particulars of their standard single-phase H.T. and three-phase E.H.T. switch gear. Further particulars from the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol. See advertisement.

London County Council invite tenders by Feb. 2 for roadwork and platelaying required for reconstruction for electrical traction on the conduit system of the existing double line of cable conduit tramways from Brixton-road to Streatham terminus, and for construction of a portion of the authorised tramways in High-street, Tooting, Merton-road, and Defoe-road.

Hornsey Borough Council invite tenders for two dry-back or water-tube boilers, smoke-consuming apparatus, two 300kw. steam dynamos, one 100kw. steam dynamo and two motor generators. Tenders to town clerk (Mr. F. D. Askey), Southwood-lane, Highgate, London, N., by 10:30 a.m. Feb. 8.

Whitby Urban District Council invite tenders for feeding and distributing mains. Specifications from the electrical engineer (Mr. L. H. King), to whom tenders by Jan. 25.

South London Electric Supply Corporation require three water-tube boilers, pipe connections, &c. Tenders to secretary by noon Feb. 1.

Leyton District Council invite tenders by 7 p.m. of Feb. 2 for wiring the Norlington-road schools.

The "Madrid Gazette" of Jan. 17 calls for tenders by noon March 23, at the Directorate-General of Public Works, *Madrid*, for a concession to construct and work an electric tramway in the Canary Islands for a term of 60 years. Further particulars are given in the "Gazette."

The "Madrid Gazette" of Jan. 12 calls for tenders for the supply of the whole or part of the requirements in respect to machines and apparatus for the electro-mechanical laboratory at the School of Industrial Engineering, *Bilbao*, Spain. The list of requirements and other particulars are set out, and tenders are to be sent in by April 12 to the School. The "Gazette" can be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

TENDERS RECEIVED AND ACCEPTED.

Bermondsey (London) Borough Council received the following tenders for two water-tube boilers, coal bunkers and coal-handling plant and extension to steam-feed exhaust pipes :—

Babcock and Wilcox (with economisers), *accepted*	£7,990
do (without economisers)	7,600
Stirling Boiler Co. (including economisers)	8,018
Graham, Morton & Co. (tender incomplete)	1,869

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Tyneside Tramways and Tramroads Co. (Ltd.) have placed an order with the British Westinghouse Co. for the equipment of six electric tramcars, including trucks (Brill 21E) for four single truck cars, and likewise for Brill No. 27G bogie trucks, 4ft. wheel base, for two cars. The order includes Westinghouse magnetic brakes for the cars, and heater equipments to be used in connection with the brakes.

Messrs. Belliss and Morcom have received orders for one 300 H.P. engine direct, coupled to Siemens alternator for Kingston-on-Thames (through Siemens Brothers & Co.), for two 290 H.P. engines coupled to Siemens 250kw. generators for Pembroke Dockyard, and for one engine for coupling to a Brush dynamo at Devonport, Tasmania (through the Brush Company).

An order has been placed by Ashington Coal Co. with the British Westinghouse Co. for a motor-generating set, consisting of a three-phase induction motor, driving a direct-current generator. The motor will run on a 40-period circuit, at 480 to 500 volts, and 575 revs. per min., driving by direct connection the dynamo, which at 480 to 500 volts will have a rated output of 20 0kw.

Kirkcaldy Corporation have accepted the tender of Browett, Lindley & Co. for a 430kw. Browett-Laurence Scott generating set at £4,619. There were 31 tenders, which included over 150 prices for various combinations of plant.

East Ham Electric Lighting committee have placed an order for an overhead traveller at the generating station with Peirson & Co. at £108; and for a motor-driven air compressor with Reavell & Co. at £66.

Blackpool Corporation has ordered from the British Westinghouse Co. a generating set, comprising a Browett-Lindley engine driving a 450kw. Westinghouse dynamo. The latter will be horizontally divided and so compounded as to give 500 volts at no load, and 530 to 550 at full load, 330 revs. per min.

Coventry Corporation have placed an order with J. and H. McLaren for an additional 1,000 H.P. engine (at £4,169) coupled to a 600kw. alternator of the British Schuckert Electric Co. (at £1,150).

Sunderland Corporation have placed an order with the Electrical Co. for two 125kw. motor-generators, battery booster and switchboard for the Hendon sub-station at £2,100.

Wolverhampton Corporation have placed an order with Milne and Voss for a tramway salt-feeder car for the tramways at £150.

Walsall Corporation have accepted the tender of the Leeds Steel Works for 100 tons of tramway rails.

Messrs. Partridge and Jones have placed an order for electrical plant with the British Westinghouse Co. for their Blaensychan colliery, near Pontypool, including a 112kw. direct current generator driven by a Belliss engine. The generator will supply power to a 100 H.P. motor coupled to Markham haulage gear.

BUSINESS NOTICES.

The Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C., notify that they have taken over the sale, for this country (until permanent arrangements have been made), of the Ferranti-Schuler alternating-current single-phase motor, specially adapted for lift and crane work in consequence of its great starting-to que. The Lahmeyer Company have for some time owned the Continental patents. The motor was described in our last issue.

Messrs. R. White & Sons, Widnes, have been appointed sole district agents for the Lahmeyer Electrical Co.

Messrs. Chas. Hopkinson, Bertram Hopkinson and Ernest Talbot, consulting engineers, 29, Princess-street, Manchester, and 26, Victoria-street, London, S W., have dissolved partnership. Mr. Chas. Hopkinson will continue the Manchester practice in his own name and Mr. Ernest Talbot, with Mr. A. D. Stevenson, will continue at 26, Victoria-street, London S.W., as Talbot and Stevenson.

The Armorduct Improved Electric Conduit Co., of Newcastle-on-Tyne and London, and Messrs. Atkinson, Schmahl & Co., of the former town, have amalgamated, and a private company (the Armorduct Mfg. Co., Ltd.) has been formed to take over, as from Jan. 1, 1904, the two businesses. The new company also absorbs the business of Alan Robson & Co., Newcastle-on-Tyne. The chief office will now be at 6, Farringdon-avenue, London, E.C.

British Westinghouse Company have now extended their office at Market-place-buildings, Sheffield, which is in charge of Mr. C. A. Slater, and the office is now open for general business.

LIQUIDATIONS, BANKRUPTCIES, &c.

In the liquidation of the Mannesman Tube Co. (Limited and Reduced), the liquidators, Messrs. E. Waterhouse and G. Franklin, have declared a first and final distribution to the unsecured creditors of 3s. $0\frac{8}{32}$d. in the £1. The liquidators call attention to the fact that practically the only asset not pledged to the debenture-holders was the uncalled capital of the company. The failure is of a somewhat ancient date, and the liquidators explain that the delay in the distribution has been caused owing to a dividend having to be provided on the deficiency of the claim of the debenture-holders. The total receipts under the liquidation have been over £37,000. The Board of Trade fees have been £453, liquidators' remuneration £1,500, costs and other disbursements have reached a considerable sum, and the total dividend now declared on admitted claims, amounting to £211,546. 18s. 5d., is £31,979. 18s. 11d.

The adjourned meeting of creditors of the British Electric Car Co. (Ltd.) was held on Thursday last week.

The liquidator (Mr. J. J. Wild) said the examination of the company's affairs led him to think that there would be no further losses on the works as at present staffed, but that, if any change occurred, the financial position was likely to improve. Existing contracts would, he hoped, result in a small profit. No further contracts would be invited. The meeting authorised the receiver and manager to negotiate for the sale of the business as a going concern.

An amended statement of affairs in the bankruptcy of Max Margowski, 13 and 14, Abchurch-lane, London, E.C., has been filed, showing gross liabilities £13,507, deficiency £956. The examination has been adjourned to Feb. 4.

Claims against H. J. Furniss, electrician, 5A, Queen-street, Derby, must be in by 30th inst. to Mr. F. Stone, 47, Full-street, Derby.

The Auxiliary and Light Railways and Tramways Co. (Ltd.) is to be wound up voluntarily. Mr. F. G. A. Hitchcock, 20, Victoria-street, London, S.W., is liquidator. Claims by March 3.

The Rangoon Electric Construction Syndicate (Ltd.) is to be wound up voluntarily, and Mr. F. C. Ridley, 3, Princes-street, London, S.W., is liquidator.

A meeting of the Electric Lamp Supply Co. (Ltd.) will be held on Feb. 18 at 6 Guildhall-chambers, London, E,C., to receive an account of the winding-up.

Plant for Sale.—Two Parker dynamos, a booster, and a shunt-wound charging dynamo are advertised for sale on another page.

Mr. J. C. Stevens will offer on Jan. 29, at 3 p.m., the contents of a gentleman's workshop, including a 4 B.H.P. Crossley oil engine, a brush dynamo, planing and drilling machines, &c. Particulars from Mr. Stevens, 38, King-street, Covent Garden, London, W.C. See advertisement.

Works, &c., for Sale.—Some modern well-equipped car-building works, occupying a covered area of $8\frac{3}{4}$ acres, with 25 acres available for future extensions, are advertised for sale in another column. Applications to Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C.

There is for sale a compact engineering works, with good modern engineer's plant, in a London suburb. See advertisement.

Some manufacturing premises are advertised for sale or letting on lease, without restriction and with or without steam power. The premises adjoin Laindon station, Essex, 22 miles from London. Particulars from Messrs. I. Levy & Son, 62, Albany-road, Old Kent-road, London, S.E.

Catalogues, &c.—A new (No. 163) list is issued by the British Thomson-Houston Co. and deals with the B.T.-H.-Edison incandescent lamp of both low-voltage and high-voltage types. A special lamp, the Navy bulb lamp, for ship lighting, is amongst the illustrations.

Messrs. Chambers, Scott & Co., Motherwell, N.B., have just issued a brief description of their electric overhead travelling cranes. Copies of the pamphlet can be obtained on application.

The latest calendar to hand is a useful hanging calendar from Messrs. W. T. Henley's Telegraph Works Co. Although last, this is not the least useful of the calendars we have received.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Jan. 13 to 19 with the ports of destination:—

Africa—Alexandria, £30; Cape Town, £340; Durban, £1,586 (including £516 telegraph material); East London, £432 (including £67 telegraph material); Port Elizabeth, £54. *Australasia*—Auckland, £30; Fremantle, £68; Melbourne, £111 (including £75 telegraph material); Otago, £42; Perth, £284; Sydney, £1,730. *Belgium*—Ostend, £20. *Ceylon*—Colombo, £19. *China*—Chefoo, £36; Shanghai, £572 (including £256 telegraph material). *Holland*—Amsterdam, £1,006; Rotterdam, £180. *Hong Kong*, £18. *India*—Bombay, £1,068 (including £953 telegraph material); Calcutta, £2,355. *Mauritius*, £82. *Japan*—Kobe, £70;

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Yokohama, £1,090 (including £880 telegraph material). *North Atlantic*—£14,300 (telegraph cable). *Portugal*—Lisbon, £257; Oporto, £78. *Russia*—Reval, £55; St. Petersburg £55. *Seychelles*, £41 (telegraph material). *Spain*—Coronel, £35. *Straits Settlements*—Singapore, £20. Total £26,064, against £31,326 in the corresponding week last year (Jan. 14 to 20).

New Switches for Large Currents.—With the steadily increasing sizes of generating units, &c., in modern central stations, the old type of switch is growing less satisfactory on account of the considerable effort required to break the circuit, necessitating, in some cases, the combined exertions of two men. To meet this difficulty, the British Thomson-Houston Co. has introduced a laminated brush lever switch, some forms of which are shown in the illustrations. They are said to be specially serviceable for use with currents up to several thousand amperes and at moderate voltages. The switch blades are laminated and are protected from detrimental effects due to arcing by a secondary contact on which the current is finally broken. The laminations consist of rolled copper bound together by thicker outside spring bars and by a gunmetal block on the inside of the laminations, the whole fastened together by steel clamps. Fig. 1 represents a 3,000-ampere 250-volt laminated lever switch. For still heavier currents and for higher potentials a laminated brush toggle switch, as shown in Fig. 2, is being introduced, suitable, we are informed, for use on circuits the pressure in which does not exceed 600 volts. It is made in sizes for dealing with currents up to 10,000 amperes in strength. Not only does the toggle form of mechanism ensure ease of operation, but it also makes the final contact under heavy pressure, securing thereby a good electrical connection. As is the case with the switch first described, this second form is also provided with a special arc-breaking contact, and, unless specially constructed for alternating currents, this device is provided with a magnetic blow-out. The supporting and actuating mechanism of this switch is of wrought iron or steel, enamelled black, while the handles are of hard wood, stained black and polished.

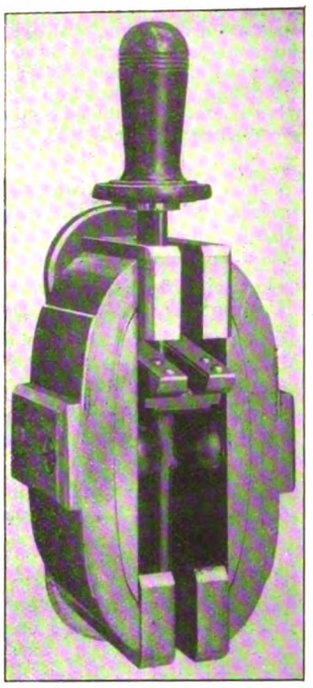

FIG. 1.—3,000-ampere 250-volt Laminated Lever Switch.

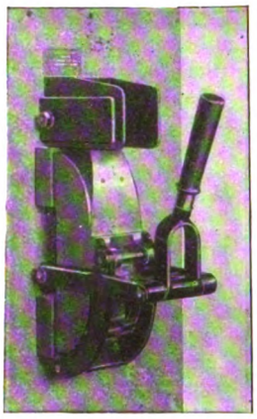

FIG. 2.—8,000-ampere Single-pole Brush Toggle Switch.

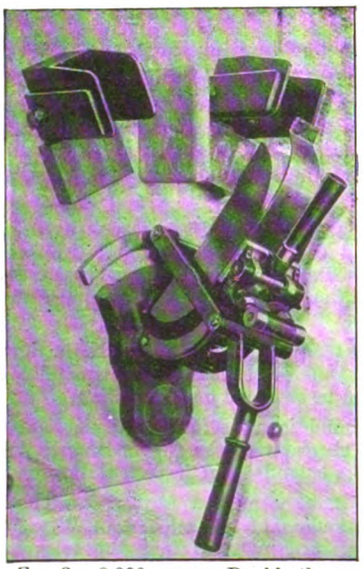

FIG. 3.—8,000-ampere Double-throw Brush Toggle Switch.

Electrically Driven Pumps and Compressors.—The Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C., have just issued an illustrated description of a number of electrically-driven pumps in which the electric motor is coupled direct. It is pointed out that this simple method of driving can only be used with advantage with pumps for large outputs, in which the speed of the pumps and that of the motor can be easily adjusted to each other. Pumps for smaller outputs are provided with single or double reduction gearing. The accompanying illustration, Fig. A, shows a motor-driven compressor with the motor bolted to the side of the air vessel and driving the compressor by means of single reduction gear. This compressor is used for cleaning dynamos by compressed air. From the compressor pipes are taken to each dynamo to be cleaned, and by means of flexible tubing connected up to the end of the piping the machine can be expeditiously cleaned. Fig B shows a compressor fitted to a canal lift which serves to keep the floats of the lift under a pressure of three atmospheres to relieve the lift from the pressure of the water.

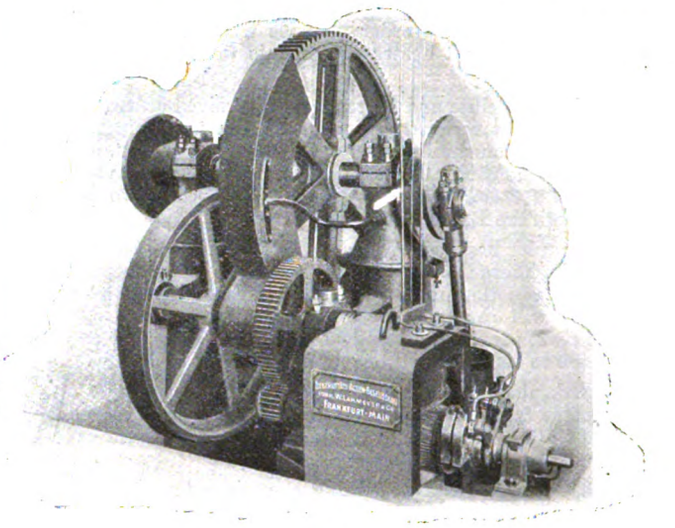

FIG. A.

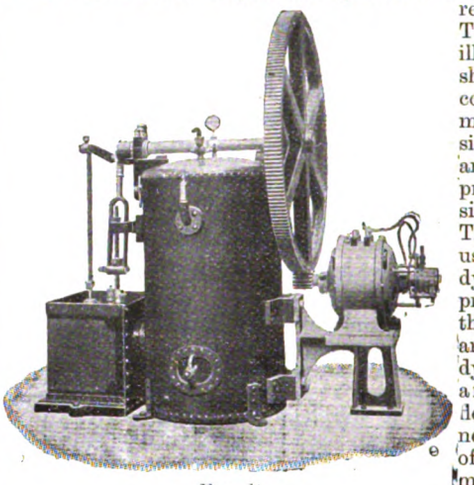

FIG. B.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

November 21, 1903.

25,451 H. J. HADDAN (S. Zielenziger, Germany). Arc lamps.*

25,461 MARCONI'S WIRELESS TELEGRAPH CO., C. S. FRANKLIN, H. A. MADGE and E. BERRY. Apparatus for wireless telegraphy.

25,462 MARCONI'S WIRELESS TELEGRAPH CO. and R. G. KINDERSLEY. Transmitting instruments for wireless telegraphy.

November, 23, 1903.

25,473 R. THRELFALL. Birmingham. Sensitive hot-wire voltmeters.

24,482 L. MOLLOR. Manchester. Variable electrical ignition for gas engines.

25,525 B.T.-H. Co. (G.E. Co., U.S.) Electric starting switches.

25,526 B.T.-H. Co. (G.E. Co., U.S.) Speed limiting devices.

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25,527 B.T.-H. Co. (G.E. Co., U.S.) Train control systems.
25,550 F. E. Clotten. Electrolytic recovery of metals.
25,567 E. Morck. Producing a shifting of phase of 90deg. in alternating current meters.*
25,571 W. C. Head, W. A. Snape and R. Volland. Electric lamps.
25,573 H. J. Dawson. Adjusting mechanism of arc lamps used with cinematograph and other apparatus.
25,577 W. J. Davy. Arc lamps.
25,583 E. R. Standfield and W. E. Kenney. Electro-medical belts.

November 24, 1903.

25,591 V. W. Delves-Broughton and J. A. Cole. Induction coils and transformers.
25,620 W. F. Martin Devonshire. Life-saving guard for electric railways and the like.*
25.633 J. W. Ewart. Arc lamps.
25.657 G. Zapf. Liverpool. Lighting arresters.
25.663 Falk, Stadelmann & Co. and L. Thurnauer. Telephone systems.
25,669 S. G. Brown. Conductors or cables.
25,677 J. Pearson, F. R. M. Cutcheon and J. F. Williamson. Protecting electrical windings from static strains.*
25,698 J. H. Ladd. Bodies adapted for lighting purposes and rendered incandescent by electricity.

November 25, 1903.

25,704 A. Johnston and S. G. Martin. Swansea. A carbon-break fuse.
25,725 H. J. Rogers, E. M. Munro and H. Brecknell. Bristol. Electric signalling for electric railways and tramways.
25,741 P. Braham. Glow-lamp holders.
25,765 D. Cervera. Electrical recording apparatus.*
25,777 C. E. S. Phillips. Mercury vacuum pumps.

November 26, 1903.

25,792 J. Speed. Method of agitating solution to quicken electrolytic deposition of metals.
25,814 W. Willenbücher. Manchester. Trolley heads for electric tramcars.*
25,847 J. D. R. Blain. Godalming. Dynamo-electric generators and motors.
25,848 B.T.-H. Co. (G.E. Co., U.S.) Apparatus for measuring speeds of rotation.
25,849 B.T.-H. Co. (G.E. Co., U.S.) Rheostats.
25,850 B.T.-H. Co. (G.E. Co., U.S.) Time limit devices for switches and the like.
25.851 B.T.-H. Co. (G.E. Co., U.S.) Operating repulsion motors.
25,852 B.T.-H. Co. (G.E. Co., U.S.) Methods of exhausting vapour conductors.
25,853 B.T.-H. Co. (G.E. Co., U.S.) Insulating material.
25,454 B.T.-H. Co. (G.E. Co., U.S.) Suspenders for overhead conductors.
25.855 B.T.-H. Co. (G.E. Co., U.S.) Switches.
25,856 B.T.-H. Co. (G.E. Co., U.S.) Automatic air-brake systems
25,867 B.T.-H. Co. (G.E. Co., U.S.) Tube coating machines.
25,858 B.T.-H. Co. (G.E.Co., U.S.) Windingsfor dynamo-electric machines.
25,870 Bastian Meter Co., C. O. Bastian and C. H. Churchill. Electrolytic electricity meters.
25.885 H. Wolfenden. Securing reflectors, &c., to incandescent lamps.*
25,886 J. R. Dick. Coin operated or controlled electricity meters.
25,887 W. H. Scott. Speed controllers for electric motors.

November 27, 1903.

25,905 R. C. Meredith and T. Young. Birmingham. A sparking plug for internal combustion engines.
25,925 P. M. A. Mathews. Manchester. Resistances.
25,929 J. Wolfson. Birmingham. Adjustable incandescent button.
25 937 A. Blackman. Hampton Wick. Accumulators.
25,955 H. J. Leeves-Johnson and M. Moser. Safety switch wedge.
25,969 W. Griffiths and B. H. Bedell. Safety device for contact-stud systems of electric traction.
25,970 W. Griffiths and B. H. Bedell. Current collector for stud-contact systems of electric traction.
25,990 H. A. Mavor and Mavor and Coulson (Ltd.) Brush holders.

November 28, 1903.

25,994 T. D. Frew. Perth. Shade ring forceps.
26,005 J. Fearnhead. Bolton. Apparatus for electric stoves.
26,043 V. César and E. Guarini. Railway signalling by means of a line circuit.*
26,051 G. Finzi. Voltage regulating devices for alternating current lines.
26,058 J. Y. Johnson. (E.A.G. vorm. W. Lahmeyer & Co., Germany.) High-voltage spark arresters.*
26,067 P. F. Corkhill. Liverpool. Advertising appliances in connection with telephones.
26,069 T. von Zweigbergk. Multiple electric motor control.

November 30, 1903.

26,074 J. B. Hogan. Sound-conveying apparatus for telephones.
26,082 E. F. Kent and F. Rogers. Cambridge. Automatically preventing speed of electric cars exceeding a predetermined limit.
26,083 W. Cardno and J. G. Dalton. Cambuslang. Electric furnaces.
26,111 C. J. Andersson. Microphones.
26,112 K. A. Lindstrom. Induction motors.
26,124 T. B. Stewart, W. H. Turner and R. E. Dixon. Controlling and operating electric railway and tramway points.
26,165 R. C. Smith. Electric elevators.
26,170 P. Kirkup and W, Alderson. Switches.
26,174 F. W. Howorth (F. Everhart and J. Dossert, U.S.) Couplings for electric cables.
26,180 A. Hepke and H. Ascher. Fuses.

December 1, 1903.

26,200 D. Burns and J. M. Fleming. Glasgow. Electric generator.
26,208 J. E. Jaggar. Leeds. J. E. Jagger's electric tram car cover.
26,211 W. Fairweather (W. M. Miner, U.S.). Multiplex telephony.*
26,230 International Trolley Controller Co. and J. Kynoch. Combined trolley arm and brake controllers for electric tramcars.*
26,241 H. Leitner. Byfleet. Electrodes for secondary batteries.
26,242 Siemens Brothers & Co. (United Telpherage Co., U.S.) Telphers partly applicable, also to vehicles propelled electrically from a distance.
26,247 W. L. d'Olier. Electric driving mechanism for centrifugal machines.*
26,248 P. G. Randall. Telephone transmitters.*
26,255 H. P. Childress and N. M. Sauls. Attachments to desk telephone instruments.*
26,259 J. Y. Johnson. Regulating speed of engines driving electric generators. (W. Lahmeyer & Co., Germany.)*
26,261 C. Bailly. Magneto-electric ignition devices for internal combustion engines.*
26.264 E. du Bois. Electrically winding up springs or weights.
26,267 C. W. Atkinson. Electric measuring and recording devices.
26,268 C. W. Atkinson. Electrolytic meters.
26,269 W. P. Thompson. Switches. (H. Schor, France.)
26,271 F. E. Peters. Liverpool. Cohering receivers.*
26,273 G. A. E. Kohler. Controlling device for electric motors.
26,274 Brown, Boverie & Co. Ventilating electrical machines. (Date applied for, December 16, 1902, being date of application in Switzerland).*
26,276 W. Geipel and F. M. T. Lange. Electricity meters.

December 2, 1903.

26,307 F. J. Turquand and J. F. Wakelin. Electrical connection for electro-chemical apparatus.
26,352 H. Emonds. Vacuum arc lamps with external air-cushioned regulating device.*
26,372 H. Soar and W. H. Fellows. Cells for storage batteries.
26,378 J. Y. Johnson. Regulation of asynchronous alternating or three-phase electric motors. (W. Lahmeyer & Co., Germany.)*
26,380 J. Y. Johnson. Safety fuses. (W. Lahmeyer & Co., Germany.)*

December 3, 1903.

26,427 A. Eckstein and A. E. Angold. Manchester. Electro-magnetic controlling gear for arc lamps, circuit breakers and the like.
26.435 L. Jacot. Electrically actuated mechanism.
26,449 W. J. Bell. A new form of ammeter and voltmeter.
26,456 B.T.-H. Co. (G.E. Co., U.S.) Insulated electric conductors.
26,457 B.T.-H. Co. (G.E. Co., U.S.) Insulated coils for electrical apparatus and process of making the same.
26,458 B.T.-H. Co. (G.E. Co., U.S.) Insulating electric conducters.
26,459 B.T.-H. Co. (G.E. Co., U.S) Brake systems.
26,460 B.T.-H. Co. (G.E. Co., U.S.) Electric rheostats.
26,461 B.T.-H. Co. (G.E. Co., U.S.) Rotary electric converters.
26,462 B.T.-H. Co. (G.E. Co., U.S.) Electric arc lamps.
26,463 B.T.-H. Co. (G.E. Co., U.S.) Air-brake systems and valves therefor.
26,464 B.T.-H. Co. (G E. Co., U.S.) Static influence electrical machines.
26,465 B.T.-H. Co. (G.E. Co., U.S.) Systems of electric motor control.
26,476 P. J. Driscoll and H. Sleeman. Electric incandescent lamps.
26,488 M. S. Napier. Electrical ignition apparatus.

December 4, 1903.

26,513 J. A. de Macedo. Yorks. Canopy trolley for electric tramcars driven on the overhead system.
26,530 H. E. Tugill. Bristol. Mechanism for electro-mechanically playing pianos, organs, and the like.
26,533 W. Krause. Electric heaters.
26,537 W. Hepworth-Collins. Manchester. Conduits for containing electric cables and wires and pipes and tubes, and the like.
26,538 W. Hepworth-Collins. Manchester. Conduit for containing electric cables and wires and other wires, tubes, and the like, primarily intended to be carried along thoroughfares.
26,553 W. Best, A. Best and R. O. Best. Apparatus for electrically igniting miners' safety lamps.
26,577 G. Finzi. Field magnets for electrical machines.
26,589 A. Bourdos and H. C. W. Gibson. Incandescent electric lamps.
26,595 K. Schaffler (recte Glossl) and E. Jilcke. Electric igniting apparatus.

December 5, 1903.

26,603 H. Faerber. Bath. Electric motors and dynamos.
26,607 H. Robertson. Edinburgh. Combined electric switch wall socket and plug.
26,618 R. C. Meredith. Birmingham. A mechanical switch for electric installation of motor cycles.
26,634 J. L. J. Gobiet. Coventry. Contact breakers, switches and the like particularly applicable for use upon internal combustion engines and the like.
26,659 P. Masson. Magneto-electric ignition devices for internal combustion engines.*

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SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

1,070 EFREM and SCHWARZ. Arc lamps.
1,095 MCELROY. Electric lighting systems.
1,132 DIXON. Cord grips for lamp-holders and supply fittings.
1,155 W. T. HENLEY'S TELEGRAPH WORKS and PFIFFNER. Manufacture of cables.
1,157 HEAD. Electric ignition for internal combustion engines.
1,299 STEWART. Safety devices for live conductor breakage.
1,416 PRESTED. Miners' electric lamps.
1,830 BULLERS LIMITED and CHAMBERS. Third-rail insulators of electric railways.
1,949 CAROLAN (G.E. Co., U.S.). Surface contact structures.
2,030 BARBER. Couplings for metal tubes containing electric wires.
2,060 CHAUDOIR and CASTON. Automatic electric lift gate lock.
2,198 BLOXAM (Ellison.). Automatic switches.
2,961 SIEMENS BROS. & Co. and FERREIRV. Electric semaphores.
3,281 HEIN and MÖLLER-HOLST. Electric controlling apparatus for lifts.
3,873 LE ROY. Resistances and the like.
3,986 VANZETTI (Levy). Telegraph apparatus.
4,163 MÜLLER. Electromatic agitating instrument for vibratory massage. (Date applied for, Feb. 22, 1902.)
4,247 SIEMENS BROS. & Co. and FERREIRA. Device for locking points.
5,619 BIRKBY. Electrical connection between terminal and trolley head.
7,026 SIEMENS BROS. & Co. and FERREIRA. Apparatus for detecting whether points are in correct position, and an electric switch for use therewith.
7,742 COLLINS. Electric hair brushes.
8,259 SLAUGHTER. Systems of electrical distribution.
8,436 SOMERVILLE, HICKS and HOWARD and BULLOUGH (LIMITED). Permanent magnet electric generating machines.
11,129 OTTO. Ozonizers of low frequency adapted to be connected directly to a dynamo.
11,315 SIEMENS BROS. & Co. and FERREIRA. Device for locking an actuating part when the part to be actuated is locked.
12,377 ASHCROFT. Production of alkali metals by electrolysis.
15,600 GLADSTONE. Voltaic batteries. (Date applied for, Dec. 17, 1902.)
15,831 KLEINSCHMIDT. Apparatus for welding railway joints by electricity.
17,367 VAN DER VALK. Safety devices for strong current overhead conductors.
18,323 COSTER and SMITH STORAGE BATTERY CO. Machine for making battery grids.
18,680 ERIKSEN and KOEFOED, HAUBERG, MARSTRAND AND HELWEG AKTIESELSKABET TITAN. Controlling electric elevators.
18,755 BLENDER. Electrical apparatus communicating and recording instructions.
18,867 IMRAY. (Soc. des Telegraphs Multiplex. Systeme E. Mecardier.) Telegraph apparatus.
19,250 BRIGGS. Telephone-receiver holders. (Date applied for, Sept. 6, 1902.)
19,520 SCOTT. Systems for controlling alternating-current motors. (Date applied for, Sept 13, 1902.)
19,540 PETERS and ELLINGSON. Electric signals for railways.
19,553 CASEVITZ. Printing telegraph apparatus. (Date applied for, Sept. 11, 1902.)
19,748 PETO. Protecting terminals and ensuring good contact.
19,801 BAYLAY and TRITTON. Electro-chemically deposited jacket for explosion engines and the like.
19,996 OESTERREICHER and NEMELKA. Automatic block-signalling.
20,012 BALLARD and HOWARD. Electric cable terminal.
20,155 RIEUNIER. Electricity meters. (Date applied for, Oct. 2, 1902)
20,230 WETMORE. Automatic circuit breakers.
22,101 DANIELS. Coupling apparatus for tapping circuit wires. (Date applied for, Jan. 2, 1903.)
22,432 DORMAN and SMITH. Ceiling fittings.
22,572 SIEMENS BROS. & Co. (Siemens and Halske A.G.). Working electrical winding engines.
22,573 SIEMENS BROS. & Co. (Siemens and Halske A.G.). Safety fuse device.
22,643 THOMPSON. Brush holders for dynamo-electric machines.
22,644 IMRAY. (Siemens-Schuckertwerke G.m.b.H.) Contact apparatus for electric relay master clocks.
22,765 SMITH. Storage battery plates. (Date applied for, Sept. 10, 1903.)
23,151 KOLLER and ASKENASY. Producing suitable circulation of the electrolyte in electrolytic processes.
23,220 WATSON. System of automatic signalling on railways.
23,225 GOEHST. Electric lamp sockets.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26¼d. per oz. (Jan. 21). Consols 88⅛—88¼ for money, 88 1/16—88 1/16 for account; 2½ per cent. annuities 87¾—88 (Jan. 21). Consols Pay Day, Feb. 3; Stocks and Shares Continuation Days, Jan. 26 and Feb. 9; Ticket Days, Jan. 27 and Feb. 10; Pay Days, Jan. 28 and Feb. 11; Mining Share Carry-over Days, Jan. 25 and Feb. 8.

BLACKPOOL, ST. ANNE'S AND LYTHAM TRAMWAY CO. (LTD.)—At an extraordinary meeting on Friday it was decided to reduce the nominal capital from £150,000 (fully paid) to £125,000. The nominal amount of preference shares will be reduced from 20s. to 18s., and the ordinary from 20s. to 16s.

CENTRAL LONDON RAILWAY CO.—Dividends are announced for the past half-year at the rate of 4 per cent. per annum on the ordinary, preferred and deferred stock, £10,000 being placed to reserve and £36,000 carried forward. A year ago the dividends were the same, with £10,000 to reserve and £27,717 forward.

CHILI TELEPHONE CO. (LTD.)—An interim dividend at the rate of 6 per cent. per annum for the half-year ended Sept. 30 has been declared.

CITY AND SOUTH LONDON RAILWAY CO.—For the half-year to Dec. 31, the balance, after providing for interest and preference dividend is sufficient to allow of the payment of a dividend on the consolidated ordinary stock at the rate of 2 per cent. per annum, carrying forward £746, comparing with 3½ per cent. a year ago. £2,000 is placed to renewal fund and £1,268 carried forward.

CROMPTON & CO. (LTD.)—A directors' circular to the shareholders states that the keen competition in the electrical trade, referred to in the chairman's speech at the last meeting, still continues, and, although a larger amount of business has been done during the half-year ended Sept. 30 than in any corresponding period in the company's history, prices have ruled so low that only a moderate profit has been earned after providing for interest. The directors have, therefore, decided to await the results of the full year's working before making any distribution to the shareholders.

DIRECT UNITED STATES CABLE CO. (LTD.)—The report of the directors for the six months ended Dec. 31 states that the half-year's revenue, after deducting out payments, amounted to £47,814. 16s. 4d., compared with £52,544. 1s. 10d. for the corresponding period of 1902, a decrease of £4,729. 5s. 6d. The working and other expenses for the same period, including income tax, amounted to £21,816. 3s., leaving a balance of £25,998. 13s. 4d. as net profit, making, with £2,693. 15s. 6d. brought forward, £28,692. 8s. 10d. For the corresponding period of 1902 the working expenses, &c., were £21,747. 10s. 1d. Interim dividends of 3s. per share for the quarters ended Sept. 30 and Dec. 31 (payable Jan. 30), together amounting to £18,213, have been declared, and after setting aside £8,000 to reserve £2,479. 8s. 10d. is carried forward. Reserve has been debited with £30,178. 1s. 5d. for cost of cable repairs, and, after being credited with interest on the investments, profit on sale of securities and amount set aside from revenue, now amounts to £462,094. 9s. 6d, taking investments at cost price.

DUBLIN AND LUCAN ELECTRIC RAILWAY CO.—For the half-year ended Dec. 31, the profit was £1,625, and the directors, after payment of preference dividend, are placing £700 to reserve and carrying forward £359.

EASTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year to Sept. 30 shows that the revenue amounted to £565,703. 9s. 7d., from which are deducted £168,232. 6s. 7d. for ordinary expenses and £48,004. 11s. 3d. for expenditure relating to repairs and renewals of cables, depreciation of spare cable, sundry differences in exchange and income tax payable abroad, leaving £349,466. 11s. 9d., to which is added £5,031. 3s. 10d. brought forward, making £354,497. 15s. 7d. After making provision for income tax payable in England, interest on loan from Eastern and South African Telegraph Co., interest on mortgage debenture stock, and for two quarterly dividends on Preference stock (absorbing in all £94,630. 4s. 10d.), there remains £259,867. 10s. 9d., from which is allocated £7,000 for maintenance of ships, £120,000 to general reserve and £100,000 to meet the two interim dividends of 1½ per cent. on the ordinary stock for the quarters ended June 30 and Sept. 30 respectively. The balance of £32,867. 10s. 9d. being carried forward. The new rules and regulations agreed to at the Telegraph Conference recently held in London come into operation on July 1 next, from which date the following tariffs will be reduced:—*From Great Britain.*—To Portugal, Spain and Gibraltar, from 3½d. to 3d. per word; to Tangier, 5d. to 4½d.; to Malta, 6d. to 4½d.; to Greece, 6½d. to 6d.; to Egypt (first Region), 1s. 7d. and 1s. 10d. to 1s. 5d.; to Labuan, 5s. to 3s.

MANX ELECTRIC RAILWAY CO. (LTD.)—The report for the period ended Sept. 30 (one year and six weeks) states that the gross receipts amounted to £41,300, expenditure £20,434, leaving net earnings £20,865. After deducting interest (£8,863), profit earned before incorporation (£4,005) and preference dividend (£4,731), the balance to be carried forward is £3,266. During the past year new works have been undertaken upon capital account, the total expenditure being £49,239, made up of new plant and equipment (£44,399), new retaining wall and permanent way at Bulgham Bay (£3,332), purchase Dhoon Quarry (£1,508).

METROPOLITAN RAILWAY CO.—The directors announce a dividend for the past half-year at the rate of 3 per cent. per annum, comparing with 2½ per cent. last year.

PERTH ELECTRIC TRAMWAYS (LTD.)—According to an Australian cablegram, the receipts for last year amounted to £62,097, and the working expenses to £34,871.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—A dividend is recommended for the half-year ended Dec. 31 of 7s. 6d., together with a bonus of 2s. per share on the ordinery shares, making (with interim) a dividend of 12½ per cent. and a bonus of 2 per cent. for 1903.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—A dividend of 4 per cent. for the year ended Dec. 31 is recommeded (carrying forward £1,250).

SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LTD.)—This company sold during the quarter ended Christmas, 1903, 2,009,230 units of current, realising £18,230. The figures for the corresponding quarter in 1902 were 379,167 units, realising £7,412.

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STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to allow £50,000 4½ per cent. debenture stock of the *Isle of Wight Electric Light and Power Co. (Ltd.)* to be quoted in the official list. The 27th inst. has been appointed a special settling-day in the further issues of 5,763 ordinary £1 and 5,763 £1 6 per cent. preference shares of the *West London and Provincial Electric Supply Co. (Ltd.)*

TUBES LIMITED.—The report for the year ended Sept. 30 shows a net trading profit of £7,501, which compares with a loss of £26,304 for the previous year. The improvement is due in part to a considerably increased output, but chiefly to savings in cost of manufacture.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

CAMBRIDGE ELECTRIC TRAMWAYS SYNDICATE (LTD.)—Reg. Jan. 14, capital £5,000 in £10 shares, to adopt an agreement with the British Electric Traction Co. (Ltd.) for the acquisition of its interest in an agreement dated June 21, 1898, with the Cambridge Street Tramways Co. and for the purchase of certain shares held by the British Electric Traction Co. in the Cambridge Company, to construct, acquire, equip, maintain and work by electricity or other power any tramway or tramways in the town or county of Cambridge, and to carry on the business of tramway, railway and omnibus proprietors, carriers of passengers and goods, &c.

CANADIAN ELECTRIC TRACTION CO. (LTD.)—Reg. Jan. 12, capital £120,000 in £1 shares, to construct, work, lease, edminister or control electric, steam and other railways and tramways and electrical storage, power or lighting works, and to carry on the business of carriers of passengers and goods, electrical engineers, electricians, mechanical and chemical engineers, contractors, manufacturers of and dealers in railway, tramway, electric and other apparatus, users and suppliers of electricity, &c.

EAST CHESHIRE LIGHT RAILWAY SYNDICATE (LTD.)—Reg. Jan. 16, capital £3,000 in £5 shares, to establish a company with powers under Light Railways Act, 1896, to construct, maintain and work a system of light railways from Mottram to or near Hyde, Stalybridge, &c., to acquire tramways or railways in Cheshire or elsewhere in the United Kingdom, to equip, maintain and work the same by electricity or other power, to carry on the business of railway, tramway, motor car, &c., proprietors, manufacturers of rolling stock, carriers of passengers and goods, electricians, suppliers of electricity, &c., and to adopt an agreement with E. A. Chadwick. First directors: G. Pearson, M. Fenton, J.P., L. H. Moordom, J. Ridyard, J.P., and A. H. Gibbings. Reg. office, 129, Stamford-street, Stalybridge.

PETO AND RADFORD (LTD.)—Reg. Jan. 16, capital £40,000 in £1 shares, to adopt two agreements with Peto and Radford (Ltd.) and P. and R. Storage Battery Co. (Ltd.) and to carry on the business of manufacturers, of and dealers in electricity meters and other electrical instruments apparatus, &c., electricians, accumulator manufacturers, photographers, automatic machine manufacturers, opticians, &c. The subscribers are W. Peto (electrical engineer), F. W. A. Radford (electrical engineer), F. G. Hart (electrical engineer), H. J. Day (electrical engineer), E. Mumford, W. A. Carroll (electrician), and C. W. Marshall.

STATUTORY RETURNS.

AUTOMATIC ELECTRICAL ADVERTISING SYNDICATE (LTD.)—In return to Dec. 21 the capital is £4,500 in £1 shares, all of which have been taken up. £1 per share has been called up on 3,000, and £3,000 has been received. 1,500 shares are considered as fully paid. No mortgage or charges.

SANITAS ELECTRICAL CO. (LTD.)—According to amended return to Aug. 29 (filed Nov. 14) the capital is £4,000 in £1 shares, 3,750 of which have been taken up. £1 per share has been called up on 1,750 shares, and £1,750 has been received. £2,000 is considered as paid on the remaining shares. No mortgages or charges.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—The return to Sept. 30 (filed Nov. 10) gives the capital as £135,250 in 62,000 preference, 33,250 ordinary and 40,000 unclassified shares of £1 each, of which all the preference and ordinary shares have been taken up. £1 per share has been called up on 48,750 preference and 16,250 ordinary shares, and £65,000 has been received. £30,250 is considered as paid on 13,250 preference and 17,000 ordinary. Mortgages and charges, £20,000.

PACIFIC AND EUROPEAN TELEGRAPH CO. (LTD.)—In return to Dec. 15 the capital is £100,000 in £10 shares, all of which have been taken up. £4 per share has been called up, and £40,000 has been received. Mortgages and charges, £100,000.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—According to return to Dec. 31 the capital is £350,000 in £1 shares, of which 204,056 have been taken up. 15s. per share has been called up on 99,056 shares, and £74,179 has been received, leaving £113 in arrears. 105,000 shares are considered as fully paid. No mortgages or charges.

NEW PHONOPORE TELEPHONE CO. (LTD.)—The return to Oct. 14 gives the capital as £10,000 in 9,000 ordinary and 1,000 founders' shares of £1 each, of which 5,111 ordinary and 1,000 founders' shares have been taken up. 10s. per share has been called up on the ordinary and £2,555. 10s. has been received. 1,000 founders' shares are considered as fully paid. No mortgages or charges.

MORTGAGES AND CHARGES.

BATH ELECTRIC TRAMWAYS (LTD.)—Memorandum of satisfaction in full of two mortgages on unpaid capital, dated Aug. 29 and Sept. 15, 1903, securing £10,000 and £15,000 respectively, has been filed.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—A security dated Jan. 1, 1904, to secure an unspecified amount, but stamped to cover £20,000, has been regd. Property charged, company's undertaking and property, including uncalled capital and real, leasehold and personal estates. Holders, E. D. Vaisey and R. J. Moffatt.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Jan. 2 of £1,150 debentures, part of series created June 3, 1896, to secure not more than two-thirds of paid-up capital charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £33,550.

PERTH ELECTRIC TRAMWAYS (LTD.)—A trust deed dated Dec. 30, 1903, to secure £50,000 debentures created by resolution of Dec 22, 1903, has been registered. Property charged, the benefit of certain agreements, deposit, provisional order and acts of Parliament and tramways, plant, machinery, &c., in Perth, W. Australia. Trustees, Lord A. Butler and J. S. Austen.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 16	1,051	+ 336	33	40,909	+ 7,678
Ayr Corporation	,, 9	189	+ 29	34	10,537	+ 100
Barnsley	,, 8	133	- 7	1	158	- 32
Bexley District Council	,, 18	121	...	15	2,387	...
Birkenhead	,, 17	1,004	+ 156	2	1,986	+ 192
*Birmingham Tramways Co.	,, 16	5,022	+ 673	2	10,068	+ 796
*Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 14	275	+ 10	§11	88,519	- 226
Blackpool and Fleetwood	,, 16	159	- 3	3	410	- 51
Blackp'l,St.Anne's&Lytham	,, 14	138	+ 116	‡11	1,590	+ 1,045
Bolton Corporation	,, 17	1,628	+ 195	42	77,145	+ 8,619
Bournemouth Corporation	,, 13	887	...	2	1,744	+ 209
*Bradford Corporation	,, 17	3,416	+ 560	40	157,887	+ 20,905
Brighton Corporation	,, 17	741	+ 97	41	38,496	+ 2,687
Brisbane Tramways	,, 2	2,682	+ 373	22	51,817	+ 849
*Bristol Trams & Carriage	,, 15	4,548	+ 529	8	36,505	+ 1,691
*Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	,, 16	777	+ 127	42	41,822	+ 7,281
Burton Corporation	,, 10	294	...	24	8,576	...
Calcutta Tramways Co.	,, 16	R37,740	+R5,586	3	R117,062	+ R23,046
Camborne-Redruth	,, 18	99	...	11	7,381	+ 3
Cardiff Corporation	,, 16	1,861	+ 465	42	82,403	+ 21,346
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 16	7,057	- 189	3	20,702	- 194
Chatham & Dist. Lt. Rys.	,, 14	515	+ 141	2	1,011	+ 186
City & South London Rly.	,, 17	3,159	- 304	3	9,514	- 746
Cork Electric Trams Co.	,, 14	396	+ 54	2	812	+ 14
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 8	470	+ 89	1	540	+ 41
Dover Corporation	,, 16	170	+ 15	†42	9,520	+ 69
Dublin & Lucan Railway	,, 17	96	+ 16	¶3	221	+ 11
Dublin Southern District	,, 15	717	+ 110	2	1,592	+ 476
Dublin United	,, 15	3,677	+ 355	¶2	7,934	
Dudley—Stourbridge	,, 8	688	+ 14	1	768	- 77
Dundee Corporation	,, 18	780	+ 71	2	1,905	+ 185
East Ham Council	,, 16	585	+ 160	†42	27,949	+ 7,876
Gateshead & Dist. Trams	,, 8	833	+ 48	1	1,038	- 82
Glasgow Corporation	,, 16	12,656	+ 1,998	33	451,961	+ 47,683
Gravesend—Northfleet	,, 8	207	+ 30	1	231	+ 14
Greenock & Port Glasgow	,, 8	502	+ 87	1	599	- 11
Halifax Corporation	,, 6	1,142	+ 16	41	55,826	+ 5,899
	,, 13	1,031	+ 56			
Hartlepool Tramways	,, 8	243	+ 89	1	289	+ 9
Huddersfield	,, 16	1,135	+ 238	2	2,228	+ 818
Hull Corporation	,, 16	1,957	+ 302	†42	79,690	+ 5,592
Ilkeston Corporation	,, 13	115	...	9	1,076	...
Ipswich Corporation	,, 16	307	...	2	2,316	...
Isle of Thanet Co.	,, 16	217	+ 27	...	...	...
Kidderminster & District	,, 8	90	- 11	1	99	- 27
Kirkcaldy Corporation	Dec. 30	207	...	46	8,297	...
	Jan. 6	343				
	,, 13	174				
Lanarkshire Trams Co.	,, 14	486	...	2	1,859	...
Leeds Corporation	,, 16	4,877	+ 444	42	230,400	+ 14,075
Liverpool Corporation	,, 9	9,622	+ 295	2	19,318	+ 284
*Liverpool Overhead Rly.	,, 17	1,569	+ 128	3	4,730	+ 291
*London County Council	...	...	...	...	...	...
Lowestoft	,, 16	136	...	†26	5,917	...
Manchester Corporation	,, 16	10,531	+ 2,684	31	360,797	+ 178,804
Mersey Railway	,, 16	1,395	+ 306	2	4,488	+ 1,269
Merthyr	,, 8	170	+ 11	1	189	- 10
Middleton	,, 8	235	+ 10	1	281	- 37
Newcastle-on-Tyne Corp.	,, 16	3,442	+ 646	2	6,910	+ 1,169
Newport (Mon.)	,, 16	424	+ 264	15	6,542	+ 8,432
Oldham, Ashton & Hyde	,, 8	476	- 28	1	561	- 102
Perth (W. A.) Elec. Trams.	,, 15	1,425	+ 197	2	3,094	+ 462
Peterborough	,, 8	118	...	1	127	...
Poole and District	,, 8	221	+ 18	1	248	- 17
Portsmouth Corporation	,, 16	1,356	+ 277	†42	74,076	+ 4,912
*Potteries	,, 8	1,464	- 10	1	1,623	- 216
Reading Corporation	,, 14	546	...	...	...	...
Rothesay	,, 8	68	+ 17	1	83	- 6
Salford Corporation	,, 18	3,443	+ 815	42	160,578	+ 45,490
Sheerness	,, 6	48	...	1	43	...
Sheffield Corporation	,, 17	4,149	+ 471	3	12,807	+ 1,010
*Southampton Corporat'n	,, 14	855	+ 57	2	1,700	+ 27
Southend Corporation	,, 13	186	+ 19	41	13,412	+ 2,038
Southport Tramways	,, 8	232	+ 26	1	276	- 13
S. Staffordshire Trams.	,, 8	658	- 16	1	737	- 106
Sunderland Corporation	,, 17	1,013	+ 107	42	41,360	+ 2,454
*Swansea Trams	,, 8	450	+ 19	1	511	- 48
Taunton Trams	,, 8	47	- 5	1	53	- 12
Tynemouth and District	,, 8	200	+ 14	1	245	- 17
Tyneside Trams Co.	,, 18	248	+ 90	2	501	+ 112
Wallasey District Council	,, 16	595	+ 111	†42	28,994	+ 3,538
Weston-super-Mare	,, 6	15	- 10	1	15	- 10
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 8	801	- 21	1	833	- 64
Wrexham	,, 8	89	...	1	100	...
Yorkshire Woollen District	,, 8	526	...	1	589	...

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed. Jan. 20	Rate per Cent. Yielded.	Dividend Due	Business Week to Jan. 20 Highest.	Business Week to Jan. 20 Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅞—5	4 17 6	April, Oct	4⅛	4⅞
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
10	10 0	Barcelona Tramways Ord.	7½—8½	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 —96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 —102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	99	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10¾	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 —82	3 12 9	..	..	..
St.	5%	Do. Pref. Ord. Stock	91 —94	5 6 2	..	..	..
10	5/0	† Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝—104⅝	4 6 7	..	..	..
100	4½	† Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	11½—11⅝	6 16 2	..	11⅝	11⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—11⅝	5 2 2	Feb, Aug	11⅝	11⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	123	122½
5	..	Buenos Ayres and Belgrano Ord.	3 —3½	..	..	3⅜	3⅛
5	3/0	Do. 6 per Cent. "A" Cum Pref.	5½—5¾	5 4 0	..	5½	..
5	3/0	Do. "B"	4¾—5¼	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	105⅛	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	100	99½
5	2 6	Calcutta Tramways	6½—7	4 12 10	..	6⅛	6⅛
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 —107	4 4 2	..	..	..
1	1/0	Cape Electric Tramways Shares	1⅝—1¾	9 1 4	..	1⅝	..
St.	4%	Central London Ordinary Stock	91 — 94	4 6 7	June, Dec	94	92
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	4 0 4	..	..	..
St.	4%	Do. Deferred Stock	91 —94	4 8 11	..	..	..
100	4%	† Do. 4 per Cent. Debs.	113 —116	3 9 0	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	4¾ - 5¼	4 15 3	..	4⅛	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	49 —52	6 3 9	Feb, Aug	49⅛	48⅛
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 —129	3 18 7	Feb, Aug	..	..
St.	5%	Do. (1896)	123 —126	4 0 4	..	..	..
St.	5%	Do. (1901)	120 —125	4 1 1	..	122½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	102 —105	4 16 5	..	103⅜	103
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12½ —13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3½—4½	6 13 4	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 —8	3 15 0	..	7⅛	7⅛
10	..	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—14¾	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	3⅛	3⅛
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	11%	Liverpool Overhead Railway Ord.	4⅞—5	2 10 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 16 10	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	97 —99	4 0 9	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11½—11⅝	4 5 1	..	11⅛	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	104½	103½
St.	..	Mersey Con. Ord. Stock	8 —11	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	1—1⅛	4 8 11	..	⅞	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	103 —105	4 17 1	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	106 —108	4 5 1	..	106	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 —102	4 18 0	..	100	..
10	10/0	Potteries Electric Traction Ord.	8½—9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 —94	3 9 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	49 —52	6 1 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	94 —96	6 7 0	F,My,Ag,N	96	94
St.	1/0	Do. Deferred	7⅛—8	0 13 0	F,My,Ag,N	8	7⅛
100	$2	Commercial Cable Capital Stock	175 —185	4 7 0	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 —92	4 7 0	Jn Ap Jy,O	89	..
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2¾—3⅛	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7⅛—8⅛	5 17 8	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅞—101⅛	4 9 1	Jan, July	..	..
20	3/0	Direct United States Cable	10 —10⅛	6 3 10	Ja,Ap,Jy,O	..	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	98 —101	4 9 1	Jn, Dec	..	..
St.	25/0	†Eastern Ordinary	119 —124	5 12 11	Ja,Ap,Jy,O	122	119½
St.	17/6	† Do. 3½ per Cent. Pref. Stock	87 —90	3 17 9	Ja Ap,Jy,O	89	88
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	107	..
10	2/6	†Eastern Extension	10⅞—11⅛	6 4 5	Ja,Ap,Jy,O	11⅛	10⅞
St.	4%	Do. 4 per Cent. Deb. Stock	106 —109	3 14 4	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	99 —102	3 18 10	Feb, Aug	100½	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 11	May, Nov	100½	100
10	5.0	Great Northern of Copenhagen	24½—25¼	4 18 1	Jan, July	25⅜	..
100	4½%	Great Northern of Denmark 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	12 6	Halifax & Bermudas, 1904	37 —40	6 5 0	May, Nov	40	38½
100	6%	Indo-European	98 —102	5 18 3	Mar, Sept	..	..
100	4%	London Platino-Brazil, 6% Debs., 1904	97 —100	4 0 0	June, Dec	..	..
10	4/0	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	5 —6	3 6 8	..	..	..
2½	..	West African Telegraph Shares	⅛—⅜	..	..	..	..
100	4%	West Coast of America	95 —98	4 1 8	Jan, July	..	..
10	..	Do. 4 per Cent. Debs.	⅝—¾	..	May, Nov	..	..
10	8/0	West India and Panama	6 —6½	9 4 8	May, Nov	6⅛	6
10	..	Do. 6 per Cent 1st Pref.	4½—5½	..	May, Nov	..	..
100	5%	Do. 6 per Cent. 2nd Pref.	99 —102	4 18 0	Jan, July	..	..
10	3/0	* Do. 5 per Cent. Debs.	11⅜—12½	5 14 3	Mr,Jn,O,D	12⅜	11⅞
100	5%	Western Telegraph	99 —102	4 18 0	June, Dec	..	..
St.	4%	* Do. 5% Debs. (2nd Series, 1906)	98 —101	3 19 3	..	..	..
		Do. 4% Deb. Stock (red.)					
		FINANCIAL, INVESTMENT, &c.					
5	3/0	†Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8¼—8½	4 11 5	Ja Ap Jy O	8⅛	8⅛
10	2/0	Do. 6 per Cent. Pref	12⅛—13	4 12 4	Ja Ap,Jy,O	12⅛	12⅛
		Reuter's	6⅞—7⅛	5 6 8	April, Oct	..	..
		Submarine Cables Trust (Cert.)	118 —123	4 18 9	April, Oct	118	—
		TELEPHONES.					
5	6/0	Chili Telephone (fully paid)	4¾—5½	5 14 3	August	..	..
St.	6%	National Co. Pref. Stock	102 —104	5 18 0	..	..	103
St.	5%	Do. Def. Stock	77 —80	6 2 10	..	..	78½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13 —14	4 5 9	Feb, Aug	14	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5½	4 15 3	Feb, Aug	5⅜	5
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 —97	3 12 2	June, Dec	96½	96
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	100 —102	3 18 5	..	101⅛	101
1	0/7½	Oriental	¾—1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
5	3/0	United River Plate	5½—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 - 105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Greenwich. Dist. Ord.(f.p.)	¾—1	..	..	..	..
1	..	Do. 7% Cum. Pref.	1⅛—1⅜	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	114 —117	3 17 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½ - 13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1stDebs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10 —10½	4 5 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	9⅜—10½	3 8 4	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	6¼—7½	4 6 8	..	..	..
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	106 —109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	8⅜—9½	5 8 1	Feb, Aug	8⅛	8⅛
5	2/3	Do. 4½ per Cent. Pref.	5½—5⅝	3 18 3	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜—5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 —105	3 16 3	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5½—6	4 3 4	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	105 —108	4 3 3	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10½—10⅝	6 19 6	Feb, Aug	10⅝	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅛	13⅛
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec	124½	124
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	103½	..
10	4/0	County of London & Brush Prov. Ord.	7½—8½	4 14 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	11⅝	11⅛
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 1 10	..	109	108½
St.	27/6†	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5½—6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 7 5	..	..	..
10	..	Havana Electricity Co. Shares (£8 paid)	7½—8½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	11 —12	4 3 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
5	..	London Electric Supply Ord.	1⅞—2½	..	..	1⅛	1⅛
5	3/0	Do. 6 per Cent Pref.	5½—6	5 0 0	..	5⅜	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	97 —100	4 0 0	Mr,Jn,S,D	97⅛	..
10	8 0	Metropolitan Electric Sup. Ord.	17—18	4 6 1	April, Oct	17⅛	17⅛
5	..	Do. 4½ per Cent. Cum. Pref.	5¼—5⅝	..	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 4	..	..	..
100	4½	Midland Elec. Corp. for P.D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6 0	Notting Hill Electric Ord.	12½—13½	4 8 11	March	13⅛	13
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5½—5¾	4 15 8	March	..	..
St.	4%	† Do. 4% Deb. Stock	97 —100	4 0 0	..	..	..
1	..	Rand Electric	⅞—1⅛	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½—15½	4 13 9	Feb, Aug	15	..
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	98 —101	3 10 4	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3 —3½	3 11 5	..	3⅜	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	85⅜	85⅛
5	1/9	South London Electric Supply Ord.	3½—3⅝	4 13 4	..	..	..
5	2/6	Urban Electric Supply Ord.	4½—5⅛	4 17 7	..	..	..
5	2,6	Do. 5% Cum. Pref.	4½—5⅛	4 17 7	..	..	..
5	6/6	Westminster Electric Supply Ord.	12½—13⅛	4 16 4	Mar, Sept	13	12⅞
5	2/6	† Do. 5 per Cent. Cum. Pref.	6 —6⅛	3 16 11	..	6	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½—⅝	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	1/16—⅛	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	103 —105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	4 —4½	6 13 4	..	4½	4⅜
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 3 4	..	95	94
2	..	Brush Electrical Engineering	2—2½	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼—1⅝	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	75 —80	5 12 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	11 —12	6 5 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	5⅜	5⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	90 —95	4 15 3	..	..	..
1	0,7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March	..	..
1	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	7 10 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	97⅞—100⅞	5 0 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8½—8¾	..	..	..	..
5	..	Do. 6% Cum. Pref.	5½—5¾	..	..	5⅜	..
St.	4½%	Do. 4½% Deb. Stock	103—105	4 5 9	..	..	..
5	..	Edison & Swan United("A"Sh.)(£8 pd.)	¼	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	¾	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	2/6	†Edmundson's Elec. Corp. Ord.	6 —6½	5 7 8	H'lf-yearly	6⅛	..
5	3/0	Do. 6 per Cent. Cum. Pref.	6 —6½	4 12 4	..	..	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 4 11	..	..	..
2	1/2½	Electric Construction Co.	1⅝—1⅞	6 8 0	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	98	..
1	..	Electrolytic Alkali Ord.	½—¾	..	..	..	..
1	7½	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 —98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	13½—14½	6 17 11	Feb, Aug	14½	14⅛
5	2/3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	18⅞	18⅜
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10⅜—11½	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33 —36	6 13 4	Mar, July	35	33
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 —103	3 17 8	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	4½—5⅛	5 18 2	Apr, Oct	4⅛	..
5	2/0	Do. 6 per Cent. Cum. Pref.	5½—6	5 0 0	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 5	May, Nov	..	..

Provision has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

IN connection with evidence which has been given before the Royal Commission on London Traffic referring to the establishment of a new tribunal for the control of all matters relating to traffic and for the curtailment or total abolition of the veto now enjoyed by the local authorities, it is interesting to note an experience recently undergone by the London United Tramways Company. This company is desirous of constructing a tramway from Ealing Broadway to Brentford High-street, a distance of about 2 miles, thus joining the Thames Valley and Uxbridge lines, and for this purpose a Bill has been promoted. Currency has been given to the statement that the company was by no means anxious to carry out this work, but that residents in the neighbourhood urged the desirability of such an undertaking, and the company therefore set its hand to the plough in spite of the high estimated cost of the line—£40,000 per mile. Possibly owing to the idea thus getting abroad that the company were philanthropists, the Ealing Town Council and the Brentford Urban District Council, whose assents had to be obtained to conform with the Parliamentary Standing Orders, thought that the company might be disposed to extend their generosity. The Ealing Town Council fixed the price of their consent at £7,000.

THE Brentford Urban District Council preferred capital payment in kind, and an annual contribution as well. They offered their consent to the two-thirds of a mile within the urban district of Brentford on the following terms:—The provision at Kew Bridge of such a public lavatory and convenience as the Brentford District Surveyor may design, the construction of a subway for foot passengers at the same point, the widening of the High-street to 80ft. for the very considerable distance between the waterworks and Ealing-road,—all these things to be carried out at the company's expense,—and, in addition, an annual contribution to the Council of £1,000 at the least was demanded. But this is not all. If the company should proceed with other proposed extensions (not in Brentford, but likely to increase the traffic through that district), the Council will oppose the Bill unless the High-street be widened to 80ft. throughout its entire length. Such instances as these are far more eloquent than any number of expert witnesses in favour of the establishment of the proposed new tribunal.

THE adjourned discussion on Mr. MCMAHON'S Paper took up more than the normal time of a meeting, but was far from exhausting the subject matter. The Council of the Institution has marked its appreciation of the two excellent Papers for which we are indebted to Mr. MCMAHON by presenting him with the Willans' premium, and the great majority of members of the Institution will ungrudgingly approve of the Council's award. It is noteworthy that, during the course of the discussion, no one impugned the method of distribution which is shown to give such excellent results, or suggested that polyphase transmission and rotary converters would be preferable. The reason is simple: The City and South London figures are unapproachable on that side. If it were possible to get the capital expenditure on the distribution system it would be seen that the total economy (*i.e.*, that including capital charges) is comparatively even better than the distribution efficiency. Mr. HOBART criticised the use of the batteries but hardly seemed to appreciate the difference between the economic value of a battery as ordinarily employed in an electric lighting station, a "floating" battery, and one assisted by the Highfield booster. The curves in the Paper hardly do the battery arrangement full justice, because—as Mr. MCMAHON explained—he prefers to keep the battery well charged and available for keeping his service going in case of need rather than to obtain from it the maximum regulating power.

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PROF. CARUS WILSON'S objection to the earthed middle conductor seems to have been induced by a one-sided consideration of fire risks. The lessons of the Liverpool and the Paris tunnel disasters must not be overlooked, but it is by no means clear that the existence of an earthed return had any direct causative influence in either case. The Liverpool accident was rather due to unfortunate persistence in running with a faulty armature. The earthed return or middle wire is, in fact, a very valuable fault detector, and it is much safer to have every fault in train equipments shown up as soon as it occurs than to have faults masked until others—perhaps on distant trains—appear and cause a complication of troubles. The great safety as against shock, of having every conductor at a known and definite potential in relation to the earth, is of inestimable importance. The remarks of one speaker, that such an arrangement on a tramway would render more difficult the observance of Board of Trade regulations as to drop and difference of potential between returns and pipes, seems almost to involve the proposition that a difference of two quantities may be greater than the sum. There is only one conceivable condition in which rail drop would be greater with the three-wire than with the usual method of working—and it is one that could very easily be prevented. The real difficulty about three-wire working on tramways is that of insulation, especially at "crossings," and until a real and lively demand arises this difficulty is not likely to be overcome.

AT a time when one hears grumbles on every hand regarding the depressed state of British trade, when directors of manufacturing concerns complain of keen competition and defer any declaration of dividend until the end of the 12 months' working, and when the proposed change in the Fiscal Policy of the country is the principal topic of conversation—at such a time as this it is interesting and instructive to observe the state of affairs existing in other countries whose foreign trade consists of imports only. Egypt is a case in point; it is not, and probably never will be, a manufacturing country, but the opportunities open to foreign manufacturers are very considerable, especially in connection with electrical work. The *Egyptian Gazette* points out that large developments in telegraphy, lighting and traction are taking place, and that the demand for finished products is constantly increasing. British manufactures are recognised as the best, but their high price and inaccessibility often stand in the way.

IT is said that the only country that can compete with Great Britain in traction material is the United States, but the latter is handicapped by its distance from Egypt, which involves higher freight rates and longer time in delivery. American manufacturers also appear to be more difficult in the matter of credit than their British cousins, but their general methods of business have been developed to a very high state of efficiency. American firms are said to be represented on the spot by agents who will supply complete sets of designs and catalogues, and who will quote prices on the shortest possible notice for articles to be delivered within four weeks of the date of order. But in doing business with a British firm it is necessary to enter into a lengthy correspondence, which entails delay in delivery, and other disadvantages.

AS an indication of the present tendency towards extending the areas of individual electricity supply undertakings and the absorption of their smaller neighbours, the proposal of the Blackheath and Greenwich District Electric Light Co. to take over the Crystal Palace District Electric Supply Co.'s Provisional Order is not without interest. The Blackheath and Greenwich District Electric Light Co., under sec. 6 of their 1903 Act, are empowered to acquire either part or whole of the Crystal Palace Company's undertaking, and the Board of Trade has just signified its approval of the system proposed in the event of the former company deciding to take the steps provided for in the Act. High-pressure two-phase current at 50 ~ per sec. will be generated at the Blackheath and Greenwich Company's works, and distribution will take place from sub-stations in the Crystal Palace district, at low pressure, either on the two-phase or single-phase two-wire system. The station of the Crystal Palace District Company, it will be remembered, was one of the old J. E. H. Gordon works, and was started in 1893 as one of the first high-pressure continuous-current schemes. It has, we believe, never proved extremely successful from a financial point of view, and as a final disaster it was almost completely wrecked by a boiler explosion in 1900. Since then, however, the works have been reconstructed and have been running well, but the necessity for a complete shut-down for some time after the explosion seriously hampered the progress of the undertaking. The Blackheath and Greenwich District Company holds Provisional Orders for Lewisham and Penge in addition to its own Blackheath and Greenwich area. These had been obtained by the respective Urban District Councils in 1901, but have so far remained undeveloped, so that the area of the company's operations will now be fairly wide.

SIR WILLIAM WHITE made some interesting remarks when presenting prizes to the students of the City and Guilds of London Institute on Monday. On such an occasion he was in duty bound to refer to the oft-repeated complaints as to the backwardness of this country in the matter of higher technical education. In a manner, peculiarly English, he said, there had been a marked tendency to depreciate unduly what we possessed and what we had done. At the same time, it was absolutely necessary, in view of the advancement of technical education abroad, that a new departure should be made here. What was wanted was co-ordination of educational agencies on a carefully-considered plan. If the best results were to be obtained, there must be conferences between teachers and the representatives of the professions, businesses and manufactures, and he would be extremely hopeful of the results which would follow the work of any advisory committee containing representatives of all the great engineering associations in this country. A permanent advisory committee of this nature would be of considerable value; and it will be remembered that a somewhat similar suggestion with regard to the organisation of science teaching in this country was made by Sir NORMAN LOCKYER in his presidential address to the British Association last year. Sir WILLIAM WHITE'S proposal, however, appears to be more practical and easier of fulfilment, and, coming as it does from one of our most eminent engineers, who also may be regarded as representing the Institution of Civil Engineers, it deserves the careful consideration of the Government.

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Personal.—Lord Rayleigh has been created a foreign knight of the Prussian Order "Pour le Mérite."

The Post Office Telephone Service.—A new telephone exchange on the Post Office metropolitan telephone system was opened at Croydon on Tuesday.

Russia and Japan.—The *Electrical World* of New York states that the Japanese Government has ordered back to Japan 12 of the 15 Japanese engineers who are at the Westinghouse Electric Co.'s works at East Pittsburg.

Royal Academy of Sciences of Turin.—The Milan correspondent of the *Daily Telegraph* states that the yearly prize of £1,200 offered by the Royal Academy of Sciences at Turin for the advancement of physical sciences has been divided between Signor Marconi, for his discoveries in wireless telegraphy, and Prof. Grassi, of the Roman University, for his researches into the causes and cure of malaria.

Watt Anniversary in Glasgow.—Last Saturday the James Watt anniversary dinner was held by the Institution of Engineers and Shipbuilders in Scotland at the Windsor Hotel Glasgow, Mr. James Gilchrist presiding. More than 300 representatives of science, engineering and shipbuilding were present, among them being Mr. R. Kaye Gray, president of the Institution of Electrical Engineers.

County of Durham Electric Power Supply Co.—In the supplement of the electric power companies of the United Kingdom, which was published with our issue of January 22nd, a slight mistake occurred in the description of the area covered by the County of Durham Electric Power Supply Co. As a matter of fact, the company has no authority to supply in the towns of South Shields or Sunderland, but it has authority to supply in the rural districts of South Shields and Sunderland.

Radium Ore.—Reports with little or no confirmatory data are being circulated stating that further sources of radium ore have been discovered. One statement attributed to Mr. R. Spiegel by the *Daily Chronicle*, states that he has discovered appreciable quantities of radium in samples taken from some of the slag heaps of Swansea, and a Laffan telegram from New York announces that vast quantities of earth containing radium have been discovered at Llano, Texas.

Electric Driving of Printing Machinery in the Bank of England.—Experiments have been carried out at the Bank of England for some time with a few electric motors for driving the printing machines, and so successful have these proved, that a complete change is now being made to electric driving for all the printing and other machinery in the Bank premises, including the deep-well pump. The work is being carried out under the supervision of Mr. Bernard M. Drake.

High-speed Electric Railway Experiments in the United States.—The *Morning Post* states that the New York Central Railway is arranging for an exhaustive test of a new kind of electric engine, said to be capable of drawing a full passenger train at the rate of 135 miles an hour. A special stretch of track, 9 miles long, near Schenectady is being prepared, and the tests will take place within a fortnight. If successful, the engines will be adopted by the railway in place of the present steam locomotives.

U.S.A. Cable Enterprise.—The United States Government have laid military cables from Skagway (Alaska) to Sitka, and from St. Michael (Yukon) to Safety Harbour, near Fort Davis. They also propose to lay cables from Vancouver (British Columbia) to Queen Charlotte Islands, thence to Sitka and on to Valdes, whence a landline exists to Eagle City, with a branch to Rampart, and on to St. Michael. There are, in addition, landlines from Eagle City along the frontier between Alaska and British Columbia, which also possesses landlines connecting the principal towns in the interior.

Northern Polytechnic Institute.—On Thursday, January 21st, the prizes gained by the students of the Northern Polytechnic Institute during the session 1902-1903 were distributed by Mr. A. M. Torrance, J.P., Mayor of Islington. In presenting the report, the principal of the Institute drew attention to the encouraging increase in the number of students, particularly in the engineering and workshop classes, and touched upon the appreciation which various firms showed towards students of the Institute. A new departure had been made in the form of a senior technical day school for engineers, architects and builders. After the meeting the Institute was opened for the visitors' inspection.

Large-scale Electricity Distribution in Switzerland.—According to the *Schweizerische Elektrotechnische Zeitschrift* the large water-power station of the Compagnie Vandoise des Forces Motrices des Lacs de Joux et de l'Orbe has recently been completed, and supplies no less than 190 municipalities with light and power. The station is situated near Vallorbe (Switzerland), and derives its power (10,000 H.P.) from the water which flows from the Lac de Joux, the useful head being 780ft. Current at a pressure of 13,000 volts is generated by Oerlikon generators, and is distributed at this voltage over the supply area.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903 ..	—
Gibraltar—Tangier	Jan. 18, 1904 ..	Jan. 19, 1904
Tarifa—Tangier	Jan. 18, 1904 ..	—

Royal Meteorological Society.—The annual general meeting of this society was held last week at the Institution of Civil Engineers, Capt. D. Wilson-Barker, F.R.S.E., president, in the chair. The report of the Council, which was read by the secretary, described the work carried out by the Society during the past year, and showed that there was an increase in the number of Fellows. One remarkable feature was that out of 13 deaths reported, four of the Fellows had reached the great age of 92 or more years. The Symons gold medal for 1904 was awarded to Hofrath Dr. Julius Hann of Vienna, in consideration of his eminent services to the science of meteorology. Count L. Széchenyi, first secretary to the Austro-Hungarian Embassy, attended and received the medal on behalf of Dr. Hann. At the conclusion of the meeting, the officers and Council for the ensuing year were elected.

Safety Devices on the Berlin Underground Railway.—The additional devices on the Berlin electric underground railway, which were ordered in consequence of the Paris disaster, have, according to the *Zeitschrift für Electrotechnik*, been practically completed. A second and quite independent lighting circuit has been installed in the tunnels. Water hydrants and sand boxes have been increased in number, and each carriage is supplied with a sand box and hand pump. Hand pumps are also placed every 375ft. in the tunnels. Each underground station is connected directly to the fire-alarm circuits. Curtains made of impregnated wool are to be employed in the cars, and they are specially prevented from coming into contact with the emergency lights. A short circuiting device is provided which may be actuated from the motor cab or from the interior of the carriage.

High-Speed Trials in Germany.—A Reuter telegram from Berlin states that, in the Budget Committee of the Reichstag on Tuesday the question of the fast electric railway travelling was raised. Herr Budde (Minister of Public Works) said that the matter was still in its preliminary stage, and that in connection with the project the principles of suspension railways and monorail systems came under consideration. As regarded fast travelling, only preliminary experiments had been made, and he could not authorise the use of such railways for travellers generally. It was also very far from clear whether the scheme would be practicable from economic points of view. The trials would be continued with due caution, and in the meantime the experiments on the line between Berlin and Grosslichterfelde were giving very favourable results. The Prussian Government would take all possible advantage of the results of these trials.

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Physical Society.—Among the Papers presented at a meeting of the Physical Society on January 22nd was one by Mr. S. Skinner on "The Photographic Action of Radium Rays." The Paper was taken as read, and the following is the official abstract:—

It is well known that a photographic plate by exposure to radium rays is affected in such a way that the plate develops similarly to its development after exposure to light. The experiments described in the Paper are an attempt to answer the question: Are the actions the same? As far as can be seen, the final results of the actions and developments are the same, and the experiments appear to indicate that only slight differences occur in the early stages. The plates, suitably enclosed, were subjected to the rays from varying quantities of radium bromide for varying times, and the results showed that the intensity of the developed image increased rapidly to a maximum value with increase of exposure, then decreased, first, rapidly, and finally very slowly until a stage was reached in which there was practically no dark image formed on development. It is found that spark images are at first obliterated by radium rays which do not cause such a great density as that of the spark images obliterated, and that with prolonged exposure the radium rays reverse the spark images.

The Jandus Arc Lamp Patent.—The Jandus Arc Lamp and Electric Co., of Manchester, seeks leave to amend the specification of patent No. 15,479 of 1893, granted to L. E. Howard for "Improvements in Electric Arc Lamps." The proposed amendment refers wholly to the wording of the patent. References to comparative efficiencies of "Jandus" and ordinary arc lamps and to the voltages for which they may be used are to be deleted. The various reasons given for placing the arc high up in the globe are to be omitted, and the references and reflections regarding the luminosity of the gases surrounding the arc are to be very much shortened. In consequence, claims 2, 3 and 4 of the original specification will be deleted from the amended one. Claim 15, too, is to be omitted. In the original specification it reads thus:—

In an electric arc lamp the combination with the positive electrode, of an enclosing globe, and a hood, closely fitting the open top of said globe and provided with a metallic guide in open communication with the atmosphere through which said moveable electrode is made to pass for the purpose described.

Photography of Electrical Phenomena.—An interesting lecture on the above subject, illustrated by numerous lantern slides, was delivered by Dr. George Rodman at the Camera Club last Monday. Making use of his Röntgen apparatus, Dr. Rodman said that he had photographed numerous electric discharges and groups of coins arranged in various positions on a sensitised plate. The photographic plate was supported by a larger glass plate, underneath which was placed a metallic plate. One or more of the coins and the plate of metal were connected in various combinations, by means of wires to the terminals of the induction coil. When a spark was produced the discharge radiated from one coin to the other and spread over the photographic plate and, on developing, not only were the characteristic and fantastic forms of the discharge brought to light, but that side of the coin which rested on the sensitised plate had been reproduced, in some cases very clearly. No explanation was offered by the lecturer of the latter phenomenon.

Electrical Equipment of the Great Western Railway.—In connection with the proposed "electrification" of the Hammersmith and City line of the Great Western Railway, our previous announcement that the contract for the boilers has been let to Messrs. Babcock and Wilcox is now confirmed. The Electric Construction Co. will supply the 6,600-volt three-phase generators, which will be driven by Belliss engines. These engines will be of Messrs. Belliss and Morcom's high-speed standard design with forced lubrication. They will be eight in number, and each will develop 1,080 B.H.P. at normal load and 1,250 B.H.P. at maximum load. The engines will be of the triple-expansion three-crank vertical enclosed type, to work at a steam pressure of 190lb., and with 500°F. superheated steam at the stop valve. Very stringent conditions are attached to the contract with regard to governing and steam consumption. In addition to the eight large sets there will be two auxiliary engines and dynamos for lighting and power work, one set to drive a three-phase generator, the other to drive a continuous-current dynamo. The engines in this case will be of the Belliss two crank compound design, and similar in many respects to the large engines; they will also work under superheated steam. Messrs. Belliss and Morcom will also supply four surface-condensing plants, each condenser having 4,200 sq. ft. cooling surface, with a two-crank vertical side-by-side compound engine driving an Edwards air pump. The circulating pump will be of the centrifugal type directly driven by a small three-phase induction motor. Messrs. Kennedy and Jenkin are the consulting engineers.

Cooper-Hewitt Lamp.—Dr. Max von Recklinghausen lectured on Thursday, January 21st, at the Camera Club, on "Mercury Vapour Lamps and their Application to Photography." Just before the commencement of the lecture the chairman, Mr. James Swinburne, was photographed in the light of two 60-volt 3-ampere Cooper-Hewitt lamps which were hung at an approximate distance of 4ft. from him, the exposure lasting about half a second. No photographic precautions regarding the distribution of light were observed, and the result was that when a print of the negative was pinned to the blackboard an hour afterwards it resembled an attempt at a black-and-white sketch more than anything else. However, the test proved the effect of the rays on sensitised photographic material. After tracing in a few words the history of the mercury lamp, the lecturer dealt at some length with its theory and construction, and then discussed its suitability for photographic purposes. Nearly all the details touched upon by the speaker have been published in *The Electrician*, Vol. XLVII., pp. 50, 934, 946; Vol. XLVIII., p. 743; Vol. XLIX., p. 393; Vol. L., p. 509; Vol. LI., p. 917. When run at normal current densities the spectrum of the lamp consists of well-defined lines of yellow, green, blue and violet, with very little red, but when the lamp is forced and overrun the red lines become more prominent. Two 60-volt 3-ampere lamps of the tilting type were connected in series to the 100-volt supply available in the lecture room. Occasionally they failed on account of low pressure, but glowed between interruptions quite steadily. An animated discussion, mainly touching on photographic subjects, followed the lecture.

Generating Station Flooded.—Apropos of the note bearing the above title which appeared in *The Electrician* of January 8th, we have received the following from the British Thomson-Houston Co.

Before the late South African war, there were installed in the Knights Deep Mine in Johannesburg, by the South African General Electric Co., 12 three-phase 50 H.P. slow-speed induction motors, and 36 15kw. type H transformers, for operating pumps, all manufactured by the General Electric Co., of Schenectady, U.S.A. When the war broke out, it was found impossible to remove the pumps, motors and transformers before allowing the shaft to fill up with water, and consequently they were left under between 500ft. and 1,000ft. of water. Two and a-half years later, when peace was declared, the shaft was emptied of water and the apparatus removed to the surface. Three of the motors were completely re-wound in the Johannesburg repair shop of the South African General Electric Co., but the others were simply dried out in an oven heated by steam coils and then soaked in oil. This was done as an experiment to see whether the insulation had perished, and, contrary to expectation, it was found that these motors had not suffered during their immersion sufficiently to make it necessary to re-wind them, and they were put back into service after having undergone the treatment mentioned. Then the type H transformers which had been under water were treated in the same way, and it was found that they also did not need re-winding. Shortly after some of them were put back, six out of nine 50kw. transformers of another manufacture, which had never been in service and which were new, burned out just after having been installed. These new transformers were promptly replaced by an equivalent number of type H General Electric transformers which had been under water and operated satisfactorily under the same conditions caused the transformers of another make to burn out. An order for nine 50kw. transformers to replace all of those furnished by the makers of the burned-out transformers was given to the South African General Electric Co. on the splendid showing made by their apparatus.

——At a flood in Des Moines, U.S.A., water rose in the power house of the Des Moines City Railway Co. 2ft. above the engine-room floor, soaking for 30 hours both 1,000kw. 575-volt railway generators nearly up to the engine shaft. As soon as the water was pumped out steam radiators were put in the generator pits and salamanders placed near the generators on the engine-room floor. The engines were run at half-speed for one or two days until the generators seemed to be perfectly dry on the surface. Then the armatures were short-circuited with full-load current through the switchboard ammeter, the shunt fields being separately excited from an 80-volt generator, and reversed with reference to the series field. The field coils were so saturated with water that they acted like water rheostats, and as much as five times the normal current was applied before they were warmed up. As the water was driven out from them the resistance increased and the current was gradually reduced. After running for a few days with full-load current on the armature,

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the current was increased to 50 per cent. overload or to about 2,500 amperes. This warmed up the armature very well, but the commutators of these machines remained so remarkably cool that even this current did not heat them sufficiently to drive out the moisture that had soaked in. Salamanders were placed in the generator pits, and sheets of asbestos were used as deflectors to throw the heat from the salamanders on to the iron ring of the commutator spider, and to protect the engine eccentric, the brush-holder rigging and commutator from the heat. This scheme proved very effective. Every other bolt was taken out of the commutator clamping flange, in order to allow the moisture and steam to pass out through the bolt holes. Practically all the machinery has been put in running condition again.

Fire at Salford Generating Station.—The fire, reported on p. 512 of *The Electrician* of last week, which broke out at 8 a.m. on January 17th at the Salford Corporation electricity works, started amongst the cables conveying current generated by the 800kw. machines to the traction switchboard. The cause of the fire cannot be stated with any certainty, but it appears likely to have been due to the failure of a shunt-wire, the arcing caused thereby setting fire to the larger cables; these cables were all rubber-covered and braided, and the fire spread with great rapidity. The engineer-in-charge, as soon as he found the cables ablaze, shut down all the machines and endeavoured, by the application of sand, to overcome the flames; finding, however, that they were still making headway, he telephoned for the fire brigade, who arrived within four or five minutes of receiving the call. The firemen, directed by the chief of the fire brigade and the engineer-in-charge, applied the water with good effect, and in half an hour the flames were extinguished. An examination of the switch room and balancer room, which is situated immediately beneath the first-mentioned room, showed that the whole of the rubber cables which feed the throw-over switches controlling the supply to the lighting and traction boards respectively had been entirely destroyed as far as machines 1 to 4 were concerned. The connections to both switchboards from these four throw-over switches were also rendered useless, as were the rubber tail ends of the traction feeders. Several panels on the traction switchboard itself were damaged, and most of the wiring was destroyed, in addition to the shunts of the wattmeters and ammeters and the Board of Trade panel. The connections on the lighting switchboard were not damaged, with the exception of the leads from the throw-over switches mentioned above; when these had been cut away, the lighting and power supply was resumed. It then remained to remake the connections to and on the traction switchboard. Owing to the heavy section of the cables required, this was a work of considerable magnitude, there being some 2 tons of copper required, all in short lengths. Current was supplied temporarily by the Manchester Corporation to the Salford system, by connecting together the trolley wires of the two towns by means of jumpers. The rearrangement of the traction switchboard was completed by 3:45 a.m. on the Monday, in ample time for the full service of cars to be run out at the usual hour. The damage is estimated at about £1,500, and is covered by insurance. Although the fire brigade extinguished the fire in the ordinary way, very little damage was done to the plant in the balancer room, owing to the careful manner in which the hose pipes were directed. The fire demonstrated the danger which may occur where a large number of rubber-covered cables are used, even when the cables—as in this case—are carefully cleated up and arranged, and are all in view. The cables which were burnt were constantly subject to a temperature of 70deg. or thereabouts, and so were in a very dry condition.

Electrical Engineers Volunteers.—At the headquarters of the Electrical Engineers (R.E.) Volunteers on Wednesday evening, Major Pitt, R.E., unveiled a tablet which has been erected in memory of the members of the corps who died in South Africa during the late war. A detachment of the corps formed a guard of honour, and, in addition to a number of friends of those who died and some ex-members of the corps, there were present Mr. R. Kaye Gray, president of the Institution of Electrical Engineers, Col. Crompton, C.B., Major Erskine and Major Lloyd, R.E. Having been introduced by Col. Crompton, Major Pitt said that they met that evening with mingled feelings of regret and pride, regret for their comrades who had given their lives in South Africa, and pride that they had done their duty to their country and died for it. In South Africa the Electrical Engineer Volunteers had fought as only the best of soldiers could possibly have fought. In proportion to its strength the corps had sent out the largest number of any volunteer corps, but in justice to the other regiments it should be pointed out that the Electrical Engineer Volunteers were specially asked to send out several detachments on account of the usefulness of the work carried out by the first body of members who went to South Africa. He greatly regretted that Dr. John Hopkinson, the founder of the corps, had not lived to see what it had accomplished. He certainly could not have expected that it would have been called upon for active service so soon, but he would not have been surprised at the results. Major Pitt then briefly referred to the engagements in which the various detachments of Electrical Engineer Volunteers took part, and the rewards bestowed in consequence. Personally, he said he would have liked to see the names of all who went to South Africa engraved upon the walls of the headquarters of the corps, but the great number precluded the possibility of this. Of the eight members who died, seven succumbed to enteric fever and the other was killed in a railway accident. He then unveiled the memorial, which is a rectangular sheet of gunmetal, with raised letters having burnished faces, inscribed as follows:—

In memory of Second-Corporal A. Holdaway, Sappers E. C. Short, F. C. Weakley, E. J. West, F. Kelly White, C. H. Richardson, S. Foxcroft, J. P. Allen, who died on active service, South African war, 1900-1901-1902.

The tablet bears the badge of the corps. Major Erskine thanked Major Pitt for unveiling the memorial, and the ceremony ended.

The Chelmsford detachment of the Electrical Engineers (R.E.) Volunteers held a dinner at Chelmsford on Saturday. Major Erskine, the commanding officer, was in the chair, supported by Capt. Phillips and Sergeant-major Gunn, from headquarters, Sergeant Rook, senior non-commissioned officer of the Chelmsford corps, and others. Over 50 members were present out of a roll of 60. During the evening Capt. Phillips stated that the War Office were about to give the corps some submarine mining apparatus with which to practice.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

FRIDAY, January 29th.

ASSOCIATION OF TECHNICAL INSTITUTIONS.

10:30 a.m. Annual Meeting at the Leathersellers' Hall, London, Sir John Wolfe Barry, F.R.S., in the chair. An address will be delivered by the president-elect, the Right Hon. Sir John E. Gorst, M.P.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, Westminster. Lecture by Mr. A. P. Head on "Metallurgy as Applied in Engineering."

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Extra Meeting at Storey's Gate to discuss the "Sixth Report to the Alloys Research Committee on the Heat Treatment of Steel," by the late Sir W. C. Roberts-Austen, F.R.S., completed by Prof. William Gowland.

TUESDAY, February 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7:30 p.m. Meeting at Owens College. Paper to be read: "Steam Turbines," by D. Chilton.

FARADAY SOCIETY.

8 p.m. Meeting in the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W., when the following Papers will be read: (1) "Notes on Aluminium Welding," by Sherard Cowper-Coles. (2) "Some Applications of the Theory of Electrolysis to the Separation of Metals from one another," by A. Hollard.

WEDNESDAY, February 3rd.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Visit to the Plumstead Electricity and Destructor Station of the Woolwich Borough Council.

LONDON ELECTRICAL CONTRACTORS' ASSOCIATION.

6 p.m. Meeting at the Holborn Restaurant. Paper to be read: "On the Rights and Liabilities of Electrical Contractors under the Electric Lighting and other Acts," by R. Tweedy Smith.

THURSDAY, February 4th.

RÖNTGEN SOCIETY.

8:*30 p.m.* Ordinary Meeting at 20, Hanover-square, W. Discussion evening. Subject: "Production of Photographic Reversal through the action of various Radiations."

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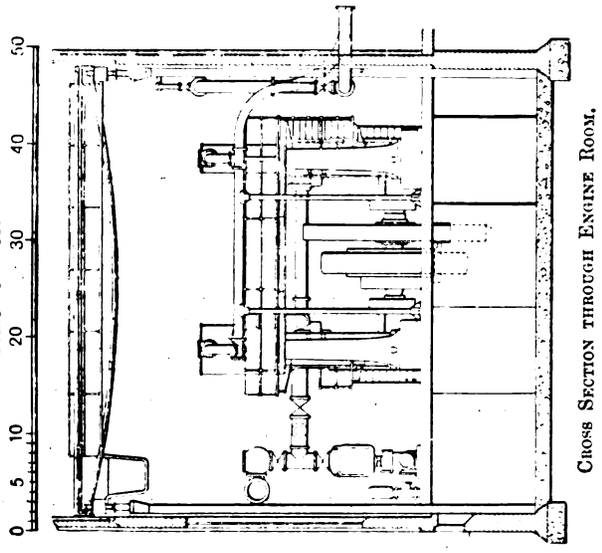
THE GREAT NORTHERN AND CITY RAILWAY.

In our issue of January 15th, we published some details relating to this railway, which will probably be open to the public next week. We are now able to give further particulars, as well as drawings and photographs illustrating various features of the undertaking.

An Act of Parliament was obtained by the promoters in 1892 and Sir Douglas Fox and Partners, in conjunction with the late Mr. J. H. Greathead, were appointed consulting engineers. The construction of the line, however, was not commenced until 1899, and from that time up to the present moment work has been going on continuously. As a matter of fact, the section from Moorgate-street to Drayton Park has been completed for some considerable time and trains, driven from the Poole-street generating station, were actually running more than twelve months ago. In spite of this, it was decided not to open the railway for public traffic until it was completed quite through to Finsbury Park, one of the reasons, it is reported, being that if any portion of the line had once been thrown open to the public it would have no longer been legal to pay interest out of capital, as provided by the Act.

A sum of £2,080,000 was allotted to applicants for shares and debentures, the latter representing a quarter of the whole capital. Messrs. S. Pearson & Son (Ltd.) secured the contract for the entire construction and equipment of the railway, and they will work it for a period of three years from the date of opening. The new railway runs on what is practically a straight line from Finsbury Park to Moorgate-street, and



Cross Section through Engine Room.

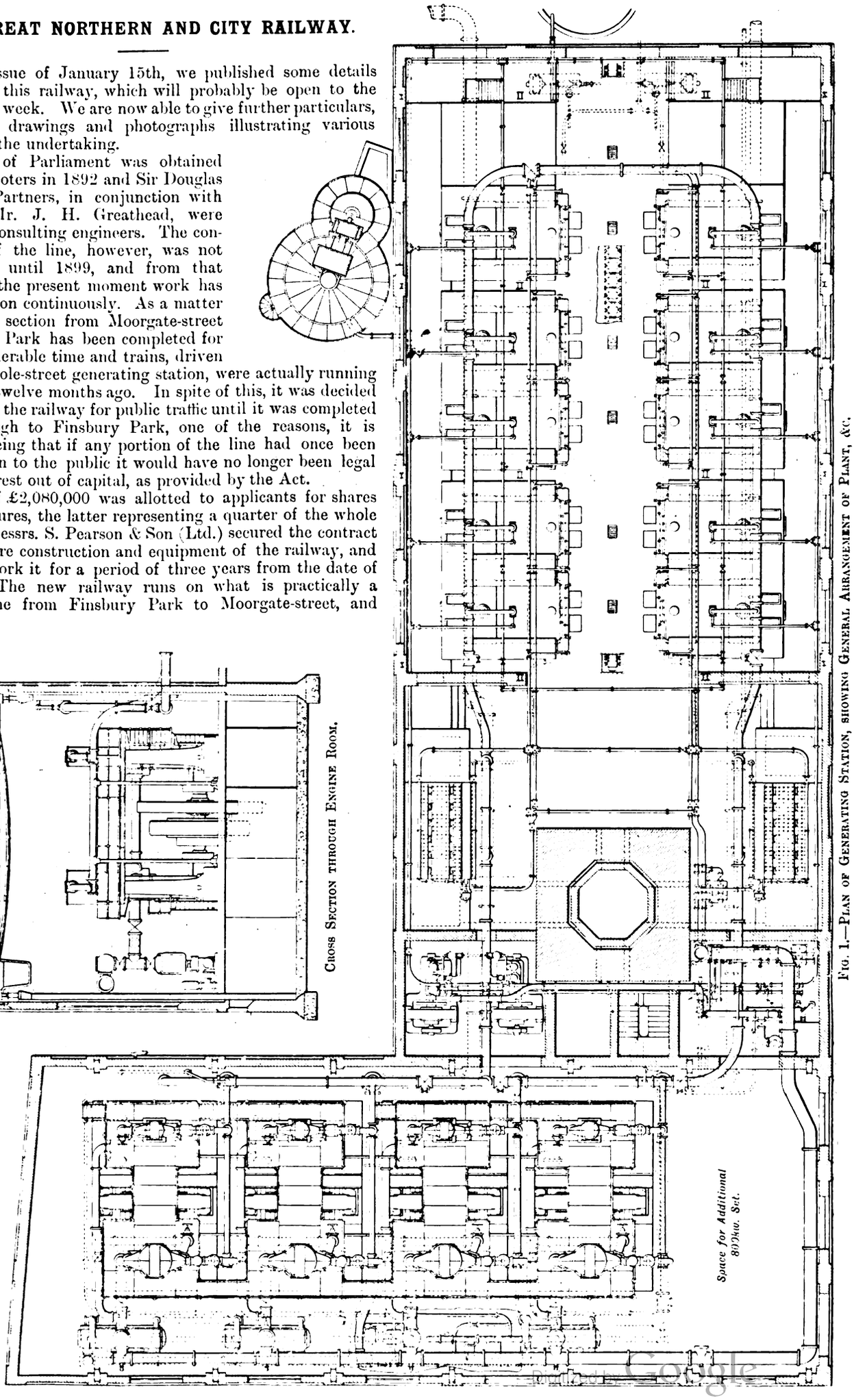


Fig. 1.—Plan of Generating Station, showing General Arrangement of Plant, &c.

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an extension has just been commenced to Lothbury. It is notorious that facilities for reaching the City from the neighbourhood of Finsbury Park are lamentably deficient, and in view of this fact, it is to be expected that the traffic on the Great Northern and City Railway will be very large to commence with, especially in the mornings and evenings. Throughout the day, also, the traffic will be considerable owing to the connection which the line makes with the Great Northern main line, and it is anticipated that no fewer than 10 million passengers per annum will be secured from this source alone.

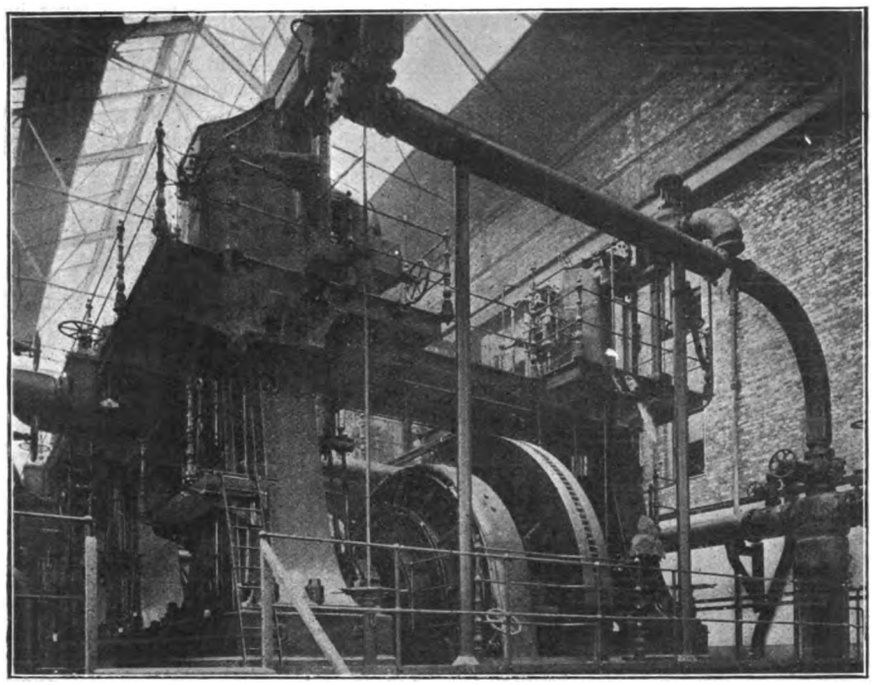

FIG. 2.—ENGINE ROOM, SHOWING MUSGRAVE-B.T.H. 800KW. SET.

In connection with the Finsbury Park terminus, there are a few engineering details of more than ordinary interest. When the line was first projected it was intended to run the rolling stock on to the Great Northern tracks at Drayton Park, where it now emerges from the tunnels, but on consideration it was found inexpedient and almost impossible to adopt this plan, owing to the capacity of the Finsbury Park station being already taxed to its utmost. An arrangement was therefore come to with the Great Northern Railway for running underground all the way to Finsbury Park, and the larger company supplied the necessary capital for this extension. But while this course removed certain difficulties it created fresh ones, and considerable skill and ingenuity was required to overcome them. It was necessary to construct two booking offices, and provide lifts for the conveyance of passengers from the main line to the tube, and all this, with the exception of the building of one booking office, had to be carried out under the main line tracks without interfering with the traffic running over them. The result is that heavy Great Northern express trains travelling at high speeds pass over subways, booking offices, and a lift shaft, and within 2ft. or 3ft. of the heads of passengers. The underground work is simply a maze of steel girders, and the excavations were rendered extremely hazardous, owing to the nature of the material which had been used for the original Great Northern permanent way. So small is the available headway that it was found impossible to employ electric lifts at Finsbury Park station, and the lifts are therefore operated by water power pumped electrically. But the tube is so near the surface that lifts seem superfluous, and when the cages are at the bottom of the shaft their tops are nearly on a level with the floor level. There is only a short incline and a few steps between the booking office under the Great Northern tracks and the platform level. Highbury station was not in the original scheme, but it was thought that a great deal of traffic might be derived from a station situated at such a busy point as Highbury corner, and the construction of this station is, therefore, being pushed forward with all possible speed.

In this issue we publish a drawing showing the arrangement of the power station (Fig. 1). The site, it will be observed, is of a peculiar and awkward shape, and there is much credit due to the engineers of the British Thomson-Houston Co. for the way in which they have succeeded in getting plant of the requisite capacity installed in the given area. As we have previously mentioned, there are four Musgrave cross-compound engines, each of 1,250 H.P., and these are supplied by a 10in. steam ring main. When running condensing these engines consume 14lb. of steam per I.H.P., and their normal speed is 100 revs. per min. Geipel steam traps with three-way cocks are employed. The Hunt coal conveyor has a capacity of 30 tons per hour; we reproduce a photograph of a portion of this conveyor (Fig. 3), showing the motor and gear by which it is driven Reference was made in our issue of January 15th to the auxiliary sets, consisting of Peache engines directly coupled to B.T.-H. generators; although these have been installed specially for driving motors for pumps, &c., in the power house and for lighting the tunnels and stations, yet they have been so designed that they may be paralleled with the large traction sets if required. Most of the tunnel and station lighting is effected by means of incandescent lamps, five 108-volt lamps being connected in series, but in certain of the station lighting it has not been found advisable to adopt this system, and in place of it circuits carrying three 185-volt lamps in series have been run. By this means it is possible to effect a considerable economy, as it will not be necessary to leave five lamps running when, perhaps, only two or three are required. All the lamps were made by the British Thomson-Houston Co. at their Rugby works.

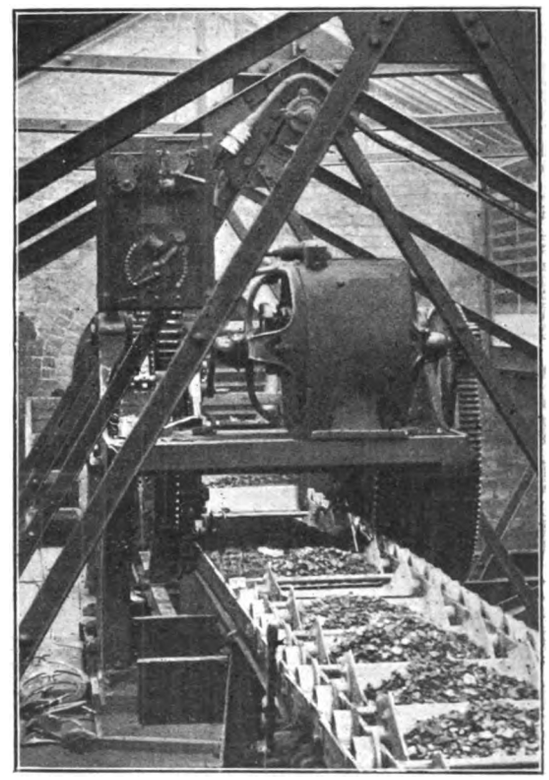

FIG. 3.—HUNT COAL CONVEYOR.

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Fig. 5 is a section of the tunnel and shows the brackets on the right-hand side by means of which the feeder and other cables are carried through the tunnel. At no point are these cables buried or in such a position as not to be accessible for immediate and easy examination. Fig. 7 is a specimen of some of the more difficult track work which was encountered. Owing to the two conductor rails being outside the running rails, it was no easy matter to ensure that connection should always be made by at least one collector shoe on each conductor rail. Moreover, great care had to be taken to avoid short circuits by the shoe touching adjacent positive and negative conductors at the same time. At certain points the two rails of different polarity come very close together, and if the work had not been very carefully gone into beforehand, considerable trouble must have occurred. The collector shoes have a vertical movement of $\frac{7}{8}$in., and when down to their lowest point clear the running rails by $1\frac{1}{8}$in. They are suspended by links and their own weight ensures good contact. All the motors

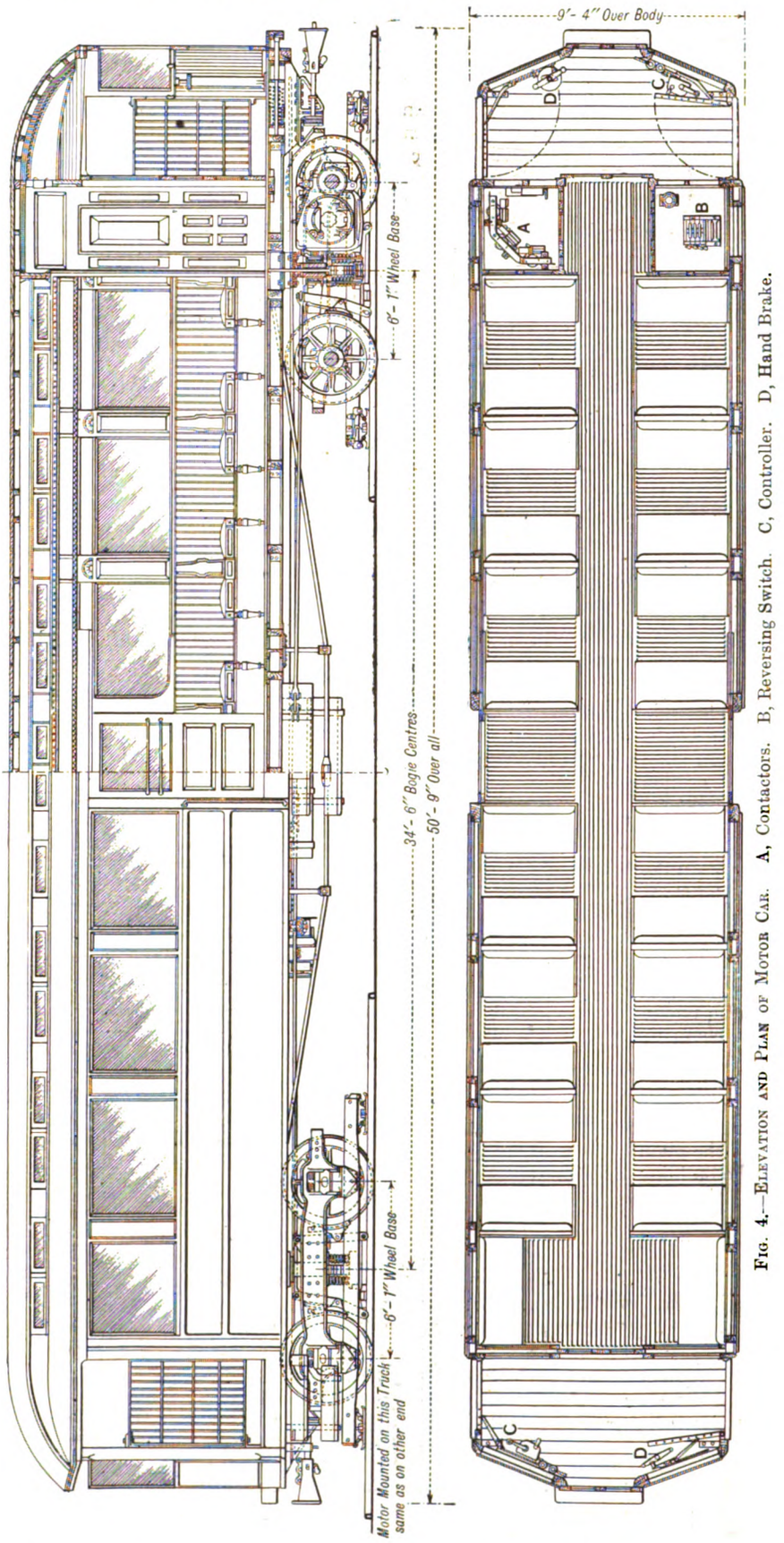

Fig. 4.—Elevation and Plan of Motor Car. A, Contactors. B, Reversing Switch. C, Controller. D, Hand Brake.

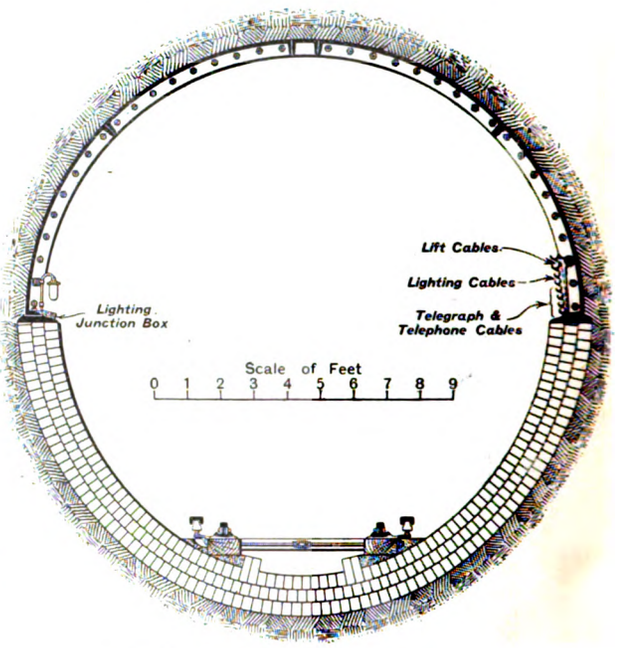

Fig. 5.—Section through Tunnel.

are spring-borne and of standard type. The depot at Drayton Park includes a car shed capable of holding 28 cars.

From Fig. 4 it will be seen that the "contactors" are not placed underneath the coach body as they are on the Metropolitan

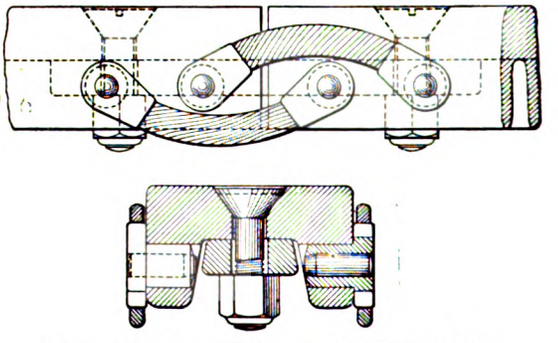

Fig. 6.—Collector Rail-bonds and Fish-plate. (One-fourth full size.)

District and North-Eastern trains, but are housed in a separate compartment at the end of the coach in much the same way as on the Central London Railway. Owing to the position of the conductor rails, it was found impossible to place these contactors under the coach and some difficulty was experienced in providing suitable accommodation for them. It was, however, finally decided to remove seating room for four persons at the end of each motor coach and to build a separate compartment, divided

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into two parts by the gangway. When the coach happens to be in the middle of the train, these compartments are closed to the public by doors, and when the coach is at the end of the train—in which position it is not necessary for passengers to pass through—the doors are folded back, so as to shut off the whole compartment from the public.

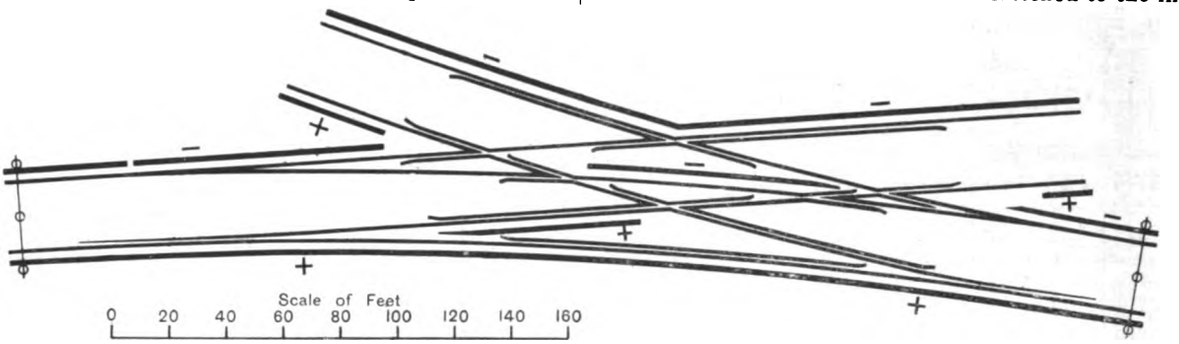

FIG. 7.—SPECIMEN OF DIFFICULT TRACK WORK.

In the compartment on one side of the gangway the contactors are situated, they being held in position by angle-iron brackets; the compartment on the opposite side of the gangway accommodates the reversing switch, resistances, &c. It will also be seen from Fig. 4 that the controller and hand brake are situated outside these compartments.

The method of bonding and joining the conductor rail is shown in Fig. 6. The fishplate is bolted to the underside of the rail, which is of channel section, and the bonds are riveted to the sides. The rail is not fastened to the insulators in any way, but is held in position merely by its own weight. Ordinary porcelain insulators supported on iron brackets fastened to the sleepers are used in the tunnels, but in the open double petticoat insulators are employed.

"TANGENTIAL" TRACTION.

A brief description of this interesting traction system was published in *The Electrician*, Vol. XLVII., p. 4. Since then the idea has been further developed, and although the experiments with regard to it are not yet concluded, the following description is of interest. The particulars given below are taken from a communication by the inventors, Messrs Rosenfeld and Zelenay, to the *Bulletin* of the Institute Montefiore.

A three-phase winding produces in a stator—built up between the rails of the track—a horizontally-moving field, which corresponds to the rotating field produced by the stator of an ordinary three-phase machine. The difference, in fact, is merely one of degree, inasmuch as the stator laid along the track may be regarded as part of an ordinary stator with an infinite diameter. The magnetic flux, travelling approximately at train speed, cuts the conductors of that part of the system corresponding to a rotor and called "propeller," which is attached to the locomotive or motor car it is intended to propel. In order to save cost and electrical energy, the stator is not laid continuously along the line, but is divided into sections, which are spaced at certain distances apart, these distances depending on the existing conditions of traction. Notwithstanding the discontinuity of the stator, the train receives a constant pull if only the length of the "propeller" equals the distance between the axes of two stator blocks. Moreover, to avoid energy losses in those stator parts not utilised at the time for propulsion purposes, switching arrangements have been provided by means of which only that section of stator blocks is supplied with current over which the train is passing. According to circumstances, a section is composed of one or more stator blocks. In the latter case, each of the three windings of the one block is connected in series with the corresponding winding of the next, and at the distant end of each section the three windings are short-circuited by a switch as the train enters the section. This switch is operated by a small low-voltage three-phase motor, the rails, which are insulated from one another and also in sections, acting as conductors for the rotor circuit. Since the stator of the switch motor is continually fed with current, the rotor will commence to actuate the switch as soon as its circuit is closed by a train entering the section. It is stated by the originators of this ingenious system that in practice, by reason of the low voltage in the rotor circuit, no special insulation of the rails is required. After the train has passed on to another section, the switch opens automatically by means of a counterweight.

Figs. 1 and 2 clearly show the construction of the stator block. It is 2·77 metres (9ft.) long and 0·5 metres (1ft. 8in.) wide over the pole tips. The pole core has a section of 25cm. by 16cm. (10in. by 6¼in.). Altogether there are 24 coils—*i.e.*, eight per phase—and they are wound with copper wire of a diameter of 2·7mm. (0·106in.). Current is fed to the windings at a pressure of between 1,300 and 2,000 volts. In order to test the stators under conditions such as would prevail in practice, they were, it is stated, exposed during four months to the action of the rain and sun, and were then subjected to a pressure of 6,000 volts without showing any signs of failure. The stators are fastened to concrete foundation blocks, and do not rest directly thereon but are supported by wooden cross sleepers resting on the concrete, and by brass supports. On the cross sleepers also rest the small rails used for supporting the propeller (see *The Electrician*, Vol. XLVII., p. 4). The propeller (Fig. 1) has a length of 19 metres (60ft.) which is about equal to that of the two-bogie cars employed in the tests. Since, in the experiments conducted by the inventors, the stator blocks were spaced every 18 metres, it follows that no interruption in the propelling force took place. The propeller is composed of 12 parts, each 1·57 metres (5ft. 1in.) long, which are mechanically, electrically and magnetically connected by means of flexible joints. A squirrel cage type of winding is adopted for the propeller, which, like the stator, is fitted with laminated pole-shoes. For starting, however, a resistance, constructed of a compound of nickel and iron is inserted in the squirrel-cage winding. A peculiarity of this starting device is that the resistance of each rotor bar may be separately controlled. The aim of the independent propeller, which forms no part of the car proper and simply acts as a tractor, is to ensure a uniform air-gap of a constant length. In practice, of course, this gap will vary somewhat with the conditions of the track, but it is, for mechanical reasons, impossible for the gap to become less than 10mm. (0·394in.). Later observations tended to show that the small track might be dispensed with, and that the ordinary running rails might be used to guide the propeller. A device is fitted to the propeller by means of which the gap may be varied through wide limits, so as to rectify any wear in the rails, wheels, &c.

The switches, mentioned above, are provided with a double break, the one by which the circuit is finally interrupted being of carbon or zinc To obtain a speedy interruption a current of compressed air is directed against the point where the arc

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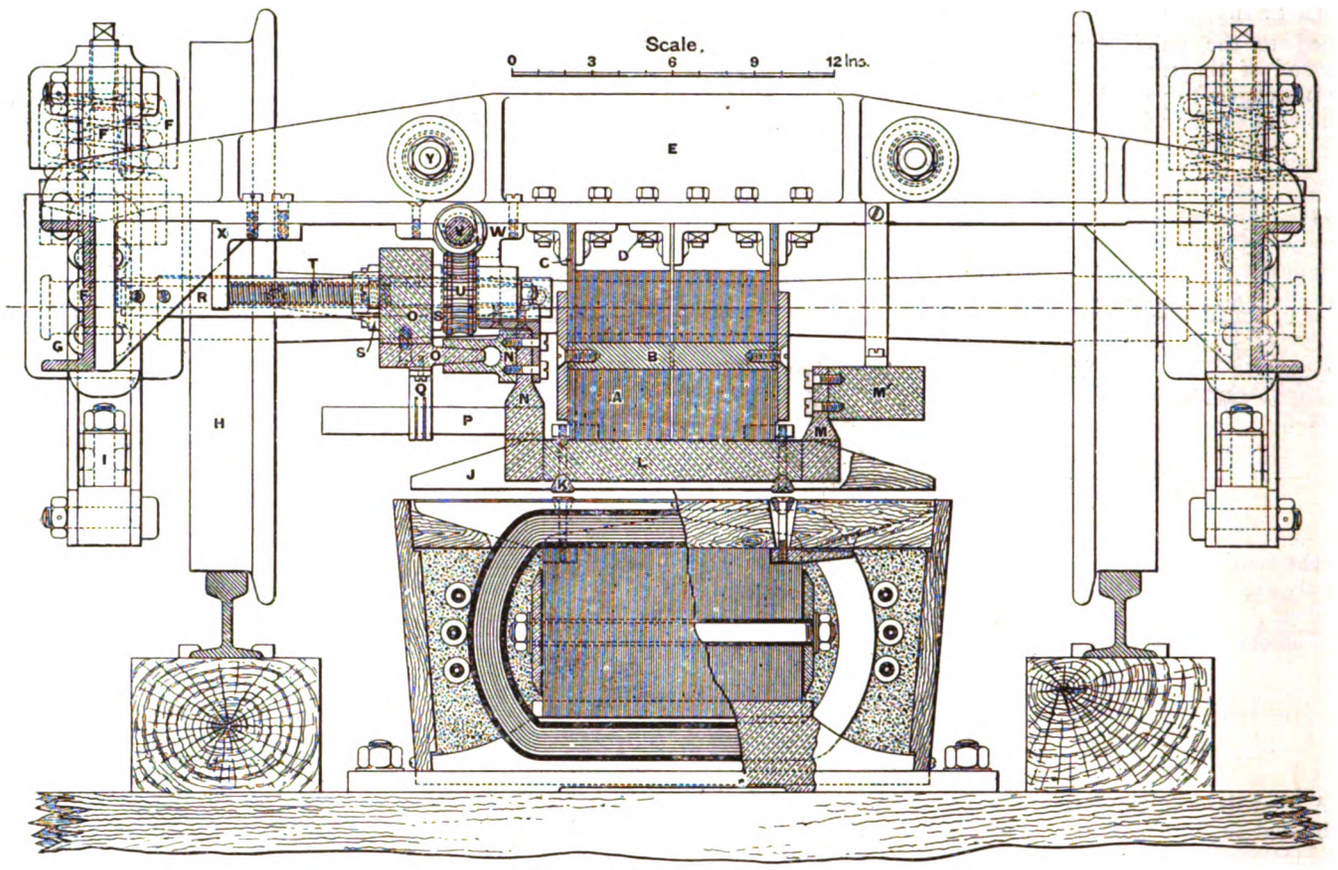
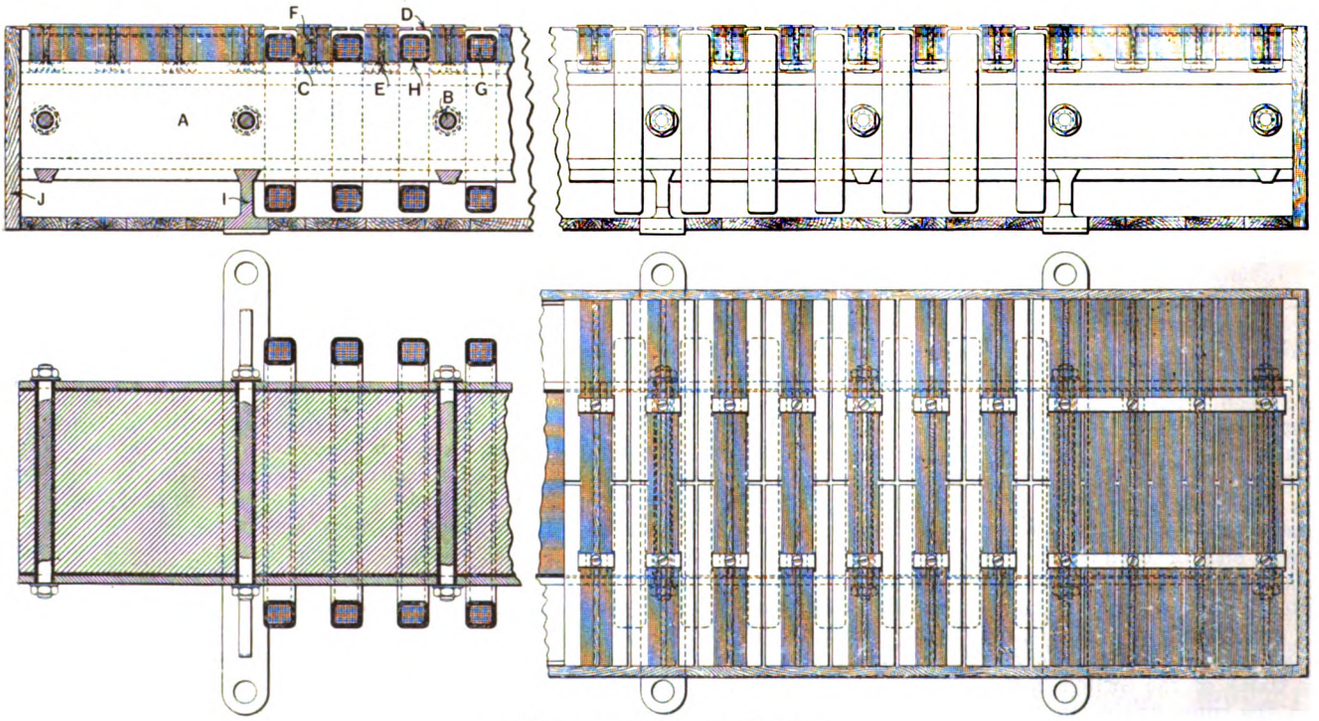


"Tangential" Traction System.

Fig. 1.—Section through Propeller and Stator Block.

A, Core built up of iron stampings 0·0197in. thick; B, plates and distance piece; C, suspension; D, angle iron and bolts used in connection with the suspension of the core; E, suspension bridge for the propeller; F, frame; G, oil boxes; H, wheel; I, details of suspension; J, propeller teeth, iron stampings 0·0197in. thick; K, supports and bolts for the teeth; L, brass conductor bars; M, brass connections; M', short-circuiting piece; N, brass connections to the short-circuiting piece N'; O, switch for short-circuiting the armature bars; P, nickel iron resistances; Q, rubbing contact of brass; R, guide; S, supports; T, screw; U, worm gearing; V, shaft; W, support; X, support; Y, bolts and springs connecting two propeller parts.



"Tangential" Traction System.

Fig. 2—Plan of Stator Block.

A, Core built up of iron stampings 0·0197in. thick; B, plates, bolts, &c., of non-magnetic material; C, teeth, iron stampings 0·0197in. thick; D, non-magnetic support for the teeth; E, bolt used for fixing the teeth to the core; F, gap piece used in connection with the bolts E; G, coils wound with cotton-covered copper wire 0·106in. in diameter; H, insulation; I, non-magnetic support for the core; J, wooden case.

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forms, and an automatic valve shuts off the compressed air when it is not required. In order to avoid the complication introduced by the compressed air blow-out, several interrupters were subsequently remodelled, by means of which it was possible to break the circuit in oil, and it appears that these work very satisfactorily. An experimental line, 800 metres ($\frac{1}{2}$ mile) in length, was constructed near the works of the Electricité et Hydraulique Cie., the head of which, Mr. Dulait, has taken a practical interest in the development of the system. Four hundred metres ($\frac{1}{4}$ mile) were equipped electrically, 20 stators being distributed over this length. Fifteen were wound so as to produce 2 poles per stator, but the remaining five, erected at and near the starting point, were 4-pole ones, exercising a correspondingly larger pull on the propeller. Excepting a 4 per cent. gradient 50 metres (164ft) long the line was horizontal. Each stator formed one section, and was connected to the line in shunt to the others. The total weight of the car, including the propeller, is given as 22 tons.

A TRAMWAYS TELEPHONE SYSTEM.

Mr. P. S. Sheardown, electrical superintendent of the Dublin United Tramways Co, has, with the assistance of his late assistant, Mr. J. H. Millen, developed a system of service telephones in connection with the Dublin tramways which has several points of interest. Six 3/22 three-core cables leaving Ringsend power station and radiating out to the various termini are looped in on the way to about 80 feeder pillars and 13 offices or car depots on the various routes. One of the wires is used for the Board of Trade earth voltage test, but the other two are available for telephone service. The problem that has been worked out is: While maintaining the simplicity of the open circuit system with only one ringing battery located at the power station,

A. From the power station to ring up a depot, or, when there are two depots on one pair of wires, to ring up either depot without calling the second;

B. To put in communication with each other any two outlying depots;

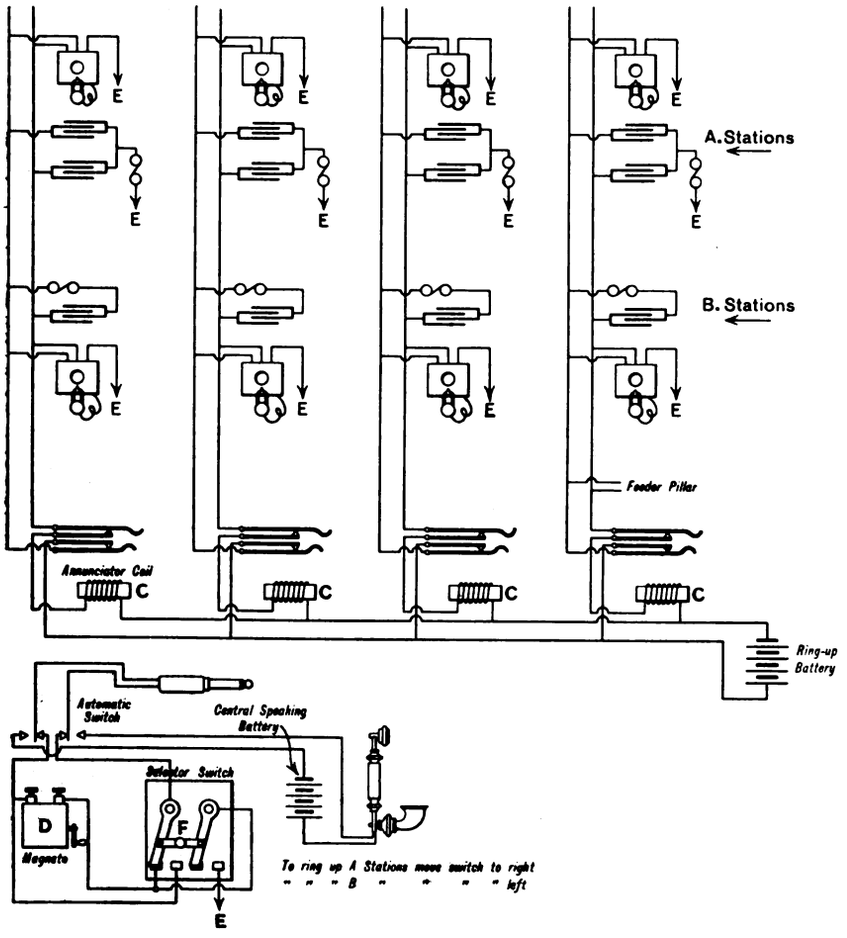
C. For the outlying depots to signal to the power station when they have finished speaking through to another depot.

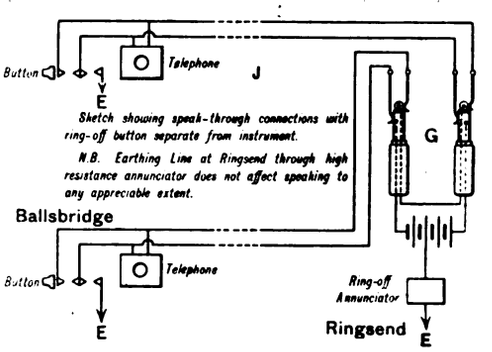
This is arranged without an earth return, the only ground connection being through a high resistance at the power station, when two depots are connected through. An earth return would, of course, not have been possible, as the telephone wires are parallel to and close to the feeder cables, and the current fed through the latter to the tramway motors is constantly varying at a sufficiently rapid rate to cause noise in a single telephone circuit by induction.

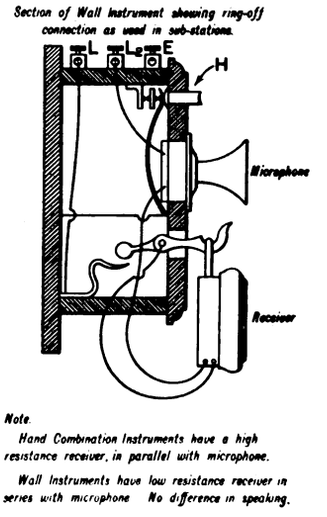
At first the feeder pillars were equipped with a box containing an induction coil and plug receptacle, as supplied by a well-known firm, but a good deal of trouble was experienced with these owing to dampness in the feeder pillars, which, on wet days, practically short-circuited the terminals, causing the annunciator to keep dropping at the power station. They have, therefore, been replaced in each case by a small porcelain fuse base with a spring terminal at each end, through which the portable telephone (which is small enough to carry in the pocket) is connected to the wires. Good speaking is obtained, without an induction coil, over 6 or 8 miles of line.

As already stated, the power station is rung up from the feeder pillars or depots by a battery current, but the depots are rung up from the power station by a magneto ringer. If there is only one depot on a pair of wires, the depot bell is placed across two line wires in series with a $2\frac{1}{2}$mfd. condenser, as shown at B on the diagram. If there is a second depot two condensers are used, being connected one to each wire, and then in parallel through a bell to earth, as shown at A. The simplest way of doing this would doubtless have been to connect a condenser and bell through one of the lines to earth for one depot, and a similar arrangement on the other wire for the second depot; but with this arrangement it was found in this case that as often as not both bells were rung, although the magneto was only connected to one wire.

Each pair of wires at the power station is connected to a double line jack with ordinary annunciator coil and extension







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bell, as shown at C. When the plug is inserted in the jack, the wires are both disconnected from the bell battery circuit and (with the receiver lever down) are connected on to the magneto ringer D. If the selector switch shown at F is to the left, the connection is across the two wires, and a B station can be rung up; if the selector switch is placed to the right the magneto is connected across the two wires (in parallel) and earth, and can ring up an A station on that particular line. When the receiver is taken off the hook the magneto is cut out completely, and the telephone and a separate speaking battery are brought into operation.

When two depots wish to speak through, the two plugs and a third battery, as shown at G, are employed. It will be noticed that the middle point of the battery is connected through a high-resistance drop indicator and bell to earth. This is to enable either depot to notify the power station when they have finished speaking. This is done by pressing a button on a depot instrument, when, as shown at H, both line wires are connected to earth.

In the portable telephone a high-resistance receiver is employed in parallel with the microphone, but in the depot instruments a low-resistance receiver in series with the microphone is used.

THE CITY AND SOUTH LONDON RAILWAY: WORKING RESULTS OF THE THREE-WIRE SYSTEM APPLIED TO TRACTION, &c.*

DISCUSSION.

Thursday, January 14th (concluded from p. 538).

Mr. H. M. SAYERS said that Mr. McMahon had thoroughly grasped the notion that economy of distribution and economy of generation had to be considered together, and that to get the lowest possible cost of current at the car was an object which must not be left out of consideration. It was no use to put a station in the best possible place for generating purposes and then have to use—on account of the position of the station—a transforming system, which meant a constant loss of 10 or 15 per cent. of the power generated. Mr. McMahon had succeeded in getting something like 91 per cent. of his generated power to his locomotives. By doing this he had shown that by his system a low-tension station with 10 or 11 miles of line could beat a high-tension three-phase station. With regard to Prof. Carus-Wilson's remarks at the previous meeting, he understood that the objection to the third-rail arrangement was that it was earthed, and consequently that any leakage from a car became, or might very frequently become, a short circuit. He himself thought that Prof. Carus-Wilson was looking at one danger and rather overlooking another. It would be within the memory of a good many that early experience with alternating-current transformer systems showed that it was very desirable indeed to make sure of the exact difference of potential between any part of the system and earth, and that necessity, and also some very sad lessons which arose from overlooking this, led to the use of concentric cables with the outer earthed. There was then always one dangerous terminal, but they knew which one it was. There was the safe terminal, and they knew what they could do with it. It seemed to him, however, that there was no difficulty in arranging for the middle rail in such a system as Mr. McMahon's to be insulated throughout the course of the line and to be earthed at the generating station, and this might be made to afford a test of the insulation on each side of the system. It was well known that with continuous currents the negative conductor became the most leaky very rapidly. If the middle wire was not earthed it was practically certain that the positive conductor would get 1,000 volts above earth and the negative be at earth potential very soon, and under these conditions the positive conductor became dangerous both to human life and to the motors. It seemed to him very much better to earth the middle wire in a definite way under such conditions as would afford a test of the insulation of the rest of the circuit and keep the volts distributed in a perfectly known manner.

Mr. J. W. BROWN spoke with regard to the lifts. He said he had been associated with electric lifts since the early days of electric power and we now seemed to have arrived at a very satisfactory one. Mr. McMahon, in comparing electric with hydraulic lifts, had come to the conclusion that, in first cost, the electric lift was the cheaper, whereas for a travel less than 160ft. the hydraulic was the cheaper. In the case of the Central London lifts the estimates for the hydraulic came out at considerably less than the estimates for the electric. This was, however, without taking into account the pressure main from Shepherds Bush to the Bank and the exhaust main from the Bank to Shepherds Bush, the cost of which, of course, quite outweighed the difference between the two systems. In the case of New Brighton tower, where the lifts were 300ft. high, the electric were considerably cheaper than the hydraulic. Possibly he (Mr. McMahon) was comparing an estimate obtained from Messrs. Armstrong some 13 years ago for hydraulic lifts with the price quoted by electrical engineers for electric lifts to-day. He thought sufficient advantage was not taken of the experimental lift at Kennington, and had the makers taken full advantage of it, there would have been less trouble afterwards. The contractors were considerably hampered by the small amount of head room above the lifts, and consequently the guide sheaves were very small, some being only 3ft. in diameter. This diameter for a 1in. rope was very small indeed. In a number of text-books it was stated that the size of the sheave should be 30 times the diameter of the rope. In that case, however, not sufficient life was obtained out of the rope. On the hydraulic lifts on the City and South London Railway the sheaves were 5ft. diameter, and the result was that the life of the ropes was about seven or eight years. He did not agree with what had been said during the discussion that the S drive did not affect the life of the ropes. There was no doubt that an S drive did lessen the life of the rope. As to the ideal lift for tube railways, the first condition was that the lift should start off quickly, attain its maximum speed, get up to the top level and shut off automatically. This condition the hydraulic fulfilled perfectly, but the electric did not. The latter could be started and get up to maximum speed quickly, but it could not be stopped so well as the hydraulic. There were many things to contend with in this connection, including that unknown quantity, the lift attendant, and the variable load. With regard to the second condition, low cost of working, no doubt the electric was cheaper than the hydraulic lift. He thought that Mr. McMahon's figures did not put the case for the former as high as they might have done. The efficiency could be considerably improved. They might have a system combining the advantages of the hydraulic and electric systems. If this could be done, he thought the result would be a nearly perfect lift.

Mr. W. H. PATCHELL, who expressed regret at the absence of Mr. Mark Robinson from the discussion, said that his experience with regard to engines was in accord with Mr. McMahon's. But the author did not tell the whole tale, his remarks rather leading to the belief that it was purely a question of speed. There were many other factors. An important one was the number of cylinders. He had proved to the satisfaction of his shareholders that he could handle any load that came on more cheaply with one three-cylinder triple-expansion 1,500 H.P. engines than he could with three three-crank six cylinders 500 H.P. compound engines. He could run through on less coal than by chopping about on one, two or three engines, although the total plant would be the same. It might be said that it was a question of compound versus triple, but it was not. In another works he had similar triple engines of 1,500 H.P., and compound engines of 2,500 H.P. The 1,500 H.P. engines ran at 230 and the others at 84, and his stokers had found out what Mr. McMahon's stokers had found out—viz., that they could take on any load more easily with the 2,500 H.P. engines than if the 1,500 H.P. engines were running. It was a question of the number of cylinders, and the question of the type of valve also came in. Too much importance was attached to small cylinders. It was said that they could be repaired and examined more easily. But with two cylinders tandem vertical, the high-pressure cylinder had to be taken off before the low-pressure cylinder could be got at. That was a loss of time. Then again, comparing 9in. with 13in. cylinders it was much easier to strip a 13in. cylinder than two 9in. cylinders, although they were of equal area. With regard to steam there was a very great deal in what Mr. Booth had said. When he (Mr. Patchell) had stated, before the Institution of Mechanical Engineers in 1896, that superheated steam was better than saturated steam, even if it was reduced to the temperature of saturated steam, he was laughed at. But he had since proved it over and over again, and he believed it was solely due to the fact that Mr. Booth had put forward - viz., that the superheated steam had less water in it than saturated steam. If anyone wished to satisfy himself let him go in for steam calorimetry. It was impossible to get two results running. With two men taking steam from the same pipe two results would be obtained, and with two men and two calorimeters four results might be obtained. The only thing to do was to put in a thermometer and make sure the steam was superheated. Mr. McMahon had got a most excellent condenser in his engine room, but at the wrong side of his engines—he referred to the double ring of steam pipes. If he would run a day with this double ring and another day with one ring shut off he would find a great difference. But not only had he a double ring, but double stop valves. At the same time Mr. McMahon was to be congratulated upon the comparison between his results in 1903 and those in 1894, and the Paper ought to be considered with a knowledge of what the author had had to contend with. He could not burn his whole plant down and start afresh, but had to go on adding to it and improving it as opportunity arose. The question of joints in steam mains blowing out had been mentioned. But this ought not to happen, as perfect joints could be made, and it was surely not necessary to have a double steam ring, with its inherent defects simply because he was afraid of a joint blowing. Mr. Hobart had stated at the previous meeting that he hoped people would go in for 1,000-volt motors. He, personally, had not worked on tramcars, but he had been running 40-200 H.P. motors for several years, and the breakdowns had been practically nothing. But then, he did not put 1,000 volts on the field, which would have to be done in the case of a tramcar motor. If they could work with fixed motors there was every hope of the voltage being raised for tramway or locomotive work. With regard to the balancers, he did not quite gather from the Paper whether the fields were crossed or compounded. When he first tried balancing on the three-wire system he thought of having the fields crossed. Then Messrs. Siemens asked him to try some compound turns. There was very little indeed in it, but he thought the crossed fields had just the slightest advantage.

* Paper read before the Institution of Electrical Engineers.

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Mr. E. J. FOX said he was sorry that Mr. Mark Robinson could not be present, but he had had to leave London on short notice. With regard to the table of generating costs at Stockwell, Mr. McMahon had been good enough some weeks ago to send him the details of these costs, which he had wanted for comparison with some other stations working under similar conditions with very good load-factors, and he would like to give a few figures. Mr. McMahon's coal consumption per kilowatt for six months come out at 3·9lb. He had found there was very little difficulty —under certainly rather better conditions than Mr. McMahon's—in getting down to 2¾lb. or 3¼lb. with quite cheap coal costing about 5s. per ton at the pit's mouth. In one case he knew of, the figure was 2·8lb. with a rather bad week-end load, which was equivalent to 2·7lb. if the load for the week-end had been maintained. In another case the average coal consumption per kilowatt, for almost every month, came out at 3·10lb. of coal at the switchboard, the coal costing 5s. per ton, so that seeing that these figures compared with about 4lb. by Mr. McMahon, it showed there was still a good deal of margin between the best that could be done and the best that was done in average working. An average individual reading the Paper would be inclined to think, for the comparisons made between Willans and Corliss engines, that it would be difficult to get these very low costs with high-speed engines. But it would be a mistake to assume this, for the reason that to get the lowest figures which he had mentioned it was absolutely necessary to use high steam pressures and fairly high degrees of superheat, probably between 550 and 600deg. in the engine. The question of high steam pressures resolved itself into triple expansion engines, and the Corliss engines were not very fond of running triple. At any rate, such engines were not very often met with. Lancashire mill owners had tried during the past few years to work their engines triple-expansion, but on the ground of first cost, more than for any other reason, they had abandoned the idea, and the tendency now seemed to be to compound two engines with superheated steam. Therefore, they really came to a comparison between high-speed engines running triple expansion and Corliss engines running compound. With regard to superheat, it was impossible to use such high degrees on Corliss engines as on high-speed engines, and the final result was that the triple-expansion high-speed engines with a high degree of superheat were more economical than Corliss compound engines with a moderate degree of superheat. But on such a basis the comparison was not a fair one at all. The figures were very much in favour of high-speed engines. When dealing with installations whose works costs were very low—he had one at 0·18d. or rather under ½d. on working costs—the capital charges were a very big proportion of the working costs, about 50 per cent.; and when the whole problem was figured out it would be found, as Mr. McMahon rather suggested, that Corliss engines became too expensive for the job. On the smaller sizes up to 600kw. or 700kw. they would be out of it on the ground of price, and on the larger sizes they would be out of it in favour of turbines on the ground of first cost alone. With regard to the actual figures which had been given in the Paper, he thought one or two relating to the Willans engine were rather misleading. Early in the Paper a table was given which showed that the figures obtained on test were very much better than the guaranteed figures. This brought the comparison between the two engines a good deal closer together. For instance, 18·5lb. of steam per brake horse-power was promised, but 17¾lb. was obtained. Taking that very size of engine and taking the figures which would be obtained for steam consumption under conditions which favoured high-speed engines, that 18·5lb. per brake horse-power would be reduced to 11·7lb. in ordinary working conditions; 11·7lb. against 16·3lb. promised by the Corliss engine. And it was the same all the way down the line; the figures with higher steam temperature and steam heat were very much below those given for the Corliss engine. With regard to repairs and maintenance Mr. McMahon had stated that the Corliss engines had cost less to maintain. As a matter of fact, the author's costs were very low, whether for Corliss or high-speed, but in making the comparison, one should couple the items of labour in the station and repairs together, for the simple reason that high-speed engines cost rather more in repairs than Corliss, whereas, in the case of the latter the running labour and labour on repairs could not be well differentiated.

Mr. P. V. McMAHON, in reply to the discussion, said a good deal of stress had been laid on the advantage of an insulated return both by Prof. Carus-Wilson and Mr. Hobart, on the ground that, if one earth occurred, the system would not break down until there was another earth. He did not agree with this, and thought the sooner the breakdown happened and was done with, the better. Imagine a fault on the positive side about which nothing was known. Presently one on the negative side was developed, and then the two motors were absolutely broken down together, whereas with the rail return as soon as there was an earth, one motor could be thrown out of service and the train sent home on the other motor without delaying the traffic. Prof. Carus-Wilson also referred to the fact that electric locomotives were nearly extinct. As a matter of fact, the City and South London Railway Co. thought it would extinguish them eight or nine years ago and, with that object in view, a motor car train was built; but it was found in tunnel work that unless there were plenty of sidings such a system was almost an impossibility. The amount of shunting and the cost of it far outweighed any advantage to be gained from getting rid of the locomotives. For surface work, however, motor carriages were best. He could not, however, bring his trains to the surface like the Central London Railway could. Mr. Hobart had objected to the number of boosters and transformers in the system, but perhaps he had been rather frightened by the diagram. It was made worse than it really was in order to simplify it. There were not so many armatures as Mr. Hobart thought. If he had to do the whole thing over again he should certainly go in for the same system, although there were some things he should avoid. He would simplify the switchboard. Again he would not use, perhaps, such small sets. Then there were the old Mather and Platt generators which he would not have in the station if he had had a free hand, although he had great respect for them. But they represented a certain amount of capital which either had to be written off or sold at a loss. But they came in all right with the exception of the disadvantage that the voltage regulation was not so good as when steam boosters were used. Mr. Hobart was also not in favour of using batteries. That might be all very well from the point of view of the man who designed a station and then cleared out. But he had to live with it, and batteries had been his salvation on many an occasion. Again, there was the advantage that, if there was a very heavy short-circuit on the third rail, it was possible to maintain the lighting and lifts independent of the generating station. There had been trouble with trains getting across the rails and the third conductor, making it necessary to cut the current off, and the passengers had had to walk to the next station. But the lifts and the lighting had both been kept going. Mr. Hobart had suggested that, in going in for a continuous-current system of distribution, he might have gone in for 4,000 volts. He agreed, but they might have some difficulty in getting the Board of Trade to agree to 1,000 volts on the motors in a tunnel. And after all, supposing this were used, what additional efficiency was going to be obtained? If it was only 1 or 1½ per cent., was it worth while going in for it? Mr. Bjornstad had referred to the question of ropes on the lifts. This was hardly a subject which the Institution of Electrical Engineers was deeply interested in, but still the fact remained that the rope question had a very important bearing on electric lifts, and there was no doubt that the life of a rope on a hydraulic lift was very much longer than upon an electric. In his own case the difficulty was due to the confined space in which it had been necessary to place the machinery. This was fairly well proved by the fact that on the Angel extension the ropes had about twice the life of the ropes on the other lifts, but there was more room for the machinery. There was no ropemaker who did not object to bend his ropes first in one direction and then in the other. The S drive was certainly bad. Mr. Brown had taken exception to his statement that the first cost of the electric lift was equivalent to the hydraulic. He quite agreed with Mr. Brown in the way he put it, but he himself was rather taking it that if one had to instal electric lifts a distance from the station, in comparison with hydraulic lifts, at the same distance, the electric came out cheaper. Perhaps in his own case the advantage was not so pronounced as on the Central London Railway. On the question of economy, coal consumed in working 10 hydraulic lifts was equal to the coal consumed for 25 electric lifts. If only the difficulty of stopping and starting could be got over, and they could be regulated as nicely as the hydraulic lifts, there was no doubt about the preference for the electric lift. Mr. Brown had expressed the hope that someone would bring forward a happy combination of the two, but perhaps Mr. Brown's modesty prevented him mentioning his own idea of a balanced electro-hydraulic lift which gave all these advantages. Mr. Stevens had referred to the question of circuit-breakers, and he did not know whether objection was taken to the manner in which they were used on the City and South London Railway, in having resistance across, or not. By having resistance across, the man at the switchboard could see if the short was temporary or permanent. The resistance was so arranged that with a short there would only be 500 amperes. There was also another switch in the circuit, with which the machine could be shut off. He quite admitted that there was a disadvantage in having a resistance across in the case of a broken-down cable, because current was then being sent into the fault. In the case of the railway, however, each section had a fuse, and in every case the fault had been spotted and dealt with. Mr. Stevens had also referred to the suggested regulations for the Paris Metropolitain Railway. On the City and South London line there had been a fuse in each section ever since the opening of the railway, and telephonic communication had lately been established between the locomotive and the stations. There had always been telephonic communication from station to station, but now bare wires had been installed, and each locomotive had a telephone, so that if the driver was in trouble he rang up the nearest signal box and communicated with somebody at the station. If the train was likely to be delayed more than two or three minutes in a section, the signalman could switch on the lights in the tunnel, these being fixed every 50ft. Mr. Booth had referred to the coal consumption as being only what had been obtained 30 years ago, and suggested an arrangement of he did not know how many cylinders. The average station engineer, to arrive at that result, would hardly go in for such an arrangement now, even if he could get a better economy in coal. In taking the costs per unit, Mr. Booth compared the City and South London Railway with a colliery, but although the coal he burned varied between 3s. and 6s. at the pit mouth, it cost from 8s. to 8s. 6d. a ton extra before it was brought to London. In fact, the cartage of the coal from the river side alone was 1s. 3d. to 1s. 6d. per ton. With regard to the water meter in the suction of the pump, he had tried this but had not been satisfied. The idea of having the meters between the pump and the boiler was because he then measured the actual water pumped into the boiler, and there was no leakage. As to the question of motor-driven pumps for the boilers and condensers, he had been into that fairly closely when the new plant was put in; but there was one objection to a motor-driven pump. Unless there was a battery—and he had not one then—it was impossible to start the pump without having a generator going, and therefore he had steam-driven pumps. Another important point was that the air pumps cost nearly double as much when they were motor driven. His bonds were of the Neptune type. A hole was simply rimered out and the bonds put in and then driven in tight. There had been no trouble with the contact resistance, but there had been some difficulty with the wires of the bonds breaking off short near the terminals. He had lengthened the bonds, and this seemed to have got over the difficulty. With regard to Mr. Jones' figures of the coal per unit he believed Mr. Jones used a little better

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quality fuel than he himself did. The same speaker had also referred to the units per ton-mile at the switchboard and on the locomotive. It was rather difficult to arrive at the figure for the ton-miles at the switchboard on the City and South London Railway because he had no wattmeter in the third-rail feeders. But probably the reason why Mr. Jones got a better result was because his sections were so much longer than was the case with the City and South London Railway. He had found from locomotive tests on the line that of the total energy used for taking a train through a section one-half was taken up in accelerating the train, so that if the section were doubled in length—and his sections were approximately half a mile—the energy used per section would be reduced proportionately, because there would only be one start as against two. The load on the City and South London Railway was very steady, due to the fact that the lifts and lights were practically taken from the same 'bus bars. As to the failure of the locomotives, which Mr. Jones had referred to, he was now able to give a better figure—viz., 0·45. In reply to Mr. Clarke, he could say that the Willans engines were tested at the maker's works and the Corliss engines were tested at the station after erection. He appreciated the remarks that perhaps the Willans engine was not so economical at full load as the Corliss was at half-load, but he would not reply fully to this point at present. Mr. Clarke suggested double generators. This had been fairly fully considered, and although it looked a much more convenient method at first sight, there were times when one wanted to put a single machine on—when there were not very many trains—and if there were two generators on an engine the engine was being run round with only one generator. There were also complications of the switchboard introduced. Mr. Clarke also raised the question of pipes. All his pipes were insulated as they left the tunnel, so if any were damaged they were the company's own property. With reference to the Highfield boosters being incapable of taking the variations of current, he could regulate them to do more than they were shown to do in the diagrams in the Paper. He had let the reducers take up much of balancing purposely, and tried to keep the battery fairly evenly charged. There was no doubt that, if he wanted to, he could make the battery to the Highfield booster take up more of the peaks than they did at present. He did do so sometimes, but as a rule he did not. He could not see how a short-circuit on one side would raise the pressure on the other side to 1,000 volts, as the machine was immediately short-circuited. He agreed with Mr. Sayers that if the return rail was insulated throughout it would be better to earth it at the generating station to avoid shocks in the tunnel. He found there was a good deal more leakage from the negative than the positive, and also more trouble with the insulation on that side than on the other. In answer to Mr. Patchell with regard to the double range of steam pipes, he agreed that perhaps he was right on this matter, but personally he did not care to hang on one pipe. He would rather be safe and sure than have an extra 1 per cent. efficiency. The fields of the balancers were not crossed, but were compound. Mr. Fox had referred to some very good results in works where they probably worked longer hours. No doubt the cheaper coal accounted for some of the better results. One figure was 2¾lb. per kilowatt-hour. This was certainly a better result than his own, but perhaps the engines were better loaded. All the same he did not wish to say that no one could do better than the City and South London Railway Co. With regard to the relative cost of a Corliss or high-speed engine, there was no doubt that the Corliss was out of it with low powers, but with powers, say, 500kw., the slow-speed engine of the Corliss type had an advantage, and his results certainly led to this conclusion. At the same time, he did not say that he would care to be without Willans engines. They were very convenient for starting up and running up in a hurry, but at the higher powers they gave an indication that they took more steam per kilowatt. Mr. Fox rather jumped from the Willans engine to the turbine. If higher power was wanted, perhaps everyone would prefer the turbine, but they would prefer to see a little more of the turbine before useing it extensively. He did not agree that the Corliss engine cost more for repairs than high-speed engines. He had had very little repairs, and for the period given in the Paper the cost of repairs for both types was about the same.

The PRESIDENT (Mr. R. Kaye Gray), in proposing a vote of thanks to Mr. McMahon, said that the Council, to whose share this year fell the award of the Willans premium, after careful consideration, thought they could not do better than give it to Mr. McMahon. The award was for the two Papers by Mr. McMahon—viz., the one read in 1899 and the one just discussed,

A hearty vote of thanks was then accorded to Mr. McMahon.

Removing Ice from the Third Rail.—Cleaning the third rail appears to have been done successfully by the Grand Rapids, Grand Haven and Muskegon Railway Co., which has an exposed rail and is operated through an open country. According to the *Electrical World* of New York, a solution of chloride of calcium poured on the third rail instantaneously removed a covering of ice or sleet, and, moreover, protected the rail so that it was not covered again with ice for at least three hours. These tests have also shown, it is said, that the solution will not injure either the steel rail or the copper bonding. Three cars on that line have been equipped with reservoirs, located in the motorman's vestibule, from which tubes extend to a point directly over the third rail. In this reservoir the solution is placed. A stop cock regulates the flow of the fluid.

THE RATING OF TRAMWAY AND LIGHT RAILWAY UNDERTAKINGS.*

BY W. G. BOND.

THE PRESENT PRACTICE AND HOW IT MIGHT BE IMPROVED.

Although I gave an affirmative answer to the secretary's request for a Paper on Tramway Rating, I expressly disclaim any intention of posing as an expert in this recondite subject. The fact is, it has merely been my good fortune to come across this question in the ordinary course of business, and to get myself somewhat hopelessly entangled in the network of strained interpretations and judicial *obiter dicta* of which English rating law is composed. My studies in this direction have afforded me some amusement and much instruction, and if this Paper fails to do the same in regard to my audience to-night it will not be the fault of the subject-matter. However, be that as it may, my chief object in reading this Paper to-night is to provoke a vigorous and incisive discussion of a very important matter.

Local Taxation and National Taxation.—Tramway companies, like all other undertakings, must, of course, bear their fair share of the burden of national and local taxation. But I doubt whether it is quite realised by those connected with tramway enterprises how much heavier is the burden of local taxation as compared with that of national taxation. Roughly speaking, a tramway company pays three to four times as much in rates as it does in income tax, which, under our existing fiscal system, is practically the only important national tax such a company is called upon to pay. I will quote a few round figures, taken at random from tramway concerns up and down the country. Company A paid in 1902 £313 in income tax and £1,275 in rates. Company B paid in 1903 £166 in income tax and £447 in rates. Company C paid in 1903 £295 in income tax and £737 in rates. Whether we agree with Adam Smith that "Every tax is to the person who pays it a badge, not of slavery, but of liberty," or whether we agree with Gibbon that taxes can fall "like a hailstorm upon the land and like a devouring pestilence on its inhabitants," we must all agree that a tax which abstracts so much from our pockets is worthy of occcasional consideration.

Present Practice.

The famous 43rd of Elizabeth was the first modern act to place local taxation upon a more or less definite and statutory basis. The most specific direction contained in this act was that the necessary money in the case of each area was "to be gathered out of the same parish according to the ability of the same parish." Since then many acts have been passed, the most important being the Acts of 1836, 1840, and 1869. It was, I think, clearly the intention of the framers of the Act of 1601, that everyone belonging to a parish (whether residing in it or out of it) should contribute to the financial needs of the parish according to his ability. What the measure of this ability was to be was, however, left entirely undefined.

Rent: The Measure of Taxable Ability.—In 1836 this gap was made good, and the custom which had grown up of taking rent paid as the measure of taxable ability for local purposes was duly legalised. Let me quote a few words from sec. 1 of this act:—"Whereas it is desirable to establish one uniform mode of rating. . . . No rate for the relief of the poor in England and Wales shall be allowed by any justices, or be of any force, which shall not be made upon an estimate of the net annual value of the several hereditaments rated thereunto, that is to say, of the rent at which the same might reasonably be expected to let from year to year, free of all usual tenants' rates and taxes, and tithe commutation rent-charge, if any, and deducting therefrom the probable average annual cost of the repairs, insurance, and other expenses, if any, necessary to maintain them in a state to command such rent. . . ." Rent, less certain deductions (which arise from the erroneous belief that rates are in their final incidence a tax on property owners), has thus come to be the statutory basis for estimating a parishioner's taxable ability. It is to be observed, however, that the rent actually paid is not necessarily the standard, but the rent "which might reasonably be expected" to be paid. But it may be asked: What has all this to do with tramways, railways and the like? Well, that is the very question I am always asking myself. Such devices of the Evil One were quite unknown to our Sovereign Lady Queen Elizabeth, and no one (not even Mr. Yerkes) has, at yet, offered to take a yearly tenancy of the Great Western Railway. American judges have, I believe, ruled that electricity is a manufactured commodity, and, therefore, liable to import duty; but no English judge, so far as I am aware, has ruled that a tramway is a Brixton villa.

Now, it is just at this very point that the interest of the game commences. Foreigners, when new sources of revenue arise, usually devise new and appropriate methods of tapping them. And so do Englishmen, when national revenue is concerned. But in regard

* Paper read before the Tramways and Light Railways Association last night.

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to local taxation, we have preferred to allow the judges to stretch and strain the simple words of the original act until plain English has become uncommonly like double Dutch ; we have allowed them to evolve a chaos of case-hardened case law, which requires a grand army of experts to decipher and to work. And even the experts, I shrewdly suspect, only see "as through a glass darkly." And we have done so rather than abandon the hoary 43rd of Elizabeth ; and notwithstanding that even His Majesty's Commissioners, in their invertebrate final report on local taxation, are forced to admit that, "peculiar difficulty arises with certain other kinds of properties which are seldom or never let on the terms contemplated by the statute." The lawyers have, in fact, evolved the following ingenious catena: Under the Act of Elizabeth, *et seq.*, it is only occupiers, it is true, who are taxable for local purposes. Under the same statutes, they are taxable according to their annual rent. The tenants of railways, tramways, and the like, being few and far between, we have no means of estimating the annual value of such properties. These properties must not, however, escape taxation, and in order to observe the letter of the law we must invent an "hypothetical tenant," and ascertain what rent such an imaginary being might reasonably be expected to pay his imaginary landlord. To do this, we must (although disclaiming, in accordance with the law, all intention to tax profits) first of all ascertain the gross revenue of the railway or tramway, deduct therefrom ordinary working expenses, allow our hypothesis something for his imaginary stock-in-trade (which was expressly exempted from local taxation by the Act of 1840), and, finally, we must deduct the equivalent of the sums allowed in the case of house property for maintenance and renewal. The final result is the net rent which our figment could afford to pay his imaginary landlord—*i.e.*, it is his ratable value. In short, to quote again from the report on local taxation "the Courts have approved a method of valuation starting from the profits earned, and arriving at the annual value of the rateable portion of the undertaking by a series of deductions." To illustrate how this arbitrary procedure works out in practice, I append a specimen valuation of an electric tramway, taken from a booklet of which I have been guilty.*

SPECIMEN VALUATION OF AN ELECTRIC TRAMWAY.

Gross receipts—						
Traffic, advts., &c.				£60,000	0	0
Working Expenses—						
Coal, &c.	£5,000	0	0			
Oil, water, waste, stores, &c.	2,000	0	0			
Wages	22,000	0	0			
Salaries	2,500	0	0			
Rates, taxes, and "working insurances"	2,500	0	0			
	34,000	0	0			
Cars: Renewals and fire insurance	4,000	0	0			
				38,000	0	0
Net receipts				£22,000	0	0
Tenant's Capital: Allowances—						
Present value of 100 cars at £500	£50,000	0	0			
Cash	5,000	0	0			
	£55,000	0	0			
Interest thereon at 5 per cent. } 17½ per cent.	2,750	0	0			
Trade profit „ at 10 per cent. }	5,500	0	0			
Risks at 2½ per cent. }	1,375	0	0			
				9,625	0	0
Gross value				£12,375	0	0
Landlord's Allowances: "Statutables"—						
Repairs... Buildings, Generating plant, Permanent way, Overhead equipment	4,800	0	0			
Renewals fund (including insurance premiums) Buildings, plant, permanent way and overhead equipment	4,200	0	0			
				9,000	0	0
Rateable value				£3,375	0	0

Notes on Specimen Valuation.—I have made no attempt to set out every item in detail, nor to include every possible item. The specimen valuation is only intended to be indicative of the principle pursued in deducing the rateable value of a tramway concern from its gross revenue. I will now refer briefly to some of the more important points connected with the valuation. It is evident, I think, from the definitions of gross and rateable value given in the Act of 1869, that the legislature intended that the principle of averages should apply—*i.e.*, that the rateable value of a company should not be determined by taking the results of a single year's operations, but by deducing an average figure for receipts and expenses from the published accounts of a number of years—two or three, say. By "working insurances" I mean those relating to workmen's compensation, third party, fidelity and burglary. The wages and materials expended in keeping the cars in a running condition are included in the general working expenses. The item of £4,000 includes only the insurances of the cars against fire and the sum which a responsible tenant would have to set aside annually for the purchase of new cars in place of those worn out. The power house, plant, buildings and so forth, do not form part of the "hypothetical tenant's" property, and all the cost of the upkeep, renewal and insurance of these falls upon the landlord. In fact, the "hypothetical tenant" should be regarded, as nearly as may be, as working a line under lease from a corporation which owns the electric generating plant, overhead wires and permanent way. The reason for deducting from gross takings the interest to which the tenant is entitled on the capital he employs in the business is obvious, if I made myself plain in the preceding part of my Paper. But it should be mentioned here that the rates per cent. given in the specimen valuation, whilst they have not been legalised by Parliament, have been "legalised" by long-continued custom, and no abatement of these rates should be allowed upon any pretence whatsoever. On the contrary, there are, in my opinion, several valid reasons in the case of tramways for raising the customary rate of 2½ per cent. allowed for "trade risks." By "trade risks" is surely meant an extra allowance in consideration of the risks attached to the making of all trading profits, such as the diminution of the earning power of an electric tramway by reason of strikes, increased price of coal, bus competition, the upheaval of the roadway by the Post Office or a municipality engaged in wasting public money, or an unnecessary duplicate telephone system, snowfalls, fogs, &c. And I contend that these risks of a tramway are decidedly greater than those of, say, a railway company, and a corresponding increase of the normal percentage might very well be claimed.

Coming now to "Statutables." In the case of railways, &c., the question of the proper amounts to be allowed under the head of "Statutables" has been well hammered out in the courts, and as new undertakings, such as electric tramways, present many peculiarities, arising for the most part out of their liability to be bought up by local authorities, it is expected that a fresh hammering-out process will have to be gone through in their case before the question of "Statutables" is settled on a definite and generally recognised basis. Let me quote what I have said elsewhere on this point of "Statutables": "What is the basis of parochial valuation? The gross value. Now this is defined as 'the annual rent which a tenant might reasonably be expected taking one year with another to pay.' Now it cannot be maintained that a tenant could be 'reasonably expected' do pay as high an annual rent for a hereditament when his tenure is limited, and the price at which his plant may be taken from him is uncertain, as he would if there were no such limitations and uncertainties. These limitations and uncertainties, under which tramway and electric lighting undertakings labour, are an added risk over and above the ordinary risks incidental to ordinary trading, and should be allowed for. This contention is strengthened by the fact that the element of permanency of tenure seems to have been generally assumed as a matter of course in previous legal decisions on assessment matters. For instance, Mr. Justice Wightman, in Reg. *v.* the West Middlesex Waterworks Co., expressly refers to it: In practice, a tenant of a parochial portion of a canal, railway, gasworks, waterworks or the like has rarely if ever been known; but an hypothetical tenant must be assumed, and the terms of such a tenancy are not difficult to be conceived if in the hypothesis some necessary incidents are also assumed to be involved, such as, first, that each part of the apparatus is to continue in joint co-operation, no one tenant of an essential part being able to stop his part; secondly, that the title to the required land is permanent, so that there is no risk of being compelled to move fixed capital. . . But the compulsion to move fixed capital is in effect the very compulsion which is put upon landlord and tenant, under the terms of the purchase clauses of the Electric Lighting Act of 1888 and the Tramways Act of 1870. Hence, there is a good case for demanding a special allowance for the tenants of undertakings subject to municipal purchase. And the same argument applies to the landlord of such precariously-situated properties: he should be allowed something over and above the ordinary 'Statutables.' A landlord liable to be bought out under the terms of either of the above-mentioned acts would expect—and would get, in practice—something over and above the usual rate of profit. The normal sums should be allowed for the making good of wear and tear and for insurance against fire. On the other hand, the rate of allowance for the renewal of the buildings, plant, permanent way and overhead equipment should be increased above the customary rating standard. . . ."

Apportionment of Rateable Value.—But the rateable value has only been arrived at so far. It must now be apportioned, on the one hand, to land, buildings, machinery, &c., and, on the other, to track. And, finally, these apportionments must be divided up among the several local authorities within whose jurisdiction power-

* "The Rating of Electric Lighting, Electric Tramway and Similar Undertakings."—*The Electrician* Printing and Publishing Co.

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house, depot and track may be situated. The proportion of the total rateable value to be allotted to buildings, &c., is determined in the following manner:—The "structural value" of the buildings and plant and the value of the land is estimated by the assessor, and 4 per cent., or some similar percentage, of this value is deemed to be their rateable value, the balance of the aggregate rateable value being deemed to be the rateable value of the track. The rateable value of the track should, strictly speaking, be divided among the several parishes in proportion to the receipts from these several parishes, in which complicated process the way-bills of the concern come into play. The apportionment of the rateable value is, of course, a matter of secondary interest to a company as compared with the determination of the amount of that rateable value. All the same, the apportionment has a certain degree of interest for the company. It is to a company's obvious pecuniary interest to see that as large a proportion as possible of the total rateable value is allotted to parishes where rates are low.

Tramway Working at a Loss.—It must not be too hastily assumed that a tramway company working at a loss necessarily escapes having to pay rates. It has been held that "if an occupier derives no benefit of any description from its occupation, it (the property) forms no part of the general ability of the parish." But, as I have said elsewhere, "it is well-nigh impossible to show that a company derives 'no benefit of any description,' especially as the term 'beneficial occupation' has been expressly stated to be not synonymous with 'profitable occupation,' and has even been stretched to include property held at a loss year after year in the hope of a future profit, and to include all manner of remote and indirect benefits. Only a long-established tramway undertaking which had made no profit over a long term of years, and which could not be shut down owing to penalty clauses in its act or order, could hope to be deemed 'discharged from its legal liability to rates.'"

Rough Test of Correctness of an Assessment.—Before leaving this part of my subject, I should like to mention a ready test which may be applied to ascertain roughly if any given tramway is overrated. My experience is that over a number of electrical undertakings the rateable value comes out at a little over 20 per cent. of the net profits, as shown on the balance-sheet. Hence, I suggest that the responsible officers of a company need not trouble themselves over much until their rateable value begins to exceed this figure. To argue that a concern is overrated because its rateable value per route or track-mile is high as compared with that of another concern is to adopt a basis of comparison which is entirely fallacious. Naturally a concern making high profits per route-mile will have a high rateable value per route-mile. Such a ratio tells one nothing at all. On the other hand, the ratio of the rateable value to the profits should be approximately constant, provided the assessments have been carried out correctly and the profits have been determined on substantially uniform lines.

Light Railways.—Light railways have two statutory rights to a special reduction of rateable value. By sec. 5, sub-sect. 1 (*c*) of the Light Railways Act of 1896—a section at once elaborate, obscure and of little practical utility—the Treasury may, for one or other of four definite purposes of limited likelihood, and provided three other separate and improbable conditions are fulfilled, grant a special advance to assist the construction of a light railway. Then, provided the advance be a free grant, this rare, if not unique, specimen of a railway may be given a certain degree of preferential treatment in regard to the determination of its rateable value, provided (finally) that no rating authority has a valid objection. The special treatment which may be accorded, after all these improbable conditions have been fulfilled, is to the effect that during a period not exceeding 10 years the light railway will not be assessed to any local rate at a higher value than that at which the land occupied by it would have been assessed if it had remained in the condition in which it was immediately before the land was acquired for the purpose of the railway. All this has obviously little to do with light railways as we know them in England.

The other special privilege of light railways is more substantial, and will have the effect of appreciably reducing the rateable value of light railways as compared with tramways. The whole thing would seem to the lay mind to hang upon a comma. I understand, however, that punctuation is not admitted to affect the strictly legal interpretation of an act. The following are the sections bearing on this point:—Public Health Act, 1875, sec. 211.—"With respect to the assessment and levying of general district rates under this act, the following provisions shall have effect—namely, (1) (*b*) . . . and the occupier of any land covered with water, or used only as a canal or towing path for the same, or as a railway constructed under the powers of any act of Parliament for public conveyance shall be assessed in respect of the same in the proportion of one-fourth part only of such net annual value thereof." Then sec. 12, sub-sec. 2, of the Light Railways Act reads as follows:—"Subject to the foregoing provisions of this act, and to any special provisions contained in the order authorising the railway, the general enactments relating to railways shall apply to a light railway under this act in like manner as they apply to any other railway; and for the purposes of those enactments, and of the Clauses Acts so far as they are incorporated or applied by the order authorising the railway, the light railway company shall be deemed a railway company, and the order under this act a special act, and any provision thereof a special enactment. Provided that a light railway shall not be deemed a railway within the meaning of the Railway Passenger Duty Act, 1842. . . ."

Reduction of the Burden of Rates.—One way to keep down the very heavy burden of local rates is, naturally, to keep down the assessment; but an equally effective method is to keep down the total rate in the £. Both methods can, of course, be put in operation at the same time. As to the first, I have indicated several directions in which tramway and light railway undertakings can press for special consideration with reasonable chance of success. But it is obvious that if railways, tramways, farmers and parsons all obtain special reductions, others will probably do likewise, and the final result, unless the total sum to be raised for local purposes is also reduced, will be that a company will be paying very much the same in rates as before, only, instead of the rateable value being £1,000, and the total rate in the £ being 4s., the rateable value will be £200 and with a 20s. rate in the £. It seems to me, therefore, that an even better line for a company to take is to lose no opportunity of exposing municipal extravagance and of securing adequate representation on the money-spending bodies.

Possible Improvement on Present Practice.

I have devoted so much space to the present that I have left myself very little space to deal with the future. Briefly, my firm conviction is that, even in conservative, case-law ridden England, the present practices of rating 20th century undertakings on the lines of the 43rd of Elizabeth, and of raising practically all the money required for local purposes from a single tax, cannot continue much longer. The system of subsidies or subventions to local authorities from Imperial sources is a pernicious one, as usually carried out in this country, and has probably reached its limits. Sooner or later, local authorities will be face to face with the necessity of levying a preposterous rate in the £, or of finding additional substantial sources of revenue. I cannot help thinking that we shall then see the rating absurdities which I have alluded to swept away, and trading concerns (at any rate those such as tramways) will be taxed on the basis of their income tax assessment as fixed by the Inland Revenue authorities. I do not suggest for one moment that these assessments are beyond cavil, but they are arrived at in a manner incomparably more simple and less arbitrary under sec. 12 of the Customs and Indland Revenue Act, 1878, than local taxation assessments. In any case a single relatively simple and fair assessment will take the place of two separate assessments, one of which is expensive, unfair and ridiculous. Local authorities and companies will no longer employ valuers and barristers; the taxable value will be easily ascertainable; companies working at a bona fide loss will no longer be told they still have a taxable value because they are in "beneficial occupation" of a hopelessly lean line. The difficult question will be, of course, to prevent local authorities from throwing the entire burden, or a disproportionate share of the burden, of local taxation upon "the stranger within their gates"—*i.e.*, upon railway, tramway and similar concerns.

In 1899-1900 nearly £36,000,000 was raised by rates. Let me assume (solely for the sake of illustration) that it was found that one-quarter of this sum was levied from railways, tramways and the like, and three-quarters from house property and the like. Then let me further assume (again only for the purpose of illustrating my argument) that it was found that an average rate of 4s. in the £ on house property, and 1s. in the £ on the income tax, assessments of the companies would have realised these respective sums of £27,000,000 and £9,000,000. Then Parliament could direct that for the ensuing five years no local authority should impose a higher rate than ¼d. in the £ on the income tax assessments for every 1d. per £ of rateable value. At the end of every quinquennium these relative poundages might be open to revision by, let me say, the Local Government Board. The Royal Commissioners, notwithstanding the very voluminous character of their report, did not see their way to make any suggestion as to how local taxation in England might be radically reformed; but a perusal of their final report will show that His Majesty's Commissioners fully realised the intolerable state into which our so-called system of local taxation has fallen.

I cannot do better, since I have advertised a patent medicine of my own, than to call attention to the remedy for all the taxing ills tramway companies are liable to which is propounded by the Royal Commissioners themselves. "We recommend," they say, "that special properties, such as railways, canals, mines, tramways, docks, telephones and gas, water and electric light works, should be valued in first instance by a valuer appointed by the valuation authority—*i.e.*, the county or borough valuation authority—objections being heard by that authority, and appeals being made to the Railway Commission or a special tribunal created for that purpose." The commissioners then proceed a step further, and state that, with

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regard to these special properties they are "of opinion that if the occupiers of such properties or the local authorities concerned desire it, they should be able to have the properties valued by the Government valuer of railways instead of by the county or borough valuation authorities, and that an appeal should then lie to the Railway Commission or a special tribunal created for that purpose." If the present system of valuing special properties is incapable of fundamental improvement, then the extended recommendation of the commisioners should certainly be adopted. It would protect companies against the well-known tendency of rating authorities "to try it on" with an iniquitously high assessment.

A TRACK CIRCUIT BLOCK SIGNAL FOR ELECTRIC RAILWAYS.*

A demonstration of the "Young" system of block signalling for electric railways was recently given at Rochester, N.Y. The difficulty of designing a system which would work on the "track circuit" principle is chiefly due to the fact that the rails are almost universally used for the return conductor.

The new method leaves both rails available for the trolley return, and yet utilises them for the indicating track circuit. Briefly, it involves nothing more than the substitution of an alternating signalling current for the ordinary battery current. Necessarily, also, the separation between successive block sections cannot be simply by the usual insulating joint, since this would prevent the trolley return current from passing, but must be accomplished by a device which gives free passage to the trolley return while serving as insulator for the alternating signalling current. A further requirement is that the electromagnetic relay must be such as to be actuated by alternating instead of direct current.

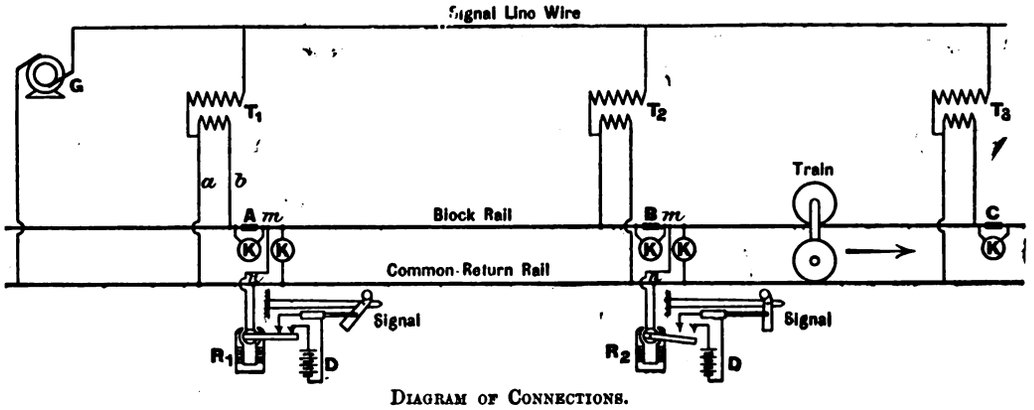

DIAGRAM OF CONNECTIONS.

The arrangement of apparatus used to carry out this idea is shown in the accompanying diagram. One of the two track rails is divided by insulating joints, A, B, C, into consecutive blocks, AB, BC, &c. At the entrance of each block (trains assumed moving to the right in the diagram) is placed a signal mast, whose arm may be operated either by compressed air or by electric motor, in the usual manner. In our illustration a small battery, D, is shown supplying the motor mechanism of the signal arm; the circuit of this battery is controlled by a relay, R, and when closed, as at R_1, the signal arm is pulled down into the inclined position indicating "Clear," while when the circuit of D is open, as at R_2, the signal arm is pulled by a counter-weight into the horizontal or "Danger" position.

The signal circuit current is supplied by a small alternating-current generator, G, in the power house or sub-station. This machine supplies current at 300 volts and 100 cycles to a line wire strung along the line of the railway. The power transmitted over this wire is always quite small. At the far end of each block there is a small step-down transformer, T, which supplies a 3-volt alternating-current to the preceding block (by the wires *ab* in the diagram). The 300-volt side of the transformer is connected to the unbroken or common return rail. Each block, therefore, has an alternating potential of 3 volts impressed across the rails at the far or leaving end of the block.

At the entering end of each block the indicator wires *mn*, leading to the relay, are taken off. The relay itself is virtually a small alternating-current motor adapted to be operated by the 3-volt track circuit current from *mn*. It may be constructed in various ways. In the demonstration of the system the relay was arranged with separately-excited field windings supplied from suitable connections to the line wire. In any case its action is such that, when current flows in the track circuit, the armature of the relay will tend to rotate and thereby presses a contact arm against two contact points in the local circuit of the signal mechanism. When no current passes in the track circuit the contact arm drops away from its contact points and opens the circuit of battery D, thereby giving a "Danger" signal. Evidently this occurs when a train in the block (as in block BC) short circuits the track circuit from wires *ab*.

It will be noticed that the block rail is broken by insulating joints A, B, C, &c. In order to usefully employ this rail for part of the trolley return circuit these insulating joints are shunted by special bonding devices marked K, which offer free path to the direct current of the trolley return, but oppose a high resistance to the passage of the alternating signalling current. The nature of these devices, K, was not disclosed in the public demonstration of the system for reasons of patent application. It would seem, however, that a suitably-designed reactive or choking coil would fulfil the requirements of the case, and for our present purpose we may consider the bonds K to be merely choking coils. The passage of the trolley return current through such coils will depend only on their resistance, which may be made as low as desired, while the resistance offered to the flow of alternating current depends upon their electromagnetic inductance. We may assume that they make the block rail electrically continuous for the trolley return, but divide it into blocks as regards the alternating signalling current. A second such bond, K, is connected between the block rail and the common rail at each block point to supply the desired cross-bonding of the track without short-circuiting the signalling track circuit.

The operation of this signal system will be clear from what has already been said. It is exactly the same as that of the track circuit system of the ordinary automatic block signal. One additional feature deserves to be mentioned—the 3-volt supply wires *ab* are connected in reverse polarity in consecutive blocks, as is indicated at A and B in the diagram. The purpose of this is to give a "Danger" indication when one of the insulated joints breaks down. Suppose, for instance, that joint B loses its insulating powers. Then the secondary current of transformer T_2 has free passage into block BC, and, if a train be in the position shown, it would not fully short-circuit the relay R_2, since current from T_2 could reach this relay. In this condition, if the track circuit of adjacent blocks had the same polarity, a second train reaching B would get a "Clear" signal, even though a train is in block BC. With the reversed connections of the leads *ab* in successive blocks this cannot occur; if joint B breaks down the current from T_2 will flow across the joint and act upon relay R_2 in the reverse from normal direction; it thus throws R_2 sharply open and gives a "Danger" indication.

In regard to the details of the system as developed, we may mention that the generator G is about 2kw. in capacity, and will supply 15 to 20 miles of way, or, say, 30 to 40 signals. The transformers T take each 20 to 30 watts, and have a capacity of 50 watts. They are designed with low regulation, the secondary voltage falling off rapidly as the load increases, which adds to the certainty of action of the relays and prevents damage from short circuits. The relays are extremely sensitive and will work with a potential of 0·1 volt. It is claimed that this fact, together with the use of alternating current for the track circuit, will enable this system to operate under conditions which put out of service most automatic block signals.

The system was devised by Mr. S. M. Young of the Pneumatic Signal Co., Rochester, N.Y. In the demonstration, which was given on the Sodus Bay line of the Rochester Railway Co., the company's all-electric signal arm mechanism was employed, in which a motor operates the signal arm through gearing. For the local circuit of the signal mechanism current was taken from the trolley (600 volts) and passed through five incandescent lamps fixed on the signal arm to illuminate it. After passing through the lamps the circuit went to a small six-cell storage battery, which latter in turn supplied the signal motor under the control of the relay. This is probably the most compact arrangement possible for electric railways.

It is stated that the "Young" system may be applied quite readily to alternating-current railways. It is necessary only to select the signalling track circuit of suitable frequency to avoid interference with the power current.

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ELECTRIC RAILWAYS AND TRAMWAYS.

It is notorious that the real value of statistics and tabulated information is not as a short cut to knowledge which may be taken with safety by those hitherto ignorant of the subject dealt with. Statistical, like mathematical, investigations cannot always take account of particular circumstances and, if applied thoughtlessly to a special case, the result is frequently inaccurate and misleading. Such is not the case, however, when statistics and tables are placed in the hands of men who are thoroughly well acquainted with the subject matter. They are perhaps fully aware of the various details of the progress or expansion which the statistics are intended to show, but are frequently unable without this assistance to gauge the extent and magnitude of this progress. Thus experts know that electric tramways have been extending at a phenomenal rate in this country during the last few years, that the electric railway has become more than a subject of general conversation, and that a large number of the tramways running at present are supplied from combined electric lighting and traction power houses; but, nevertheless, some of the facts ascertainable from the tables which we publish as a supplement to this issue of *The Electrician*, bring out with surprising distinctness some of the aspects of electric traction enterprise. Let us take, in the first place, the number of electric tramways supplied from combined lighting and traction stations. These number no less than 88 out of a total of 130; that is, over two-thirds of the whole list. The new method or arrangement which we have adopted in our Electric Traction tables this year bring this point out very clearly. We have placed in two separate tables the tramways taking power from combined stations and those which are supplied from their own power houses, generating current exclusively for the tramways. The former table can be read in conjunction with the supplement table of "combined" electricity works published with our issue of January 15th, and to a limited extent with the power company supplement published with our last issue. On January 8th, it will be remembered, we published the long list of electricity works with no tramway load; so that the set of four sheets gives a complete account of the present position of electric lighting, traction and power supply in this country. Next week we shall publish our annual map of electric railways and tramways in the United Kingdom.

The enormous increase in the practice of combining electric lighting and tramway generating stations is mainly due to the

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anxiety of central station engineers to improve the load-factor by increasing the all-day load. Of course, there is much overlapping of the two loads in the winter months, and there is not a considerable all-night load, such as may possibly be attained in the future by stations supplying iron works, chemical works and the main railway lines; but still the addition of a tramway load to an electricity works is undoubtedly profitable. This is indicated, moreover, by the extremely low price charged in many cases for the tramway supply. There is another reason, not so technical, which has contributed to the extension of "combined" stations in this country. A tramway load is so much more profitable from a commercial point of view than the short-hour lighting load that tramway companies, when they have not to supply electric lighting, are wise, so far as technical reasons are concerned, to leave the older branch of the electricity supply business untouched, and to generate current exclusively for their own tramways. Although public lighting is a useful addition to the tramway load, the peaky private lighting is not. Yet it will be seen that a number of companies, including nearly all those associated with the British Electric Traction Co., buy current for their tramways from combined electric lighting and tramway stations. The reason, as we have stated, is not an engineering one; it is a question of policy and is explained by the necessity imposed on a company of obtaining the sanction of the local authority in the district before they can obtain powers to build a tramway on it. The local authority often requires various inducements before its consent is gained, and an agreement to take current from its electricity works will frequently disarm all opposition to a scheme. It will be seen that several companies take their electric power from two different municipal electricity works at the same time, and that others, while owning power houses of their own, actually take current for part of their lines from the works of the local authorities. Our long "Projected" and "In Progress" tables show that the electric traction industry is in a healthy condition and gives promise of a large extension during the year.

The extension of electric railways has been such that we have felt justified in grouping them in a separate table, in which is given information of a nature applying particularly to these undertakings. Four electric railways were running at the end of 1902: The Liverpool Overhead Railway, the City and South London Railway, the Waterloo and City Railway, and the Central London Railway. During the year 1903, two new lines have been opened, the Mersey Railway and the pioneer 6-miles of electrically-equipped Metropolitan-District Railway (the new branch from Ealing to South Harrow). In the course of the next few weeks, the Great Northern and City Railway and electrically-equipped sections of the North-Eastern and Lancashire and Yorkshire Railways will all have been opened to the public; and progress is also being made with the transformation of the Metropolitan-District Railway and the building of the tube lines of the Yerkes group (Baker-street–Waterloo, Great Northern, Piccadilly & Brompton, and Charing Cross, Euston & Hampstead) all three of which will be supplied, together with the Metropolitan-District Railway from the large power house which the Underground Railways Co. of London is building in Chelsea. The Metropolitan Railway is building its own power house at Neasden, and the Great Western Railway has just let contracts for the equipment of a large electricity works to be built at Park Royal, near Willesden, with the object of commencing the electrical equipment of its suburban lines. In electric railway work, as in tramway work, we are approaching very nearly to standardisation. The main difference between electric railway systems lies in the position of the third rail and as to whether an insulated fourth rail is employed as the return conductor. A third rail in the centre of the track is unsuitable for heavy railways on account of a low load gauge and the possibility of trailing chains, &c., coming into contact with the rail. Thus the construction adopted in the four older lines, with the positive conductor rail between the tracks, has been abandoned. The Lancashire and Yorkshire and North-Eastern Railways have both placed the positive conductor rail in the 6ft. way, the centre of this rail being 3ft. 11½in. from the centre of the 4ft. 8½in. track, and this will, we may anticipate, be the standard on all main lines. The Lancashire and Yorkshire Company has laid an insulated fourth rail as negative conductor between the tracks, this being bonded to the track rails, but this should not prevent North-Eastern motor cars from running on to the Lancashire and Yorkshire lines, and *vice versâ*. The London lines unfortunately have a different gauge for the position of the conductor rails, but as all the suburban lines with running powers on the Metropolitan-District will adopt their standard (positive rail 3ft. 8½in. from centre of track, negative in centre of track), this will form a complete system in itself. Probably the Great Western and London and North-Western will find cause for regret that they will be virtually compelled to equip their main and suburban lines on different gauges for this reason, but in practice the complication will probably not be of serious moment, and will amount, presumably, only to the provision of a few extra locomotives for conveying traffic across the suburban connecting lines from one main line to the other. To pass in review such considerations as these is not to look too far forward. The electrical equipment of railways is beyond the experimental stage, and all these points are already being seriously deliberated upon by railway engineers and the electrical engineers advising them. It will not be long before the electric railway industry is the most important of all developments of electrical engineering.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electric Traction: A Practical Handbook on the Application of Electricity as a Locomotive Power. By JOHN HALL RIDER. (London Whittaker & Co.) 1903. 10s. 6d. net.

Every practical engineer carries out his work in ways which are, in a sense, instinctive, and not due to conscious calculation. These instinctive or intuitive methods are the resultant of the individuality of the man and the circumstances in which he has had to apply his skill and energy. Though such a summary of acquired instinct is unavoidably somewhat narrow in view, it possesses the solid value that every chapter is based on memories of success and failure. Considered from this point of view, Mr. Rider's book is a valuable contribution to technical literature, and anyone who takes it as his guide may feel confident that at least on the engineering side he will not make any serious mistake. There is a strong temptation, in reviewing such a "personal document," to criticise the author's conclusions or recommendations, showing reason for a different opinion in many cases, because the reviewer's own experience has led him to other conclusions. Such a course would be of doubtful interest, and, by emphasising differences, would give a false notion of our estimate of this book's value. As a concisely-worded record of contemporary practice in an important engineering industry it takes a high place. The style is terse, clear and generally distinct. There is but little reasoning from first principles, and where there is, it seems out of keeping with the generally practical character of the work. There is also no bewildering array of alternatives; the author deals almost exclusively with what he would consider in any scheme he had to design, and leaves out the rest.

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Having said so much, the criticisms which follow should not be misunderstood. The main one which occurs to us is that Mr. Rider's point of view is almost entirely non-commercial. To take specific examples. In the second chapter on "Generating Plant," the whole matter of design of station, and selection of plant to obtain the most economical power costs at a minimum capital expenditure, is quite untouched. Again, in "Distribution," the application of Kelvin's law to economy of conductors is lucidly explained, and a useful graphic multiplication table giving the cost of energy lost in the cables at different prices is provided, but the totally erroneous statement is made that the first consideration in laying out the power side of a traction scheme should be to select a site for a most economical generating station and make the system of distribution to suit. Neither this, nor the opposite plan of fitting the station to a predetermined distribution system, is correct. The alternatives should be weighed together, and that giving the smallest total cost of power at the cars adopted.

An extreme example of the same disregard of economic considerations is found in Chapter 13, "Combined Lighting and Traction Stations," where it is suggested that the use of accumulators on such a scale as to enable the tramways in a town to be supplied entirely from a battery during the heavy lighting load, is a desirable scheme. It is quite true that the load-factor would be a splendid one—there would be some other figures on a splendid scale as well.

There are a few evidences of haste or oversight which might mislead a young engineer, to some of which the author will thank us for calling his attention. In the first chapter, the horse-power required for cars under certain conditions is discussed, and examples worked out for tractive resistance, acceleration and climbing. The formula and result for acceleration horse-power gives only half the true figure, and is, in fact, the expression for the kinetic energy of the car at the end of a certain time under a certain acceleration, whereas the result aimed at is the maximum horse-power called for by that uniform acceleration. Naturally, this maximum horse-power occurs at the maximum speed—that is, at the end of any period—and is just twice the average horse-power taken in bringing the car from rest up to that speed. It is much more convenient, as the author himself says in Chapter 5, to work out the motor-power required in pounds effort on the wheel periphery; this gives the motor performance needed in the terms required by the maker and generally used in specifications—viz., with a given gear and wheel diameter so many hundred pounds effort at so many miles per hour.

Acceleration effort is simply $\frac{\text{acceleration} \times 2{,}240}{32{\cdot}2}$ lb. per ton, and climbing a certain grade of 1 in n $\frac{2{,}240}{n}$ lb. per ton. The "track resistance" is always expressed in the same units, and the sum of the three elements for a car of any weight gives the total motor performance as regards pull, the speed giving the other factor.

The effect of hills on the average power needed is worthy of fuller consideration than has yet been given. Mr. Rider's statement that gradients steeper than 1 in 250 necessitate greater energy expenditure than a level track needs qualification. The author's views on dynamo output and engine speed invite discussion, which space forbids. It is hardly correct to say that marine practice has influenced central station practice in the direction of low engine speeds. Power for power, large marine engines run at much higher speeds than most electric supply engines. Steam turbines are not mentioned. In Chapter 4 it should have been said that the total weight of tramway feeders in a given area, assuming car service to be proportional to the area, is proportional to the square of the area, not the cube. It seems that total length has been taken for average length of feeders.

Treating of "negative boosters" the author stigmatises as "incorrect" the only disposition of a negative booster which gives an automatic control of rail drop—viz., that with the booster field in series with its armature and the track feeder. He prefers to excite with the current of the positive feeder to the same point of the line, and assumes that a series-wound dynamo driven at a constant speed on a circuit of steady resistance will necessarily excite itself and drive a current round that circuit. In practice it is rarely or never the case that the feeding points for the trolley are necessarily those for the track. It is highly inconvenient to be fettered in the arrangement of trolley feeders by track-feeding considerations or vice versa, and highly objectionable to have positive feeders taken to the fields of negative boosters. If the circuit to which the booster will be applied has a resistance a little above the "critical" value, and the booster has a straight line characteristic which will meet the drop in the cable throughout the range of current to be dealt with, a machine is obtained that meets the conditions in a very perfect automatic way with the minimum of complication and trouble.

The truth about gauge on curves could have been stated more clearly. This truth is not that the gauge should be reduced, but that it should be measured on the lines of the axles parallel to the truck centre, not radially, from which it follows that every different wheel base needs a different gauge on a given curve, assuming the width of groove and thickness of wheel flange to be unaltered. The aim should be to have no curve so sharp that wheels will bind in the grooves. Narrow streets and limits to groove width frequently prevent this; but the great alleviation conferred by the use of bogies might have been emphasised. The formula for rail-return resistance in Chapter 8 is seriously wrong. The result should be about doubled, and it was probably meant to express the resistance of a single track instead of a single rail, as stated. This is all the more probable that a correct figure is given in the last paragraph of the chapter.

There are two sides to the suggestion that small cars are inefficient and costly as compared with large ones. Mr. Rider shows elsewhere that he quite recognises this, and that there are many cases where the smaller cars give the better economic result; the great effect of frequency of service upon traffic receipts has to be considered, and the author properly states that no item in a tramway equipment requires such careful adaptation to local conditions and habits as the car. His opinion that it is only a question of time for single-deck to replace double-deck cars in the United Kingdom, is one which we fully share.

The chapters on motors, controllers, rolling stock and permanent way are excellent, that on controllers being an especially clear and intelligible account of a complex subject. Overhead work is not treated quite so fairly. The author is much enamoured of the side-wire system, for the simple reason that, in his opinion, the central or under-running wire construction is less sightly. He does not seriously argue—no engineer can—that any other disposition of the trolley wire can work so well. He does not consider cost; and clearly a double-bracket line costs more than a span-wire line. It cannot be put too clearly that operating perfection and first cost are both on the side of the central wire. Many good judges think a double row of bracketed poles more obtrusive and unsightly than a span-wire construction. Tastes differ, but cost and good working are substantial facts. Mr. Rider's figures for the cost of overhead work are much higher than the average.

The chapter on conduit construction is another excellent one. The reasons given for the adoption of a conduit system show that the author is under no illusions. He says that it is justified only where capital expenditure is of no importance—*i.e.*, where the traffic is so heavy that the capital charges form an insignificant addition to operating costs; even this, he observes, is no reason why the overhead trolley should not be used. As the capital charges on the difference of costs are of the order of £1,000 per annum per mile of double line, and the cleaning and inspection is three or four times as expensive as with overhead wires, there seem to be pretty strong reasons why the trolley should be used wherever it is permissible.

Of surface contact systems the author describes six good typical examples—he does not wish to have to use any of them; agreeing generally with his views on their relative merits, we would add that there seems to be no commercial opening for them.

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Chapter 13, on "Combined Lighting and Traction Stations," is a useful and suggestive statement of the best-tried arrangements, including that designed by the author at Plymouth. That the generation of electric power for all purposes in a given area should be under a single management cannot be disputed.

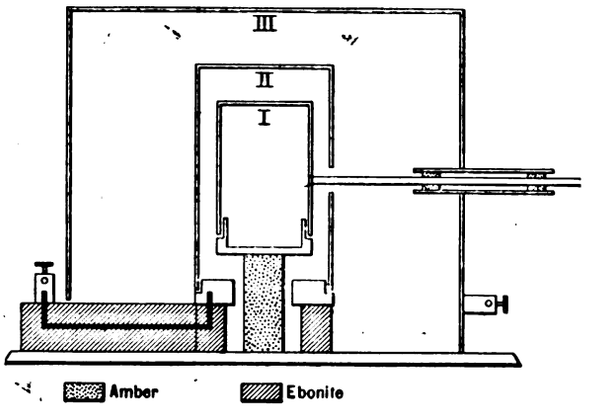
The concluding chapter on electric railways is an admirably-condensed account of the present systems of working and some of the experimental or speculative systems put forward. The relevant points of difference between tramway and railway and between main and suburban railway traffics are briefly and clearly described.

It would take much greater space than is available to do justice to the book, and many points noted for discussion are perforce left untouched. We repeat that it is a valuable record of the present state of electric traction and of the principles and conclusions guiding the action of an engineer in the responsible and difficult but fortunate and enviable position occupied by the author.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

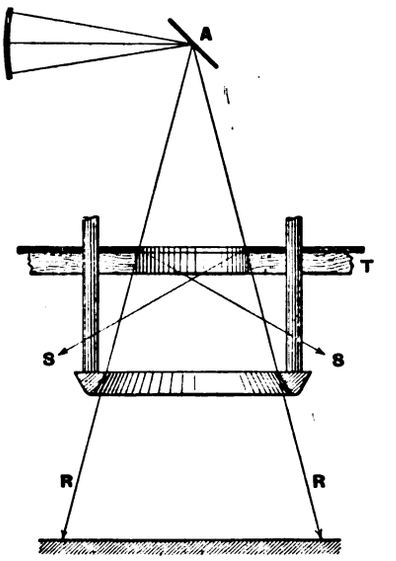
Measurement of Small Quantities of Electricity.—The main difficulty encountered in the measurement of small capacities lies in the influence of neighbouring conductors. Even the measurement with concentric spheres is subject to an error of some 25 per cent. when the capacity to be measured is of the order of 20cm. F. Harms considers that the measurement of



any capacity below 100cm. is hopeless by the usual methods. He, therefore, does not measure the capacity of a small condenser, but the induction of one plate upon the other. The arrangement adopted is shown in the diagram. The cylinder II. is joined up to the insulated pole of a battery, while the cylinder I. is put to earth, and the cylinder III. is permanently earthed. I. is then insulated and II. put to earth, and a charge is obtained on I. and the conductors connected with it which is proportional to the E.M.F. of the battery and the coefficient of induction. The latter is determined experimentally, either by means of a ballistic galvanometer or by means of an electrometer method. The values obtained in a case specified were 41·3 and 41·55 respectively by the two methods. The new method is specially valuable in absolute measurements connected with atmospheric electricity.

[F. HARMS, *Phys. Zeitschr.*, January 15, 1904.]

Elimination of Secondary Rays in Radiography.—F. Dessauer and B. Wiesner have devised an apparatus for radiography in which the disturbing effects of the secondary or S-rays are eliminated, and the sharpness of tracing considerably increased. Observations hitherto made have shown that the diffuse reflection of Röntgen rays is strong in bodies containing water or fat, and this fact explains the difficulty of obtaining good radiographs through layers of fat, or of fractures attended with considerable effusion of blood. The process adopted by the authors is practically that of filtering of the secondary rays by means of a tube suitably arranged. Such a tube is shown in the diagram, where A is the anti-cathode, SS the secondary rays, and RR the Röntgen rays. The elimination of the secondary rays is brought about by utilising the fact that they are produced in the greatest quantity near the source. The inner wall of the short upper tube T is the most prolific source of S-rays. The lower tube is shielded



from the direct impact of the X-rays by the upper tube, and whatever residuary S-rays impinge upon the plate are incapable of fogging the negative or producing loss of detail.

[F. DESSAUER and B. WIESNER, *Phys. Zeitschr.*, January 15, 1904.]

Action of Radium Rays on Mercurous Salts.—When making Clark cells it is observed that the mercurous sulphate in the depolarising paste rapidly changes from white to a dark colour if a cell is left exposed to light. S. Skinner has investigated the manner in which this change is affected by the various known forms of radiation. In sunlight, the active portion consists of the violet and ultra-violet rays. Becquerel rays from uranium nitrate have no effect, and X-rays require a very long exposure to produce any change of colour. The rays from 10 milligrammes of radium bromide, mounted as usual under mica, produce a visible result in 24 hours, while in three or four days they produce a very marked darkening. The mercurous salt phosphoresces very slightly in the presence of the rays. The author believes that the darkening is due, not to polymerisation or to the separation of metallic mercury, but to the formation of a mercury sub-sulphate.

[S. SKINNER, *Proc. Cambridge Phil. Soc.*, January 12, 1904.]

Liberation of Electrons by Röntgen Rays.—J. J. Thomson has devised a simple way of showing that a metal exposed to Röntgen rays gives out cathode rays. He mounts a small gold-leaf electroscope on a quartz support in a vessel in which a very good vacuum can be produced. When the vessel is exhausted and the gold leaves exposed to Röntgen rays they diverge, and on testing they are found to have a charge of positive electricity. If, before exposure to the rays, the leaves are charged negatively, then, when the rays are applied, the leaves at first collapse and then diverge; while, if the initial charge is positive, the divergence of the leaves increases from the time of putting on the rays. This is a very direct proof that the gold leaves when exposed to the rays acquire positive and lose negative electricity.

[J. J. THOMSON, *Proc. Cambridge Phil. Soc.*, January 12, 1904.]

Production of N-rays by Sound Waves.—The fact that the flexure of bodies provokes the emission of N-rays has led J. Macé de Lépinay to try whether sound waves produce the same effect. A sounding body undergoes a large number of alternate deformations per second. Experiments made with a tuning fork and with a cylinder of steel or bronze have yielded an affirmative result. The best results were obtained with a steel cylinder 30cm. long and 2 cubic cm. in diameter, sus-

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pended at its two principal nodes, and made to give out a musical note with a hammer. The increase in luminescence of a calcium sulphide screen under the influence of the vibrations was very marked. On suddenly stopping the vibrations, the luminosity gradually died down, and this effect was about the easiest to observe. It was noticed, however, that the increase of luminosity was feebler near the nodes than near the ventral segments, and this led the author to conclude that the real cause of the increased brightness of the screen lay in the air-waves. This was proved to be the case by interposing a screen of lead 2mm. thick or a layer of water 2cm. thick in the path of the N-rays. This had the effect of completely intercepting the N-rays, but left the air-waves access to the screen by diffraction. The phenomenon then remained the same as before. A great simplification is introduced into this experiment by employing a siren with independent air-blast. It is placed in a darkened room, so that the rotating disc is only faintly visible. As soon as it is made to sound, the disc becomes more clearly visible. The subjective element may be eliminated by carefully stopping the ears and having an assistant to turn the sounding blast on and off.

[J. M. DE LÉPINAY, *Comptes Rendus*, January 11, 1904.]

RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 522.)

Radium.—In spite of the enormous radio-activity of this element and the many additional properties it possesses in consequence, radium is very similar to thorium in the general character of its radio-activity. Its activity is, however, at least a million times greater. It produces strong visible fluorescence when its rays fall upon certain substances—*e.g.*, the platino-cyanides, zinc blende, zinc silicate, diamond, glass, &c.,—which affords an optical means of detecting and estimating the radio-activity. It is rather a curious fact that magnesium platino-cyanide, which is one of the best fluorescers under the X-rays, does not respond to the radium rays. Of the other platino-cyanides, barium and calcium fluoresce green, sodium yellow and lithium red, the same as for the X-rays. If the salts are in the form of large crystals most beautiful effects can be obtained, even with only a few milligrammes of the pure radium compounds.

M. and Mme. Curie (*Comptes Rendus*, 1899, 129, p. 823) discovered that radium has the power of conferring radio-activity on its surroundings, and this phenomenon was later studied by Curie and Debeirne (*Comptes Rendus*, 1901, 132, p. 768; 1902, 133, pp. 276 and 931). For a long time these investigators held the view that the radio-activity was "induced" in the inactive matter by the *radiations* of the radium. It is now generally admitted that the "induced" or imparted activity of radium is caused by the emanation in a precisely analogous manner to that of the allied phenomena in the case of thorium. Dorn (*Abk. der Naturforsch. Ges. für Halle*, 1900) recognised the existence of the radium emanation, analogous to that already described by Rutherford for thorium, and pointed out that its activity lasted a much longer time than in the case of the thorium emanation. It can still be detected several weeks after it has been separated from the radium producing it. The imparted radio-activity from radium on the contrary decays more rapidly than that from thorium, falling to half value in about 30 minutes.

Nearly all dry solid radium compounds give out very little emanation until they are warmed or dissolved, when there occurs a sudden evolution of the stored-up emanation several thousand times greater than that ordinarily given by the cold dry salt. If this is swept away by a current of gas or extracted by a mercury pump and stored, it will be found that the gas is spontaneously luminous in the dark and remains so for several weeks, the luminosity continuously diminishing till finally it completely disappears. Once the emanation is extracted in this manner from any given sample of radium, no appreciable further quantity can be then obtained. As the activity of the gas extracted diminishes with lapse of time, a fresh crop is manufactured by the radium, the total radio-activity due to emanation being at all times constant. The explanation is the same as in the case of thorium and thorium X, and the rate of decay of the activity of the radium emanation is similar to that of thorium X, being about 6,000 times slower than in the case of the thorium emanation. But the radium emanation, although otherwise similar in general properties to the thorium emanation, escapes into the air with even less facility from solid compounds. In both cases, so far as we know, the emanation escapes instantaneously from the compounds in aqueous solution. The emanation is being continuously produced by radium at a constant rate, in exactly the same manner as thorium X is produced from thorium.

Owing to the comparatively slow rate of decay of its activity, the radium emanation, when it does not succeed in escaping, accumulates in the compound producing it to a much more marked extent than in the case of thorium. It has been shown that if the amount stored up in a radium or thorium compound (from which no emanation escapes) at the equilibrium point where the loss through decay balances the continuous production, is represented by N_0, and q_0 is the amount produced per second, $N_0/q_0 = 1/\lambda$, where λ is the radio-active constant. (Rutherford and Soddy, *Phil. Mag.*, 1903, VI., 5, p. 450.) $1/\lambda$ for the thorium emanation = 87, but for the radium emanation = 463,000. This relation has been experimentally verified in a quantitative manner in the

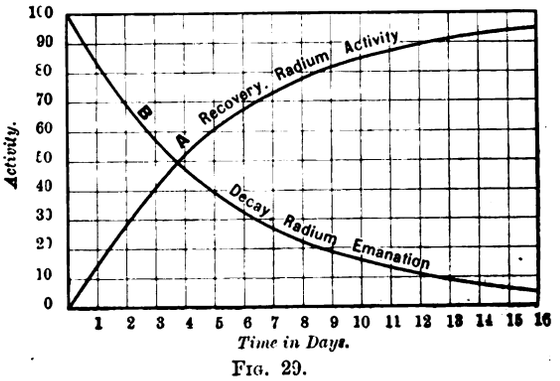

FIG. 29.

case of radium. Thus about 6,000 times as much emanation is stored up in a non-emanating radium compound under conditions of radio-active equilibrium as is present in a thorium compound under the same conditions; hence the sudden "rush" of emanation when a solid radium compound is dissolved, which is much more marked than in the case of a thorium compound. The stored-up emanation and the imparted activity it produces in the mass of the compound constitutes the greater part of its radio-activity. When they are removed by keeping the radium in solution in the open air for some hours, the activity of salt after evaporation to dryness is very much enfeebled, but slowly recovers it as the emanation and imparted activity is regenerated in the compound. The non-separable radio-activity of the radium which is retained after solution, &c., is about 25 per cent. of the activity ultimately attained, and, as in the case of thorium and uranium, consists only of α-radiations.

This enfeeblement of the activity of radium preparations through damp and the corresponding increase of activity of dry, solid salts from the moment of their preparation from their solution was known many years before the changes were connected with the escape and re accumulation respectively of the radio active emanation (Giesel, *Wied. Ann.*, 1899, VIA., p. 91; M. and Mme. Curie, *Comptes Rendus*, 1902, 134, p. 85.) Fig. 29 shows the curves obtained for the recovery of the activity of radium compounds and the decay of the activity of the emanation. They are in every respect analogous to those given for the case of thorium and thorium X (see Fig. 24). In curve A the activity regained, between the minimum and maximum

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activities, is taken as 100. Curve B was obtained by storing the emanation mixed with air in a gasholder over mercury, and removing from day to day an aliquot portion, which was introduced into a testing vessel provided with an internal electrode, so that the ionisation current through the gas due to the emanation could be determined.

The current is measured immediately after the introduction of the emanation, for the activity rises rapidly at first owing to the production of the matter causing the imparted activity from the emanation. It will be seen that the activity of the emanation falls to half value in about 3·7 days, and the value of λ is about $2{\cdot}2 \times 10^{-6}$. M. Curie (*Comptes Rendus*, 1902, 135, p. 857) found that the penetrating rays from a sealed gas tube containing the radium emanation decayed to half value in four days, and this constitutes a separate determination of the decay of the emanation. For although the rays in question do not come from the emanation, which we know gives no β-rays, but from the imparted activity, it can be shown by the disintegration theory that the rate of decay after the first few hours must be that of the radio-activity of the emanation in the tube. By subjecting the sealed tubes during the experiments to temperatures varying between 450°C. and −180°C. it was shown that the rate of decay, and therefore the radio-active constant λ, is completely unaffected by change of temperature.

The disturbing effects of the later stages of the disintegration, as, *e.g.*, the imparted activity, upon the course of the earlier ones which has already been referred to for thorium is much more marked in the case of radium. Curve A (Fig. 29) was obtained by working with radium that had been kept in solution some hours before evaporating to dryness. If, however, the dry salt containing its maximum charge of occluded or stored-up emanation is dissolved in water and *immediately* evaporated to dryness, the emanation completely escapes, but the imparted activity, produced by it in the compound, remains with the radium. The activity instead of being reduced by this treatment to the 25 per cent. constant minimum, is only reduced to about 60 per cent. of the value it ultimately attains to. But a very rapid decay to nearly the 25 per cent. value occurs in the course of the first three or four hours after the evaporation. This is due to the imparted activity produced in the compound by the stored-up emanation rapidly decaying when the latter is removed. After a few hours the activity again commences to increase, and the subsequent progress of the recovery is the same as in curve A. The converse of this phenomenon is to be found in the rapid increase of activity for the first few hours when the emanation is introduced into a fresh vessel. If the central electrode is made negative with respect to the vessel, the imparted activity is concentrated solely upon it, as in the case of that from thorium. After the introduction of the emanation the activity steadily rises, very rapidly indeed for the first few minutes, and then slowly for three or four hours until it attains a maximum nearly twice as great as at first. If at any time the central electrode is removed, the imparted activity upon it will be found to account for the increase of the value of the activity above the original value. Or, the emanation may be suddenly blown out at any stage, when the current through the gas is reduced to the proportion of the total activity due to the imparted matter on the negative electrode.

The curve of decay of the radium imparted activity is very irregular (Rutherford and Miss Brooks, *Phil. Mag.*, 1902, VI., 4, p. 18.) It consists of (1) a very rapid decrease to possibly 20 per cent. of the original value in the course of a few minutes; (2) a period of a few minutes of slow change; (3) a final geometrical decrease to zero, the activity falling to half value in 30 minutes. Now, under certain circumstances, an irregular curve can be obtained also for the thorium imparted activity (Rutherford, *Phys. Zeit.*, 1902.) If a wire is exposed for a short time only to the emanation of thorium, it is found on removal that the imparted activity increases at first instead of decaying, and may rise in the course of the first few hours to three or four times its initial value, from that point decaying at the normal rate to half value in 11 hours. So also in the case of radium, the initial rapid decrease of the imparted activity is the more marked the shorter the time of exposure to the action of the emanation. These effects would be produced in each case if the disintegration causing the activity of the imparted matter, instead of being single, consisted of more than one successive change whose combined effects give rise to the radio-activity. The rate of change of the first stage of the imparted matter of radium is very rapid, being comparable with that of the thorium emanation, and this intermediate product accounts for the initial rapid increase of activity when the emanation is transferred to a new vessel, as well as for the initial rapid decay of the imparted activity after the emanation is removed.

(To be continued.)

CUT-OUTS AND THE BRISTOL FIRE.

Mr. Leonard Andrews has sent us the following communication with regard to the disastrous fire which occurred at the Bristol Temple Back generating station on the evening of December 23, 1903, and the recent correspondence on cut-outs in our columns:—

Those engineers who remember what a high-tension switchboard was like before the introduction of the Ferranti single-pole cellular board will be thankful that the serious calamity at Bristol (described on p. 404 of *The Electrician* of January 1st) did not occur before the now generally-recognised merits of this board were fully established. The system has been introduced into so many stations, and there have been so few breakdowns of a really serious nature, that it has been considered by many to be the acme of safety, simplicity and reliability, and those of us who have expressed the opinion that there were some weak points in the design have been considered pessimistic faddists. There can now, however, be no doubt that very serious dangers do exist, and although it may be several years before another such outbreak occurs, those engineers who are responsible for systems similarly equipped are bound to realise their danger. That this is so is evident from the fact that from all parts of the country we hear of steps being taken to prevent such another catastrophe. I will, however, take this opportunity of expressing the opinion that the general principle of cellular construction is undoubtedly right, but to be sufficiently safe it must be carried much further than in the present standard Ferranti board. The divisions between the cells must be capable of resisting the attack of the severest arc imaginable.

The weakest feature of the present design is the cramping together of all the high-tension connections into so small a compass, with the result that an arc having been once started more or less complete destruction of the board has followed as a natural consequence. It is evident from the published reports of the Bristol breakdown that the origin of the trouble was the failure of one or more generator fuses. Whether the blowing of the fuse was due to a fault on a generator, to a loose connection in the fuse or to mere deterioration of the fuse wire will probably never be known. The one thing apparent is, that if fuses had not been used in the generator circuits the trouble would not have occurred. The question now arises as to whether, if fuses are done away with, it is necessary to replace them by any other device. It is argued against such replacement that an attendant must be kept on the board, and he can instantly operate the switch controlling any generator that shows signs of failing. If the fault on the generator is a breakdown to earth, the noise and fireworks accompanying the failure will, doubtless, be ample indication as to which machine it is that is running amuck. But a generator may fail in several ways without giving any such visual or aural indication that it is behaving abnormally. What, for instance, is more likely to occur than the interruption or short-circuit of the field current of the exciter of a separately excited alternator connected in parallel with others? This alternator of course becomes a short-circuit on the 'bus bars, and the first notification the switchboard attendant has of the trouble is a general drop of pressure across the main 'bus bars. He immediately looks at his ammeters to see the cause. The ammeter of the faulty machine will be hard over because of the short-circuit current passing through it, but the ammeters of the healthy generators are now carrying the whole of the outside load, in addition to the short-circuit current feeding the faulty generator, and as a consequence these ammeters will also be hard over. The pressure continues to fall and the attendant looks anxiously at the generators for some further indication to guide him in his operations. To his great relief he sees one of the generators smoking, and instantly switches it out, reasonably imagining that it is the faulty generator. He finds, however, to his horror, that he has switched out one of the healthy machines that was doing more than its share of the work and the burden upon the others is in consequence enormously increased. Nothing can now save the situation but a complete shut-down, and a fresh start, with all the delay of re-paralleling and switching on of feeder sections one by one.

The next point to be considered is, should some discriminating device be used merely as a current direction indicator, and the actual switching operations be left to the attendant, or should it be used to operate an automatic circuit-breaker? It is probable that the radical alterations necessary to equip the majority of existing switchboards with automatic circuit-breakers will deter engineers from considering the latter alternative. Where, however, new boards are being erected, there is much to be said in favour of installing reverse current circuit-breakers, as is being

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done on the Continent and in the United States. Alternating current, discriminating cut-outs can be relied upon to effectually isolate any fault except a low-resistance short-circuit across the generator leads, but under these very exceptional conditions the cut-out will not introduce any further elements of risk; it will merely remain inoperative, and the conditions will be the same as if the cut-out had not been installed—that is to say, it will be necessary to depend upon hand operation only. In the event of any other fault occurring, such as a failure of the generator field a breakdown of the engine or the flashing to pole-pieces of the armature, the cut-out will behave as required. If these cut-outs are made to operate on a reverse current of not less than 30 per cent. of the full-load current it is not necessary to cut them out of action during synchronising operations.

Mr. Clothier has suggested that if a discriminating cut-out possesses some time element it is no better than a fuse in respect of the instantaneous isolation of the fault. This, however, is not the point. The use of fuses on generator circuits is theoretically wrong, *because the fuses on the healthy generators are liable to blow before the fuse on the faulty generator.* That this does not always happen merely shows that fuses cannot be relied upon to always blow at the current they are set for. There is, however, another point in favour of automatically-operated cut-outs as compared with fuses. The blowing of a fuse is bound to volatilise a considerable quantity of metal, and this forms a highly conducting vapour which tends to maintain the arc. Although in many modern fuses this arc is, in the majority of cases, effectually extinguished, it is doubtful whether any design of fuse has yet been introduced that can be relied upon to do so under all conditions. Now, in a properly designed oil circuit-breaker no metal is volatilised and no arc is formed. I do not wish to convey the idea that the design of a reliable discriminating cut-out for alternating currents is by any means a simple matter. I have closely studied the behaviour of these interesting devices under actual working conditions for over nine years, and have at times almost despaired of surmounting all of the many difficulties that have from time to time arisen. The actual conditions under which these cut-outs have been tried include short-circuits on feeders, failures of engines, open circuits in field windings, &c. By investigating the respective conditions by aid of a Duddell oscillograph we have been able to so modify the design of our cut-out release as to ensure its working under all conditions except that of a dead short across the generator leads. The conclusions we have come to may be briefly summarised as follows:—

Alternating-current discriminating cut-outs cannot be relied upon to isolate a low resistance fault on generator leads or on duplicate feeders. A cut-out that will isolate a generator should it lose its field may fail to isolate a generator the engine of which has broken down, or vice versa, unless the cut-out is specially designed to deal with both conditions. Some types of discriminating cut-outs will operate on a heavy forward current, and are in consequence no better than fuses. Some cut-outs that will operate on a small reverse current will fail to do so on a heavy reverse current, or vice versa. Alternating-current discriminating cut-outs can be made that will under no conditions cut off a generator so long as it continues to supply current to the 'bus bars, but will isolate a failing machine immediately it tends to short circuit the 'bus bars, whether the failure be due to a broken down engine, a loss of excitation or to an earth in the armature, provided such earth is not a very low resistance fault on the terminal connected to an unearthed 'bus bar.

It is an interesting fact that so long as the supply was kept on at Bristol the pressure across the 'bus bars did not fall below 60 per cent. of normal pressure, although the 'bus bars were the whole time short-circuited by a most destructive arc.

Paris Metropolitan Railway.—We stated in our last issue, on the authority of the British Westinghouse Co., that the Paris Metropolitan Railway had decided to abandon the use of power cables carrying large currents through the train, and had awarded a contract to the French Westinghouse Co. for the supply of 100 complete equipments of their electro-pneumatic turret type control apparatus to replace the present system. The British Thomson Houston Co. have informed us that this pneumatic system is not to be used exclusively, but that the French Thomson-Houston Co. have also received an order for 100 complete equipments of the Sprague multiple unit system of train control similar to the one employed on the Central London, Great Northern and City and North-Eastern Railways, and on one of the trial trains of the Metropolitan-District Railway. The trains equipped with this system will be employed on No. 3 line of the Paris Metropolitan Railway, which, it is expected, will be opened to the public next summer. Up to the present the Paris Metropolitan have employed and are still making use of the Thomson-Houston double unit system of train control, which was fully described on pp. 33 and 34 of our issue of April 24th last. Although in this case a cable extends the entire length of the train, the British-Thomson Co. inform us that this system has nevertheless given entire satisfaction and has never been the cause of any accident.

ROYAL COMMISSION ON LONDON TRAFFIC.

Friday, January 22.

Capt. J. W. NOTT BOWER, the City Commissioner of Police, in dealing with the various causes of obstruction to the traffic in London, specially mentioned the breaking up of streets by the electric lighting companies. In one instance, in Old Jewry, two gangs of men were employed by different electric supply companies, and one gang dug up and replaced a trench, whilst immediately afterwards the other gang followed and re-opened the same trench. Although the police received notices from the Post Office authorities of their intention to open manholes, it often happened that the men had actualty been at work for some hours before the notice was received. In the case of the electric supply companies, however, no such notice, either with regard to manholes or boxes, was received, nothwithstanding that the position of these street boxes caused serious inconvenience and obstruction. Litigation was at the moment pending between the Corporation and the Post Office as to the powers of the police to deal with these obstructions in the streets, the Post Office contending that their employés, as servants of the Crown, were exempt from interference by the Police. On the other hand, the electric lighting companies were arguing that their provisional orders and acts over-ride the previous general law on the matter. He considered that the police, in all new acts affecting the City, should be empowered to regulate this matter. Although regulations had been made by the Corporation prohibiting the opening of these manholes (except in case of emergency) between 8 a.m. and 8 p.m., no notice was taken of them by the companies. He regretted that the bill of 1902 promoted by the Corporation in respect to this matter was not passed. Litigation upon this latter question had also been instituted, but inasmuch as the companies had since agreed to comply with the regulation as far as possible, the matter remained in abeyance. As to means for relieving the congestion of pedestrian traffic, he did not favour subways, as all experience pointed to the fact that the public preferred to wait at congested parts until the police made a crossing possible. He considered that the suggestion to bring a tramway along the Embankment and across Blackfriars Bridge most inadvisable and injudicious. It would serve no useful purpose as it would not touch the City again, and afforded no advantage as a north and east route. If this route were sanctioned, it would probably be used later on as an argument in favour of a more direct tramway route from north to south via. New Bridge-street, Ludgate-circus, and Farringdon-street, a proposal to which the strongest possible objection was offered, as it would lead to a complete dislocation of the traffic and cause very serious congestion. A suggestion had been made that a tramway over Westminster Bridge would relieve the traffic in Fleet-street, but with this he totally disagreed. Referring to the evidence given by Mr. Sellon that the introduction of electric tramways into Liverpool had resulted in a much better state of things with regard to traffic regulation, he said his experience at Liverpool, where he was previously chief constable, was of an entirely different character. The tramways created a much larger amount of congestion. To such an extent did the Tramways committee realise this, that they undertook to pay, out of the tramway profits, for the provision of 25 extra constables to manage the greater traffic. This amounted to some £2,000 per year in a city like Liverpool where the traffic was not so heavy, and the streets wider than those in London.

The CHAIRMAN: Were there not compensating advantanges?—None for the traffic, although, of course, there were some for the people who used the tramway. This was to be seen by the number of passengers carried.

I suppose the advantages were more than the disadvantages? You would not propose to take the tramways away?—Oh, no. There is no doubt that the tramways are popular, and I would not like to say that, even from my own point of view, I would do away with them at Liverpool.

By Mr. GIBB: He did not agree with the evidence that the introduction of tramways resulted in a better regulation of traffic. He spoke as an expert having the public interest at heart, whereas many of the witnesses before him had given their evidence with a strong prejudice in favour of tramways. He thought there would be less congestion with the present large number of omnibuses than with a smaller number of tramcars.

By Sir JOHN POYNDER DICKSON-POYNDER: There would be no objection to surface tramways coming to the edge of the City and then dipping underground. He was confident he could deal with the traffic during the period of construction provided he had the necessary powers to specify times of work in different parts of the City.

Mr. FRANK FRANCIS, executive superintendent of the City Police Force, gave similar evidence.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Konstrukion und Berechnung vor Selbstanlassern für elektrische Aufzüge mit Druckknopfsteuerung." By Dr. Hugo Mosler. (Berlin: Julius Springer.) 3m.

"L'Année Électrique, Électrothérapique et Radiographique." By Dr. Foveau de Courmelles. (Paris: Ch. Béranger.) 3fr. 50c.

"Science Abstracts," January, 1904. Section A.—Physics. Section B.—Electrical Engineering. (London: E. and F. N. Spon Ltd.) 1s. 6d. each.

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CORRESPONDENCE.

PARALLELING ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From one of the editorial notes in the last issue of your journal, I see that my Paper gives the impression that I consider machines with large coefficients of speed variation to be better adapted for driving parallel alternators than engines of high uniformity of speed. This is, however, not exactly what I meant to say. The object of the Paper was to point out that it is possible to obtain excellent results with alternators driven by single-crank steam or gas engines. My opinion is that there is very little to choose between single and multi-crank prime movers, as far as parallel running is concerned, but that, as pointed out in the Paper on p. 10, multi crank sets must have a smaller coefficient than single-crank sets, on account of the ratio $\frac{\text{synchronising force}}{\text{initial variable pressure}}$ being larger.

Nevertheless, an increase in the flywheel masses (or, which is the same thing, a decrease of q) is always a net gain where alternators give trouble, and certainly better than damping, but to go with q below the famous figure of $\frac{1}{300}$ is, in my opinion, a waste of material.

I hope to say a few more words on the subject at the adjourned discussion on February 18th.—Yours, &c.,

Bradford, Jan. 23. H. BOHLE.

CUT-OUTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to Mr. Leonard Andrews' letter in your issue of the 22nd inst., the advantage of the relay type of reverse-current cut-out over the compound-wound direct-acting, for continuous-current circuits, consists in the fact that a trip coil can be easily made which will knock out the circuit-breaker with 50 or 100 volts, or even less, across its terminals, and will not be damaged in the slightest if 500 volts are applied. This is by reason of the circumstance that the trip coil is only in circuit for an instant, when its circuit is made by the reverse current relay, the action of which is quite independent of the 'bus bar voltage. With a compound-wound cut-out, however, with the shunt coil connected across the 'bus bars, this is not possible. The values of reverse current at which this will operate vary very considerably with the 'bus bar volts.—Yours, &c., CHARLES C. GARRARD.

Manchester, Jan. 23.

THE DISSIPATION OF ENERGY BY EDDY CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your issue of October 16, 1903, contains an article on the above subject by Mr. A. Press, in which, if I understand it rightly, he would point out that the energy dissipated by electric currents induced in a circular plate varies enormously when the plate is rotated about its axis of figure in a magnetic field whose direction is in the plane of the plate, but whose density is varied, as shown by the curves in his Fig. 1. The dissipation of energy is stated to vary as much as sevenfold or more.

Mr. M. S. Duffitt, who helped me in connection with experiments on the above subject (see *Proc. Roy. Soc.*, Vol. LXX., p. 359), has worked out the cases in which a cylinder, whose length is equal to its diameter, is rotated about its axis of figure in magnetic fields whose directions are at right angles to this axis, and whose densities vary as shown in Mr Press' curves 1 and 5 Fig. 1. The induced currents are assumed to flow on the surfaces of cylinders similar to and concentric with the cylinder. The results show that the dissipation of energy, in the case in which the distribution is as represented by curve 5, instead of being more than sevenfold, as in Mr. Press' Paper, is about 0·9 of the dissipation of energy in the case in which the distribution of the same total flux is as represented by curve 1.

The results also apply to circular plates whose diameters are much greater than their thickness.—Yours, &c.

London, Jan. 21. ERNEST WILSON.

DESCRIPTIONS OF ELECTRIC TRAMWAYS AND RAILWAYS IN THE UNITED KINGDOM.

In the volumes of *The Electrician* set out below, descriptions are given (in most cases fully illustrated) of many of the electrical tramways and railway undertakings of which data and statistics are given in the Sheet Table published with this issue.

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PARLIAMENTARY INTELLIGENCE.

Since our last issue the following bills of electrical interest have been certified by the Private Bill examiners as having complied with standing orders:—Ulster Electric Power, Leicestershire and Warwickshire Electric Power, Southport-Lytham Tramroad, Preston-Blackburn Tramways, Harrow Road-Paddington Tramways, Derbyshire and Notts Electric Power, Saddleworth and Springhead Tramways (Abandonment), Stretford Urban District Council, Swindon Corporation, Isle of Thanet Light Railways, Watford and District Tramways, Great Northern and City Railway, Manchester Corporation Tramways, Tynemouth Corporation, Bridlington Corporation, Bournemouth Corporation, Carlisle Corporation, Belfast Corporation Tramways, Belfast and North-East Ireland Electricity and Power Gas, Wallasey Tramways and Improvements, Wolverhampton Corporation, West Riding Tramways, Plymouth Corporation, Clyde Valley Electric Power, Dundee-Broughty Ferry and District Tramways, Paisley Tramways, Leith Tramways, Govan Burgh Electricity, Lothian Electric Power, Preston, Chorley and Horwich Tramways and Leyton Urban District Council.

In the case of the Romford tramways, no appearance having been entered when the examiners came to consider the bill, the measure was marked "dead."

The North Wales Electric Power Bill was found by the examiners not to have complied with standing orders, and has consequently been referred to the Standing Orders Committee.

LEGAL INTELLIGENCE.

City of London Electric Lighting Co. v. Nobbs & Son.

At the City of London Court, last week, before Judge Lumley Smith, plaintiffs sought to recover £1. 16s. 6d. for current supplied to Friend & Co. on a guarantee signed by defendants.

Mr. NOBBS (the defendant) said he did not sign the guarantee himself. It was signed by a son of his some years ago, and he had never heard of the matter until now. His son was at present in Canada, and was at the time of the guarantee a partner to a certain extent in his business, but he had no right to sign any document which might involve the firm in anything.

Plaintiffs said defendants were landlords of the whole building, and it was in that capacity that plaintiffs considered they were entitled to receive from defendants the guarantee for their own tenants.

Defendant said he had a number of tenants in the building, but he had never undertaken to pay any of their electric lighting bills.

The JUDGE said he could not, under the circumstances, hold defendants liable. It was not within the ordinary authority of a partner in a tailoring business to make the firm liable for light supplied to their tenants. Judgment for defendants, but without costs.

British Accumulator Co. (Ltd.) and another v. Kramer.

In the Chancery Division on Friday, Mr. Justice Kekewich heard a motion by the British Accumulator Co. (Ltd.) and the Allgemeine Accumulatorenwerke A.G. to restrain Arnold Kramer from carrying on business of any description under style or title of the British Accumulator Co. (Ltd.), and from receiving and opening any letters addressed to that company. It also sought to restrain him from acting as manager and agent of the company and claimed delivery up of the furniture, books and other effects in the office at Victoria-street, Westminster, London.

Mr. WARRINGTON, K.C., in support of the motion, stated that the German company carried on the manufacture and sale of electric accumulators at Vienna. In 1902 they proposed to establish a branch in London, and they employed defendant as their manager. Besides a salary he was to receive 10 per cent. of the net profits of the agency. The contract could not be cancelled during the term of 18 months from date of signature. Defendant took offices in Westminster, the rent and furniture being paid by plaintiff company. From the first it seemed to have been contemplated that eventually the British business would be turned into a limited company. In 1903 the British Accumulator Co. (Ltd.) was incorporated, and a verbal agreement was made that the business and all the assets of the British Accumulator Co. should be transferred to the limited concern. The defendant refused to hand over the books and other assets. Defendant called himself chief engineer and manager of the company although he had been appointed to no position by the limited company. Plaintiffs' solicitors wrote defendant demanding the delivery of the assets of the company and defendant then made claims for compensation.

Mr. STEWART SMITH, K.C., for defendant, read an affidavit in which Mr. Kramer said the offices were taken in his name as the landlord was not willing to let them to a foreign company. He was, therefore, personally liable for the rent. He had never represented the business as his own, and had always been willing to transfer the office and furniture to the plaintiff company provided that company paid the rent due to the landlord and freed him from all liability. There was a considerable balance due to him and a substantial counterclaim for wrongful dismissal.

After discussion, it was arranged that plaintiff should give an undertaking to pay the rent due, and defendant deliver up all books, furniture plant, &c., and possession of the offices.

His Lordship ordered the costs of the motion to be costs in the action.

Sinclair v. British Electric Car Co.

In the Chancery Division on Tuesday Mr. Justice Kekewich made the usual order for accounts on a debenture-holders' action, and continued the manager's appointment until July 31.

Simplex Steel Conduit Co. (Ltd.) v. Metallic Seamless Tube Co. (Ltd.).

This case came before Mr. Justice Swinfen Eady in the Chancery Division on Saturday. Mr Sebastian for plaintiffs moved for judgment on admissions by defendants. He said that plaintiff company was incorporated in 1899 for the purpose of manufacturing and selling steel conduit and fittings and materials for electric cables. Their goods were very well known by the name "Simplex." The defendants admitted that certain of their agents had supplied goods not of plaintiffs' manufacture, under orders for "Simplex" goods.

His Lordship gave judgment for plaintiffs for an injunction.

Greenhouse v. South Lancashire Electric Traction & Power Co.

On Wednesday in the Court of Appeal (Lord Justices Vaughan Williams, Stirling and Cozens-Hardy) defendants applied to advance the hearing of his appeal.

Mr. HUGHES, K.C., for appellants, said defendant company had raised first debenture stock to the extent of £550,000. Recently it had become necessary to raise further capital for the purpose of the undertaking, and a scheme was prepared to which, of course, the assent of the debenture stockholders was necessary. £480,000 of debentures supported the scheme and £28,000 opposed. Plaintiff, who represented the dissentients, desired to restrain the company from carrying out the scheme, but the Vice-Chancellor of Lancashire dismissed his action without calling on the other side. Plaintiff had appealed, but the trustees could not act on the resolution while the appeal was pending, and it was vital that the money should be raised without delay.

Their Lordships directed that the appeal should be in the list on the next day on which County Palatine appeals were taken.

Re Geipel's Steam Trap Patent.

In the Court of Appeal, before Lords Justices Vaughan Williams, Stirling and Cozens-Hardy, on Monday, the hearing was concluded of an appeal from an order of Mr. Justice Buckley on a petition for revocation of Geipel's patent for steam traps (7,860 of 1893), and there was also a cross appeal by the patentee on the question of the terms on which he should be allowed to disclaim, his lordship having found that the patent was invalid in certain particulars. (See report of "Geipel *v.* Manchester Corporation" in *The Electrician*, Dec. 18, p. 345.)

For the petitioners learned counsel submitted that at the date of the patent there were hundreds of steam traps on the market, and several that depended upon the expansion and contraction of metal by the action of steam. The respondent appealed against the part of the order which imposed as a condition on which the patentee should be allow to apply for the amendment of his claim that he should not ask for an injunction founded upon anything done prior to the date of amendment, unless the Court in trying the subsequent action was of opinion that the specification was framed originally in good faith and with reasonable skill and knowledge. For petitioners it was said that they had been making these traps for years. They brought this action to protect their customers, and it was only reasonable for the Court to say that no action should be brought in respect of traps made before the judgment. Their Lordships dismissed the respondents' cross appeal and reserved judgment on the remainder of the case.

Assessment of Telephone Wires.

At Dumbarton last week, before Sheriff-substitute P. J. Blair, the National Telephone Co. and Glasgow Corporation appealed as to the assessment of their telephone wires. The appeals referred to the interpretation of sec. 347 of the Burgh Police (Scotland) Act, 1892, which provides that "the annual value of underground gas and water pipes or underground works of any gas or water company or corporation shall, for assessment under the act, be held to be one-fourth of the annual value thereof." Appellants possess underground telephone wires in Clydebank, and they maintained the words "or corporation" extended the interpretation of the section so as to give them the benefit of the three-fourths reduction in the police assessments. Respondents contended the section must be construed literally, and that therefore it only applied to gas and water.

Decision deferred.

Bacon and Curtis (Ltd.) v. D'Esterre.

At Bournemouth County Court last week plaintiffs sought to recover £22, due on a contract for wiring a house. For plaintiffs it was stated that an estimate amounting to £26 was originally given, but subsequently defendant had a revised estimate for £22, certain items being omitted. The greater portion of the work was done, but when the account was rendered defendant declined to pay on the ground that the work had not been completed. Plaintiffs' men went to the house, which had in the meantime been let to a lady, but were refused admission.

After hearing the evidence his Honour held that plaintiffs were ready to execute the contract, and gave them judgment for £21.

Electricity in Saw Mills.—All the machinery at the new saw mills of Messrs. John Herring & Co., Newcastle-on-Tyne, are operated by electric motors. The buildings and yard are lighted electrically. As a precaution against fire, all refuse is, immediately upon production, drawn by the suction of an electric fan through pipes, to be either "bagged" or burned.

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MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Leicester Tramways committee require an assistant electrical and mechanical station engineer, a power station shift engineer, switchboard attendants, engine drivers, engine fitter and spare engine driver, foreman for maintaining and repairing overhead work, linesmen for overhead work, chief motor inspector, motor inspectors and motor instructors. Further particulars are set out in an advertisement, and applications, addressed to the chairman of the committee at the offices of the borough engineer, Mr. E. George Mawbey, M.Inst.C E., Town Hall, Leicester, by Feb. 2.

The electricity department of West Ham County Borough require a clerk accustomed to working out consumers' accounts on the maximum demand system, and with a thorough knowledge of shorthand and typewriting. Salary £100 per annum. Also a temporary ground foreman to supervise constructional and cable-laying work under the mains superintendent. Salary £3 per week. Applications to the borough electrical engineer, Mr. J. K. Bock, Abbey Mills, West Ham, E., by February 5. See also an advertisement.

An assistant is required by a mains department for testing and inspecting installations in the North of London. See advertisement.

Doncaster Corporation invite applications for the position of borough electrical engineer and tramways manager. Salary £300 per annum. Applications to the town clerk (Mr. R. H. H. Tovey) by noon Feb. 9. See advertisement.

An arc lamp trimmer is wanted, preferably with experience with Crompton or New Century lamps. Apply 11 a.m., January 30, to 27, Osborne-street, Whitechapel, E. See advertisement.

Mr. H. D. Haigh of Huddersfield has been appointed manager of Psychiloid Limited, Love-street, Sheffield, in succession to Mr. R. G. Mercer, A.M.I.E.E., who has resigned to take up an appointment with the British Westinghouse Co.

The Senate of London University has appointed Prof. W. C. Unwin, F.R.S., a member of the governing body of the Battersea Polytechnic.

Aberdeen.—On the occasion of the annual inspection of the Ferryhill electricity works by the Council on Friday last, the convener of the Gas and Electric Lighting committee (Mr. Geo. Kemp) stated that the number of units generated during the half-year to 19th inst. was 2,014,637, or four times greater than in 1899 and 28 times greater than in 1894. After five years' working (in 1899) the consumers numbered 569, and they were now 1,250. 362 motors (aggregating 1,535 H.P.) were supplied with current, against 44 (159 H.P.) in 1899. Arc lamps had increased in the same period from 312 to 689. The total capacity of the plant at Ferryhill and Cotton street was 5,710 H.P., and a new 1,200 H.P. generating set is to be put in.

Abstracting Electricity.—At Birkenhead police-court last week a man named Martia was summoned for unlawfully making a connection to the Corporation mains and abstracting electricity without its being metered.

It was stated that the borough electrical engineer on the 18th inst visited premises, where defendant was employed, to inspect some fittings, and in the cellar found that a wire had been connected with the Corporation terminals, and that current was being used without its being registered by the meter. Defendant admitted connecting the wires, and said that he had no intention of defrauding the Corporation, but had done so to test an electric lamp for his employer. He had, however, neglected to disconnect after the experiment The bench held there was no felonious intent, but the act under which the prosecution was taken gave the magistrates no option but to impose a penalty of £5. They did not, however, grant costs, and defendant was allowed 14 days to pay.

Bath.—The electric tramway extension to Oldfield Park is open for traffic.

Battersea (London).—The Borough Council have decided to reduce the charge for current through prepayment meters from 5d. to 4d. per unit. Extensions to the electric lighting cables are to be made.

Belfast.—An inquiry was held on Tuesday into the application of the City Council for sanction to a loan of £4,350 for extending the electric light mains to the Knock district.

Blackburn.—For the nine months ended December the deficit on the Corporation electric tramways was £2,144, compared with £1,812 in the corresponding period of 1902. The total deficit to date is £24,640.

Bournemouth.—The Corporation and the Poole and District Electric Traction Co. have failed to agree upon the price to be paid by the Corporation for the company's electric tramway between Bournemouth and Poole, and the figure will have to be ascertained by an arbitrator.

Bridgend.—The demand for electric current for private lighting has exceeded anticipations. The cost of the street electric lamps is £2 each per annum, compared with £2. 13s. 11d. for the gas lamps.

Brighton.—The Board of Trade have approved the charges proposed to be made by the Corporation for supplying electricity to Patcham and Preston Rural Districts.

Caerphilly.—Several objections have been lodged to the Council's application for a provisional electric lighting order.

Camberwell.—The Council are petitioning against the London, Camberwell and District Tramways bill, and in favour of the London County Council (Tramways and Improvements) bill.

Carnarvon.—A writ has been served upon the Council by the National Electric Construction Co. for damages for alleged breach of contract in connection with the electricity supply scheme recently submitted to the Council by the company.

Chiswick.—The Aberystwith and Chiswick Electricity Supply Corporation are laying mains in the new roads on the Stamford Brook estate.

City of London.—The Corporation expended £530 in opposition to the City and North-Eastern Suburban Electric Railway Bill of 1903 (rejected on financial grounds). The Streets committee recommend the Common Council to "communicate with the Speaker of the House of Commons as to procedure in these matters, with the view of preventing this unnecessary waste of public money."

Dalkey.—The District Council have received a proposal from Mr. H. Walker to erect electricity works and to supply electric current between Pembroke and Bray at 4½d. per unit for private lighting, with special terms for public lighting.

Devonport.—The chairman of the Electric Power committee (Mr. Banbury) stated at a recent Council meeting that an agreement had been signed between the Plymouth, Stonehouse and District Tramways Co. and the Corporation for the supply of current.

For the month ended Dec. 16 the supply to the Devonport and District Tramways amounted to 75,216 units, compared with 57,000 in the corresponding month of the previous year, and to the Plymouth, Stonehouse and Devonport tramways 21,770, against 18,570. The value of current supplied during the quarter ended Dec. 31 was £1,107, compared with £447 for the corresponding period of 1902.

Doncaster.—Wheatley and Balby-with-Hexthorpe Council will oppose the Corporation bill for extending the electricity supply area.

Dulverton (Somerset).—A local builder (Mr. Fisher) has put down a steam dynamo and a battery of accumulators at his saw-mills, and is supplying electricity for lighting the local post office and a working men's club. A committee has been formed to proceed with a scheme for the electric lighting of the town.

Dunfermline (N B.).—The Fife Electric Power Co. have acquired a site for a generating station in this town.

Ealing.—The Council's omnibus bill for (inter alia) powers to wire consumers' premises, let electric motors, &c., on hire has been rejected at a ratepayers' meeting.

East Molesey.—The Council will consent to Edmundson's Electricity Corporation application for a provisional electric lighting order if no generating station is built in the area without sanction.

Electricity in Dockyards.—The electrical engineer at Devonport Dockyard has been authorised to engage 25 men for temporary service.

Exeter.—The Council on Wednesday authorised the payment of £6,749, the amount of the arbitrator's award for the acquisition of the city tramways, and also approved the proposal of the Tramways committee to carry on the present system pending arrangements for its conversion to electric traction.

Felling.—The District Council have applied for a loan for the erection of a six-cell dust destructor to the specification of the consulting engineers (Messrs. Handcock and Dykes). The order has been placed with Heenan and Froude at a cost (including buildings) of £8,699.

"Financial News" Supplement.—To celebrate its 20th anniversary our contemporary, the "Financial News" launched into colours and into poetry. In both respects success was achieved, and the special issue for Jan. 23, 1904, stands out as probably the most artistic production of a daily journal ever published in this country. The matter, too, was as good as the manner, for there were a large number of articles specially written by experts on finance and trade. Among these articles may be mentioned one on "The Telegraph and Trade," from the pen of Sir J. Denison-Pender, K.C.M.G. Instructive figures relating to the past 20 years' history of submarine telegraphy were included in Sir John's contribution to a very attractive and useful compilation of vital facts and statistics. Other articles of interest to engineering and electrical readers include "Engineering and Mining," "Motors and Cycles," &c.

Gillingham.—At the last meeting of the Town Council, Councillor Ridout raised the question of councillors requiring passes to visit and inspect the electricity works. He had received a pass from the engineer, and had sent it back, as he considered it the right of

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councillors to go there or to any of the Council's premises. Councillor Holmes said passes issued by the mayor would meet the case; electric light was a thing that necessitated a little caution, and all that would be required would be to show the pass if called upon to do so. It was ultimately decided that the mayor should sign his name in the Council year books, which each member possesses, thus ensuring their admission to the works.

Glasgow.—The first of the social gatherings of the Corporation electric tramways department took place in the City Hall on Friday evening last.

The company numbered about 3,000. The convener of the Tramways committee (Councillor Paton) presided, and referred to the onerous duties the men had to perform. Considering the difficulties they had to contend with, it was astonishing how few accidents there were. Besides the male employés, the tramway department had 105 lady assistants, of whose services he could not speak too highly. During last year they counted somewhere about £700,000, mostly in pennies and halfpennies, which weighed about 500 tons. It had just been arranged that drivers who had avoided accidents for six months would get a substantial bonus, which would be doubled if they kept clear of accidents for 12 months.

The Lord Provost (Sir John Ure Primrose) said that a concern that carried 190,000,000 passengers per annum was no mean undertaking. The tramway service was an honourable ambition for any man, and because the conditions of service were good the Corporation was entitled to look for a high type of men to carry out that service. They had a friendly society with an income of £5,000 a year to provide for days of sickness, and a superannuation fund to provide for declining years which now amounted to nearly £10,000. In 1911, when it came into active operation, he was sure the capital sum would amount to £30,000. If municipal enterprises such as theirs were to be justified in the eyes of the world, as well as in the eyes of the community, then the instruments that carried it on must be filled with desire for efficiency, and with wholehearted zeal and devotion.

Owing to opposition, the Corporation have withdrawn their proposed provisional order for powers to extend the tramways to Bearsden and Milngavie and to Barrhead.

Hackney (London).—The Electric Lighting committee recommend the Council to petition against the East London Lower Thames Electric Power Bill.

Halifax.—The Tramways committee have refused an offer by a syndicate for a transfer of a portion of the Corporation's powers for the construction of tramways from Halifax to Brighouse.

Halifax-Huddersfield Tramway Project.—Messrs. C. T. Rhodes & Son, Halifax, have submitted to Huddersfield Corporation, on behalf of a company, proposals for constructing electric tramways between Halifax and Huddersfield via West Vale and Elland or Brighouse.

Ham (Surrey).—Though Edmundson's Electricity Corporation have conceded the Council's demand for a reduction in the price of electric current from 2½d. to 2d. per unit for public lighting, the Council withhold their consent to the company's application for a provisional order until the company make "satisfactory" proposals as to private lighting.

Hamilton.—The Council have applied for sanction to a loan of £40,000 for electricity supply. On the engineer's certificate the Council have decided to give a three months' bill for £10,000 to Edmundson's Electricity Corporation (contractors for the erection of the works), the balance due (£3,814. 10s.) being paid by cheque.

Hampstead (London).—During 1903 4,086,750 units of electric current were generated at the electricity works, compared with 3,068,229 in 1902. The number of consumers on Dec. 31 was 3,550, representing an equivalent of 206,217 8 c.p. lamps connected.

Hetton.—The Council have sanctioned the application of the Sunderland and District Tramways (Ltd.) for a provisional electric lighting order.

Huddersfield.—The receipts on the Corporation tramways for the nine months ended December last were £50,676, and the working expenditure £26,781. Interest and sinking fund (without allowance for depreciation) amounted to £20,000, leaving £3,895 surplus. Receipts were 9·83d. and working expenditure 5·19d. per car-mile, compared with 10·51d. and 5·83d. respectively for the corresponding period of 1902.

Injunction.—The Simplex Steel Conduit Co. notify us that they have, by the decision of Mr. Justice Swinfen Eady in the High Court on Jan. 23 (briefly reported elsewhere), obtained a perpetual injunction restraining defendants in an action recently brought from passing off, or enabling or assisting others to pass off, any conduits or other electrical fittings or apparatus not of the Simplex Company's manufacture as or for their goods; also from selling or offering or exposing or advertising for sale or procuring to be sold any such goods under any name of which the word "Simplex" forms a part, without clearly distinguishing such goods from the Simplex Company's goods; or from selling or supplying any such goods in response to orders for "Simplex" goods. The company point out that they have been put to considerable trouble and expense by the unfortunately prevailing practice of some firms in imitating "Simplex" manufactures and taking no steps to point out that the imitation goods differ from those manufactured by the company. This is the second injunction the company has obtained within the last three months.

Kildare.—Naas District Council are seeking sanction to a loan of £3,300 for the electric lighting of Kildare, and an inquiry into the application was held last week. It was stated that the National Electric Construction Co. would supply and erect generating plant and work the station. The total working expenses would be £250 per annum.

Kingswood (Bristol).—Owing to the opposition of the District Council, the Bristol Tramways and Carriage Co. have struck the proposed Kingswood extensions out of their bill.

Light Railways.—On Monday the Light Railway Commissioners inquired into the application of the West Surrey Light Railway Co. for an order to construct a light electric railway from Guildford station to Stoughton barracks.

The consulting engineer (Mr. Harrap) said that his estimate provided £6,000 a mile for tramway construction. The terms for the supply of electric current by the Guildford Electricity Supply Co. were under consideration.

After hearing evidence, the Commissioners decided to grant an order, the question of clauses as to double lines, widenings, &c., being reserved.

The Light Railways Commissioners, after an inquiry into the Lampeter-Aberayron light railway scheme, have granted the application.

Littlehampton.—Proposals from three companies for the erection of electricity works in Littlehampton, Arundel and Wick are under consideration by the Council.

Liverpool.—The receipts of the municipal electric tramways for the year ended Dec 31 were over £524,000, an increase of nearly £18,000 on the previous year. The passengers carried were over 113 millions, an increase of 3·40 over previous year. In six years the receipts have doubled and the passengers carried trebled.

London County Council.—At Tuesday's meeting it was decided to grant loans for electric lighting of £3,653 to Islington and £2,883 to Stepney.

London United Tramways (Railways) Bill.—The Parliamentary committee reported the action which had been taken in opposing the above bill on the ground that the proposed works are tramways and not railways, and therefore require the Council's consent.—Action of committee confirmed.

Private Bills.—It was decided, on the recommendation of the Parliamentary committee, to seal, and, if necessary, present petitions against the following bills:—Baker Street and Waterloo Railway, Charing Cross, Euston and Hampstead Railway, Great Northern and City (Extension of Time), London United Tramways (Railway), Metropolitan Railway, Metropolitan District Railway, North and South Woolwich Electric Railway, Harrow Road and Paddington Tramways, London, Camberwell and Dulwich Tramways, London United Tramways, East London and Lower Thames Electric Power, St. Marylebone Electric Lighting.

The Council's Tramway Bill.—The Parliamentary committee reported that it had been found by the examiners of standing orders that the suggested routes along the Tottenham Court-road, from Cricklewood to Marble Arch, and from Streatham to the county boundary did not comply with standing orders, and the committee will endeavour to obtain a suspension of standing orders with regard to the Tottenham Court-road line.

Telephonic Communication with Theatres.—The Theatre committee recommended "that, except in those cases where direct telephonic communication with the nearest fire brigade station has been already established, a letter be sent to every licensee of every theatre and music hall within the administrative county of London in which performances are regularly given, requiring him to at once take steps to place in direct telephonic communication with the nearest fire brigade station the premises for which he holds a licence."—Decision was postponed.

London, Deptford and Greenwich Tramways.—The Highways committee reported that, although the purchase of this undertaking had not been completed, it was thought desirable, in view of the works which are being carried out in adjacent thoroughfares in connection with the construction of certain of the Council's new tramways, the opportunity should be taken to reconstruct the portion of the company's lines in Tower Bridge-road. This the Council were agreeable to, subject to an indemnity against any loss arising out of the proposed routes.

Purchase of London Southern Tramways Undertaking.—On the motion of Mr. Benn it was decided that the Council do not exercise its right of purchase of this undertaking.

Londonderry.—The local gas company have notified the Corporation of intention to sue for damages alleged to have been done to their mains in the process of laying the electric light cables. The Corporation have disclaimed responsibility, and have referred the company to the contractors for laying the cables. The gas company, however, insist upon holding the Corporation responsible.

Maesteg.—The District Council have decided to engage an electrical engineer to prepare a report upon electric lighting.

Manchester Tramways.—The Corporation are constructing tramways in Gorton, and the lines are to be worked on lease from the District Council. Droylsden Council have asked the Corporation to construct a line from Openshaw to Droylsden station, and Manchester Corporation will consent provided Droylsden is included in the Manchester area.

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The Tramways committee have arrived at an understanding with Ashton-under-Lyne Corporation in regard to the construction and working of tramways, and it is anticipated that through electric car communication between Manchester and Ashton will shortly be established. The Tramways committee have accepted a tender for 100 new electric tramcars.

The shareholders of the Trafford Park Estates Co. have approved the bill of the company which provides for (inter alia) the construction of electric tramways to join up with the Manchester and Salford systems. This portion of the bill will, however, be opposed by Manchester Corporation.

Marylebone (London).—A special meeting of the Borough Council was held on Monday evening to discuss the motion of Mr. E. R. Debenham

"That the Electric Supply committee be empowered to enter into a provisional agreement with the General Electric Co. on the lines of their letter to the Council of Jan. 19, or with any other firm of sufficient stability, and that such legal assistance as was necessary should be employed."

The Mayor (Rev. Russell Wakefield) said that, with regard to the instruction from the Council that "the Mayor approach the Metropolitan Electric Supply Co. on the question of the postponement of the payment of the £60,000 (ordered by Mr. Justice Buckley to be paid by the Council by Jan. 31) until after the poll of the ratepayers," he had an interview with the company, but their reply was that, like the Council, they were in the hands of the Court. To interfere with the carrying out of the order of Mr. Justice Buckley was beyond the directors' power. The company had subsequently confirmed this view by letter. The opinion of their counsel (Mr. Buckmaster) had been taken, and his opinion was that it would be no personal contempt of Court to omit to pay the amount on the date mentioned. He (the Mayor) asked that the Council should make up its mind forthwith as to whether the negotiations with the company should be continued. He was strongly of opinion that they should.

Councillor Sands asked counsel's opinion as to what the consequences would be if the money was not paid.

The Mayor said it was inadvisable at the moment to disclose Mr. Buckmaster's opinion on that point. With regard to the postponement of the payment until after the poll, although the Court had ordered the payment by a certain date, it would not move to enforce the order until the company takes action, and this was unlikely.

After a long discussion it was agreed that the negotiations with the company as to the terms on which the company would be willing to set aside the award should be continued, and that the committee to approach the company on this point be the Mayor and Councillors E. R. Elgood, E. R. Debenham and A. F. Sieveking. The negotiations were not to interfere with the taking of the poll. The committee are to report to a special meeting of the Council on Feb. 1.

Mr. E. R. Debenham then asked leave to amend his motion with regard to the offer of the General Electric Co. This motion had been drawn up hastily. His amended motion would be

"That the Electric Supply committee be empowered to prepare for submission to this Council a provisional agreement on the principles of the letter of the General Electric Co., dated Jan. 19, and that such legal assistance be employed as may be necessary."

Councillor Paxton opposed. The majority of the Council were convinced that the undertaking would be a profitable one, and he thought the ratepayers should reap that profit and not another company.

Col. Hopkins said he regarded the offer of the General Electric Co. as the saving of the borough. It was a genuine offer by a trading company of high standing who were prepared to take any risk of loss there may be to secure the order for the machinery. It was a thoroughly business-like offer, and should commend itself to the Council and to the ratepayers.

The motion was carried.

Councillor Edwin White asked if the London County Council had lodged a petition against the bill?

Mr. E. R. Debenham said he was not aware of any such petition having been presented.

At the meeting of the Council yesterday (Thursday) the debate was resumed on the motion "that £60,000 be paid to the Metropolitan Electric Supply Co. (Ltd.) and £25. 15s. 10d. be paid to Messrs. Barlow and Barlow, interest on amount of their costs from May 21 to June 12, 1903."

Dr. Leaf asked if Mr. Buckmaster had given the mayor to understand that no member of the Council would be held personally liable for contempt of court by the non-payment of the £60,000. Also if any councillor signing the cheque, if the money were paid, would be personally liable for the return of the money, or any part of it, in the event of the result of the poll being against the bill going forward.

The Mayor said Mr. Buckmaster's opinion was that no councillor would be personally liable for contempt, nor would any member of the Council signing the cheque be liable for surcharge, inasmuch as he pointed out that if a cheque were not prepared and signed on the application of the company, an order would be made by the Court compelling the treasurer to the Council to pay over the amount.

An amendment by Councillor Dunn, "That in view of the decision of the electors at the meeting on Jan. 19, the Council cannot comply with the order of the Court to pay over £60,000 unless and until the decision is reversed by the poll of the ratepayers," found no seconder, and was accordingly dropped.

The motion was then carried on a division by 28 votes to 15.

A short debate took place on the communication from the London County Council as to the latter's proposal for a tramway along Tottenham Court-road, and the intimation from the Holborn Borough Council that they declined to consent to such tramway; but the recommendations brought forward by the Legal and Parliamentary committee that "they agree with the Holborn Council in regard to the proposed tramway," and that "the London County Council be informed that the Council adhered to their previous resolution not to consent to the proposed tramway," were both negatived. This reverses the previous decisions of the Council.

Municipal and County Club.—Sir Francis J. S. Hopwood, K.C.B., C.M.G. (permanent secretary to the Board of Trade), will be the guest of the evening at a house dinner and smoking concert to be held on Monday, Feb. 8, at 7.30 p.m., when Mr. Laurance Gomme, F.S.A. (clerk to the London County Council), will preside.

Municipal Telephony.—At Brighton Corporation meeting last week, the chairman of the Telephone committee (Ald. Carden) presented a report which contained a recommendation that the salaries of the clerks and general office expenses of the telephone department be charged to capital account until the date when telephone rents become payable. The report was approved.

Musselburgh.—A report, prepared by Mr. H. M. Sayers, on the proposal to adopt the "G. B." surface-contact system of traction on the local tramways, was before the Council on Tuesday. After discussion the report, which was favourable to the system, was adopted. The promoters of the scheme (the National Electric Construction Co.) will shortly commence the construction of the permanent way.

Naval Electrical Stores.—It is announced that, in future, electrical stores, with some few exceptions, are to be examined by dockyard offices at the various yards, and not by naval officers from the torpedo schools as hitherto.

Stores for wireless telegraphy, instruments for position finding, torpedo directors, and armoured mining cables, are reserved for examination by representatives of the torpedo schools. Torpedo officers will continue the annual inspection of stocks of torpedo and electrical stores at the various yards. These stores will be delivered at yards other than Portsmouth.

New Barnet.—The Council have decided to enter into a new agreement with Mr. W. P. Adams, by which he will be retained as electrical engineer to the Council.

New South Wales Tramways.—The revenue of the tramways department for the quarter ended December amounted to £207,667, compared with £190,951 in the same period of 1902. The expenditure amounted to £179,642, compared with £167,915.

Newport (Mon.).—An inquiry will be held here to-day into the application of the Council to borrow £60,500 for electricity extensions.

Newton Abbot.—The Council will not oppose the application of the Urban Electric Supply Co. for an extension order to include Highweek and Milber if a reduction is made in the price of electric current.

Northampton.—The Corporation have started converting the local tramways to electric traction.

Obituary.—We regret to record the death of Ald. Eli Heyworth, J.P., which occurred at Blackburn on Thursday of last week. Deceased, who was 64 years of age, was a director of the National Telephone Co.

Perth.—The Electric Light committee will charge the North British Railway Co. 4½d. per unit for electrical energy supplied prior to May 15 last and 2½d. per unit from that date to May 15 next.

Plymouth.—The ratepayers have rejected the portion of the Corporation bill which proposed to exclude the loans under the Electric Lighting Acts from the Council's borrowing powers under the Public Health Act, 1875.

Poplar (London).—The Council are recommended by their Joint Purposes committee to present a petition against the East London and Lower Thames Power bill.

Railwaymen and Electric Traction.—On Sunday, Mr. R. Bell, M.P., addressing a meeting of the Amalgamated Society of Railway Servants, said:

Electrification is beginning to oust manual labour to a certain extent on a few lines of railway, but if our organisation is complete, as soon as a new system is introduced the workmen will be in a position to inquire the reason and circumstances for such a change and tell the railway company that their consent will have to be obtained. The workman might depend upon it that, in the near future, he would require better organisation to protect himself from the encroachments of the capitalist.

Salaries of Postal Telegraph Officials.—The committee recently appointed to inquire into the conditions of service, wages, &c., of postal and telegraph servants met last week, when

Mr. E. Trenam, controller of the Central Telegrph Office, reviewed the evidence given by the members of his staff. He dealt with a statement made by Mr. Garland as to an alleged breach of faith on the part of the department in connection with the salary obtainable by a telegraphist. That allegation was based on a note which was appended between 1881 and 1890 to certain advertisements issued by the Civil Service Commissioners when announcing competitive examinotions for male telegraph learners in London. The contention of the staff was that the note constituted a contract or promise that those who entered the service through the examination would in the ordinary course reach £190, and they claimed that all such persons should be allowed to proceed to that maximum without a break. But successive Postmaster-Generals had

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held that the note did not indicate either a contract or a promise, but simply indicated what it was possible to attain. Every candieate must have been aware that the prospect of obtaining that maximum was not unconditional, but depended on certain qualifications. Mr. Garland also referred to the dearth of candidates, but witness said that that was owing to the number of clerks needed during the late war. There was no dearth of candidates how in London.

Sandon (B.C.)—The Waterworks and Light Co. in this mining city are supplying current on the continuous-current three-wire system to about 100 consumers within a 3-mile radius. An extension of the company's plant to provide increased supply for the mines in the district is to be installed during 1904.

Sunderland.—The new electric tramway route to the east end of the borough was officially inspected and opened for traffic on Saturday. The total expenditure on electric tramways to date is about £270,000.

Soothill Nether.—The poll of the ratepayers on the Council's tramways bill has resulted in a majority for the bill.

Vancouver (B.C.).—Since 1896 the British Columbia Electric Railway Co. (whose head offices are in London) have supplied current for lighting, power and traction, both alternating and continuous. There is now connected the equivalent of 200,000 8 c.p. lamps, and consumers number about 5,000. The service includes the company's street railway, which has 40 cars running. With gas at over 7s. per 1,000 ($1·75), electric energy at 8½d. per unit for lighting and 3½d for power, on a siding scale, is increasingly popular.

Walthamstow.—At the Council meeting on Tuesday, the electrical engineer (Mr. F. A. Wilkinson) submitted a report as to the return on capital expended in wiring and lighting small house property:—

Lansdowne-road—Expenditure: Cables, £106. 9s. 11d; house services, £100. 3s. 10d.; lamp services, £8. 12s. 6d.; meters, £99; free wiring, £160. 10s.; total, £474. 16s. 7d. Net revenue: Rental, £18. 15s. 5d.; connection charges, £8. 5s.; revenue from five lamps (when connected), £8. 2s. 6d.; total, £25. 2s. 11d. net profit (after paying interest and sinking fund), or 7·4 per cent. on capital expended.

Mr. Wilkinson says he has found that when an existing tenant leaves, the incoming one will generally continue the same form of illumination, as out of 700 customers only three discontinued using the electric light since the electricity works were started 2½ years ago. The total number of 8 c.p. lamps applied for was 40,600, against 29,862 twelve months ago.

Warrington.—For the position of manager of the Corporation electric tramways there were 72 applicants, and these have been reduced to Messrs. T. Tate (Shipley), J. Telfer (Rotherham), C. Womersley (Huddersfield), and J. Worrall (New Brighton).

West Ham.—The manager of the Borough Theatre, Stratford, recently applied for a supply of current for lighting a portion of the building, to be charged at a flat rate, but upon the recommendation of the Electric Light committee it has been decided to accede to the application only provided current is taken for external lighting and payment is made according to the maximum demand system.

Will.—The estate of the late Sir Frederick Joseph Bramwell has been valued at £100,798 gross; net personalty, £91,955. Sir John Wolfe Barry, K.C.B., is one of the executors.

Willesden.—At the Council meeting on Tuesday, the electrical engineer (Mr. E. T. Ruthven Murray) reported that the Metropolitan Electric Supply Co. had commenced supply of energy at the Brent sidings of the London and North Western Railway Co. Counsel's opinion is to be taken as to the rights and powers of the company and the Council, and subject thereto, notice will be given to the company to discontinue supplying energy in the parish of Willesden, and such other proceedings are to be taken as may be considered necessary.

Wimbledon.—An inquiry has been held into the application of the District Council to borrow £5,462 for extending the electric lighting mains to Merton, in the area of the Croydon Rural Council. The clerk (Mr. R. H. S. Butterworth) appeared in support of the application, and a resident (Mr. P. Mortimer, J.P.) opposed on the ground that it was a commercial speculation in which the Council ought not to embark, and he also urged that they had no right to invade another territory.

In reply, Mr. Butterworth said that the Parish Council of Merton had no power to carry out electric lighting, and the Wimbledon Council were supplying in order to carry on the terms of their provisional order.

Worcester.—The work of converting the tramways to electric traction is making progress, and trial runs have been made over a portion of the route.

Dinner.—The annual dinner of the first section of the Cardiff Corporation tramway employés took place on Tuesday. The borough electrical engineer and tramways manager (Mr. Arthur Ellis) presided, and among those present were the mayor (Ald. Jenkins), the chairman of the Tramways committee (Councillor Courtis), the town clerk (Mr. J. L. Wheatley), &c. The dinner of the second section took place on Wednesday, when Mr Ellis again presided.

TRADE NOTES AND NOTICES.

[Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.]

TENDERS INVITED.

Islington (London) Borough Council invite tenders for the supply and laying on the solid system and drawing into existing conduits of lead sheathed, paper-insulated, double-concentric and triple core high-tension feeders and low-tension distributors, and pilot cable with feeding junction and service boxes. Specifications, &c., from the borough electrical engineer (Mr. Albert Gay), 50, Eden-grove, Holloway, N., after Feb. 1. Tenders to the town clerk (Mr. Wm. F. Dewey) by noon Feb. 24. See also advertisement.

Islington (London) Lighting committee invite proposals from contractors for carrying out of wiring for and the supply of motors to the Council's consumers on a system of simple hire or hire-purchase. Proposals to the electrical engineer (Mr. Albert Gay), 56, Eden-grove, Holloway, N., by Feb. 17. See also advertisement.

Hammersmith (London) Borough Council invite tenders for various stores for twelve months ending March 31, 1905, including arc lamp accessories, globes, &c., commutator brushes, electrical goods, incandescent lamps, insulated wires, lubricating oil, jointing materials, carbons, files, tools, &c. Further particulars from the borough electrical engineer (Mr. G. Gilbert Bell), Electricity Works, 57, Fulham Palace-road, London, W. Tenders to the town clerk (Mr. H. Thompson) by 4 p.m. Feb. 10. See also advertisement.

Sunderland Corporation invite tenders for a travelling crane and a storage battery. Specifications, &c., from the borough electrical engineer (Mr. John F. C. Snell), M.Inst.C.E. Tenders, addressed to chairman of Electric Lighting committee, Town Hall, Sunderland, to the town clerk (Mr. Fras. M. Bowey) by noon Feb. 26. See also advertisement.

The Scottish offices of the *May-Oatway Fire Appliances Limited* invite tenders for wiring certain installations for May-Oatway compensated automatic fire alarms for direct connection with the fire brigades at Glasgow. Tenders by Feb. 3. Further particulars from the managing director, 49, Queen-street, Glasgow.

Electrical contractors willing to make a speciality of fire-alarm signalling with direct brigade connections should keep in touch with the company, 92 and 94, Paul-street, London, E.C., where urgent contracts are given out without advertising. See advertisement.

Bedford Electrical committee invite tenders for the supply and erection of a high-tension switchboard. Specifications from the borough electrical engineer (Mr. R. W. L. Phillips). Tenders, addressed to the chairman, Cauldwell-road, Bedford, by noon Feb. 9. See advertisement.

West Ham Corporation invite tenders for various engine-room stores, cable, recording wattmeters, house cutout boxes, transformers, incandescent lamps and coal. Further particulars are given in an advertisement, and tenders to the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E., by 4 p.m. Feb. 11.

South Shields Corporation invite offers for the lease of certain tramways authorised by the South Shields Corporation Act, 1903, to be constructed in the borough, together with tramway stables and depot. Tenders to town clerk (Mr. J. Moore Hayton), Court-buildings, South Shields, by March 12.

Manchester Tramways committee require tenders for about 38,000 superficial ft. of patent glazing for their car repairing works. Tenders to chairman by Feb. 1.

Manchester Dock and Warehouse Extension Co. require tenders by 10 a.m. March 1 for 25 electric hoists and 10 electric fixed cranes.

London County Council invite tenders by 10 a.m., Feb. 9, for eight railway turntables for their Greenwich power station.

London County Council Asylums committee invite tenders, by 10.0 a.m. Feb. 17 for 12 months' supply of stores, including electric lighting sundries.

Swindon Corporation invite tenders for wiring Euclid-street Elementary School. Tenders to secretary, Education committee, by noon Feb. 15.

The Northern Counties (Ireland) committee of the *Midland Railway Co.*, Belfast, invite tenders by Feb. 10 for telegraph iron work, batteries, &c.

Stockport Gas and Electricity department invite tenders by noon Feb. 4 for one 160-tube fuel economiser.

Battersea (London) Council invite tenders by noon Feb. 15 for a 750kw. steam dynamo and electric pump and pipe work.

Leeds Corporotion invite tenders by Feb. 10 for wiring the branch library, Wesley-road, Armley.

Brighton Corporation require tenders by Feb. 8 for a 20-ton electric cane at Southwick station.

Westminster City Council invite tenders by noon Feb. 3 for wiring the Marshall-street baths.

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TENDERS RECEIVED AND ACCEPTED.

London County Council received the following tenders for four three-phase generators for their Greenwich generating station :—

Electric Construction Co. (*accepted*)	£29,600	Bruce Peebles & Co.	£30,558
Richardsons, Westgarth & Co.	39,343	Witting, Eborall & Co.	29,360
Dick, Kerr & Co.	36,000	General Electric Co.	24,379
British Westinghouse Co.	34,385	International Elec. Eng. Co.	23,435
Brush Co.	32,872	Siemens-Schuckert Werke	*23,406
		Siemens Brothers & Co.	*23,385

* Not to specification.

In submitting their report on these tenders the Highways committee said the lowest tender was from Messrs. Siemens Brothers & Co. for generators which did not comply with the general requirements of the Council as regards dimensions and certain other structural points. These points of departure from the specification were of great importance in view of the vital part played by this plant in the working of the Council's electricity generating station. The same objections applied to the tender of the Siemens-Schuckert Werke, of Berlin, whose tender was for the same type of machine as that of Messrs. Siemens Brothers & Co., but the plant would be made in Germany. The tenders of the International Electrical Engineering Co. and of the General Electric Co. were for machines which required an auxiliary heavy flywheel, and this would take up more space and result in a less satisfactory design of machine than was provided in the Council's specification. The tender of Messrs. Witting, Eborall & Co., was not of an entirely satisfactory character, as the design proposed, while most complete, was not entirely suited to the Council's purposes. With regard to the tender of the Electric Construction Co., which the committee recommended for acceptance, the design submitted was for a complete flywheel alternator built up with steel plates and specially suited for high speeds, the method of construction being the safest known for withstanding centrifugal strain. This firm had had large experience in the manufacture of the class of machine required by the Council. Speaking generally, the plant required was of an exceptional size, and only few firms had had sufficient experience to be entrusted with work of such magnitude. The Electric Construction Co. proposed to sub-let a portion of the contract to Messrs. P. R. Jackson & Co., or to Mr. R. G. Ross or some other firm approved by the Council's engineer.

London County Council have allowed Bolckow, Vaughan & Co., whose tender at £43,748 was recently accepted for track rails, to sublet the manufacture of the fishbolts and nuts to Guest, Keen and Nettlefold and Bayliss, Jones and Bayliss.

The following tenders for the Dyke-road tramway have been accepted by Brighton Council :—

Stewarts and Lloyds (steel poles)	£969	11	6
F. Smith & Co. (trolley wire)	325	5	2
Do. (span and guard wire)	15	10	6
Rowland Carr & Co. (bases and sections)	313	15	7
J. Needham & Sons (cast-iron fittings)	42	2	0
Dick, Kerr & Co. (pole brackets)	173	4	0
W. Wood & Co. (overhead fittings)	97	9	0
Do. (switch gear)	38	7	6
British Insulated and Helsby Cables, Limited (feeder distributing and telephone cables)	3,200	15	3
R. W. Blackwell & Co. (bonds)	580	19	2
Acme Wood Flooring Co. (wood paving blocks)	7,100	0	0
Brooks Limited (granite setts)	615	0	0

Walthamstow District Council has accepted the tender at £75,926 of W. T. Henley's Co. for tramway permanent way, cables and overhead equipment, and bonding and section pillars, and that of of F. Suter & Co. (at £20,685) for generating plant.

By an error in the figures supplied to us, we announced in our last issue that Kirkcaldy Corporation had placed a contract for a Browett and Lindley-Laurence, Scott 430kw. generating set at £4,619. This figure should be £2,619.

Battersea (London) Council have accepted the tender of Graham, Morton & Co. for coal handling and conveying plant for the electricity works at £2,337. An order for 200 prepayment meters has also been placed with the British Thomson-Houston Co.

The tender of Messrs. Rowland Carr & Co., of 6 and 8, Lime-street-square, E.C., has been accepted for the supply of cast-iron bases, switch and telephone pillars for the Brighton Corporation tramways.

Wimbledon Electricity committee received 17 tenders (from 15 firms) for water softening and storage plant for the electricity works, and that of the Paterson Engineering Co. at £1,153 is recommended for acceptance.

The May-Oatway Fire Appliances Limited have accepted the tender of Allan Arthur and Ure for wiring the premises of Brown and Polson, Paisley, for May-Oatway compensated automatic fire alarms, and that of James Maxwell & Son for wiring for a similar installation at John Ireland & Sons', Dundee.

The War Office have placed with the Hart Accumulator Co., Marshgate-lane, Stratford, E., an order for a storage battery of 115 cells for the electric lighting of the Royal Victoria Hospital, Netley.

The Aberdeen Suburban Tramways Co. have placed an order with J. G. White & Co. for the construction and equipment of their tramway lines. The amount of the contract is about £35,000.

Chiswick District Council have placed an order with the Sir Hiram Maxim Electrical and Engineering Co. (Ltd.) for an overhead traveller at £130.

Southend-on-Sea Town Council have accepted the tender of J. C. Flaxman for car shed extensions at £2,647.

Brechin Parish Council have accepted the tender of Ferguson and Carver for wiring their almshouse.

BUSINESS NOTICES.

Messrs. Robert W. Blackwell & Co., 59, City-road, London, E.C., notify that their telephone numbers are now National 1479 and 1480 London Wall, G.P.O. 8055 and 8056 Central.

Mr. T. L. Boyden, who has been for over nine years chief of the continuous-current dynamo department of the Electric Construction Co., has accepted the position of general manager to the Lister Electric Mfg. Co. Mr. Boyden takes up his duties forthwith.

The Stirling Company have opened a London office at 53, Victoria-street, Westminster, S.W., where business relating to London and the South of England will be conducted under the charge of Mr. G. Graham. The head office of the company remains at 53, Deansgate-arcade, Manchester.

The London Electrical Fittings Co. (Ltd.), Robert Works, Hampstead-road, N.W., have opened a spacious ground floor showroom at 7A, Soho-square, W., where the latest designs in electric light fittings and heaters may be seen. This company are putting on the market a novel two-light counterweight, with an adjustable range between the holders of 24in. to 12in., without spoiling the effect of the curves in the fitting.

Mr. E. Rotter, A.M.Inst.C.E., 47, Victoria-street, Westminster, and Pearl-buildings, Portsmouth, has taken into partnership Mr. T. Harison Jones, who has had large experience in tramways, mining and power work in America, and the firm will in future be known as Rotter and Jones.

Messrs. C. and W. H. Price (trading as Ross, Price & Co.), electrical engineers and contractors, have dissolved partnership. Debts by Mr. W. H. Price.

Messrs. W. Swire and P. Derbyshire, electrical engineers, &c., 2, George-street, St. Helens, Lancs., have dissolved partnership.

LIQUIDATIONS, BANKRUPTCIES, &c.

J. W. Storr, electrical engineer, Grange-road, Dudley, was examined at Dudley County Court last week. The liabilities are £319. 10s. 1d., assets nil. Debtor commenced business as "Webster, Michelson & Co.," at Dudley, with £90 capital. He sold his business to a company in 1902, receiving from the company only 1,000 £1 shares (valued at £50), but he had deposited the shares with his solicitor as security for costs. Examination adjourned.

A receiving order has been made against Gardner Bros. & Co., electrical engineers, Horninglow-street, Burton-on-Trent.

A first and final dividend of 1s. 9¾d. is payable on Feb. 5 at 24, Railway-approach, London Bridge, in the failure of J. P. Child, electrical engineer, 150, Powis-street, Woolwich, and 109, Piedmont-road, Plumstead.

Mr. F. S. Salaman, 2, Oxford-court, Cannon-street, London, E.C., has been appointed liquidator of the South-Western Electrical Co. (Ltd.) in the place of Mr. C. E. Peebles. Claims to Mr. Salaman by March 1.

The P. and R. Storage Battery Co. (Ltd.), 55, Hatton-garden, London, E.C., is to be wound up voluntarily. Mr. W. Peto, 57B, Hatton-garden, is liquidator. The newly-registered Peto and Radford (Ltd.) acquires the business.

Peto and Radford (Ltd.) is being wound up voluntarily and Mr. Wm. Peto, 57B, Hatton-garden, London, E.C., is liquidator. The new company also takes over this undertaking.

Winding-up Petition.—A petition presented by Messrs. Morris and Place, Bridlesmith Gate, Nottingham, for winding up the Electric Tramways Construction and Maintenance Co. (Ltd.) will be heard in the High Court on Feb. 2.

Plant for Disposal.—The Bank of England have been experimenting for some time with motors for driving the large number of printing machines installed in their works. The Governors are now engaged in making a complete change to electric driving for all printing and other machinery on the bank's premises, including the deep well pump. The work is being carried out under the direction of Mr. Bernard M. Drake, consulting electrical engineer to the Bank of England. The plant which will be displaced by the new arrangement is advertised for sale in another column.

The directors of the Manx Electric Railway Company (Ltd.) offer for sale by private treaty, as it stands, the whole or separate parts of the generating plant at their existing power stations at Douglas and Snaefell, comprising alternating and direct-current generators of 50kw. and 60kw. driven by electrical and horizontal and cross-compound engines, Lancashire boilers, sundry

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condensers, pumps, &c. Offers are also invited for equal-wheeled bogie trucks, car motors and car equipment sundries. Further particulars from Mr. F. Edmondson, resident engineer, Douglas Tenders, addressed to the chairman of the company, 78, Cornhill, London, E.C., by noon Feb. 25. See also advertisement.

Two Parker dynamos, a booster, and a shunt-wound charging dynamo are advertised for sale on another page.

Gorton Urban District Council have for disposal a 5 H.P. gas engine, which can be seen at works at the sewage outfall works. Particulars from the clerk (Mr. C. T. Singer) Town Hall, Gorton. See advertisement.

Works, &c., for Sale.—Some modern well-equipped car-building works, occupying a covered area of 8¾ acres, with 25 acres available for future extensions, are advertised for sale in another column. Applications to Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C.

Some manufacturing premises are advertised for sale or letting on lease, without restriction and with or without steam power. The premises adjoin Laindon station, Essex, 22 miles from London. Particulars from Messrs. I. Levy & Son, 62, Albany-road, Old Kent-road, London, S.E.

A wharf with good river frontage at Battersea is to be let. Applications to Mr. Harold Griffin, 54, High-street, Battersea, London, S.W. See also advertisement.

Compact engineering works, with good modern light engineer's plant, are advertised for sale in another column.

Alternator Wanted.—A 50kw. alternator is wanted, for 2,000-volt circuit, periodicity 50 and speed 750 revs per min. Quotations to Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C. See advertisement.

Copper Castings.—Messrs. J. Tylor & Sons, 2, Newgate-street, London, E.C., notify us that they have submitted to the Westminster Testing Laboratory samples of copper castings to be tested for specific resistivity, and that they have received a report from the laboratory to the effect that the conductivity tests show 90·08 per cent. and 90·01 per cent. respectively. Messrs. Tylor claim that they are the first manufacturers to reach so high an efficiency for these castings.

"Franklin" Patent Ventilated Frames and Covers.—Messrs. Rowland Carr & Co., of Lime-street-square, London, E.C., inform us that the use of these covers is gaining favour with consulting and electrical engineers, and that numerous orders are coming in from electric lighting and tramway engineers. The covers are also being specified and used in Government contracts.

Automatic Fire Alarms.—The Midland Railway Co. have placed with the May-Oatway Fire Appliances, Paul-street, Finsbury, London, E.C., and 49, Queen-street, Glasgow, orders for their automatically-controlled detectors and indicators for the protection of their new station buildings, goods sheds, &c., at Heysham. The Liverpool Overhead Railway Co. adopted this system after the fire which occurred at their Dingle Station, and the Lancashire and Yorkshire Railway Co. have also installed it in various buildings.

New Magazine.—The first issue of "The Electrical Magazine," a new monthly magazine, has been published, price 6d. The offices are at 4, Southampton-row, London, W.C.

Catalogues, &c.—Messrs. Clarke, Chapman & Co. (Ltd.), Victoria Works, Gateshead-on-Tyne, have recently prepared for publication a well-arranged set of circulars bound up in a flexible cover. These deal with the various classes of heavy plant and machinery manufactured by the company for use in electrical engineering work on land and sea. Some fine examples of belt and rope-driven multipolar dynamos, semi-enclosed and open type multipolar motors, enclosed type continuous-current motors, multipolar dynamos on combined bedplates for direct coupling to engines, enclosed type continuous-current motors, high-speed enclosed combined vertical steam engines, condensing and non-condensing (some fine examples of these machines are illustrated), high-speed enclosed single cylinder non-condensing vertical steam engines, high-speed vertical open type compound steam engines, high-speed vertical double-acting open type single cylinder steam engines, compound open type engines and multipolar dynamos for ship lighting plants are presented, and by means of tabulated statements and sectional drawings much information is given in a compact form. A distinct section is devoted to electric winches, and several examples of shift-guard winches, designed for special classes of work for any voltage from 100 to 500, and fitted with series-wound motors and tramway-type controllers, are illustrated. There is also shown a yard capstan, which can be fitted with hand or foot lever for working controller, and an Admiralty boat hoist capable of lifting 8 tons at 90ft. per minute. Also an Admiralty coal hoist to lift 1½ tons on barrel at 250ft. per minute or 1 ton on warp ends at 220ft. per minute. The shipyard winches shown are for single or two speeds. A further section of the set deals with projectors, and in the manufacture of this class of apparatus Messrs. Clarke, Chapman & Co. have exceptional experience and facilities. Electric windlasses, winding engines, portable electric drills, launch motors, &c., find a place in one of a very comprehensive list of high-class electrical machinery for power purposes. The method of binding the sheets affords a simple means of adding the lists issued from time to time, and merits a word of commendation.

A number of important leaflets dealing with a variety of goods listed by the Edison and Swan United Electric Light Co. are now ready for the trade and can be obtained on application. Electric light fittings of various kinds are described, and electric lighting accessories detailed. Two new types of pear switches receive particular attention, and a "Safety" tumler switch is also referred to. In the pear switches the old pressel-bar movement has been abolished, and that of the Ediswan "Wedge" tumler switch substituted. These pear switches are made in two styles (with tumler handle or with sliding rod which holds the contact lever inside), and they are particularly recommended for high-voltage purposes and are claimed to be a distinct improvement upon any pear switch previously made. Two examples of this new pear switch are shown in Figs. 1 and 2. Fig. 1 shows the tumler movement operated by handle and Fig. 2 the same movement operated by pressel bar. The "Safety" H.V. tumler switch is in all-china, with a new movement ensuring a very quick and long break. This switch is shown (without cover) in Fig. 3. The two contacts are sunk well below the surface, and are separated by a bridge piece which prevents any arc being maintained. Circuit is made by a pin in the handle, which works in a slot in the contact arms. At the end of the movement the pin falls into a recess, which has a partial locking effect, ensuring very quick break when the handle is pushed back. There are also leaflets on the "O.K." dry cell, Ediswan dynamo and motor brushes, vulcanised flexible cords and C.M.A. flexible cords respectively, and Ediswan carbons, suitable for any make of arc lamp. These latter are listed both cored and solid for open and enclosed lamps.

Fig. 1.

Fig. 2.

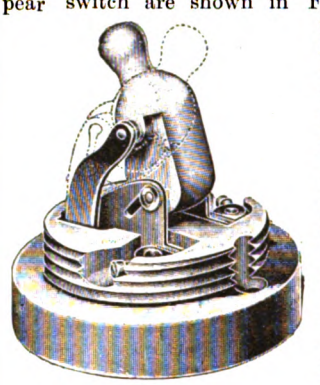

Fig. 3.

The Crypto Works Co., 29, Clerkenwell-road, London, E.C., are placing on the market a new carbon copper brush composed of very finely divided copper mixed with pure graphite, which is claimed to materially reduce the resistance and at the same time to reduce the wear and tear on the commutator. The company state that these brushes have been in use on their own machines for some time, and their efficiency has been demonstrated, while the commutation has not suffered.

Messrs. Thos. Thompson & Co., 35, New Broad-street, London, E.C., have ready a new list of tachometers (speed indicators), for which extreme sensitiveness and great accuracy is claimed. Various forms of this apparatus are illustrated, including a high-speed counter with a special interrupting device for accurate readings.

Messrs. Plutte, Scheele & Co., Queenhithe, London, E.C., have ready a new catalogue of electric lighting accessories manufactured by Messrs. Schmahl and Schulz, Barmen, Germany, for whom this firm are sole agents for the United Kingdom and the colonies.

The New Brotherton Tube Co., of Commercial-road, Wolverhampton, are issuing a useful hanging calendar with illustrations of a variety of the company's special class of manufactures.

We have received from the University Tutorial Press, Burlington House, Cambridge, a copy of the "London University Guide and University Correspondence College Calendar" for 1903-4.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Jan. 20 to 23 with the ports of destination:—

Africa—Durban, £407. *Argentina*—Buenos Ayres, £429. *Australasia*—Auckland, £422; Sydney, £845; Wellington, £118. *Belgium*—Antwerp, £198. *Burma*—Rangoon, £12. *Canada*—Halifax, £40. *China*—Shanghai, £11. *Cochin China*—Saigon, £3. *Germany*—Hamburg, £155 (tele-

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graph material). *Gibraltar*, £385. *Holland*—Amsterdam, £35; Rotterdam, £33 (including £20 telegraph wire). *Hong Kong*, £18. *India*—Bombay, £113; Calcutta, £462; Madras, £22. *Japan*—Tokosaka, £583; Yokohama, £110 (telegraph apparatus). *Java*—Batavia, £30. *Straits Settlements*—Singapore, £40 (including £30 telegraph wire). *Sweden*—Gothenburg, £70. Total, £4,541, against £21,628 in the corresponding week last year (Jan. 21 to 27).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December, 7, 1903.

26,687 R. LEE. Electric lamps for vehicles.
26,772 T. L. CARBONE. Arc lamps for high tensions.*
26,775 C. D. ABEL (Siemens and Halske A.G., Germany). Manufacture of homogeneous masses, tantalum and like difficultly fusible metals.*
26,776 C. D. ABEL (Siemens and Halske A.G., Germany). Incandescent bodies for glow lamps.*
26,783 C. W. BREEDLOVE and R. R. GRANT. Electrically-operated railway switches.*
26,788 F. M. LEWIS. Electro-motors of induction type.
26,792 J. H. WILSON. Electric sanitary closets.*

December 8, 1904.

26,807 C. MARSTON and P. L. RENONY. Wolverhampton. Sparking plugs.
26,808 W. L. BULLOWS. Walsall. Telegraph poles.
26,823 J. T. PEARSON. Burnley. Street electric lighting.
26,825 G. E. WATMOUGH. Leeds. Electrical device to indicate when trolley leaves the wire.
26,827 D. BURNS and J. M. FLEMING. Glasgow. Wind motors for generation of electricity.
26,842 CROMPTON & Co. and A. J. HODGSON. Chelmsford. Automatic cutouts.
26,843 CROMPTON & Co. and A. J. HODGSON. Chelmsford. Arc lamp suspension apparatus.
26,848 and 26,849 W. FAIRWEATHER (Stromberg Carlson Telephone Mfg. Co., U.S.) Telephone systems.*
26,850 W. FAIRWEATHER (Stromberg Carlson Telephone Mfg. Co., U.S.) Selective signalling systems.*
26,851 W. FAIRWEATHER (Stromberg Carlson Telephone Mfg. Co., U.S.) Central exchange apparatus and connection.*
26,856 CROMPTON & Co. and R. C. HARRIS. Electric circuit-breaker mechanism.
26,857 CROMPTON & Co. and A. J. HODGSON. Arc lamps.
26,863 S. ROWE. Telephonic recorder.
26,873 G. L. HOGAN. Automatic telegraph apparatus.

December 9, 1903.

26,912 G. DAVIS. Incandescent lamps.
26,913 J. SWINBURNE and G. H. BAILLIE. Telephone exchange system.
26,915 G. E. FLETCHER. Manchester. Wall sockets and switches.
26,916 A. E. WALKDEN. Manchester. Electric advertising on vehicles.
26,922 W. M. ROGERSON. Halifax. Laying cables and the like.
26,935 D. E. EVANS. Pencoed. Electrical controller.
26,947 F. H. WEHRMANN. (U.S.) Automatic electric street indicators for cars.*
26,954 H. C. MOFFATT. Mechanical device for electric lifts.
26,961 J. MCCULLOUGH. Switching mechanism for double filament lamps. (Date applied for Dec. 10, 1902, date of application in U.S.)*
26,965 H. B. SWIFT. Clutch for arc lamps.
26,966 A. N. PETIT. Sound receiving and reproducing instruments.
26,967 A. T. WEDELIN. Switch.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

24,013 FANTA and BUTLER. Attachment of carbon and filaments in incandescent lamps.
26,836 B.T.-H. Co, CLINKER and WEDMORE. Electrical synchronism-indicating apparatus.
26,416 ZILDERLAST. Railway and tramway points operated by or from the vehicles, and points or switches for use upon overhead conductors of electric railways and tramways.
26,640 GEBSTMANN. Electrical apparatus for automatically actuating signals on and stopping railway engines and trains.
26,870 DERI. Alternating-current motor.
26,970 LIQUID (ELECTRIC) REGISTER SYNDICATE and CASSALL. Electrical apparatus for registering discharge of liquids by pumps.
27,322 PIEPER. Switches.
28,391 BORVELL. Automatic fire-alarm systems.
28,958 PIEPER. Rheostats.

1903.

159 BABBER and LARMUTH. Electric bells.
822 EDISON. Storage batteries and manufacture thereof.
2,189 BRAY, MARKHAM, REISS and BRAY, MARKHAM AND REISS (LTD.) Switches.
2,277 RIDINGS. Arc lamps.
7,608 EVANS (A.E.G). Continuous-current arc lamps.
11,304 JOHNSON-LUNDELL ELECTRIC TRACTION Co. (Lundell). Control of electric motors.
12,189 HUNTER. Wall plugs and similar electrical fittings.
14,542 LINDQUIST. Controlling devices for electric motors.
14,605 BOWELL and PEARSON'S FIRE ALARM. Heat alarm fuses for automatic fire alarms.
17,399 FURRY (McCarty and Beebe). Decomposing water by electrolysis.
18,234 SACHS. Fuse blocks.
20,405. SCHROTTKE and GESELLSCHAFT FUR DRAHTLOSE TELEGRAPHIE, m.b.H. Producing rapid electrical oscillations and system of devices therefore.
20,572 REICHENBERGER and WEIERSMULLER. Induction device for medical and like purposes.
20,889 KELLNER. Electrolysis of chlorides of the alkalies.
21,592 SIEMENS BROTHERS & Co. (Siemens and Halske A. G.). Electromagnetic signalling apparatus.
22,486 SHOEMAKER. Electrical range finders. (Date applied for Jan. 10, 1903.)
23,224 GORHST. Electric signs.
23,235 SUNDQUIST and WAHL. Telephone relays or repeaters.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.).

The sixty-third half-yearly general meeting of the shareholders of this Company was held on Wednesday at River Plate House, Finsbury Circus, London, E C., under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. A. R. Hardie) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN, in proposing the adoption of the report and accounts, said: The gross revenue for the half-year ended Sept. 30, 1903, amounted in round figures to £566,000, against £583,000 for the corresponding period of 1902, a decrease of £17,000. The decrease in the net receipt for messages was £35,500, but this has been reduced to a total decrease of only £17,000 by various per contra items. The reduction in the message receipts is principally in the Cape Joint-Purse, the Australian, and the China, Japan and Manila traffics, those branches alone showing a decrease of £63,000. This falling off is accounted for by the reduction, as from January 1, 1903, in the Cape Joint-Purse tariff from 3s. to 2s. 6d. per word for ordinary and from 1s. 6d. to 1s. 3d. per word for Government telegrams, and the heavy falling off in Government traffic with South Africa. The volume of traffic for ordinary and press telegrams increased at the rate, of 9 and 19 per cent. respectively, but, of course, a much larger development must take place before we are recouped for the reduction in the rate just referred to. Although the traffic with Australia shows a considerable falling off, due to what may justly be described as the unfair and unstinted competition of the British Government Pacific cable, still, I am pleased to say, that we are holding our ground, so far as it is possible for us to do so under these adverse conditions, and that the loss of revenue on this account is no more than we anticipated it would be.

In November last I spoke very fully on this subject at the meeting of the Eastern Extension Company, whose revenue on this account is more seriously affected than our own. I daresay some of you have read the correspondence which has appeared in *The Times* in consequence of my remarks. I still hold the view that the policy of establishing State-aided competition with a commercial undertaking, more especially when that undertaking has served the State and public as well as we have done, is an unsound policy. It has proved, in this case, unprofitable to the State and a most serious, I might almost say fatal, discouragement to commercial cable enterprise. The establishment of this Government cable could only be justified on strategic or imperial grounds, and not, as it has, in spite of promises to the contrary, become, an active and unfair competitor (supported by public moneys and by the official support of the British and Colonial Governments) with British commercial interests. These interests should, in my opinion, be considered identical with the interests of the Empire and should not be opposed with taxpayers' money. It is surely an anomaly that we should be obliged to contend against British as well as foreign subsidised cables at a time when so much is being said as to the necessity of encouraging British and colonial enterprise on account of foreign competition.

The large decrease under the head of China, Japan and Manila traffic results principally from the opening of the Commercial Pacific cable and the large reduction made in tariff referred to at the general meeting in July last. As I explained at a previous meeting, the Commercial Pacific Cable Co. is an American company. Their cables are laid from San Francisco to Honolulu and from Honolulu to Manila. The American company is thus brought into direct communication with the Eastern Extension Company's system in the Philippines, and the traffic is exchanged at Manila with the Commercial Pacific Cable Co. under an arrangement come to with that company after prolonged negotiations. Thus, not only is the United States brought into direct communication with Hong Kong, China and other ports of the Far East over the cables

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of the Eastern Extension and Great Northern Companies, but those companies have been able, on their side, to secure another alternative route to Europe for their traffic in case of necessity. Owing to the friendly working arrangements which exist between the various Associated Companies, this Company is always interested in any fresh development with which any of those companies may be connected. As these developments will, to begin with at all events, involve certain financial sacrifices on the part of the Eastern Extension and Associated Companies, this Company has, of course, to take its fair share in the transaction, but I trust that we shall, in the near future, derive benefit by thus further securing additional telegraphic communication with the Far East and with the continent of America, so that we hope that it will lead to a substantial development of this traffic, in which we are likewise interested.

As a part set off against the above-mentioned decrease in traffic receipts, improvements appear in the Indian, Egyptian, and Turkish traffics, and a substantial increase in that for Aden, resulting, unfortunately, from the very heavy Government and press traffic arising out of the trouble in Somaliland. Our income from investments in other telegraph companies shows an improvement of £1,800, and we have earned £1,600 more interest this half-year from the temporary deposit with our bankers of our surplus funds. The gross revenue this half-year also includes £15,300 for interest on reserve fund investments, against which, on the other side of the account, has been charged the interest on the loan from the Eastern and South African Telegraph Co., amounting to £13,100, making a small difference in favour of revenue of £2,200. For many years the interest derived from investments on account of our various reserve funds has been credited to those funds direct, and has not been brought into the credit of our revenue account. In the same way, the interest paid to the Eastern and South African Co. on account of the loan to this company (to enable us, together with our own resources, to meet the large expenditure for the new cables between Great Britain and South Africa and Mauritius), has also been debited to the reserve fund direct. It has always been a debatable point as to whether it is more correct to bring these items of credit and debit into the various reserve funds direct or into the revenue account as interest, leaving it to the stockholders to make suitable appropriations, from the revenue to the various reserve funds. The ultimate result in the account before us is practically the same by both methods, and, after weighing the arguments on both sides, I think the balance inclines to the latter as being the preferable course. We have, therefore, decided to bring this interest into the revenue account in the future. The expenses under other heads have accordingly been somewhat increased, it having been considered advisable to make special contributions out of revenue to some of the subsidiary reserve funds in lieu of carrying the interest upon them to their credit.

The ordinary expenses for the half-year amounted to £168,000, against £157,000 for the half-year to Sept. 30, 1902, or an increase of £11,000. Of this increase £2,700 is in the general expenses in London, while the working expenses at stations have increased to the extent of £8,400. The slight alteration in the method of setting out expenses renders it difficult to explain the items in detail on this occasion, but the largest portion of this increased expenditure is chiefly due to the readjustment of, and automatic increases in, salaries and wages. The principal increase is some £5,600 in salaries and wages, due to annual promotions and to the fact that our staff on Sept. 30, 1903, numbered 84 more than at Sept. 30, 1902. The other items of expenditure, with two or three exceptions, show small increases when compared with 1902, these being due to the extension of our system, as explained at the last meeting, and to the special contributions to some of the subsidiary reserve funds before referred to. The expenses attending maintenance of cables, including depreciation of spare cable, amounted to £47,500, against £77,000 in 1902, showing a most satisfactory decrease of £29,500. This, however, is an item over which the executive have little or no control, and the reduced expenditure is almost entirely due to the fact that a much smaller quantity of cable has been expended than in the corresponding period of 1902, in addition to which the receipts arising from the hire of our ships to other parties for cable repairing purposes show an increase of £10,000 compared with 1902. During the half-year under review the small balance of £915 preference stock has been issued, this completing our authorised issue of £2,000,000. Your Directors have also issued a further amount of £43,079 4 per cent. mortgage debenture stock, the liability under this head now standing at £1,838,014. The 3½ per cent. preference and 4 per cent. mortgage debenture stocks issued from time to time have been not only for general capital purposes, such as new cables, &c., but have also been issued to acquire further interest in certain telegraph companies. It has not been our custom to show our individual holdings in these companies, but you will no doubt be interested to know that the sum invested in this way now amounts to £1,461,277, the income on which appears from time to time in the revenue account under the heading "Dividend on Capital Investments in other Telegraph Companies."

As a result of the half-year's working, we are able, after providing for debenture interest and the usual quarterly dividends on the preference and ordinary stocks, to carry £7,000 to maintenance ships' reserve, £120,000 to general reserve, and to carry forward a balance of nearly £33,000 to the next half-year, against about £22,000 carried forward in the corresponding period of 1902. During the half-year we have repaid £100,000 to the Eastern and South African Telegraph Co. on account of the loan, of which £650,000 is still outstanding, and we have applied a similar amount from the reserve fund to the reduction of the expenditure on account of new cables.

You will observe that the notice calling this meeting has been signed by our new secretary, Mr. A. R. Hardie, who has previously occupied the position of accountant to the Company for many years. Mr. George Draper, who has so long served the Company, has reached the age of retirement, and the Board have had great pleasure in voting him an addition to the pension to which he was entitled from the staff pension fund. I have nothing further to say on the report and accounts, and I now move their adoption.

The VICE-CHAIRMAN and MANAGING DIRECTOR (Sir J. Denison-Pender, K.C.M.G.) seconded the motion.

Mr. JOHN NEWTON said that he had been very glad to hear the chairman's remarks with reference to the vote which the Directors had made to Mr. George Draper on his retirement from the position of Secretary, and he trusted that their late secretary might enjoy health and strength in his retirement for many years to come. He agreed with the Chairman's remarks as to unfair competition, and the great disturbance which would be created in the development of telegraphic enterprise by the action of the Government in connection with the Pacific cable; and there was one point in regard to the matter which should be thought of by those who were not interested in cable companies—namely, that investors in such companies did not feel quite safe whether the Government would continue to develop that spirit of competition with existing companies to which the Chairman had referred (hear, hear). What would have been the consequences to the country if this Company had not had the enterprise and pluck to lay the cable to the Cape when they did? and why, having rendered this service to the State, should they be interfered with as they had been (hear, hear)? He had been glad to notice that the Directors had adopted the principle referred to by the Chairman of crediting to revenue the interest on the reserve fund investments.

Mr. ROSE alluded to the serious depreciation in the value of the Company's investments on account of reserve, and said that he understood that the depreciation was about 14 per cent.

The CHAIRMAN, in reply, said with regard to the value of the Company's investments, the matter referred to had not, of course, been lost sight of, but he thought that it was much wiser to make a definite statement, as the Directors did in the accounts, as to the amount of money that was invested. They did not say anywhere that the investments were of this or that value, but that a definite sum had been invested out of profits, and the cost price of the investments was given. If they were to value the stocks up and down he thought that somewhat of a false impression might be produced. Their accounts also differed altogether from bankers' accounts; their investments had not to be treated as liquid assets in order to fortify the credit of a bank or a commercial company lending and dealing with money. Their investments represented money put away for requirements, and whenever those requirements arose the Directors had to consider very carefully which of the various investments should be realised and which retained for better times. Of course, everyone knew that all gilt-edged securities had in the past two or three years been very much more depreciated than the real value of such securities would justify. He did not think that the depreciation in the Company's reserve fund investments need alarm the shareholders. He might add that the net result of realisations up to date had been the very satisfactory addition to the reserve fund of some £63,000. On the subject of State-aided competition with commercial enterprises he thought he had already said enough in his opening remarks and in the letter which he wrote to *The Times*. He did not think that anything could be more suicidal for a great country than for it to employ its funds in discouraging private efforts, and the recent action of the Government in competing with them for the Australian traffic—and especially in the unstinted way in which that competition was carried on—was, to his mind, such a discouragement for all commercial enterprises that if it had taken place 30 or 40 years ago he did not suppose that the whole civilised world would have had anything like that amount of telegraphic and cable communication which they now enjoyed (hear, hear). One could not but hope that such competition would not be repeated (hear, hear). He then put the motion, which was carried unanimously.

After the re-election of the retiring Directors and Auditors, the proceedings terminated with a vote of thanks to the Chairman and Directors.

Direct United States Cable Co. (Ltd.).

The fifty-third ordinary general meeting was held on Tuesday, under the presidency of E. M. UNDERDOWN, Esq., K.C.

The GENERAL MANAGER and SECRETARY (Mr. T. Finnis) read the notice calling the meeting, and

The CHAIRMAN, in moving the adoption of the Directors' report and accounts, said: Gentlemen, with regard to the revenue for the six months to Dec. 31, after deducting outpayments, it amounted to £47,815, while the working and other expenses, including income tax but exclusive of the cost of repairs, absorbed £21,816, leaving a balance of £25,999, the working and other expenses, including income tax, but exclusive of the cost of repairs, absorbed £21,816, leaving a balance of £25,999. With £2,693 brought forward there is a total amount of £28,692, which has been appropriated as follows:—Interim dividend of 3s. per share to Sept. 30, £9,106. 10s.; a similar amount to Dec. 31; we propose to set aside to reserve fund account £8,000; and we carry forward to the current half-year £2,479. Those sums together amount to the total above mentioned of £28,692. Now, with regard to the revenue, it shows a falling off, but that does not arise from anything peculiar to this Company or, in fact, to any other Company. The falling off, as you are well aware, is due to the general torpidity of business. Inasmuch as our traffics are always an index of the condition of business, we cannot but expect that a falling off should have taken place in the past half-year in the enormous amount of business which is generally transacted between this country and the United States. There is a reduction of something like 9 per cent., but let us hope that that is only temporary; and, if it is any consolation to us, we know that all our competitors and

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friends have suffered from the same reason. The working expenses, as you know, are practically the same, and no remark is necessary to be made on that matter. I told you at our last meeting that we had had some heavy repairs on the main section of our cable. A considerable amount of the cost was dealt with then, but a certain balance had to be brought forward, and it forms a charge to the revenue of the six months now under review. As, however, you are aware, all these matters are dealt with according to a system which has prevailed so long, and which, in my opinion, has worked so well. We debit these repairs to the reserve fund, and against that we continue to make up this fund by the steady application to it of a reasonable amount from revenue. In that way we stand very much as we did before. The total amount of our investments is somewhat lower, but we shall, we hope, proceed to make that up. I do not think there is any other matter referring to our business with which I need trouble you. We are quite contented with the manner in which our business is going on. It is conducted with very great care. All our stations are in perfect order, and I think I may here mention that my son has visited all the stations in the United States, in Canada and in Nova Scotia. This was a very desirable thing to do, and I may say that he found everything in perfect order, and the staff doing their duties quite to his satisfaction, as they had already done to ours. He has furnished us with a valuable report on various matters. I cannot conclude without alluding to a very painful subject—the loss of our dear old friend, Admiral of the Fleet the Hon. Sir Henry Keppel, who has gone from us full of years and honours. The loss of such a colleague really goes beyond the regret which is customarily expressed on these occasions, because—as to everyone else with whom he was brought into association—he had endeared himself to us, who had been working with him for many years. His character endeared him to everyone—from the highest in the land, Royalty—to all officers in the service, from the admiral to the middies and from the middies to the bluejackets. We do not think he suffered, for he faded away from extreme age. All that we can do is to express our regret, and the Board have requested me to convey that sentiment to his family. I am quite sure that this meeting will acquiesce in that step, and share with us in recognising the loss we have sustained. I should like to add that, inasmuch as we desire to maintain the utmost economy, we do not at present intend to fill up the vacancy at the Board thus occasioned, and this will, of course, effect a corresponding reduction in our outgoings. I conclude by moving the resolution which I have already read to you.

Sir JAMES PENDER, Bart., seconded the resolution.

A short discussion followed, and in reply to Capt. Goodsall, Mr. James Roberts and Mr. James Bennett.

The CHAIRMAN stated that the depth of water in which their last great repair was carried out was about 2,100 fathoms. Although, of course, the repairs varied from very heavy to very slight ones, yet the average repairs over the whole period, as he stated at their last meeting, represented a sum which had been amply covered by the interest yielded by their investments. Of course, it was impossible to anticipate what might happen in the future, but what they had to console themselves with was the fact that there seemed to be absolutely no difficulty in dealing with the most complicated repairs. It was also to be remembered that when a repair was made a long section of absolutely new cable was generally put in, and the mended portion of the cable, therefore, became as good, if not better, than it was before. The cable was in very good condition as he stated at their last meeting. As to their investments, these were periodically looked after, and inspected both by the Directors and the auditors. He then put the resolution, which was carried unanimously.

Mr. WILLIAM MAUD proposed a vote of thanks to the Chairman, Directors and Staff for the able way in which the business had been conducted. He had, he said, attended a good many of the Company's meetings, although he had not been at them so frequently as when the former Chairman was alive. He could, however, see that the business was conducted in just the same way and on the same lines which were inaugurated by the late Sir John Pender. He was very pleased to see that the reserve fund figured at such a respectable amount, for, as he had said before, he regarded that fund as the backbone of the Company.

The motion was seconded and carried unanimously, and the Chairman having replied, the proceedings terminated.

CENTRAL LONDON RAILWAY CO.—The directors' report for half-year ended Dec. 31 states that the capital expenditure during the half-year has been £44,226. 6s. The receipts were £175,235. 3s. 9d., and the working expenses £97,363. 9s. 2d., leaving £77,871. 14s. 7d. The number of passengers carried during the half-year was 21,774,850, against 22,425,776 in the same period of 1902, and 23,179,138 in the June half-year 1903. The workmen carried in the last half-year numbered 3,012,210, about 14 per cent. of the total passengers carried. After providing for interest on debenture stock the available balance was £116,504. 5s. 6d., including £10,425. 18s. 5d. reserved to meet dividend on deferred stock, and £45,406. 8s. 11d. from last half-year. The directors recommend the declaration of dividends of 4 per cent. per annum for the half-year on the undivided ordinary and preferred ordinary stock and on the deferred ordinary stock for the whole year. The balance (£46,078. 7s. 1d.) is to be appropriated by adding £10,000 to reserve and carrying the balance (£36,078. 7s. 1d.) forward. The inquiry by a Royal Commission on the important question of a future provision needful for London traffic is still proceeding, and in view of the statement in the House of Lords that no bills for new tube lines would be dealt with in 1904 session, the directors decided not to make any application to Parliament this year. The additional sub-station at Bond-street is practically complete, and will be brought into service shortly. The large fan at Shepherds Bush is in regular working order, with the result that the air in the tunnels has been considerably improved. The new motor cars are also found to work satisfactorily. The company have arrived at a final settlement with the Electric Traction Co., all points of difference having been submitted to and decided by the arbitrator, Sir Benjamin Baker. The directors desire to take this opportunity of recording their appreciation of the manner in which the novel and important work of constructing and equipping the railway has been carried out by all concerned.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORP. (LTD).—The report of the directors for the year ended Dec. 31 records the satisfactory results of the year's trading in both the West-end and City areas of the company's supply.

West-end Undertakings.—Notwithstanding that several large premises to which supply has hitherto been given have been demolished in connection with County Council and other improvements, the number of lamps added was 55,326, or nearly 21,000 lamps more than in 1902. The engineer-in-chief certifies that the plant and machinery have been maintained in a high state of efficiency. The total mains laid is 221 miles. The revenue from sales of current for 1903 was £110,083. 12s. 2d. The balance of net revenue was £53,890. 4s. 2d. £14,000 was distributed as interim dividend at the rate of 8 per cent. for the half-year to June 30 last, and there is £39,890. 4s. 2d., which the directors propose to divide as follows:—4½ per cent. preference dividend to Dec. 31, £15,750; 12 per cent. for the half-year to Dec. 31 on the ordinary shares, making with the interim 10 per cent. for the year, £21,000. Carry forward, £3,140. 4s. 2d.

City Undertaking.—The distributing station buildings at Barbican have been completed and machinery is being installed. The total mains laid is 215 miles. The engineer-in-chief certifies that the plant and machinery have been maintained in a high state of efficiency. There have been connected up to the City mains during the past year 91,384 additional 8 c.p. lamps, making a total of 242,113. The progress of the business has more than realised the expectation of the directors. The gross revenue from sales of current was £56,036. 8s. 11d., or over 100 per cent. more than in 1902. The net revenue account shows a profit of £11,499. 11s. 1d. The 4½ per cent. preference dividend to Dec. 31 has been paid.

The extension of the company's business renders it necessary to increase the capital, and power to effect this increase will be sought at the annual meeting on Feb. 3.

CITY AND SOUTH LONDON RAILWAY CO.—The report of the directors for the half-year ended Dec. 31, states that the receipts from all sources amounted to £75,811, and cost of working £36,284. 4s., leaving a profit of £39,526. 16s. Inclusive of the balance forward from June, the net revenue account is £41,026. 16s. 11d. After making provision for interest and transfer to renewal fund of £1,500, there remains available for dividend £28,296. 10s. 4d., out of which the directors recommend that the full 5 per cent. preference dividend be paid, and that a dividend at the rate of 2 per cent. per annum be paid upon the consolidated ordinary stock for the half-year, leaving £746. 10s. 4d. to be carried forward. During half-year 8,711,062 passengers were carried, against 9,511,450 in the June half last year and 9,877,199 in 1902. The receipts for the same periods were £72,286. 3s. 6d., £78,384. 19s. 9d. and £82,131. 7s. 1d. respectively. The directors, while regretting that the receipts of the line show so large a decrease point out that the receipts in 1902 were abnormally increased owing to the interruption of the South London tramways while under re-construction for electric working, and also to the increased traffic due to the ceremonies in connection with the Coronation. Apart from these abnormal sources of revenue, the general traffic of the line has been maintained, and is slowly but steadily recovering from the competition of the electric tramways. It has been found necessary to reduce the fares over some portion of the line; also to popularise the issue of season tickets both by reducing their cost and issuing them for shorter periods. Negotiations are proceeding with the various railways interested as to the nature of the works and other arrangements in connection with the extension to King's Cross, St. Pancras and Euston.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The directors' report for the year ending June 30, 1903, states that the chief efforts of the directors have been directed towards obtaining a permanent basis for profitable business in the future, and a very considerable further extension of the operations of the company has resulted. This extension has been principally in connection with the equipment of further ships, the coast stations mentioned as available for communication in last year's report having served for a great part of this increased shipping traffic. Preparations have been made for a wireless service on new routes other than the Atlantic, and nine new coast stations have already been equipped, and 14 further are on order. The opening of these stations will, it is thought, result in profitable contracts with lines of ships voyaging on these routes. In particular, mention is made of a contract now practically concluded, relating to the equipment of a whole fleet taking the Mediterranean route. Ships actually equipped since the last general meeting include five of the Hamburg-American Line, which discontinued the use of the German Slaby-Arco apparatus to avail itself of the Marconi system, two North-German Lloyd, four Red Star, four Cunard (on the Boston service), and four Compagnie Generale Transatlantique, making 19. Besides the contract referred to above, now practically completed, other important ship contracts are in negotiation. The stations which have been erected, or are in course of erection by this and the associated companies (which include Lloyd's stations, over which this company has exclusive rights for wireless telegraph purposes for 14

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years from Sept. 26, 1901) number 54. The report contains the names of 47 of the great liners and channel steamers in the Cunard, Norddeutscher Lloyd, Allan, Atlantic Transport, American, Compagnie Transatlantique, Belgian Mail, Red Star, Hamburg-American, and Isle of Man fleets. An arrangement has recently been made with Reuter's Agency for the regular transmission through the company's stations to vessels fitted with the Marconi system of press telegrams giving the latest news, which is then published in newspapers printed on board the vessels. Even at the present time the company is deriving a considerable profit from this business, although the range of transmission has been limited. The report continues: "When the latest and, as will have been noted by the articles in the daily press, highly successful results obtained by Mr. Marconi in his long-distance experiments, are applied to coast stations, and a daily wireless news service can be maintained throughout the Atlantic voyage, this branch of its business will, it is confidently anticipated, prove a very large source of revenue."

The ever-increasing business of the company has necessitated the erection of a new station at Waterloo, near Liverpool, for training operators for ship and shore stations and for the superintendence of the wireless service on vessels running into Liverpool. This station has been working most satisfactorily for some time.

An agreement has recently been concluded with the Government of Newfoundland for the installation of a number of stations on the coasts of Newfoundland and Labrador, which will be begun in the spring. These stations will be available for ships equipped with the Marconi apparatus.

A wireless telegraph conference for the regulation by international legislation of wireless telegraphy for shipping purposes was proposed to the Powers by the German Government in May, 1903, and the conference met in Berlin in August last. The proposal for this conference was (the report continues) a menace to the company's interests, and engaged the serious attention of your directors. As the result of representations to the British Government, they accepted the invitation of the German Government on the condition that the conference should take the form of a preliminary discussion only, and that the delegates should not have power to pledge their Governments to any particular course of action. The conference was, therefore, of a preliminary character, and while the majority of the Powers represented were in the main in favour of intercommunication between all ships equipped with wireless apparatus, irrespective of the system employed, there were two most significant reservations—those of the British Government and of the Italian Government. Having regard to the important part played by these countries in the shipping of the world, and to the shipping routes which they with their colonies command, it is felt that even if the recommendations of the other parties to the preliminary conference should be adopted at a subsequent conference, the effect upon this company's business will not be of great consequence while England and Italy remain outside the arrangement.

Mr. Marconi has been busily engaged throughout the year in perfecting apparatus for long-distance communications, and for the purpose of testing improvements in the apparatus, and as a demonstration to independent persons of its capabilities, in his voyage across the Atlantic in August on board the "Lucania," and in a voyage on H.M.S. "Duncan" to Gibraltar in October, messages were transmitted to the ships throughout their passages. The tests conducted on H.M.S. "Duncan" were watched by Admiralty officers at Poldhu and on board the ship, with the result that, as reported by the Admiralty officials, long-distance messages were sent from the powerful station at Poldhu to H.M.S. "Duncan" in Gibraltar Harbour and throughout her voyage without in any way interfering with short-range Marconi apparatus on other ships of the British Navy. Special interest attaches to the tests on H.M.S. "Duncan" in that, while they were taking place, the magnetic storm of Oct. 31, which caused disturbance of land telegraph and submarine cable systems, was in operation. These disturbances, however, had no prejudicial effect upon the receipt or transmission of the wireless messages. On the "Lucania," on the occasion referred to, news messages were transmitted direct to the ship from Poldhu and Cape Breton throughout her voyage and published on board.

The directors again call attention to their indebtedness to the Government of Italy, "which, after a profound study of our system by its experts, has accorded to Mr. Marconi further special facilities for experiments, and concessions of great commercial value, from which the company, through Mr. Marconi, directly benefits."

Although the accounts for 1902-3 should, in accordance with the articles of association of the company, have been presented in December last, the directors considered it desirable to postpone the general meeting owing to the serious illness of the manager.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

ARMORDUCT MFG. CO. (LTD.)—Reg. Jan. 20, capital £10,000 in £5 shares, to acquire the business of electrical engineers, merchants, agents for and dealers in all kinds of electrical apparatus, appliances and accessories, &c., carried on as Atkinson, Schmahl & Co. and the Armorduct Improved Electric Conduit Co., and to carry on the same and the business of electricians, mechanical engineers, producers and suppliers of electricity, manufacturers of conduits, bare and insulated wires and cables, &c. First directors, W. Schmahl (governing), A. Lynen and A. G. Robson. Reg. office, 6, Farringdon-avenue, London, E.C.

BRECKNELL, MUNRO AND ROGERS (LTD.)—Reg. Jan. 18, capital £30,000 in 2,000 £5 preference shares and 20,000 £1 ordinary shares, to acquire business of electrical and mechanical engineers, founders and brass finishers, carried on at Bristol as Brecknell, Munro and Rogers, to adopt certain agreements and to carry on the said business and that of tool makers, millwrights, machinists, electricians, &c. First directors, H. Brecknell, E. M. Munro and H. I. Rogers (joint managing). Reg. office, Thrissel-street, Bristol.

EDMUNDSON'S FURNISHING AND ENGINEERING CO. (LTD.)—Reg. in Dublin Jan. 9, capital £18,500 in £5 shares, for acquiring the undertaking of Edmundson's Furnishing and Engineering Co. (Ltd.) of Dublin. First directors, J. R. Wigham, J. W. Edmundson and W. R. and B. Wigham. Reg. office, 35, Capel-street, Dublin.

STATUTORY RETURNS.

ARGENTINA ELECTRIC TRACTION CO. (LTD.)—In return to Jan. 1 the capital is £500,000 in 100,000 shares of £5 each. All shares have been taken up, but no calls have been made. No mortgages and charges.

CAPE ELECTRIC TRAMWAYS (LTD.)—The return to Dec. 2 gives capital as £500,000 in 500,000 shares of £1 each, of which 480,000 shares have been taken up. £1 per share has been called up on 80,000 shares, and £80,000 has been received. 400,000 shares are considered as fully paid. No mortgages or charges.

SHERARD COWPER-COLES & CO. (LTD.)—The annual return to Dec. 14 states that the capital is £25,000 in 7,000 preference and 18,000 ordinary shares of £1 each, of which 6,656 preference and 18,000 ordinary shares have been taken up. £1 per share has been called up on 6,656 preference and 500 ordinary shares, and £7,156 received. 17,500 ordinary shares are considered as fully paid. Mortgages and charges, £6,500.

MORTGAGES AND CHARGES.

ELECTRIC TIMBER SEASONING AND PRESERVATION CO. (LTD.)—Five debentures, all dated Jan. 14, 1904, (1) to secure £1,482. 10s., (2) to secure not more than £131, (3) to secure £225, (4) to secure £200, and (5) to secure not more than £374. 15s., all charged on company's undertaking and property, present and future, have been registered. Holders: G. Mathieu, R. B. Weaver and E. H. Stevenson. Satisfaction in full of charge dated July 30, 1903, securing £800, is also notified.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 25 1/16d. per oz. (Jan. 28). Consols 87 1/16—88 1/16 for money, 87 1/8—88 1/16 for account; 2½ per cent. annuities 87⅞—88¼ (Jan. 28). Consols Pay Day, Feb. 3; Stocks and Shares Continuation Days, Feb. 9 and 23; Ticket Days, Feb. 10 and 24; Pay Day, Feb. 11; Mining Share Carry-over Days, Feb. 8 and 22.

BLACKPOOL AND FLEETWOOD TRAMROAD CO. (LTD.)—After providing for interest, there is a balance of £10,677, and a dividend at the rate of 9 per cent. per annum is recommended. £1,500 is added to depreciation reserve, £500 to special reserve, and £1,927 carried forward.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)—The transfer books and register of members will be closed from Feb. 5 to 14, inclusive, preparatory to payment of the dividends on the first and second preference shares for the half-year ended Dec. 31.

BRITISH ELECTRIC TRACTION CO. (LTD.)—Subscriptions at par for £250,000 4½ per cent. second debenture stock have been invited this week.

DEVONPORT AND DISTRICT TRAMWAYS CO.—The shareholders have approved the proposed Devonport and Plymouth Light Railways Order.

DUBLIN UNITED TRAMWAYS CO. (1896), LTD.—The directors' report for the half-year ended Dec. 31, states that the amount available for division is £48,950, and dividends for the half-year at the rate of 6 per cent. per annum on both the preference and ordinary shares is recommended, the latter tax free. £4,000 has been placed to reserve, £2,000 to maintenance during current half-year, and £1,000 to an accident insurance fund. The balance (£6,775. 0s. 2d.) is carried forward.

EAST LONDON RAILWAY CO.—The chairman (the Hon. A. E. Gathorne-Hardy) referred to the question of electric traction at the meeting on Tuesday, and said that the deadlock between the Metropolitan and District and the other leasing still companies continued. All probabilities pointed to the suburban parts of all metropolitan lines being electrically worked before long. If the installation were made, the only benefit it could confer on the companies not using the electrical method of traction would be that they would get their proportion of 44 per cent. of the increased traffic towards their loss on working expenses. He agreed that if they electrified their line and not the East London Railway, the present method of working would really become impossible. He believed the East London Railway would soon be electrified, and he knew that experimental cars had been run over their line by the underground companies to see how they could be worked.

EDINBURGH STREET TRAMWAYS CO.—In the report for the Dec. half-year, reference is made to the agreement with Leith Corporation for the sale of the tramways for £60,000. The Corporation are promoting a provisional order for acquiring and working the tramways, adopting electric traction, &c.

ELECTRICAL ENGINEERING IN ITALY.—The Compagnie d'Electricité Thomson-Houston de la Méditerranée (Milan) and the Italian business of the Allgemeine Elektricitäts Gesellschaft (Berlin) are to be united,

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and a new company, entitled the Allgemeine Electricitäts Gesellschaft Thomson-Houston, has been formed, with an authorised capital of 6,000,000fr. (which will be contributed in equal shares by the two former companies). Senator Fris, formerly president of the Cie d'Electricité Thomson-Houston de la Méditeranée, will be president of the new company, which also acquires the Curtis steam turbine and the Riedler pump patents.

ELEKTRIZITATS-AKTIENGESELLSCHAFT VORM. SCHUCKERT & CO.—The financial year has been altered so as to make the period covered by the accounts the same as that of the Siemens-Schuckertwerke and the Siemens and Halske Aktien Gesellschaft. The report for the four months to July 31 states that the Austrian Schuckert Co. declared a dividend of 7 per cent. for the year ended March; that the Cie Générale d'Electricité de Creil has undergone no material alteration since the last report; the British Schuckert Electric Co. had gone into liquidation in order to unite with Siemens Brothers & Co. (Ltd.); and the Gesellschaft Schuckert & Co., St. Petersburg, has entered into agreements with the Russian Elektrotechnische Werke Siemens and Halske A.G. (St. Petersburg) and the Siemens Schuckert-Werke (Berlin) under which a re-adjustment of the Russian business will be carried out. The Russische Schuckert-Gesellschaft (Mannheim) had declared a 5 per cent. dividend. The total receipts were 767,662m., general management expenses were 98,115m., redemption of bonds 445,000m., interest, &c., 170,180m., taxes 92,051m., and the amount which remained to be written off (19,164m.) having been provided for, the result of the four months' trading was a deficiency of 56,848m. The depreciation and repairs to meet the necessities of the Siemens-Schuckert Werke were 349,351m., and the Government and legal fees in connection with the establishment of the Siemens-Schuckert Werke (295,791m.) had had to be met, the result being a deficiency of 701,990m., which has been covered out of reserve.

GREAT EASTERN RAILWAY CO.—Lord Claud Hamilton, at the meeting on Wednesday, said the directors thought that, though they might earn the applause of the press and the electrical engineering world by rushing into electrical working, it would be a suicidal policy in the transient state of electrical development to embark on any vast capital expenditure which might in a brief period prove to be of little value to the shareholders or to the public. (We would refer Lord Claud Hamilton to the table of electric railways which we publish this week, and the reference to the standardisation of main electric railways in our leading article.—ED. *E.*)

GREAT NORTHERN AND CITY RAILWAY CO.—The directors' report for the half-year ended Dec. 31 states that the railway between Moorgate-street and Finsbury Park is now practically completed, and for some time past a service of trains has been running experimentally almost daily. The line will be opened for public traffic between these two points when the Board of Trade certificate has been obtained. The underground work for the new station at Highbury is well advanced, and the extension from Moorgate-street to Lothbury will be proceeded with as soon as possible. The sanction of the proprietors will be asked for a bill to authorise an extension of time for completing a small portion of the line at the south end of Moorgate-street station. At the conclusion of the Wharncliffe meeting on Feb. 2, a train will be in readiness at Moorgate-street station to run to Finsbury Park and back. Shareholders will be invited to take this opportunity to inspect the undertaking.

LIVERPOOL OVERHEAD RAILWAY CO.—The accounts for the past half-year show an available balance of £10,882, and the directors recommend payment of the 5 per cent. preference dividend and 1½ per cent. on the ordinary shares against 1¼ per cent. on the latter for the corresponding period last year.

LONDON, BRIGHTON AND SOUTH COAST RAILWAY CO.—At the meeting on Wednesday the chairman (Lord Cottesloe) said that existing competition was sufficiently keen, particularly that of rate-aided undertakings, worked perhaps at a loss of which the company had to bear a share, and the question of how best to meet and counteract it was undoubtedly one for the consideration of every board of railway directors. The introduction of some system of electrical working might possibly prove to be one way of dealing with the matter, so far at any rate as suburban and short-distance traffic was concerned, and the board were giving careful consideration to it. But a very large capital outlay would be required even if only a short length of line were equipped, and the rapid advance which was being made almost from day to day in electrical science rendered it at least possible that any system adopted might in a short time become out of date and have to be superseded at a further heavy cost. There was also the question of how to deal with the rolling stock which would become unnecessary if electrical working were adopted.

MANX ELECTRIC RAILWAY CO. (LTD).—At the meeting on Tuesday the report given in our last issue was adopted.

METROPOLITAN RAILWAY CO.—The directors, in their report for half-year ended Dec. 31, recommend a dividend upon ordinary stock at the rate of £3 per cent. per annum and to carry forward £21,294. 5s. 8d. The work of electrification is being proceeded with rapidly by the company's engineering staff. The building of the power station at Neasden is practically completed. The building of the necessary sub-stations and the equipment of the permanent way are proceeding.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO.(LTD.)—The transfer books will be closed from Feb. 3 to Feb. 17 inclusive, preparatory to payment of the dividend for the half-year ended Dec. 31.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—The directors have been authorised to issue £50,000, part of £250,000 debenture stock which the company is empowered to issue under its 1900 Act.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered 150,000 £1 fully-paid 6 per cent. cumulative preference shares of *The Kalgoorlie Electric Power and Lighting Corporation (Ltd.)* to be quoted. The Committee have been asked to grant quotations to a further issue of £45,000 Vancouver Power Debentures of £100 each of the *British Columbia Electric Railway Co.*, and a further issue of £21,979 stirling 500-year 4 per cent. redeemable debenture stock of the *Commercial Cable Co.*

TUBES LIMITED.—At the meeting yesterday (Thursday) the chairman (Mr. Arthur Chamberlain, J.P.) said there was a trading profit on the year of £7,501, against a loss of £26,000 in 1902.

WATERLOO AND CITY RAILWAY CO.—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended Dec. 31, carrying forward £355. The dividend at Dec., 1902, was 3¼ per cent. with £279 forward.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.)—The directors recommend a dividend at the rate of 14 per cent. (less tax) for the half-year ended Dec. 31, payable March 1, making 13½ per cent. for the year.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 23	1,083	+ 320	34	41,991	+ 7,999
Ayr Corporation	,, 16	160	+ 160	26	10,868	+ 142
	,, 23	166	+ 23			
Barnsley	,, 15	141	- 4	2	299	- 86
Bexley District Council	,, 22	123	...	16	2,511	...
Birkenhead	...	...	...	...	...	...
*Birmingham Tramways Co.	,, 23	5,051	+ 559	3	15,119	+ 1,355
*Blackburn Corporation	,, 22	728	+ 99	§43	36,630	+ 1,561
Blackpool Corporation	,, 21	268	+ 9	§42	38,783	- 294
Blackpool and Fleetwood	,, 23	190	+ 27	4	6.0	- 24
Blackp'l, St. Anne's & Lytham	,, 21	143	+ 124	‡12	1,783	+ 1,159
Bolton Corporation	,, 24	1,612	+ 66	43	78,757	+ 8,686
Bournemouth Corporation	,, 20	840	...	3	2,584	+ 209
*Bradford Corporation	,, 24	3,404	+ 544	41	161,243	+ 21,419
Brighton Corporation	,, 24	689	+ 3	42	89,185	+ 2,689
Brisbane Tramways	Dec. 9	2,480	+ 42	23	54,297	+ 891
*Bristol Trams & Carriage	Jan. 22	4,491	+ 374	9	40	+ 2,065
*Buenos Ayres & Belgrano	Dec. 20	5 277	+ 451	10	26	+ 1,774
	,, 27	3,659	+ 369			
Burnley Corporation	Jan. 23	822	+ 178	43	42,644	+ 7,459
Burton Corporation	,, 24	270	...	25	8,845	...
Calcutta Tramways Co.	,, 23	R34,083	+ R3,026	4	R151,145	+ R26,072
Camborne-Redruth	,, 25	101	...	12	7,482	...
Cardiff Corporation	,, 23	1,779	+ 294	43	84,183	+ 21,610
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 28	7,100	+ 324	4	27,802	+ 180
Chatham & Dist. Lt. Rys.	...	...	...	...	...	...
City & South London Rly.	,, 24	3,227	- 140	4	12,791	- 886
Cork Electric Trams Co.	,, 21	398	+ 19	3	1,210	+ 52
Darwen Corporation	,, 22	201	+ 6	43	9,752	- 245
Devonport & Dist. Trams.	,, 15	466	+ 94	2	1,006	+ 135
Dover Corporation	,, 23	162	- 7	‡43	9,682	+ 61
Dublin & Lucan Railway	,, 24	92	+ 8	4	313	+ 19
Dublin Southern District	,, 22	192	+ 22	¶3	2,194	+ 663
Dublin United	,, 22	3,620	+ 125	¶3	11,554	
Dudley—Stourbridge	,, 15	713	+ 83	2	1,481	+ 6
Dundee Corporation	,, 20	761	+ 44	3	2,066	+ 179
East Ham Council	,, 23	561	+ 137	‡43	23,530	+ 7,9 3
Gateshead & Dist. Trams	,, 15	838	+ 117	2	1,811	+ 55
Glasgow Corporation	,, 28	13,374	+ 1,745	34	465,836	+ 49,429
Gravesend—Northfleet	,, 15	206	+ 38	2	428	+ 52
Greenock & Port Glasgow	,, 15	414	+ 88	2	1,013	+ 77
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 15	286	+ 49	2	625	+ 58
Huddersfield	,, 23	1,099	+ 207	3	3,327	+ 525
Hull Corporation	,, 23	1,979	+ 319	‡43	81,670	+ 5,912
Ilkeston Corporation	,, 20	120	...	10	1,196	...
Ipswich Corporation	,, 23	274	...	3	2,620	...
Isle of Thanet Co.	,, 23	198	- 18	...	...	...
Kidderminster & District	,, 15	90	- 2	2	190	- 29
Kirkcaldy Corporation	,, 20	179	...	47	8,476	...
Lanarkshire Trams Co.	,, 21	523	...	3	1,892	...
Leeds Corporation	,, 23	5,(20	...	43	235,420	+ 14,075
Liverpool Corporation	,, 16	9,531	+ 1,046	3	28,849	+ 1,330
*Liverpool Overhead Rly.	,, 24	1,497	+ 43	4	6,227	+ 334
*London County Council	,, 16	9,084	+ 1,966	‡42	412,229	+ 74,245
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 23	10,720	+ 2,(22	32	371,526	+ 176,623
Mersey Railway	,, 23	1,497	+ 403	3	4,342	+ 1,094
Merthyr	,, 15	187	+ 29	2	376	+ 19
Middleton	,, 15	228	+ 14	2	508	- 23
Newcastle-on-Tyne Corp.	,, 23	3,441	+ 526	3	10,351	+ 1,695
Newport (Mon.)	...	...	...	...	...	...
Oldham, Ashton & Hyde	,, 15	471	- 16	2	1,082	- 118
Perth (W. A.) Elec. Trams.	,, 22	1,423	+ 221	3	4,517	+ 683
Peterborough	,, 15	1(8	...	2	235	...
Poole and District	,, 15	220	+ 10	2	467	- 7
Portsmouth Corporation	,, 23	1,282	+ 64	‡43	75,358	+ 4,996
*Potteries	,, 15	1,617	+ 237	2	3,271	+ 21
Reading Corporation	,, 21	518	...	...	...	...
Rothesay	,, 15	36	+ 7	2	119	+ 1
Salford Corporation	,, 25	3,705	+ 884	43	164,283	+ 46,373
Sheerness	,, 18	47	...	2	90	...
Sheffield Corporation	,, 24	4,217	+ 418	4	17,024	+ 1,438
*Southampton Corporat'n	,, 21	815	+ 72	3	2,545	+ 99
Southend Corporation	...	...	...	...	...	...
Southport Tramways	,, 15	229	+ 33	2	505	+ 20
S. Staffordshire Trams.	,, 15	736	+ 141	2	1,478	+ 35
Sunderland Corporation	,, 24	1,024	+ 90	43	52,366	+ 2,526
*Swansea Trams	,, 15	460	+ 5	2	971	- 43
Taunton Trams	,, 15	49	+ 6	2	102	- 5
Tynemouth and District	,, 15	195	+ 26	2	441	+ 8
Tyneside Trams Co.	,, 20	265	+ 85	3	766	+ 198
Wallasey District Council.	,, 28	578	+ 89	‡43	29,572	+ 3,628
Weston-super-Mare	,, 18	20	- 3	2	35	- 13
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 15	318	+ 20	2	651	- 45
Wrexham	,, 15	97	...	2	197	...
Yorkshire Woollen District	,, 15	534	...	2	1,023	...

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Jan. 27.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Jan. 27. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4¾–5	4 17 6	April, Oct	4⅛	4⅛
St.	6%	Do. Permanent 6% Deb. Stock	125 –130	4 12 4	..	..	..
10	10/0	Barcelona Tramways Ord.	7⅛–8¼	5 17 8	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	91 –96	4 14 5	..	..	..
100	5%	Do. 5 per Cent. Debs.	97 –102	4 18 10	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 –3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 –102	4 8 3	..	99	97½
10	8%	Bristol Tramways and Carriage Ord.	20 –21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼–10½	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 –82	3 12 9	..	79½	..
St.	5%	Do. Pref. Ord. Stock	91 –94	5 6 2	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10¼	4 15 3	..	..	..
4[illegible]	4½%	Do. 4½ per Cent. 1st Mort. Debs.	102⅝–104⅞	4 6 7	..	..	..
100	4½	Do. Vancouver Power Debs.	98 –101	4 9 1	..	..	..
10	6/0	British Elec[illegible] Traction Ord.	11½–11⅝	6 16 2	..	11⅝	11⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–11⅝	5 2 2	Feb, Aug	11⅝	11⅜
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –123	4 1 4	..	..	..
5	..	Buenos Ayres and Belgrano Ord.	3 –3½	..	..	3½	3⅜
5	3/0	Do 6 per Cent. "A" Cum Pref.	5½–5¾	5 4 0	..	5⅜	..
5	3/0	Do. "B"	4¾–5¼	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 –107	4 13 6	..	105	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 –101	4 19 6	..	99⅜	..
5	2/6	Calcutta Tramways	6½–7	4 12 10	..	6⅝	6⅝
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 –107	4 4 2	..	107	106½
1	1/0	Cape Electric Tramways Shares	1⅜–1⅞	9 1 4	..	..	..
St.	4%	Central London Ordinary Stock	94 –97	4 4 3	June, Dec	99	94
St.	4%	Do. 4 per Cent. Pref. Stock	98 –101	4 0 4	..	100⅜	99
St.	4%	Do. Deferred Stock	91 –94	4 8 11	..	91	..
100	4%	Do. 4 per Cent. Debs.	113 –116	3 9 0	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf.	4¾–5¼	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	49 –52	6 3 9	Feb, Aug	51	49
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 –129	3 18 7	Feb, Aug	126½	..
St.	5%	Do. (1896)	123 –126	4 0 4	..	..	..
St.	5%	Do. (1901)	120 –125	4 1 1	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 –112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	102 –105	4 16 5	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12½–13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3¾–4¼	6 13 4	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 –97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 –8	3 15 0	..	7⅜	7⅛
10	..	Gt. Northern, Piccadilly & Brompton Ord., Spever Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	Imperial Tramways Ord	20 –21	4 18 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½–14¾	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4⅞–5	2 10 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10½	4 17 7	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	97 –99	4 0 9	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref..	11¼–11⅜	4 5 1	..	11⅜	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 4	..	104⅛	..
St.	..	Mersey Con. Ord. Stock	8 –11	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅛–¼	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	1–1¼	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	103 –105	4 17 1	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	106 –108	4 5 1	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½–2½	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 –102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½–9½	5 5 3	..	9	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 –10	5 0 0	Feb, Aug	9⅜	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 –105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3½%	Waterloo and City Ord.	91 –94	3 9 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 –102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2½–3½	..	Jn, Dec ..	3⅛	3
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	50 –53	6 0 9	F,My,Ag,N	50½	..
St.	30/0	Do. Preferred	95 –97	6 6 2	F,My,Ag,N	96½	95
St.	1/0	Do. Deferred	7⅞–8¼	0 12 6	F,My Ag,N	9⅛	8
100	$2	Commercial Cable Capital Stock	189 –190	4 4 5	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 –92	4 7 0	Jn Ap,Jy,O	91⅛	90¼
10	7/0	Cuba Submarine Ord.	7 –8	10 0 0	Feb, Aug	7⅛	..
10	10/0	Do. Preference 10 per Cent.	16 –17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½–8½	5 17 8	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅞–101⅛	4 9 1	Jan, July	..	..
20	3/0	Direct United States Cable	10 –10½	6 3 10	Ja,Ap,Jy,O	10⅛	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	98 –101	4 9 1	Jn, Dec ..	..	..
St.	20/0	Eastern Ordinary	119 –124	5 12 11	Ja,Ap,Jy,O	121½	120
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 –91	3 16 11	Ja,Ap,Jy,O	90	88
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –108	3 14 1	May, Nov	105½	105
10	2/6	Eastern Extension	10¾–11½	6 4 5	Ja,Ap,Jy,O	11⅛	10⅝
St.	4%	Do. 4 per Cent. Deb. Stock	106 –109	3 14 4	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb.1909	99 –102	3 18 10	Feb, Aug	100⅜	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞–102⅞	3 18 11	May, Nov	..	..
10	5/0	Great Northern of Copenhagen	24 –25	5 0 0	Jan, July	25⅜	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	98 –101	4 9 6	June, Dec	..	..
25	12/6	Indo-European	38 –41	6 1 11	May, Nov	39½	..
100	6%	London Platino-Brazil. 6% Debs., 1904	109 –103	5 19 5	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 –100	4 0 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	5 –6	3 6 8	..	..	..
2½	..	West Coast of America	⅛–¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 –98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜–½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 –6½	9 4 8	May, Nov	6⅛	6
10	..	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	101	..
10	3/0	Western Telegraph	11⅞–12½	5 14 3	Mr,Jn,O,D	12	11⅝
100	5%	* Do. 5% Debs. (2nd Series, 1906)	99 –102	4 18 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 –101	3 19 3	..	99½	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 –5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8¼–8⅝	4 11 5	Ja Ap Jy O	8⅛	8⅛
10	3/0	Do. 6 per Cent. Pref.	12⅛–13	4 12 4	Ja Ap,Jy,O	12⅛	..
5	4/0	Reuter's	6¾–7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	118 –123	4 18 9	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Jan. 27.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Jan. 27. Highest.	Lowest.
		TELEPHONES.		£ s. d.			
5	6/0	Chili Telephone (fully paid)	4¾–5¼	5 14 3	August ..	4¾	..
St.	6%	National Co. Pref. Stock	102 –104	5 18 0	..	103½	102½
St.	5%	Do. Def. Stock	78 –81	6 1 2	..	80	79½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13½–14½	4 2 9	Feb, Aug	..	..
10	6,0	Do. 6 per Cent. Cum. 2nd Pref.	13½–14½	4 2 9	Feb, Aug	14	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref...	5⅛–5⅜	4 13 0	Feb, Aug	5⅜	5⅛
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 –97	3 12 2	June, Dec	96½	95½
St.	4%	Do 4 per Cent. Deb. Stock (red.)	100 –102	3 18 5	..	101½	..
1	0/7½	Oriental	⅞–1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 –1⅛	..	..	..	..
5	3 0	United River Plate	5½–6	5 16 8	July.....	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½–5⅛	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	102 – 105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Greenwich. Dist. Ord.(f.p.)	¾–1	..	..	..	..
1	..	Do. 7% Cum. Pref.	1⅛–1⅜	..	..	1⅛	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	114 –117	3 17 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½–13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9⅛–10¼	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.) ...	101 –104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. &Power 1st Debs.	100 –103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10 –10¼	4 5 9	..	..	..
5	3/6	Do. 7 per Cent. Pref.	9⅞–10¼	3 8 4	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	6 –7	4 12 10	..	6⅛	..
St.	4%	Central Elec. Sup.Co.4% Guar.Db.Stock	106 –109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup...	8¾–9¼	5 8 1	Feb, Aug	9⅛	8⅞
5	2/3	Do. 4½ per Cent. Pref.	4½–6	3 15 0	Feb, Aug	5⅛	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½–5	4 10 0	..	4⅝	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –105	3 16 3	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5½–6	4 3 4	March ..	5⅛	5⅛
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	105 –108	4 3 8	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¼–10⅜	6 19 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	13⅜	13⅛
St.	5%	* Do. 5 per Cent. Deb. Stock (red.).....	121 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	8 –9	4 8 11	..	8⅜	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 1 10	..	109	..
St.	27,6%	Do. Second Deb. Stock Prov. Certs..	99 –102	..	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5⅛–6	4 3 4	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 –103	4 7 5	..	..	..
10	..	Havana Electricity Co. Shares (£8 paid)	7½–8½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	11 –12	4 3 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St.	4%	Kensington. & Kngtbg.Co.&Notting Hill Co. (Joint Station) 4% Deb. Stck.(red.)	102 –105	3 16 9	..	..	..
5	..	London Electric Supply Ord.	1⅞–2⅛	..	..	..	..
5	2/0	Do. 6 per Cent Pref.	5½–6	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 –98	4 2 1	Mr,Jn,S,D	97	96
10	8 0	Metropolitan Electric Sup. Ord.	17 –18	4 6 1	April, Oct	17⅛	17
5	..	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅜	..	..	5⅛	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	3 19 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –98	3 11 4	..	94⅛	..
100	4%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 –98	4 11 9	..	..	..
1	6 0	Notting Hill Electric Ord.	12½–13½	4 8 11	March....	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5½–5¾	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 –102	3 18 5	..	..	..
1	..	Rand Electric	⅜–½	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 –102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½–15½	4 13 9	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	93 –101	3 10 4	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord...	3 –3½	3 11 5	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	..	..
1	1/9	South London Electric Supply Ord.....	3½ - 4	4 7 6	..	3⅜	3⅛
5	2/6	Urban Electric Supply Ord.	4½ 5½	4 17 7	..	4½	..
5	2,6	Do. 5% Cum. Pref.	4½–5¾	4 17 7	..	4⅝	..
5	6/6	Westminster Electric Supply Ord.	12½–13½	4 16 4	Mar, Sept	13½	12⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –6¼	3 16 11	..	6½	6⅛
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref...	½–⅝	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅝–¾	..	Mar, Sept	..	..
5	4,0	British Insulated & Helsby Cables Ord.	6 –6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5½–5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	103 –105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	4½–4¾	6 6 4	..	4⅝	4⅝
St.	4%	Do. 4 per Cent. Mort. Deb. Stock ...	93 –96	4 3 4	..	97½	93
2	..	Brush Electrical Engineering	⅞–1⅛	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼–1⅜	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –100	4 10 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	75 – 80	5 12 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord. ...	10½–11½	6 10 5	Jan, July	11½	11⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5¾	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	104 –108	4 3 8	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅜–½	6 17 2	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. (red.)	90 –95	4 15 3	..	..	..
1	0,7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March ..	..	..
8	1/6	Crompton and Co. (Nos. 1 to 54,000) ...	1½ –2	7 10 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	97⅞–100⅝	5 0 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8½–8¾	..	..	..	..
5	..	Do. 6% Cum. Pref.	5½–5¾	..	..	5⅝	5⅛
St.	4½%	Do. 4½% Deb. Stock	103–105	4 5 9	..	..	..
5	..	Edison & Swan United("A"sh.)(£3 pd.)	¾	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½–1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 –77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 –81	6 3 5	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜–6⅛	5 12 0	H'lf-yearly	6⅛	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅝–6¼	4 16 0	..	6⅜	5⅝
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 –106	4 4 11	..	..	..
2	1/2½	Electric Construction Co.	1⅝–1⅞	6 8 0	Jan, July	..	..
2	2 9⅜	Do. 7 per Cent. Cum. Pref.	2½–3	4 13 4	July	2⅜	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅛–¼	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	½–1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	9½ –10	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 –98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	13 –14	7 2 10	Feb, Aug	14⅛	13⅛
5	2/3	Do. 4½ per Cent. Pref.	5 –5¼	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 –112	4 0 9	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 –19	5 5 3	Feb, Aug	18⅞	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 –103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10⅜–11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	83 –86	6 13 4	Mar, July	35	33½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909.....	100 –103	3 17 8	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	4 –6	6 10 0	Apr, Oct	..	..
5	3,0	Do. 6 per Cent. Cum. Pref.	5⅜–6	5 0 0	Apr, Oct	5⅜	5⅜
St.	4%	Do. 4 per Cent. 1st Mort. Debs.....	98 –102	3 18 5	May, Nov	100⅛	..

*In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote the se...

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NOTES.

ALTHOUGH no measures of electrical interest were announced in the KING'S Speech on Tuesday, we must hope that the Government may nevertheless endeavour to pass one or two Acts effecting the much-needed revision in electrical legislation. A modification in the powers of Local Authorities to oppose and obstruct electric lighting and traction Bills, involving an abolition of the present power of veto, is much needed, and the Light Railways Act has still to be placed on a firm and correct basis. Another Bill which we should welcome this session would be one relating to the purchase of the country's telephone system by the Government. Under the National Telephone Co.'s licence, the Government has power to purchase the company's system at a valuation at the end of this year. In view however, of the recent speech by the Chancellor of the Exchequer, Mr. AUSTEN CHAMBERLAIN, in which he emphasised the necessity of national retrenchment, we can hardly expect this satisfactory solution of the telephone question at present.

WHATEVER may be the explanation of the non-success of the efforts of English and German physicists to repeat Prof. BLONDLOT'S N-ray experiments, there is no doubt that the discoverer himself is thoroughly satisfied with regard to their separate identity, and that he is, in conjunction with other French physicists, adding fresh experimental material week by week. In a Paper read before the French Academy of Sciences, an abstract of which appears in Mr. FOURNIER D'ALBE'S notes this week, he makes the remarkable announcement that he has definitely succeeded in measuring the wave-length of the new rays, both by diffraction and by the method of NEWTON'S rings, and that the wave is so extremely short that about 100,000 of them go to the millimetre. He claims to have found a whole line spectrum of the new rays, extending over about an octave. The most surprising thing about the rays is that with so short a wave-length they should have the high penetrative power, which not only enables them to penetrate air, but even wood and aluminium. The anxiety of physicists to have some confirmation of these sensational announcements outside Nancy is naturally enhanced by the far-reaching character of the latest details, which, we must admit, bear the impress of careful and conscientious work.

AN entertaining discussion followed the reading of Mr. W. G. BOND'S Paper on the rating of tramways last week. Although the meeting at which the Paper was read was poorly attended, two supporters of the present system of rating were present, and gave us the opportunity of hearing all there was to say in favour of a method of rating based on a purely imaginative foundation. As our readers will have learned from the Paper, which we published in our last issue, the method of rating a tramway undertaking owned by a company is based on the hypothesis that the company does not own it. It is imagined, for the purpose of arriving at the rateable value, that the company is a tenant renting its undertaking from a supposititious landlord, and the problem is to arrive at a sum to represent the rent that the hypothetical tenant would pay to the supposititious landlord. Moreover, as the Act upon which this ingenious system is based was evolved in the time of good Queen BESS, when it was chiefly land that was let on lease by landlords to tenants, this further complicates the matter and necessitates delicate adjustments before the imaginary rent can be arrived at.

THE rating experts who were present at the meeting could not adduce any arguments that carried weight in favour of the "hypothetical-tenant" system of rating. They discussed

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seriously and earnestly, however, whether certain charges could rightly be deemed to be paid by the "tenant" or the "landlord," and when it is remembered that annual sums aggregating several thousands of pounds change hands in accordance with the solution of such abstract problems as these, it is evident that the law relating to local taxation has need of a firmer and more definite basis. About a year ago, a Royal Commission, after tying itself into the knot which over-indulgence in these mental calisthenics must inevitably produce, came to the conclusion that an alteration of some nature was necessary; but, although some improvement would be effected if their mild suggestions with regard to valuations and rating appeals were acted upon, something far more drastic is required. We cannot but agree with Mr. BOND that the true basis of assessment should be that of income, and as the assessment of income is already made once by a Government Department for the purpose of income tax, it should be unnecessary to make a new assessment of a more elastic nature for the purpose of local taxation.

WHATEVER support the new University of Liverpool receives from outside sources, it is, at any rate, receiving substantial encouragement from the citizens of that city. On a recommendation by the Finance Committee, which came before the Liverpool City Council on Wednesday, it was unanimously decided to grant a sum of £10,000 during 1904 to the new University. This grant will be paid out of the rates, and it is anticipated that it will be more than met by the addition of 1d. in the £. Moreover, it is hoped that the subsidy will not be simply for the present year, but that the contribution will be made an annual one. There are, rightly, certain conditions imposed, one of them being that the Council shall have the right, from time to time, to nominate some person to make an inspection of the work of the University and report upon the educational methods employed, with a view to ascertaining how far such methods are in the interests of the city. It is also stipulated that the University shall make an annual report to the City Council of its work, and that of the sum of £10,000 not less than £1,000 shall be devoted to Liverpool scholarships, including the assistance of undergraduates and post-graduates. These conditions appear very reasonable, and both the City of Liverpool and the University are to be congratulated—the former on recognising so speedily the true value conveyed by the possession of a University, and the latter on securing such hearty co-operation and valuable support at the beginning of its career.

WE have consistently advised those responsible for the management of municipal electricity undertakings to set aside depreciation or renewal funds in addition to the payments to sinking fund which they are bound to make annually. This is of especial importance in the case of the London municipal electricity works in which the loans have been granted for a much longer period than is now allowed by the Local Government Board. We are, therefore, glad to observe that the London County Council has recently been calling the attention of metropolitan electricity committees to this matter. A note with regard to the receipt of such a communication by the Islington Borough Council will be found in another column of this issue.

ON another page of this issue will be found the first half of the report issued by the Departmental Committee appointed to deliberate upon the use of electricity in mines, and whose proceedings have been reported from time to time in *The Electrician*. Owing to great pressure on our space, it has been found necessary to publish an abstract of this lengthy report in two instalments, the second of which will appear next week. The conclusions which the Committee have arrived at are just what one might have expected after having studied the evidence which was given. Emphasis is laid on the necessity of having competent persons to superintend the working of electrical plant in mines, and it would not be surprising if the Board of Trade required persons in charge of such installations to pass certain examinations or give other proof of competency, such as is the practice in connection with marine engineering. The Committee find that the use of electricity will not tend to increase the existing dangers attendant upon labour in coal mines, but will rather have the reverse effect.

THE present financial position of the electrical undertakings owned and worked by the Barking Urban District Council is not by any means a satisfactory one. At a recent Council meeting, the accountant reported that the electric lighting revenue was overdrawn, on January 8th last, to the extent of £2,337, and that the light railway revenue account was also overdrawn to the extent of £434. The introduction of halfpenny fares produced a revenue of only 5s. to 6s. per day, and, although no fewer than 71,373 passengers were carried during December, the total receipts only reached £177. The working expenses in connection with the line have been, for a considerable time, just about double the revenue. As an attempt to make matters appear better than they really are, the Council hit upon the idea of carrying the deficit upon the electricity undertaking to a Suspense Account, so that it could be met by possible future profits, but they have been surcharged, and an appeal from this decision to the Local Government Board has been unsuccessful. So serious do the Council consider the state of affairs that they are reported to be considering the advisability of disposing of the two undertakings, and tenders will, doubtless, be duly invited. In the circumstances, this is unquestionably the wisest policy to pursue, and it is to be hoped that better results will be obtained when the undertakings are worked by private enterprise.

The Junior Institution of Engineers.—The annual dinner of the Junior Institution of Engineers will be held on Saturday, February 13th, in the Victoria Hall of the Hotel Cecil, at 6:30 for 7 p.m.

The Rugby Engineering Society.—At a meeting of the Rugby Engineering Society held at the Lower School, Clifton-road, Rugby, yesterday a Paper was read by Messrs. G. A. Neild and P. E. Banting, on "Commutation of Continuous-Current Generators and Motors."

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Torquay Tramways.—As a condition to their consent to the Dolter Electric Traction Co. installing and working a system of surface contact tramways (*The Electrician*, Vol. L., p. 192) at Torquay, the Corporation have stipulated that the following "electrolysis clause" be inserted in the Bill:—"If at any time it be proved that any injury or damage to any mains, pipes or apparatus of the Corporation shall have resulted from the use of electric current on any of the tramways authorised by this act, nothing in this act shall relieve the company from liability to make compensation for such injury or damage."

International Electrical Congress at St. Louis.—The State Department at Washington, in response to solicitation from the Director of Congresses at St. Louis, and the President of the American Institute of Electrical Engineers, as well as the Committee of Organisation of the Congress, has issued instructions to the American diplomatic officers abroad that they shall invite the various foreign governments to appoint official delegates to the International Electrical Congress of St. Louis in September, 1904. The number of delegates requested to be appointed by each country is in conformity with the precedents established at the Chicago Congress of 1893 and at the Paris Congress of 1900.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
Paramaribo—Cayenne	Feb. 27, 1903 ..	Jan. 28, 1904
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Oran—Tangier	Feb. 3, 1904 ..	—

Opening of the Newbury Electricity Works.—The small works at Newbury (Bucks) which have been erected by the Urban Electric Supply Co., were opened on Wednesday last week. The Corporation obtained a provisional electric lighting order in 1901, and transferred it to the Urban Electric Supply Co. Water power from an old mill is used to drive three Parker dynamos. The station also contains a 250-cell Tudor battery, having a capacity of 1,000 ampere-hours, and a Parker balancer and booster. The cables are Callender's, armoured and laid solid. Supply is given on a 2 × 240 volt continuous-current system at 7d. per unit for the first hour and 3d. afterwards. Mr. H. W. Bax is the resident engineer, and Messrs. Edmundson's Electricity Corporation designed the works.

Government Grants to University Colleges.—A blue book has just been issued by the Board of Education containing reports from the university colleges which participated in the annual Government grant during 1903. These colleges, together with the amounts received by them, are as follows:—University of Birmingham, £4,700; Bristol University College, £1,200; Dundee University College, £2,065; Yorkshire College, Leeds, £2,225; Liverpool University College, £3,000; Bedford College, London, £1,200; King's College, London, £2,275: University College, London, £3,000; Owens College, Manchester, £3,500; Durham College of Science, Newcastle-upon-Tyne, £2,100; Nottingham University College, £1,700; Reading University College, £500; Sheffield University College, £1,300; Hartley University College, Southampton, £1,000; University College of Wales, Aberystwyth, £4,000; University College of North Wales, Bangor, £4,000; University College of South Wales and Monmouthshire, Cardiff, £4,000.

Tramways and Light Railways Association.—The annual general meeting of the Tramways and Light Railways Association took place yesterday afternoon at the Society of Arts. The first business was the election of new members of council, in place of those retiring under the articles of association. There were six vacancies, and the following gentlemen were elected: Messrs. A. Baker, C. E. Baker, W. Worby Beaumont, A. N. Connett, James Devonshire and J. Barber Glenn. Sir Charles Rivers Wilson, K.C.M.G., past president, who was in the chair, then announced that the council had selected as chairman for the ensuing year Mr. A. Baker, late tramways manager to the London County Council, and now occupying a similar position in the Birmingham Corporation; he then called upon Mr. Baker to at once take up his duties. Mr. A. Baker took the chair and delivered a short address in which he enlarged upon the general usefulness of electric tramways from all points of view. He hoped that the selection of himself, a municipal representative, would lead to a consolidation of all tramway interests, whether municipal or private. The extension of electric traction was well exemplified by the Board of Trade returns which had recently been issued, the increases applying to both company and municipal tramways.

Electrical Equipment of the Chilian Battleship "Libertad."—In a lengthy illustrated article describing this new engine of war *Engineering* states that the electrical equipment is arranged on a more elaborate scale than that usually adopted in British ships, and the use of incandescent lamps throughout the vessel is most complete. The total number of lamps is about 1,000, generally of 16 c.p., with 50 c.p. lamps in clusters on the yard-arms, and lamps of 50 c.p. for the coal bunkers. There are five dynamos in the vessel, each of 500 amperes at 100 volts, when running at 400 revolutions, together with the necessary engines, these dynamos being all coupled up to the switchboard by specially insulated cables. The switchboard is suitable for parallel running, is capable of dealing with the total number of dynamos and circuits required, and is fitted in a position adjacent to the dynamos, easily accessible and convenient as regards manipulation of switches and other necessary work at the switchboard. The circuits are distributed to gunmetal section boxes, which boxes feed the water-tight distributing or cut-out boxes, from which the lamps are controlled. In addition to the above there is a rotary transformer, the whole being arranged so that the complete electrical equipment is entirely under the manipulation of one engineer. Five powerful searchlights of a special pattern are fitted, and generally arranged so that they can be withdrawn into cover during action or stress of weather. All the projectors are provided with automatic-feed lamps and mirrors on the Mangin principle. In addition to the electric-lighting plant, named above, there are about 70 electric motors in the vessel, generally for ventilating purposes; but electric ammunition hoists are also arranged for the 7½in. guns, and, wherever suitable, electrical power has been applied so as to reduce, as far as possible, manual labour on board.

Radium.—A Reuter telegram from Vienna announces that Prof. Eussenbauer has discovered that the application of radium in certain cases of constriction of the œsophagus when caused by cancer will partially disintegrate the malignant growth and bring about an enlargement of the gullet. Prof. Eussenbauer's method of operation consisted in placing in the lower end of a bougie pipe a rubber capsule containing 60 milligrammes of radium, and applying the pipe to the part affected, holding it there for some time. The professor found that the radium rays brought about decomposition of the ulcerous growth, thus enlarging the gullet and enabling the patient to take food in the ordinary way. This treatment obviates the necessity for an operation for the introduction of food directly into the stomach.——According to a Dalziel telegram from Paris, an extensive deposit of uranium, from which radium is obtained, has been located near Autun, in the mountains of Morvan, in an old quarry. M. Curie, together with other scientists, is shortly to pay a visit to the quarry and test the value of the discovery. ——At the annual meeting of the Manchester and Salford Hospital for Skin Diseases, which took place on Tuesday, the committee stated in their report that, "In the 'Light' department the results have been most satisfactory.—A number of cases of lupus and other tuberculous affections of the skin, which have hitherto defied treatment, have been discharged cured; but in no condition is the success more marked than in the treatment of rodent ulcer—a slow-growing form of superficial cancer, which was previously, in many cases, inoperable and beyond medical relief. In addition to the new and very effective Finsen-Reyn lamp (a smaller modification of the original Finsen lamp), we

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have recently begun to work with radium, which has been found to influence some of those varieties of cancer which have been but slightly affected by the Röntgen rays."

Effect of Violet Rays on Flowers.—Dr. J. Weir, in an article in the *Scientific American*, describes a destructive effect upon flowers which, he asserts, is produced by the action of violet light. Poppies cut in daylight immediately commenced to wither, but if shielded by a screen of red or orange material this did not occur. The most noteworthy phenomena in the effects of the violet and ultra-violet rays on the poppy were their immunising properties. A poppy which, after being subjected to the light, withered and was then cured by being shielded, remained unaffected when placed even in the direct rays of the sun. An analogous process is seen in the effect of the violet and ultra-violet rays on the skin. The first exposure of those portions of the body ordinarily covered by clothing to those rays will result in destructive changes, blisters, &c., making their appearance with subsequent desquamation. But a second exposure produces little or no changes; the skin has become immune. This fact of immunisation accounts for some of Finsen's seeming failures, if it does not account for all of them. In certain of his experiments he must have made his exposures too brief; he succeeded in getting only the immunising effect of the rays, the exposures being too short to induce or achieve a lethal or deathly effect. Microscopic examination shows that these rays produce marked physical changes in the cut stem, foliage and flower. A section of the stem examined immediately after the blossom is cut shows that the effect on cell life is instantaneous; the cell at once begins to shrink and the protoplasm to collect around the nucleus. Circulation is interfered with, and this interference progresses as the blossom withers until there is no circulation in the veins and capillaries after two or three hours. Cell movement also ceases, and the entire structure presents every appearance of death.

Engineering Standards Committee.—We are informed that the electrical conference which was convened by the sub-committee of the Engineering Standards Committee on generators, motors and transformers took place at the Institution of Civil Engineers on Tuesday and Wednesday, January 26th and 27th, and was extremely well attended. Amongst those who accepted the Committee's invitation to attend were the following:—

A. P. Trotter, G. L. A. Addenbrooke, Charles H. Merz, Leonard Madgen, Robert Robertson, A. A. Campbell Swinton, A. S. Esslemont, Bernard Jenkin, A. M. Sillar, Philip Dawson, Malcolm MacLaren (British Westinghouse Co.), H. Scholey (Dick, Kerr & Co.), Mark Robinson, E. Parry (representing Mr. H. F. Parshall), J. P. Gregory and J. S. Conover (British Thomson-Houston Co.), Hon. C. A. Parsons and Gerald Stoney (Messrs. C. A. Parsons & Co., Ltd.), Henry Mavor (Mavor and Coulson), Stuart Russell (India Rubber, Gutta Percha and Telegraph Co.), W. Scott (Laurence, Scott & Co.), E. S. W. Moore (Electric Construction Co.), J. Eck (Union Electric Co.), H. St. Hill Mawdsley and H. N. Hickley (Newton Electrical Works), A. C. Eborall (Witting and Eborall), J. J. Steinitz (Brush Electrical Engineering Co.), H. Fox (Morley Electrical Engineering Co.), W. B. Esson (Johnson and Phillips), A. F. Berry (British Electric Transformer Co.), Herbert A. Jones and F. Oelschlager (Phœnix Dynamo Co.), H. Northcote (Veritys Limited), S. L. Brunton and K. A. Scott Moncrieff (Crompton & Co.), W. Walter (Clark, Chapman, Ltd.), C. H. Iles (Messrs. Thomas Parker, Ltd.), F. Hird (Siemens Brothers).

A list of questions had, previous to the conference, been drafted and circulated to those gentlemen who proposed to attend the conference in order that they might be more exactly informed as to the precise matters to be discussed. In his short opening address, the chairman (Col. R. E. Crompton, C.B) referred to the opinions which had been expressed on the recommendation of the Engineering Standards Committee with reference to standard frequencies, and he remarked that the Committee had, for this and other reasons, decided upon holding this conference. An animated discussion took place upon the different matters referred to in the list of questions before the meeting, which did not break up till late in the afternoon of the first day. On the second day the several problems arising out of the Committee's proposals for standardising motor carcases and speeds were dealt with at length. The Committee will consider carefully all the different points raised by the several witnesses present and report at an early date.

St. Louis Exhibition.—The lighting of the cascades and colonnades, forming the most spectacular lighting feature of the exhibition, is worthy of attention, and a brief outline of the method to be used is given below. The fundamental conception of this lighting scheme involves the use of three sets of lights—white, amethyst and emerald—the use of the Cooper-Hewitt mercury vapour lamp and of searchlights installed upon the Education and Electricity buildings, the whole being under the absolute control of a single operator. In placing the lamp sockets on the colonnade and pavilions terminating the same, a triple socket was used in each case, each socket containing a white, amethyst and emerald 8 c.p. lamp. The wiring was done on a triple three-phase system using a common neutral—that is, the feeders from a three-phase system supply the light for all the plain white lamps so disposed that the system is balanced; the neutral for this set is also the neutral of a similar set of three-phase feeders supplying all the emerald lamps, while a third set supplies the current for the amethyst lamps, using the same neutral as the other two. This involves the use of 10 feed wires, and at first sight it would seem rather complicated, but the ease with which the different circuits can be controlled and the possibilities of the lighting effects that can be secured more than compensate for the seeming complication. By means of dimmers placed in each of the three circuits, they are under the control of the operator, whose duty it is to carry the lighting effects through definite and predetermined programmes, which will be given on certain nights. The Cooper-Hewitt lamps will be installed under the lips of the various spills of the three cascades, and when in operation their phosphorescent light will be imparted to the great volume of water, causing it to resemble a deluge of molten metal. The one exception to this triple lighting scheme is Festival Hall, the lights on which will always be white. The great dome, rising over 200ft. above the grand basin, will be surmounted with several rows of incandescent lamps placed as close together as possible, while the ribs will be marked with lamps placed on 6in. centres. The cornice lines and entrances will be outlined in a similar manner. No rheostats will be used, and this, the central feature of the exposition, will stand out at all times in dazzling white. The searchlights along the roofs of the Electricity and Education buildings will also be thrown upon the cascades, and the Cooper-Hewitt circuit broken.

Notes on Dielectric Losses.—In *The Electrician*, Vol. XLVII., p. 412, some data on dielectric losses in electrostatic condensers, experimentally determined by Mr. C. P. Steinmetz, were published. Dr. Paul Holitscher, in a recent contribution to the *Elektrotechnische Zeitschrift*, communicates the results of measurements on dielectric hysteresis in the micanite tubes used for insulating the conductors in high-voltage machines. The dielectric losses between the magnet frame (which was earthed) and the armature copper of a 10,000-volt 500 H.P. three-phase synchronous motor were first determined. At a constant frequency of 53·3 ~ per sec. the losses given in Table I. were observed, and it will be noticed that the increase is—for the higher pressures—approximately proportional to the third power of the voltage. The capacities, derived from the measurements with the aid of the transformer diagram, are also given in the table, and it will be seen that they increase with the pressure:—

Table I.

Secondary of Testing Transformer.		Dielectric losses. Watts.	Capacity. Mfd.
Volts.	Amps.		
9,900	0·115	354	0·0365
13,150	0·174	785	0·04283
15,180	0·213	1,265	0·0458
18,000	0·293	2,290	0·0538
20,050	0·365	3,470	0·0616
21,550	0·43	4,860	0·0700

When the machine is in service, the neutral point of the phases is connected to the frame, and only the extreme end of each winding has, therefore, the maximum potential of 5,770 volts. If, from about 6,000 volts downwards, the dielectric losses are assumed to be proportional to the square of the pressure, the lost energy through dielectric hysteresis will amount in the above case to 40 watts—*i.e.*, 0·013 per cent. of the full load

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output. Some results obtained with a second machine, designed for 400kw. at 10,000 volts, are tabulated below (Tables II. and III.):—

Table II.

Frequency per sec.	Secondary of Testing Transformer. Volts.	Amps.	Dielectric losses. Watts.	Capacity. Mfd.
40	15,500	0·101	572	0·0282
45	15,500	0·114	648	0·0281
50	15,500	0·127	726	0·0280
55	15,500	0·135	767	0·0272
60	15,500	0·147	820	0·0270
65	15,500	0·155	880	0·0265

Table III. (50 ~ per sec.)

Impressed volts.	Dielectric losses. Watts.	Capacity. Mfd.
12,000	290	0·0213
15,500	726	0·0280
19,200	1,145	0·0332

To complete the tests, the insulation resistance of the second machine was measured and found to be 21 megohms. At a voltage of 15,500 volts, therefore, the C^2R losses ($R = 21$ megohms) would be about 12 watts, which does not materially affect the result of the tests.

Rights, Duties and Liabilities of Electrical Contractors.—At a meeting of the London Electrical Contractors' Association on Wednesday, Mr. R. Tweedy Smith, the honorary solicitor, read a Paper on the above subject. A large number of invitations had been issued to consulting engineers and central station engineers, but the attendance was disappointing. The Paper gave a good deal of history. Dealing with the Electric Lighting Acts, the author stated that the Board of Trade kept seven different sets of regulations, which were all substantially the same. These applied as follows:—(1) Local Authorities—Provinces; (2) Companies—Provinces; (3) Companies—London; (4) Local Authorities—London; (5) Local Authorities—both London and Provinces in case of orders granted in 1883; (6) Local Authorities—Provinces—Licence; (7) Companies—Provinces—Licence. Great confusion, however, had been caused by the issue by undertakers of so-called rules or conditions of supply. These rules were usually printed over the names or signatures of the undertaker's engineer or the manager or secretary of a company, or sometimes over the name of the company itself, according to the particular idiosyncrasy of the person concerned. Such rules had no legal sanction whatever, except in so far as they might happen to contain the regulations of the Board of Trade. Some of such rules were very misleading, and some undertakers attempted to take upon themselves autocratic powers, and to represent such rules and conditions as obligatory when such was not the case at all. Several instances were given of such arbitrary rules, special reference being made to the Hampstead, Stepney and Woolwich Borough Councils. But where contractors thought they were being improperly dealt with, there were several courses open to them to pursue. By sec. 70 of the Schedule to the Electric Lighting (Clauses) Act of 1899 the undertakers were bound "to supply to any person demanding them, at a price not exceeding 6d. for each copy, the Board of Trade Regulations (not the undertaker's regulations) for the time being in force" in the district. There was a penalty of not exceeding £5, and also a daily penalty not exceeding £5, upon undertakers not supplying such regulations. By applying for a copy of such regulations the contractor was then in a position to make sure there were no special regulations for the district, which, however, was very seldom the case. The contractor's next step was to apply to the undertakers to state the reasons for their declining to make a connection, and by the Board of Trade Regulations (No. 41) the undertakers were bound "to serve upon the consumer a notice stating their reasons for so declining." A notice stating that the installation was defective, without giving reasons, was not sufficient. If no notice was taken by the undertakers, and no supply was forthcoming, steps could then be taken, either under sec. 30 of the Act of 1899, and which imposed a penalty of 40s. for each day on which the default occurs, or proceedings could be taken under sec. 19 of the Act of 1882. The want of uniformity in supply contracts was then touched upon, and the suggestion was made that it would be very advisable that the association should adopt a form of application and contract to be used throughout the country. The attitude of the London electrical contractors in the matter of free wiring by municipalities was next dealt with, it being now well known that no opposition is made where provision is included in such bills that the work shall be put out to contract. The final point made by Mr. Tweedy Smith was in respect to Workmen's Compensation, in connection with which he thought it possible that an argument could be brought forward successfully to prove that an electrical contract or did not come within the provisions of the Act. The definition of the Act was as follows:—Employment "in or about any building which exceeds 30ft. in height, and is either being constructed or repaired by means of a scaffolding, or being demolished, or on which machinery driven by steam, water or other mechanical power is being used for the purpose of the construction, repair or demolition thereof." In the discussion which followed the reading of the Paper, a few station engineers spoke first. Mr. Cottam (Hampstead), Mr. Boot (Tunbridge Wells) and Mr. Hesketh (Folkestone) all objected to the tone of the Paper as being directed against supply station engineers. They insisted that their sole object was not to tyrannise over the contractor, but to eliminate the "jerry" wireman, several examples of whose work each had had to contend with. Mr. Cottam thought the association had pursued a wrong policy in absolutely opposing free wiring by municipalities. They had been the cause of much work being stopped in Hampstead, and if they had stipulated at the commencement, as they did now, that the work should be given to contractors, they would have benefited themselves considerably. In reply to these criticisms several contractors repudiated the suggestion that they were antagonistic to the supply station men, their aim being to introduce uniformity into the various regulations under which they had to work, both on the part of municipalities and the fire offices.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, February 6th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

10 a.m. Visit to the Baker Street and Waterloo Railway Works. Meet at Messrs. Mowlem's works, Lambeth-road, S.E.

TUESDAY, February 9th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street, Glasgow. Paper to be read: "Should Electric Supply Undertakings Hire Motors," by S. E. Britton.

WEDNESDAY, February 10th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, S.W. Paper to be read: "On Small Private Installations," by H. Purle.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. Meeting at the Royal Institution, Liverpool. Paper to be read: "Electric Transmission from Water Powers," by E. K. Scott.

THURSDAY, February 11th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "Transatlantic Engineering Schools and Engineering," by Dr. R. Mullineux Walmesley.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting at the Royal College of Science. Paper to be read: "The Steam Turbine," by F. C. Porte.

FRIDAY, February 12th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, South Kensington, when Dr. R. T. Glazebrook, F.R.S., President, will deliver an address.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, S.W. Paper to be read: "The Electricity and Destructor Station at Plumstead," by T. S. Nash.

SATURDAY, February 13th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at Edinburgh. Paper to be read: "Coal-cutting Machinery," by Mr. Giorgi. In the afternoon a visit will be paid to Messrs. Bruce Peebles & Co.'s works.

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NOTES ON THE CURTIS TURBINE.

In a Paper on the Curtis turbine read by Mr. F. Samuelson before the Rugby Engineering Society last November, but only just available for publication, the author described the new machine at considerable length. A description of the turbine, similar to that contained in the Paper, was published on p. 160 of *The Electrician* for November 20, 1903, and need not be repeated. In the remainder of his Paper, Mr. Samuelson referred to

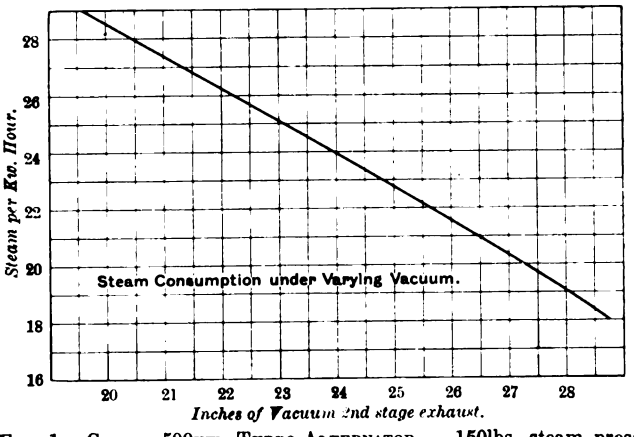

FIG. 1.—CURTIS 500KW. TURBO-ALTERNATOR. 150lbs. steam pressure, 115°F. superheat, 30in. barometer, 1,800 revs. per min., load 660kw.

various curves showing the effect of different degrees of vacuum and expansion upon the steam consumption.

Turning to Fig. 1, he said the curve was plotted from the tests made on a 500kw. turbo-generator in the B.T.-H. Co.'s power house, and showed very clearly the enormous gain in economy with a high vacuum. No difficulties were encountered in obtaining a high vacuum. The outfit consisted of an ordinary horizontal surface condenser with a cooling surface of 1,500 sq. ft., a twin Edwards' air pump and a centrifugal pump for the circulating water. The pumps were motor driven, and the power taken by the air pumps was 1·8kw., and by the circulating pump 7·1kw. at a load of 470kw., representing 1·9 per cent. of the output of the turbine.

higher superheated steam for the turbine, but from tests made elsewhere on a Curtis turbine of the same output, the tendencies of the curve were shown to continue to about 300°F. superheat. Superheating improved the real thermal efficiency, or, in other words, reduced the coal bill. The probable reasons were the increased steam volume, and owing to the steam being less wet after the expansion, the friction in the buckets was considerably reduced.

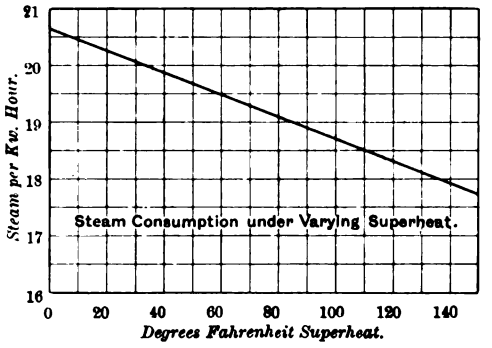

FIG. 2.—CURTIS 500KW. TURBO-ALTERNATOR. 150lbs. steam pressure 30in. barometer, 28·5in. vacuum, 1,800 revs. per min., load 660kw.

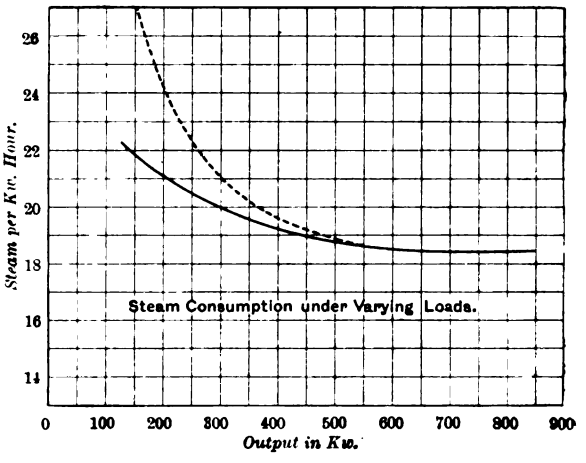

FIG. 3.—CURTIS 500KW. TURBO-ALTERNATOR. 150lbs. steam pressure, 115°F. superheat, 28·5in. vacuum, 30in. barometer, 1,800 revs. per min.

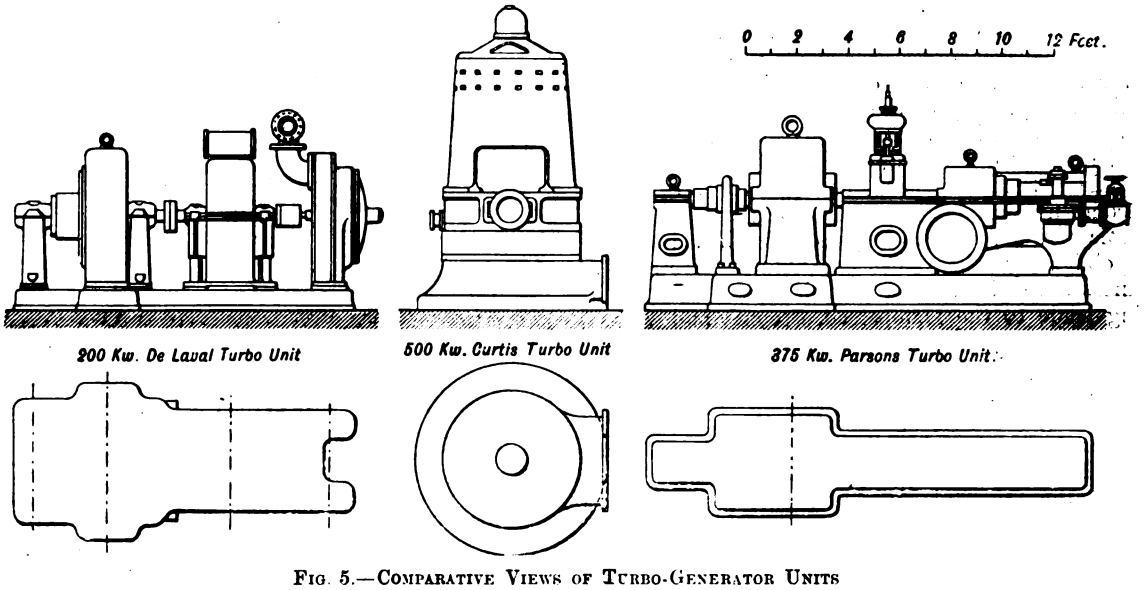

FIG. 5.—COMPARATIVE VIEWS OF TURBO-GENERATOR UNITS

	De Laval.	Curtis.	Parsons.
Size of Units.....	200kw.	500kw.	375kw.
Speed :—Revs. per min..	9,000 for Turbine. 900 for Generator.	1,800	3,600
Floor Space	95 sq. ft.	50 sq. ft.	81 sq. ft.
Floor Space per Kw. ..	0·47 sq. ft.	0·1 sq. ft.	0·21 sq. ft.
Weight	30,000lbs.	42,000lbs.	25,000lbs.

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Fig. 3 showed a curve giving the steam consumption for different loads. To obtain a steady load on the generator, water resistance boxes were made use of, and careful readings of all instruments were made every sixth minute. The condensed steam was delivered alternately to two tanks and weighed at six-minute intervals. All bye-passes were disconnected and all precautions taken to obtain absolutely reliable results, and the tests with different loads were repeated. The flatness of this load curve was at once apparent and compared very favourably with similar curves obtained from reciprocating engines and other turbines. At the normal full load rating of 500kw., the difference in steam consumption between full and half-load, was $1\frac{3}{4}$lb., and between full and quarter-load, $3\frac{1}{2}$lb. The 500kw. rating for this turbine was, moreover, a very conservative one, and it could well be rated at 750kw. In that case, the load points would be located lower on the curve, and the difference in steam consumption still better, being between full and half-load only 1lb., and between full and quarter-load 2·9lb. The dotted curve represented relatively the average steam consumption from a number of

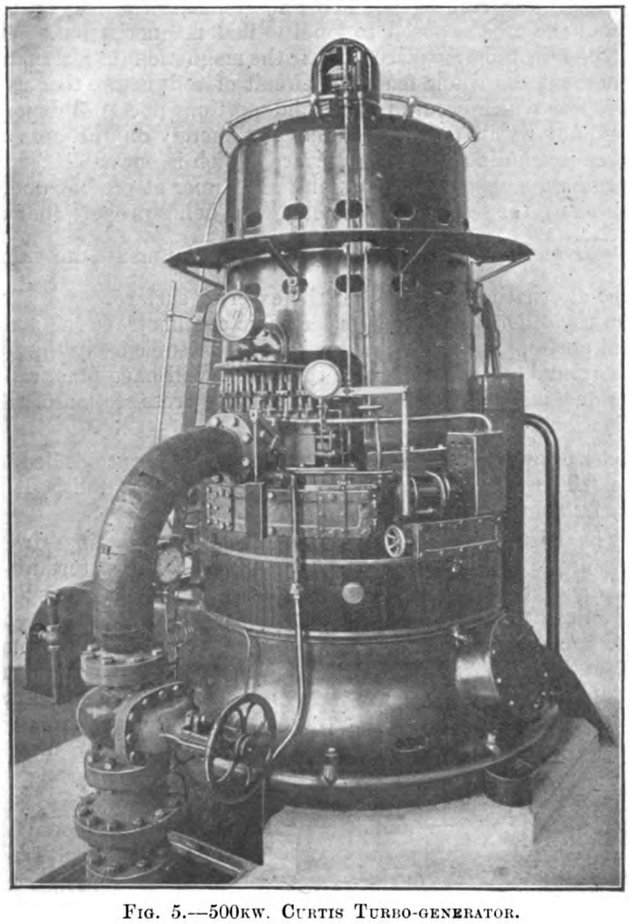

Fig. 5.—500kw. Curtis Turbo-generator.

first-class reciprocating engines of approximately the same rating as the turbine and assuming the full load steam consumption to be the same for both.

One of the great advantages arising from the use of the steam turbine was due to the entire absence of internal lubrication, thus making it possible to return the condensed steam directly to the boilers without the use of troublesome oil separators. Cost of oil and feed water was thereby lessened, and troubles arising from boiler scale and priming were reduced to the lowest possible extent. The cost of attendance should be small, as the turbine had only two glands or packings, requiring no lubrication, and one principal moving element, requiring no adjustment. The only part of the turbine subjected to high pressure steam was the steam chest and its valves. Leaky joints were thereby greatly reduced. Even with very highly superheated steam the buckets were not exposed to a high temperature, the heat of the steam being converted into velocity, while the steam passed through the nozzles, the temperature of the steam corresponding to the expanded pressure. The machine, having no reciprocating parts, vibration was absent, and only very light foundations were required. This fact, together with the small amount of floor space occupied by the Curtis turbine, should materially reduce the cost of the station lay-out.

Another feature of considerable importance was the uniform turning movement obtained in the Curtis turbine by the con-

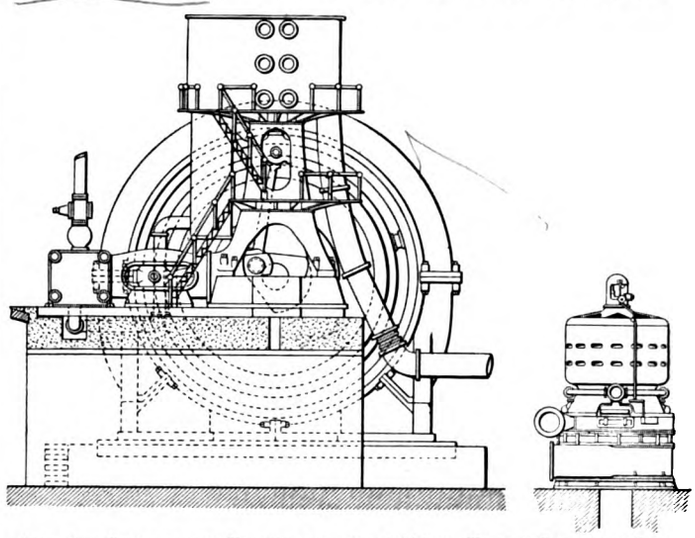

Fig. 6.—Comparative Elevations of a 5,000kw. Engine Directly Connected to a Generator, 75 revs. per min., and a 5,000kw. Curtis Steam Turbine Directly Connected to a Generator, 500 revs. per min.

tinuous supply of steam to the buckets, and speed regulation by varying the volume thereof. Water carried over from the boilers in large quantities did no injury to any part of the turbine while many serious accidents to cylinder engines were due to this cause. The great saving in weight in the turbo-generator, as compared with the reciprocating engine and its separate generator, was not to be overlooked. Cost of handling

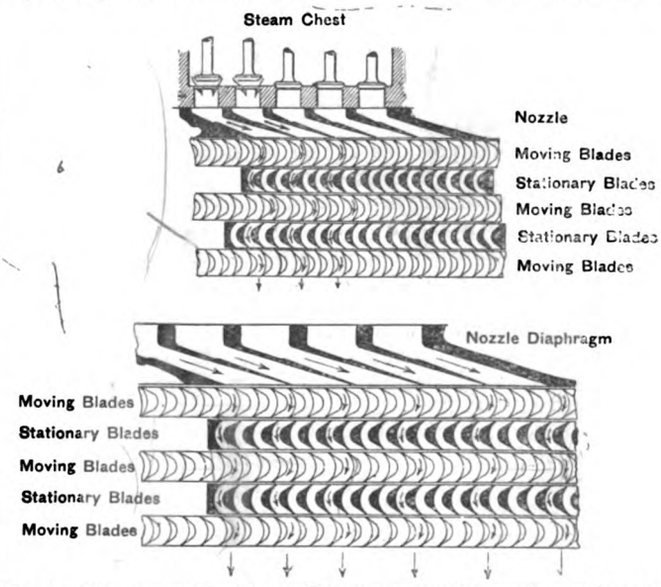

Fig. 7.—Diagram of Nozzles and Buckets in the Curtis Steam Turbine.

in the shops, in transit and in erection, as well as the final cost of production, was materially to the advantage of the turbo-generator.

In addition to the curves used by Mr. Samuelson for illustrating his Paper, we have received some interesting drawings and photographs, relating to the Curtis turbine, from the B. T.-H. Co. Fig. 4 shows the respective space occupied by a 200kw. De Laval turbine, a 500kw. Curtis turbine and a 375kw. Parsons turbine. Fig. 5 portrays the 500kw. Curtis turbine installed in the power house of the B. T.-H. Co.'s works at Rugby. Fig. 6 is also interesting and is self-

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explanatory. Fig. 7 shows the arrangement of nozzles and buckets in the Curtis turbine.

Those of our readers who desire further information relating to this interesting engine will find full details in *The Electrician*, Vol. LI., p. 1,051, and on pp. 21, 88, 160 and 242 of the present volume.

EDDY CURRENTS IN DYNAMO MACHINES.

BY MICHAEL B. FIELD.

In the following article I propose to discuss the Paper entitled "Experiments on Eddy Currents" read before the Newcastle Local Section of the Institution of Electrical Engineers on December 14, 1903, by Dr. Thornton, and published in abstract in *The Electrician* of January 1 and 8, 1904.

I wish at the outset to express my sincere appreciation and admiration of the experimental work carried out by Dr. Thornton in connection with eddy currents induced in solid iron and steel masses; these experiments appeal to me with particular force, inasmuch as I, too, have made oscillograph experiments to demonstrate the existence of rapid fluctuations of magnetism in the solid portions of large alternators (vide footnote in my Paper on "Resonance Effects," read before the Institution of Electrical Engineers, Vol. XXXII., p. 655, of the Institution *Journal*), and have long fully recognised the importance of a research in this direction.

The method of observing the reversal of current in the short-circuited sections of a continuous-current machine is very pretty, and should afford great assistance in the more minute study of the process of commutation.

Anyone who has stood before a switchboard controlling a large alternating-current system and watched the regular pulsations of the ammeter needles, both in the main armature and field circuits when two or more alternators are running badly in parallel, must have been seized with the desire for some magic sixth or seventh sense capable of appreciating every change occurring from instant to instant, not only in the iron and copper portions of the alternators themselves, but also in every machine or motor connected thereto. Unfortunately, some trivial matter disturbs the onlooker's train of thoughts, the subject for the nonce is put out of mind, and there, too often, the matter ends for the interested spectator. Dr. Thornton's Paper is, then, most welcome; *it makes us think*.

That fluctuations of magnetism can occur to a considerable extent in the solid portions of magnet frames has long been fully recognised. In quite the early days of stationary iron-clad armatures, with single-phase windings threaded through holes, it was quite usual to stamp six holes per pole-pitch in the armature plates where only two would be utilised for the winding, *expressly* to prevent too great changes of the reluctance of the magnetic path in different positions of the magnet wheel relative to the armature winding.

This article will deal more particularly with Dr. Thornton's deductions as based on his experiments. It appears, in the first place, that the author has entirely under-estimated the shielding effect of the skin of solid masses on the interior portions, and, in consequence, fallen into the error of assuming the laws of the loss of power due to eddy currents in the skin of solid masses are similar to those which determine the loss in laminated portions. It appears that it is the latter the author has based his deductions upon, with the result that his conclusions are certainly misleading. In the issue of *The Electrician* of April 8, 1892, Prof. J. J. Thomson published an investigation on the distribution of magnetism and eddy currents in iron plates subjected to alternating magnetic forces, and the results arrived at were as follows:—

Consider a plate of thickness $2h$ cm. forming part of a magnetic circuit so that the lines of force lie in the plane of the plate (*e.g.*, as in the laminations of an alternator armature), then the eddy current loss in ergs per second per centimetre of external area of plate (1cm. on each side being reckoned as 2cm. of area) is

$$E = \frac{\sigma m}{32\pi^2} H^2 \frac{\sinh 2mh - \sin 2mh}{\cosh 2mh + \cos 2mh}$$

where $m = (2\pi\mu p/\sigma)^{\frac{1}{2}}$, σ = specific resistance of material, μ = magnetic permeability, $p = 2\pi$ times the frequency, H = amplitude of the magnetic force just outside the plate, the magnetic force being assumed to vary as a sine function; or, if E′ represents the loss per cubic centimetre instead of per unit area, we have $E' = E/h$.

In the two cases we shall refer to—viz., when h is very small and when h is very large—these expressions can be very much simplified. We have in the first case $E' = H^2\mu^2 p^2 h^2/6\sigma$, and in the second case $E = \sigma m H^2/32\pi^2$; and this is the important point, for we see that, when h is large, the loss can be expressed as so much per unit of side area and is independent of the thickness. In an article in the following issue (April 15, 1892) Prof. Ewing elaborated Prof. Thomson's results, showing to what depth the magnetic effect penetrated below the skin into the interior. With a frequency even as low as 20 per second this distance is only a few millimetres—that is to say, beyond a few millimetres the induction is so weak as to be negligible; hence, if we consider the yokes or poles of any but the smallest machines, whatever may be the shape of their cross-section—be it circular, rectangular or elliptical—we can still apply the results obtained and calculate the loss on the basis of the area exposed to longitudinal magnetisation. We see, then, in the first place, that if the magnetic flux alternates throughout the whole magnetic circuit of a dynamo, that part of the loss which occurs in the solid portions does not depend in amount at all on the volume, but merely on the area of surface (excluding the polar surface, which is not subjected to *longitudinal* magnetising forces in the manner at present under discussion), the loss per centimetre area being proportional to $H^2\sqrt{\mu p\sigma}$ or $B^2\sqrt{\frac{p\sigma}{\mu^3}}$, where B represents the maximum value of the alternating induction at the exterior surface.

On the other hand, the loss per cubic centimetre in the laminated portions, provided the laminations be sufficiently thin, is proportional to $B^2p^2h^2/\sigma$, and in this case B will have practically the same maximum value over the whole cross-section of the lamination.

Let us now see how this fits in with Dr. Thornton's deductions. The quotations are from the Paper as published in *The Electrician*.

"The loss of efficiency of dynamo-electric machines from this cause" (eddy currents) "can be approximately determined from the fact that, while other losses caused by hysteresis and mechanical friction vary directly with the speed, eddy current losses are proportional to its square. . . . But the total eddy current loss for a continuous-current machine is about 30 per cent. of the whole. The remaining 27 per cent.," (*i.e.*, deducting 3 per cent. for the eddy loss in the laminated portion) "or practically all, must therefore take place in the solid magnet frame."

Now, the method of separating the eddy current loss from that due to hysteresis and friction in a dynamo or motor, as first given, I believe, by Kapp, is to run the machine with no load as a motor with constant excitation, measuring the power put in at different speeds. Let P represent the power thus measured after deducting the C^2R losses, then P/n which, of course, represents torque (n being the speed) is plotted vertically, n horizontally. This curve comes out in all up-to-date machines a straight line, which, if produced backwards, will cut the vertical axis above the zero. Calling this intercept a, we have $P/n = a + bn$, where b is some constant, which means that, for a given excitation, $P = an + bn^2$. The first term on the right-hand side of the equation represents the friction and hysteresis loss: the second is usually taken as the eddy current loss in the armature core plates and armature conductors which are subjected to the alternating magnetic forces. But now comes in the question, if 30 per cent. of the total loss in the machine, is that due to eddy currents, of which 27 per cent occurs in the solid part, and 3 per cent. in the laminated portions, and if in the solid portions the loss is proportional to $\sqrt{n}$ and in the laminated portions to n^2, how does it come about that a straight line is obtained in the manner described? The fact of the line being straight shows that whatever term there may be of the order of $n^{\frac{1}{2}}$ in the expression for P/n, it

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must have a small coefficient, and therefore the loss in the solid portions must likewise be small.

In speaking about the solid rings on which he experimented, Dr. Thornton says: "At the lower frequency *it has been assumed* that the shielding effect is not sufficient to lower the magnetisation reached at the inner parts of the core, because the long, thin cross-section is very much less favourable to the flow of eddy currents than a circular area." The figure below (Fig. 1) shows very approximately the actual distribution of the magnetic flux in Dr. Thornton's cast-iron ring, and Fig. 2 shows the distribution of induction at different points measured inwards from the skin in a solid cast-iron magnet limb, caused by a magnetic force alternating with a frequency of only

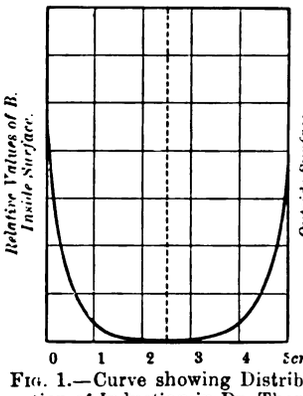


FIG. 1.—Curve showing Distribution of Induction in Dr. Thornton's Cast-iron Ring. Thickness taken as 5cm. $\omega = 18$. No saturation assumed. Induction slightly greater at inside than outside surface owing to shorter magnetic path.

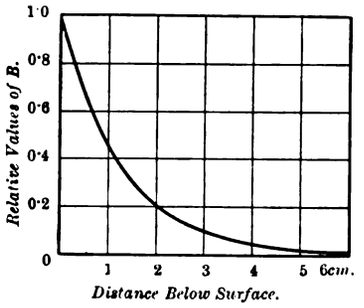
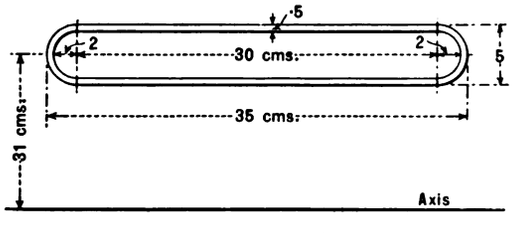


FIG. 2.—Curve showing Distribution of Induction in Solid Cast-iron Magnetic Limb. $\omega = 2$. At 6cm. below surface induction is practically zero.

2 per second. Prof. Ewing has, moreover, pointed out that, if anything, these equations exaggerate rather than under-estimate the amount of magnetism which finds its way into the interior, in his own words (*The Electrician*, April 15, 1892): "No doubt there is a further reduction due to hysteresis; the wave, as it penetrates loses energy through hysteresis as well as through generating eddy currents, but of this the theory does not take account, inasmuch as it assumes a constant value for the magnetic permeability." As a matter of fact, in those experiments by Dr. Thornton where the core was partly magnetised by a continuous current and a very small alternating magnetic force superposed, the permeability will be very nearly constant throughout the cycle, and the calculations based upon Prof. Thomson's formulæ must, therefore, very nearly approximate to the truth.

Now, without going into any deep mathematics, let us form some idea of what effect this shielding has.



The above represents a ring of cast-iron of practically the same dimensions as Dr. Thornton's cast-iron ring. I have taken nearest round numbers in centimetres.

Imagine a skin all over this ring of solid iron 5mm. deep, and the rest so finely laminated that no eddy currents occur therein. This will evidently be far more favourable for a uniform induction throughout the cross section than the author's solid ring.

I am going to assume that eddy currents circulate in the skin due to the E.M.F. produced therein by the total induction in the laminated portion. There will be also induction in the skin which will tend to increase the value of the current in the exterior portions; but we will not take account of this increase, thus making the case as favourable as possible for uniform induction.

We know the value of the induction at the exterior surface of the skin is that due to the exciting ampere-turns alone and is independent of the eddy currents.

We shall compare this value with that in the interior or laminated portion.

The total area of the laminated portion is 132·6 sq. cm. Let us take a maximum induction in this portion of the ring as 500 lines per square centimetre.

The total flux will be, therefore, 66,300 lines. The total E.M.F. in the skin considered as a single short-circuited turn, will be, with a frequency of 18 cycles per second. $2\pi \times 18 \times 66{,}300 \times 10^{-8}$ = say, 0·075 volts max. The mean length of this short-circuited turn is 74·1cm., and mean cross-section may be taken as 97·5 sq. cm. Its resistance, therefore, taking the specific resistance of cast-iron as 98·5 microhms, is 75×10^{-6} ohms. Thus the maximum value of the current circulating in this skin, as the short-circuited secondary of a transformer, will be at least 1,000 amperes. The current, therefore, in the exciting coil in order to produce the induction in the interior of 500 lines per square centimetre must consist of two components, the first equal and opposite to the demagnetising ampere-turns of the skin current, the second that necessary to produce the flux in the interior. The exciting ampere-turns must, therefore, be slightly greater than 1,000. Now, it is these alone which produce the flux in the exterior surface of the skin, as this is unaffected by the currents within the skin.

The length of the magnetic path at the exterior surface is 210cm. Hence $H = \frac{4\pi}{10} \times \frac{1{,}000}{210} = 6$, but this magnetic force will produce in cast iron an induction of over 4,000 lines per square centimetre; hence we see that in this case, which is, as already stated, manifestly far more favourable for uniform induction than that of Dr. Thornton, and with as low a frequency as 18, we find the value of the induction at the interior in a case taken at random is only one-eighth of that at the exterior.

"The ring experiments (Table III.) therefore closely approximate to the conditions of practice, and it may with reason be inferred that the losses will be in much the same ratio and of the same order of magnitude in similar yoke-rings and magnet cores." Then follows Table III., the heading of the seventh column being "Eddy-current watts per cubic centimetre of" (solid) "core," and elsewhere in several places we find indications of the assumption having been made that the eddy-current loss in different masses can be compared on the basis of unit volume.

"Now the energy loss* in an iron core" (speaking of solid cores forming magnet limbs and yokes of dynamos) "varies as the square of the alternating ampere-turns applied to it; but the secondary voltage in an exploring coil about the core is proportional to the primary ampere-turns. By measuring the exploring coil voltage under various conditions of working the magnetic movements producing eddy currents within the core can be gauged."

It is then assumed that the values of the squares of the exploring coil voltages are proportional to the eddy-current losses in the solid cores. Let us see if this be so: Dr. Thornton shows that the magnetic fluctuations may consist of different components of widely differing frequency.

If B_i is the value of the amplitude of the induction at the surface of the limb, alternating with the frequency represented by ip, where p is, as before, 2π times the fundamental frequency and i represents the harmonic in question, then $E = k\Sigma\sqrt{ip}B_i^2$, but the maximum value of the total alternating flux of the frequency ip can readily be shown to be $k_1 B_i / \sqrt{ip}$. The square of the E.M.F. shown on the hot-wire instrument connected to the exploring coil will, therefore, be proportional to $\Sigma ip B_i^2$, the summation in each case being extended to all the alternating components of the flux.

Now, it is abundantly clear that since the loss depends on the square root of the frequency, and the square of exploring coil voltage directly on the frequency, the one cannot possibly be taken as the gauge of the other if there are components of different frequency constituting the total alternating flux.

* Presumably "power loss" is meant, or "energy loss per second."

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Let us take an example: Suppose we have two components, B_1 B_{15}, of frequencies corresponding to p and $15p$ respectively, and suppose under one set of conditions $B_{15}=B_1/3{\cdot}88$, we have

$$E=k\sqrt{p}\left(1+\frac{1}{3{\cdot}88}\right)B_1^2=k\sqrt{p}B_1^2\times 1{\cdot}257,$$

$$^*\ e^2=k'pB_1^2\times 2.$$

Now let, under a new set of conditions, B_{15} become twice its old value, we have

$$E=k\sqrt{p}\left(1+\frac{4}{3{\cdot}88}\right)B_1^2=k\sqrt{p}B_1^2\times 2{\cdot}03,$$

$$e^2=k'p(1+4)B_1^2=k'pB_1^2\times 5.$$

This example taken at random shows that in this case, while the eddy current loss has only increased about 60 per cent., the square of the exploring coil voltage has increased 150 per cent.; in fact, we see that no proportion can exist. Dr. Thornton has, therefore, to prove the existence of only one frequency before we can place any value at all on Table IV.

It is highly probable that the efficiency of a converter is affected by the regularity of the turning moment of the prime mover; but with moderately good engines, such as are necessary for the successful operation of any system, the effect on the efficiency of the converter as compared with that assuming turbines as prime movers is probably inconsiderable. I have already given reasons why, in my opinion, we cannot place any reliance on the exploring coil method of Dr. Thornton, and the figures in Table VII. are equally inconclusive. The author says both tests were made under the same conditions of excitation and speed, and then goes on to say that in case 1 the supply voltage varied from 85 to 72, and in case 2 from 72·5 to 63·5. Since the supply in each case is stated to have been direct current, how can the converters have been run under the same conditions of *speed and excitation?* Moreover, there is such a discrepancy between the figures themselves as to show their unreliability. We have an input (continuous current) measured on ammeter and voltmeter of $84\times 82=6{,}888$ watts, as against the indication of the wattmeter 6,400 watts. Or, again, $72{\cdot}5\times 32=2{,}320$, as against 2,480 watts recorded by the wattmeter—*i.e.*, in some cases the ampere-volt value is higher, in others lower, than that indicated by the wattmeter. Surely some error in transcription must have occurred here.

The Paper is teeming with points that require further explanation; for example, what is meant exactly by the phrase "The circulation of local eddies varies not only inversely with the specific resistance, but as the square of the permeability"? I would like to know how the "circulation of eddies" is numerically estimated. Is current density, or watts per cubic centimetre meant, or what is it? Although one has a fairly good idea of what the term "circulation of an eddy" would mean in ordinary terminology, it is not one to which any definite numerical value or dimensions can be assigned.

For a given varying flux density across any plate undoubtedly the eddy current loss would be greater if the plate were made of copper than if made of iron, and it is for this reason that it is not unusual to insert copper rods or bars in the pole faces of alternating-current machines to act as anti-hunting devices. The permeability, in fact, only affects the question in so far as it reduces or augments the flux through the plate, but for a given flux density the eddy current loss is independent of μ. The two or three sentences of the Paper in this connection might, with advantage, be revised. We read "It" (*i.e.*, the loss) "is greater with poles and pole-faces of high electrical conductivity than with cast iron, because"—here follows the reason—"the circulation of the local eddies, &c. . . . . *It is for this reason* that they are much greater in *iron* than in *copper*. . . . . ."

The formula $w=ai+bi^2$ on p. 420 for the combined loss in hysteresis and eddy currents needs further explanation. I should be much obliged if Dr. Thornton would refer me to tests proving that $W_h\propto i$, and especially bearing in mind the manner in which the strength of the induction falls off as it reaches the inner portions of the ring. Prof. Ewing has certainly given an empirical law

$$\int H dI=1{,}340H-1{,}610$$

which is fairly true under certain conditions for iron plates provided H be not taken too low. This is a very different law from that assumed by Dr. Thornton.

In the appendix the author gives

$$w=anB^{1{\cdot}55}+\beta n^2B^2,$$

but the method here given of separating the hysteresis and eddy current losses is of little practical value. What we want to know is W_h and W_e under practical working conditions, not under entirely fictitious conditions; moreover, the ratio of W_h/W_e tested as described by Dr. Thornton will by no means be the same as when tested under ordinary working conditions *in the usual way.*

Figs. 4 and 6 are very interesting, but what is the meaning of the oscillations in Fig. 4? They are not time oscillations of magnetism, for time is not represented in the diagram, and what is the meaning of these variations being represented vertically at the less steep and horizontally at the steeper portions of the curve?*

If, in any of the cases given by Dr. Thornton, we knew the actual amount of the fluctuation of the magnetic force, we could readily approximately estimate the eddy current losses in the solid masses by adapting Prof. J. J. Thomson's equations to the case, but we must in any case throw overboard Dr. Thornton's estimates as valueless. In conclusion, it might be pointed out that dynamo makers calculate the hysteresis and eddy losses in armatures by means of well established formulæ of the approximate correctness of which there can be no doubt, and on this basis predict the efficiency of their machines. In the majority of cases careful calculations of this kind tally with experiments made on the machines when built; slight differences are, of course, always to be looked for depending on variations in the materials used, and possibly on the eddy currents in the copper windings not allowed for. One thing, however, is certain, there are not large losses, such as 30 per cent. of the whole unaccounted for, as Dr. Thornton supposes. It is a curious coincidence that a few days before I saw Dr. Thornton's Paper I myself submitted a Paper on eddy currents to the Institution of Electrical Engineers, and I sincerely hope that in the event of it being thought worthy of publication, Dr. Thornton will do me the honour of thoroughly criticising it.

* k, k_1, k' are mere constants.

* The figure in question was reproduced from the proof of Dr. Thornton's Paper, the original diagram not being at our disposal.—Ed. *E.*

A SINGLE-PHASE ELECTRO-PNEUMATIC RAILWAY SYSTEM.

BY BION J. ARNOLD.

Since the first announcement of the principles of my system, I have refrained from giving out any further information regarding it, giving as my reasons therefor my desire to test the system thoroughly before making further public statements. I have conducted my experiments privately and at my own expense, and had so perfected my apparatus that I had hoped to be able to celebrate the incoming of the year 1904 with a public demonstration over 20 miles of railroad.

That I would have made a demonstration on January 1st was a certainty to me, until December 18th, when I learned by telegraph, while in New York, that the car barns, located at Lansing, Michigan, of the road upon which I had been experimenting, had been completely consumed by fire. In view of the fact, however, that the single-phase electric railway is now receiving so much attention at the hands of engineers and inventors in many parts of the world, and that I believe that the year 1904 will be an epoch-making one, marking the revolution from the direct-current to the alternating-current motor for railway work, as well as the beginning, on a large scale, of the displacement of the steam locomotive on railways by the use of a substantial form of overhead construction rather than the third rail, and from the further fact that I cannot get another machine ready in the near future, I have decided to publish a record of my work up to the present time. Since it was my intention to experiment with 15,000 volts on the working conductor, all the line material had to be specially designed.

Road-bed and Track.

The Lansing, St. John's and St. Louis Railway was originally projected to extend from Lansing, the capital of Michigan, northward through St John's, Alma and St. Louis, a distance of about

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60 miles, but up to the present time only that portion extending from Lansing to St. John's, a distance of 20 miles, has been constructed. The line is equipped with 67lb. T-rail, laid on ties spaced 2ft. apart between centres, and as alternating high-tension current was to be used, only one of these rails was bonded with 38in. 4/0 bonds extending entirely around the splice bars. Since it was impossible to secure rails from the rail manufacturers in time, rails and splice bars were secured from one of the leading steam railways, and this necessitated the adoption of a supported joint and a long bond, as there was not room under the splice bars for concealed bonds. The line as at presented constructed between Lansing and St. John's has no grades exceeding 1 per cent, and no curves exceeding 7deg., except in the cities themselves, where the minimum radius is 50ft.

Overhead Construction.

Considerable care was taken in planning a suitable insulator for carrying the trolley wire, and Fig. 2 shows the construction of

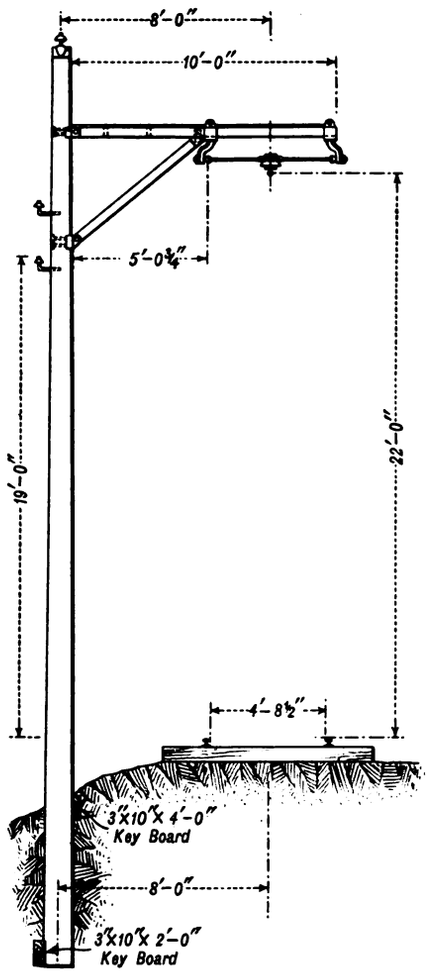


FIG. 1.—TYPICAL STRAIGHT LINE OVERHEAD CONSTRUCTION.

the annealed glass insulator used. Fig. 1 shows a typical arrangement of the straight line overhead construction, and it will be noticed that wood is used for the pole, cross-arm and brace, and that the insulator is supported by means of a short span wire from iron brackets secured to the wooden cross-arm. Their construction ensures high insulation at a low first cost, the entire line having been constructed for but a slightly increased expense over the cost of standard construction, and at the same time so built that in case of failure of the alternating-motor system, the standard continuous-current motor system could be put into service without changing any parts. The working conductor was placed 22ft. above the top of the rails, in order that train men when standing upon the tops of the freight cars going over the road could not come in contact with the working conductor.

It was planned to operate the entire road from a single 2/0 trolley wire, and with one rail bonded as previously mentioned, this amount of copper being sufficient to operate four 40-ton cars at an average speed of 30 miles per hour, with the power house located 1¼ miles from one end of the line, and operating with from 6,000 to 10,000 volts on the working conductor. Current is transmitted to the line over two No. 3 wires, and is furnished from a 300kw. rotary converter generating 380 volts at 25 cycles, and the energy is then stepped up to the working pressure of the line. It was intended, after experimenting a sufficient length of time to determine the best voltage for the working conductor, to have the generators for the permanent plant constructed so as to generate at this determined voltage, and it was for this reason that a temporary rotary converter was first installed with which to conduct the experiments.

Fig. 3 represents diagrammatically the working parts of one form of the system. The rotor R of a single-phase induction motor is geared to the axle of the car, and, by means of the crank pin C secured in pinion P, also drives the compressor cylinder RC while the stator S can freely revolve around the rotor and drive, by means of crank pin C, the compressor cylinder SC. Both cylinders are piped to air reservoirs located under the car and are also pro-

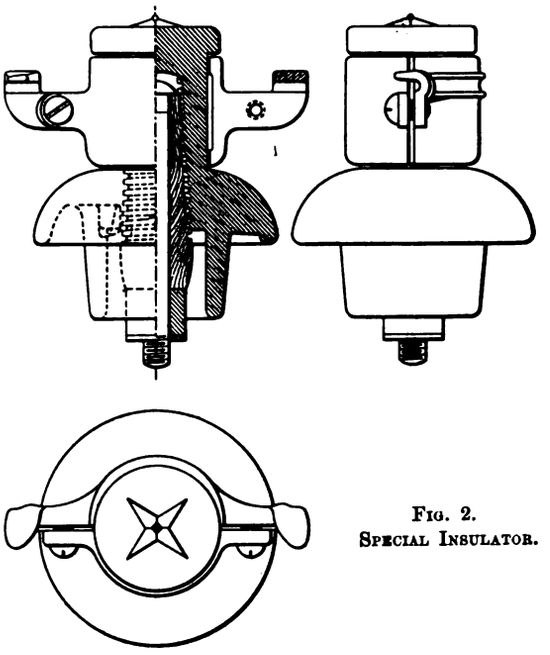
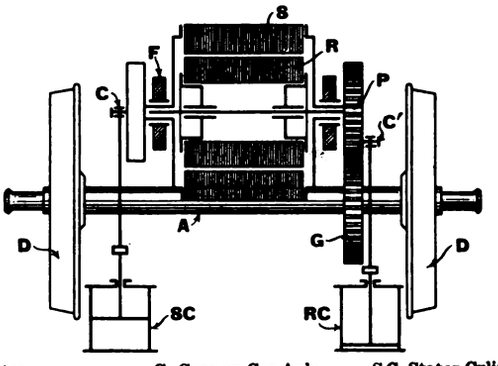


FIG. 2.
SPECIAL INSULATOR.

vided with suitable valves manipulated from a single controller on the car platform for making them perform their various functions; thus the entire regulation of the speed and power of the car are controlled by the air cylinders, and no other regulating devices are necessary. The cylinder valves are electrically operated, and this makes it possible for each cylinder, when driven by the electric motor, to compress air into the tanks, and when operated by compressed air to furnish mechanical energy for moving the car. When, for instance, the cylinder is compressing air the valves work like inlet and outlet poppet valves of a common air pump, while, on the other hand, if the cylinders are supplied with com-



R, Rotor. G, Gear on Car Axle. S C, Stator Cylinder.
S, Stator. A, Axle of the Car. C, Crank of Stator.
F, Frame. D, Driver of the Car. C', Crank of Rotor.
P, Pinion on Rotor. R C, Rotor Cylinder.

FIG. 3.—DIAGRAMMATIC ARRANGEMENT OF ELECTRO-PNEUMATIC MOTOR.

pressed air, each valve is operated electrically by a pilot solenoid connected with the valve seat in such a manner that the energy for moving the valve is supplied by the compressed air, thereby making the valve practically self-actuating. The time of operation of the valves is controlled by a series of collector rings revolving with the engine shaft, and their regular operation is interrupted and varied to suit the requirements by means of the motorman's controller. When a rotary or turbine type of air engine is used, all the above valves and reciprocating parts are eliminated, and the entire controlling mechanism consists of two air valves operated from a single engineer's valve, which may be located upon the platform of the car or in the cab of the locomotive, and so arranged that one or more units may be operated

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from the platform or cab of any unit without the necessity of connecting wires between the units.

Since the motor may be of the simplest type of induction motor without a commutator, and the system does not require the manipulation or breaking of the main current, the motor may be designed for any working voltage and be of any type which will maintain a constant speed when provided with a constant load. This eliminates the necessity of all step-down transformers, resistances or other regulating devices, and confines the current to the motors themselves, and as these are below the car floor the danger from the current is reduced to a minimum. At the same time the air cylinders, in addition to performing all the functions of speed control, give to the machine the independent unit element, and the ability to store the kinetic energy of the train in stopping and to utilise it in starting. On account of these and other features the electric motors of this system can be much smaller in capacity, when rated as continuous-working motors, than those of other systems not possessing this equalising load feature, and the capacity of the power house and line can be reduced to about one-half of what would be required with systems where the fluctuating starting loads of the cars are transmitted back to the power house. In order to better understand the different operations of the system Fig. 4, showing a speed diagram, has been prepared, in which on the axis of abscissæ ODL are represented the different car speeds in percentages of the synchronous motor speed, while the co-ordinate axis AOB represents the rotor and stator speeds corresponding to the car speeds shown. The operation of the car may be divided into the following periods:—

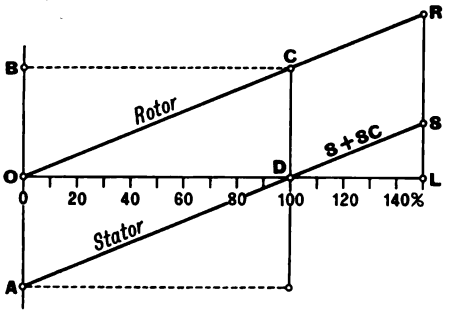

FIG. 4.—DIAGRAMMATIC REPRESENTATION OF OPERATION.

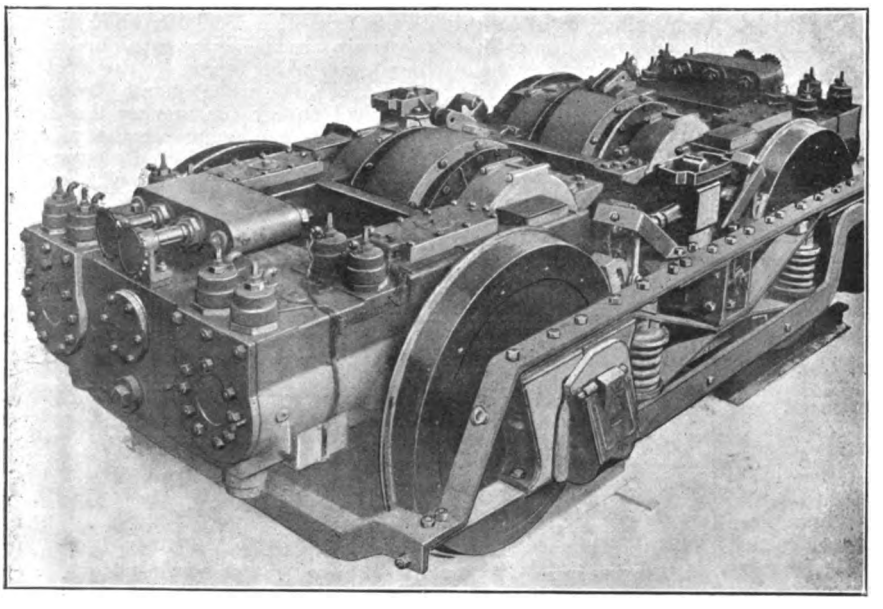

FIG. 5.—LATEST MOTOR EQUIPMENT WITH TRUCK.

1.—*Standing in the Station.*

Referring to Fig. 3 the rotor R is a standing still, while the stator S runs with full synchronous speed. The stator is then transferring the full energy of the electric motor, through the crank C, to the compressor cylinder SC, which energy is being delivered to the air reservoir in the form of compressed air. Since the relative velocity between the stator and the rotor is, under all conditions of operation, constant, the speed curves of stator and rotor may be represented by two parallel lines OCR and ADS in Fig. 4. The origin O of the given co-ordinate system represents the period of rest of the car, and therefore indicates zero rotor speed and full stator speed in a negative or downward direction, as the stator is now revolving in the opposite direction from that which the rotor must revolve to drive the car forward. Let it be further assumed that for an instant OA equals the active torque of the stator, then it will be easily understood that OB, which equals OA, represents the reactive torque of the rotor exerted on the car axle, meaning that if the car is free to move the reactive torque can be used advantageously for the starting and acceleration of the car. When the car is standing in a station it is held at rest by moving the controller to such a position that the outlet pipe from the rotor cylinder RC is throttled, thereby increasing the pressure behind the piston to such an extent that it overcomes the effort of the rotor R to revolve, thus tending to cause the stator S to revolve and at the same time holding the car at rest without the use of wheel brakes.

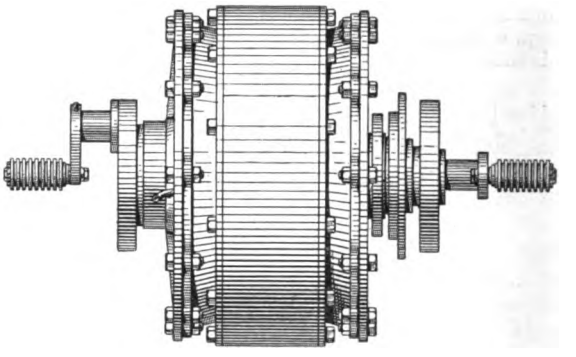

FIG. 6.—OUTSIDE END VIEW OF ELECTRIC MOTOR.

2.—*Starting and Accelerating.*

To start the car the air cushion behind the piston of RC is removed, and the air which is being compressed by cylinder SC, supplemented by the stored air from the tanks, is admitted to cylinder RC with the controller at the position of maximum cut-off. The rotor then begins to revolve, and as it accelerates the stator slows down by exactly the same amount that the rotor has increased its speed, and as the rotor and car-speed increase, the controller is gradually moved to a smaller percentage of cut-off until the car-speed corresponds to the full synchronous speed of the motor, at which time the stator comes to rest. During this period of acceleration the air compressed by cylinder SC, instead of being delivered to the tanks to lose its heat, is delivered hot directly to the rotor cylinders, thus greatly increasing the efficiency of the combination, as the heat usually lost in air systems is utilised and the advantages of heated air gained without a re-heater, and as the pressure used is low many of the ordinary difficulties in the use of compressed air disappear. If the rate of acceleration is such that cylinder RC uses all of the air supplied by cylinder SC, no exhaust to the atmosphere from cylinder RC takes place. Referring now to Fig. 4, which graphically represents this process, since the electric motor runs always at a constant speed and a constant load it has a constant torque, and, therefore, the distance between lines OCR and ADS may be considered as representing the energy delivered by the electric motor. The length of any ordinate extending from OD to OC represents the proportionate amount of energy derived from the electric motor, which is applied directly through pinion P and gear G of Fig. 3 to the propulsion of the car, while the corresponding ordinate extending below OD to AD represents the proportionate amount of the energy of the electric motor which is absorbed in compressing air through cylinder SC, which energy, in the form of air, is immediately transferred to cylinder RC and is utilised in accelerating the car. In practice however, since there will be a loss in transferring the energy from electrical energy into energy in the form of compressed air and back again into mechanical energy, this loss, whatever it may be, must be drawn from the storage tanks, and the requisite amount of air from these tanks is supplied to the rotor cylinder RC in order to maintain the full power of the electric motor upon the car axle during the period of acceleration. Should it be desired to accelerate at a greater rate than the full power of the electric motor is capable of giving to the car, the additional energy may be supplied in the form of air from the storage tanks through cylinder RC, thus increasing the total energy given to the car during acceleration, in which case this total power would be represented for any given instant by a point above line BC.

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3.—*Full Speed.*

When the rotor has reached full synchronous speed by the previous operation, this speed can be maintained by moving the controller to another position which will throttle the outlet pipe of cylinder SC until the reaction due to the pressure behind the piston equals the full capacity of the electric motor An overload or underload may be placed upon the motor by varying this pressure; but under normal conditions of operation the cylinder SC is provided with an automatic valve, which keeps a constant pressure behind its piston, thus maintaining an absolutely constant load upon the electric motor, and consequently a uniform demand of electrical energy from the line. This uniform load is represented by the parallel lines OCR and ADS of Fig. 4. With the controller set at full-speed position, the inlet valves of the rotor cylinder RC are held open, and the piston runs free. The electric motor now gives its full power to the car axle, and the stator and its air mechanism will remain at rest as long as the car runs at the speed corresponding to the synchronous speed of the motor.

4.—*Speed Variations.*

There are usually certain places on any road where high rates of speed can be maintained for short distances, and as these speeds might be higher than the synchronous speed for which the motor was designed they are provided for as follows:—Assuming that the car is running at synchronous speed, the controller may be moved to such a position that the valves of stator cylinder SC operate in such a manner as to cause it to act as an engine, and revolve the stator S in the same direction as rotor R is revolving. This now causes, owing to the constantly electrically-maintained relative difference in speed between the stator and the rotor, an increase of speed of the rotor and car axle, due to the motor automatically working as a magnetic clutch, without mechanical contact, and if the resistance of the car or train is less than the capacity of the electric motor, the air necessary for revolving the stator can be obtained, hot, from the rotor cylinder RC without drawing from the tanks, and a speed above synchronism indirectly proportional to the resistance of the train maintained indefinitely. When the resistance of the train is greater than the capacity of the electric motor, speeds above synchronism can be obtained only by supplying rotor cylinder RC with stored air from the tanks, and can only be maintained for short distances, or until the storage capacity of the air reservoirs is exhausted. This condition corresponds to the spurts that can be made by a steam locomotive

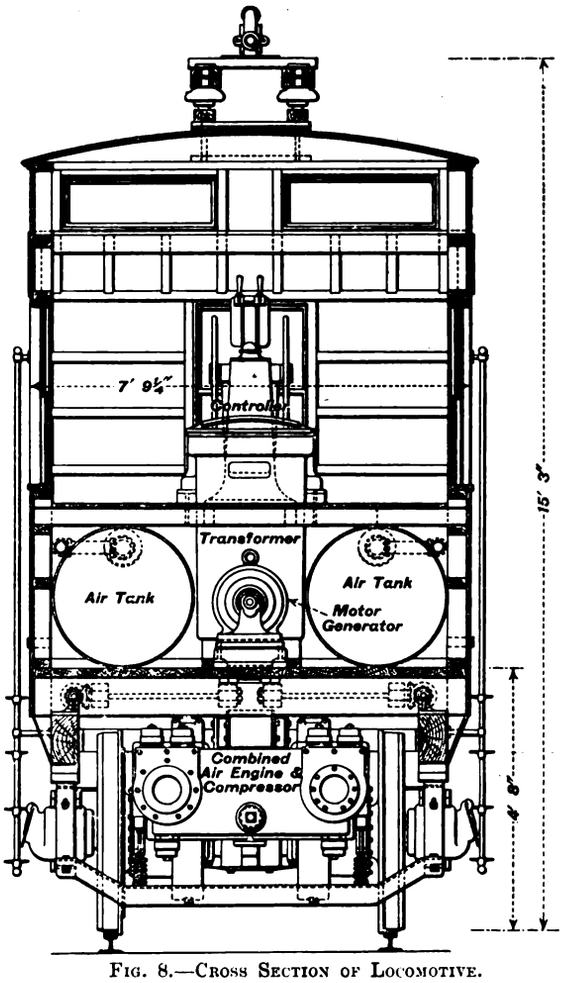

FIG. 8.—CROSS SECTION OF LOCOMOTIVE.

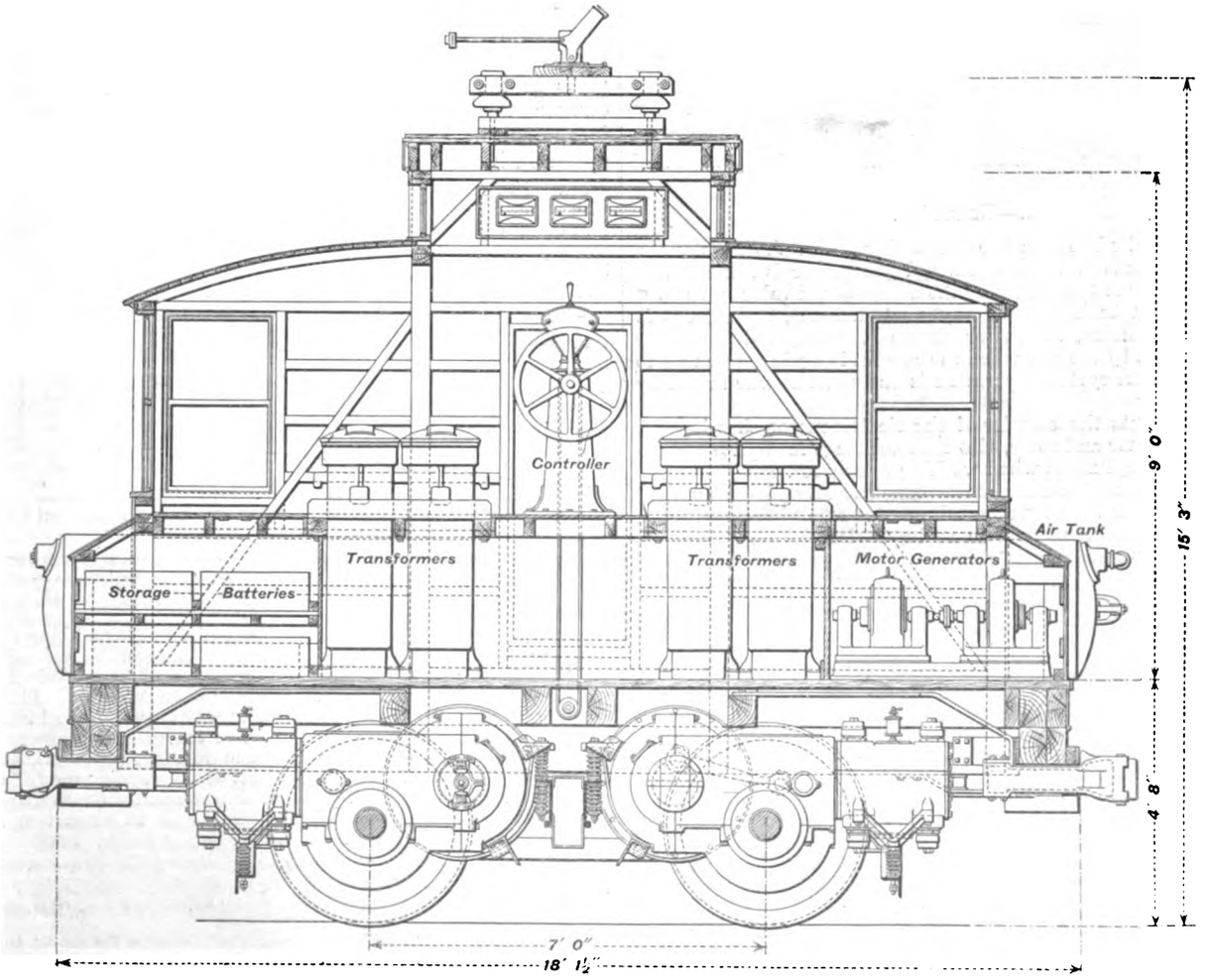

FIG. 7.—LONGITUDINAL SECTION OF LOCOMOTIVE.

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when working above the steaming capacity of the boiler. The distance from the line ODL to that portion of the line ADS above ODL in Fig. 4 represents, at any given speed, the proportionate amount of energy which must come from the tanks and be supplied through cylinder SC, and the distance from DL to CR represents the total energy given to the car by the combined action of the electric motor and the stator cylinder when operating under these conditions. The energy delivered to the car can be still further increased by admitting air into the rotor cylinder RC and allowing it to work as an engine.

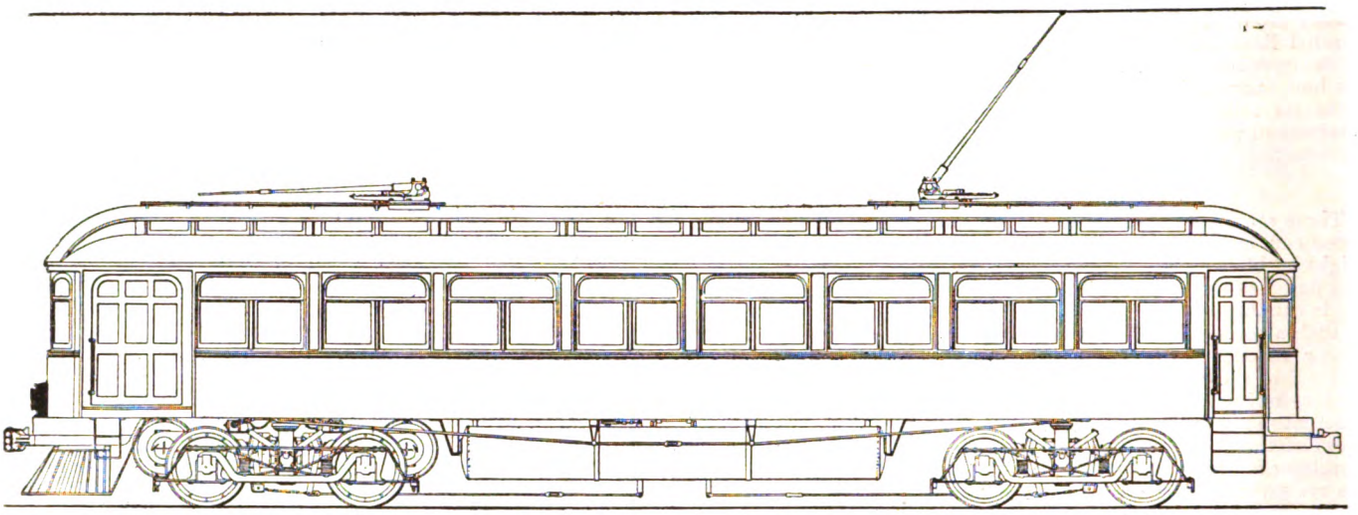


FIG. 9.—ELEVATION OF COMPLETE CAR.

5.—Retardation.

To bring the car or train to rest, instead of applying mechanical brakes to the wheels in the ordinary manner, and thereby dissipating the entire stored energy of the car or train in the form of heat, this energy is stored in the form of compressed air, to assist in starting the car or train, by setting the controller in such a position that the rotor cylinder RC compresses air and delivers it into the storage tanks. Any desired rate of retardation can be secured by throttling the delivery pipes from the rotor cylinder RC; and in practice this pipe is provided with an automatic valve which releases just before the slipping point of the wheels, thus allowing the motorman to brake as rapidly as he desires without liability of flattening the wheels. Supplemental wheel brakes are provided for emergency, but need not often be used, and the ordinary wear and tear on them is saved.

6.—Reversing.

When it is desired to run the car backward for short distances, the electric motor is not disturbed, and the power is furnished by the rotor cylinder RC by reversing the action of the valves; but if it is desired to run backward for any great distance, the current is thrown off the motor, the stator engine reversed, and the stator brought to speed by the air, when the current is again thrown on to the motor, and the cycle of operation is the same as when running forward.

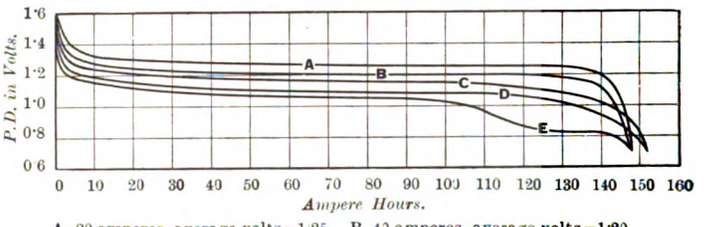
Fig. 6 represents the exterior of the electric motor showing the cranks of the stator and rotor, also collector rings for operating the valves of the air cylinders when working as engines.

The first electro-pneumatic motor constructed, and upon which the first experiments were conducted, was too small in capacity and it was decided to experiment with an improvised locomotive carrying suitable air tanks and transformers upon a temporary frame structure. This locomotive was the one upon which the trial runs were made and passengers carried on June 15, 1902. Fig. 5 shows a side view of the new electro-pneumatic locomotive carrying two motors, constructed after the preliminary experiments had been made on the first motor. For experimental purposes this truck was fitted up in the form of a locomotive as shown in longitudinal and transverse section by Figs. 7 and 8, and it was this locomotive that was recently destroyed by fire. In order that the locomotive might operate as an independent air unit upon tracks not equipped with overhead electrical conductor it was provided with a small storage battery and small motor-generator for charging the batteries and for operating the head light. These auxiliaries are not necessary for the successful operation of the system, provided the locomotive can always be supplied with electric current from the working conductor, for then the valves can be made to operate from alternating current and thus eliminate the use of motor-generator and batteries. When, however, it is desired to operate independently of the electric conductor these auxiliaries are necessary, and one set may supply an entire train. It will be seen that the locomotive is also provided with transformers, another auxiliary which is unnecessary when the motors are designed for the voltage transmitted over the working conductor, but in this case transformers were used because the manufacturer of the motors could not be induced, at the time they were purchased, to build a high-tension motor for railway work, consequently the parts of a standard motor were utilised and a pressure of 200 volts adopted for the motors, as this was the most economical voltage that could be used with the particular parts selected. This locomotive was provided with all necessary testing instruments, and had been operated in the barns for some time and found to perform all its functions successfully, and would have been placed on the road and experiments with it would now be in process had it not been destroyed.

THE EDISON ACCUMULATOR FOR AUTOMOBILES.

The following is an abstract of the discussion which took place at the Institution of Electrical Engineers on Thursday, January 28th, upon Mr. W. Hibbert's Paper on the above subject. The Paper, which was read on November 26, 1903, appeared in our issue for November 27, 1903:—

Mr. HIBBERT, before the discussion commenced, said a few words with regard to an improvement in the cell. During the summer he found that the cell which he had under test was not balanced. One of the plates had a greater capacity than the other. This had suggested an obvious improvement, and he wrote to Mr. Edison about it. Subsequently he had had a letter from America to say that such an improvement had already been effected. He had known this previously to the time when



A, 20 amperes, average volts = 1·25. B. 40 amperes, average volts = 1·20.
C, 60 amperes, average volts = 1·15. D, 80 amperes, average volts = 1·10.
E, 100 amperes, average volts = 1·03.

he read his Paper, but had rigorously determined to say nothing until he had confirmed his opinions. Since that time, however, he had conducted experiments which had confirmed the results sent him by Mr. Edison. Mr. Edison called it a half cell, but it was more than that. There was a re-arrangement of the plates—viz., six negatives and 10 positives—but he had no particular detailed description of the cell as improved by Mr. Edison. But he had the above curves, and from these there was sufficient information to say that the improvement was a decided one. The cell was 12·7lbs. in weight, and it gave 140 ampere-hours. The average watt-hours per pound came out to 13·7. This was an intimation of the improvement in the output of the cell per unit of weight, and he should say, from the fact that it was likely to be more perfectly balanced than in the former cells, that the efficiency was not at all unlikely to be higher than before. However, as he had made no experiments upon it he could say no more.

Dr. J. A. FLEMING said it was, perhaps, a matter for regret that the discussion on Mr. Edison's alkaline cell had been separated by so many

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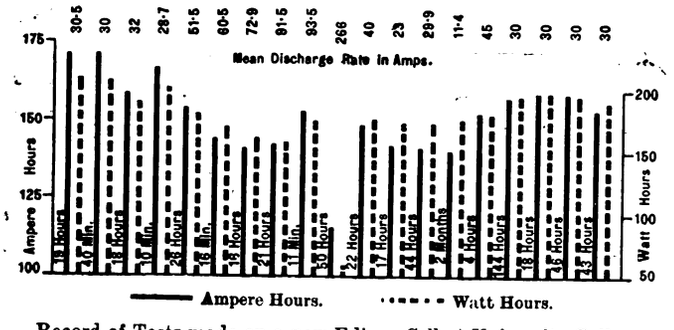
weeks from Mr. Hibbert's excellent Paper, because by the time they had arrived at the discussion, Mr. Edison had arrived at a new cell. However, the few remarks he had to make concerned the first cell described by Mr. Hibbert. Similar cells had been sent to Janet, Hospitalier, Finzi, Hibbert and himself, and all of them had obtained practically the same results. The cell required a certain amount of formation. As it came from the manufacturers it had to be heavily overcharged at first in order to bring it up to its full capacity. The cell was handed to him last July, and he had been obliged to neglect it for some months. It was not until September last that he had been able to ask Mr. W. C. Clinton in the Pender Laboratory to make some measurements on the cell. (These measurements were summarised in the table and diagram shown below):—

Summary of Results of Experiments by Dr. J. A. Fleming on a 28-Plate Edison Automobile Cell, carried out in the Pender Electrical Laboratory, University College, London. September, 1903—January, 1904. Observations by Mr. W. C. Clinton.

The cell in each case was discharged down to 0·8 volt on closed circuit, except in discharge No. 10, where initial voltage was 0·7 volt and final 0·3 volt.

No. of dis-chrge.	Mean cur-rent.	Mean P.D.	Max. current.	Min. cur-rent.	A.H.	W.H.	Previous charge in A.H.	Average charging rate.
1	30·6	1·224	32·0	22·6	173·0	212	900	30
2	30·0	1·214	32·0	19·0	173·0	210	660	60
3	31·9	1·208	33·0	20·0	159·5	193	274	60
4	28·7	1·216	32·0	17·0	168·5	205	269	60
5	51·4	1·179	57·0	31·0	155·5	183	262	60
6	60·5	1·192	69·0	36·0	145·0	173	225	100
7	72·9	1·147	80·0	41·0	142·0	163	225	100
8	91·5	1·117	112·0	62·0	143·5	160	230	100
9	93·5	1·161	116·0	60·0	154·0	178	237	100
10	266·2	0·49	375·0	170·0	115·5	57	245	100
11	40·0	1·197	42·0	24·5	150·0	179	281	97
12	34·0	1·211	36·0	21·0	130·0	158	184	92
13	23·0	1·231	24·0	13·0	143·0	176	237	95
14	29·9	1·234	30·0	17·0	142·0	175	315	105
2 months' rest charged.								
15	11·4	1·273	11·6	8·5	141·0	179	283	105
16	45·0	1·200	45·0	45·0	154·0	184	390	80
17	30·0	1·245	30·0	30·0	159·0	198	436	32
18	30·0	1·249	30·0	30·0	161·0	201	225	60
19	30·0	1·245	30·0	30·0	160·0	195	336	60

At end of 13th discharge cell was short-circuited for 16 hours.



Record of Tests made on a new Edison Cell at University College, London. Sept. 1903—Jan. 1904.

Practically the same results had been obtained as those recorded by Mr. Hibbert. The cell weighed 17·8lb., and when properly formed it discharged, at 30 amperes, about 173 ampere-hours, or 212 watt-hours, and hence this corresponded to about 12 watt-hours per pound of fully-charged cell, the E.M.F. being on an average 1¼ volts. This cell was one of the 28-plate cells containing 14 positives and an equal number of negatives. His experiments were chiefly directed to ascertain as far as possible what could be done with a single cell. The first object of his observations was to ascertain how the cell was affected by abnormal rates of charge and discharge; secondly, if these high discharges brought about any permanent loss of capacity; thirdly, if the high discharges brought any of the active material out of the pockets; and, lastly, if any evidence existed of sensible local action between the active material and its supports. With regard to the first set of experiments the chart spoke for itself. The cell was continually discharged at greater and greater rates, commencing at 30 amperes and rising to a discharge beginning at 375 amperes tailing down to 170 amperes, the average being 266 amperes, and at that heavy discharge the cell had a very considerable capacity. The cell was always discharged on a constant resistance, and in the case of the heavy discharge it was short-circuited with $\frac{1}{100}$ ohm. That heavy discharge brought about a temporary diminution of the capacity, but at the end of 20 discharges the cell had come back to very nearly the same capacity as at the beginning. There were discrepancies between these discharges at constant rates, but this depended upon the time the cell stood between the charge and discharge. The chart gave the times between the charges and discharges. He had found, as Mr. Hibbert had also found, that the cell had a remarkable power of taking up a charge in a short time. With regard to the effect of the heavy discharges upon the active material, he desired to find whether the active material was brought out of the pockets by these operations. Consequently, he had the contents of the cell drained and the cell washed out in distilled water. The weight of the deposit taken from the cell was 1·4 grammes. This deposit he sent to the chemical laboratory and had it analysed, where it was found to contain carbon 22 per cent., and the remainder iron and nickel oxides, so that the active material came out only to the extent of 1·4 grammes in four months' use. He had in his laboratory a lead battery by a leading maker which had been in use for four years, and he had taken out 2cwt. of lead oxide from it, which was equal to about 1lb. per annum per cell. There were about 60 discharges in a year, so that the Edison cell was a considerable improvement. Then with regard to the local action between the active material and the supports. This seemed to be a very important point. It was well known that in the case of the lead cell there was a very considerable amount of local action between the lead support and the active material, and he had been anxious to see what evidence there was of any such action in the case of the Edison iron-nickel cell. One of his experiments was interesting. He had a number of pieces of iron prepared and polished. One piece was rusted on one half. Other bright slips of iron had some of the nickel and iron oxides placed on them, and all were placed in a vessel containing a 20 per cent. solution of caustic potash, which was the electrolyte of the cell, and allowed to stand in this for two months. At the same time a plate of lead having on one end a little PbO_2 was placed in dilute sulphuric acid. At the end of that time the iron plates were just as bright as when they were first put in, and a remarkable fact was that there was not the slightest extension of the rusted portion on the one piece of iron. The alkaline solution had prevented any extension of the rusting. The experiment also brought out the fact that nickel oxide and iron oxide were insoluble in the caustic potash solution. This absence of local action appeared to be a very important point, because it enabled the supports to be made of very thin metal. When the cells were opened one was surprised at the exceedingly thin sheet steel of which the supports were made, and also the thinness and lightness of the pockets. Mr. Edison's important discovery in connection with this subject appeared to have been the preparation of a particular form of oxide of iron which could be reduced by the electrolytic ions produced in caustic potash. In contrast with the lead cell, the electrolyte in this cell took no part in the chemical action. It merely served to convey the oxygen backwards and forwards. There was no change in the density of the electrolyte during the period of charge and discharge. There was an immense gain in getting rid of dilute sulphuric acid as an electrolyte and thereby enabling the use of a light mechanical metal vessel as the containing cell and one unacted upon by the liquid. He might mention that when taking efficiency tests of the cell, there was a little difficulty experienced in determining when the charge was complete, because the cell boiled all the time. But the manner in which the completion of the charge could be recognised was by a rise in the open circuit voltage as the charge approached its completion. All his tests had been laboratory tests, and he had not had an opportunity of carrying out any observations under automobile conditions. He had had sent him one of the new cells already referred to by Mr. Hibbert, but his experiments were not sufficiently advanced to be published, but as far as his laboratory tests were concerned the advantages of the old cell could be summed up in the following way:—As far as its weight and capacity were concerned, it was not distinctly greater—or not largely greater—than that of many light weight lead cells. On the other hand, there seemed clear evidence that the durability of the plates might be very much greater, and there was also good evidence that the disintegration or deposit of the active material was considerably less than the lead cell, and also that local action between the active material and the supports was practically absent, and that the cell in consequence of this would bear being left idle for a considerable time under a charge or no charge. At the same time it had an enormous power of taking up a charge. These were all very good points, and whilst results of further experiments would be awaited with interest before finally judging, there seemed to be no doubt that the arrival of this cell in the arena of practical work would stimulate improvements in all classes of cells. Mr. Wade read a Paper before that Institution four years ago, in which he began by classifying all possible secondary cells into two classes—viz., lead-sulphuric cells which were practicable and all others which were not practicable. But in the meantime, Mr. Edison had been at work and had produced an alkaline cell of very great value indeed, and in doing so he had laid the electrical engineering fraternity under a further obligation to him.

Mr. E. J. WADE said he thought his classification of secondary batteries four years ago, which had been referred to by Dr. Fleming, was justified then. He agreed that things now appeared to be on rather a different footing. He thought all the members who were interested in storage batteries owed a great debt of gratitude to Mr. Hibbert in that he had relieved them from the terrible alternations of hope and fear that they had been going through during the past two or three years, owing to the daily paper reports, and it was a relief to find that the lead battery was not yet compelled to put up the shutters, although there were formidable rivals. He felt afraid to raise any theoretical questions, and yet there were some points upon which he should like a little further information. Mr. Hibbert had dealt with the cell almost entirely from the outside. He had taken the ingoings and the outcomings but, figuratively speaking, he personally would have been glad if Mr. Hibbert could have got inside the cell and pulled it to pieces, and said a little more about the why and the wherefore of its action. For instance, with reference to Fig. 2 of the Paper he would like to ask what Mr. Hibbert considered the causes which determined the characteristic curves of discharge potential given there. The curves very closely resembled those of a lead storage battery. First, there was a rapid fall for a short time,

* *The Electrician*, Vol. XXIX., pp. 67, 95 and 119.

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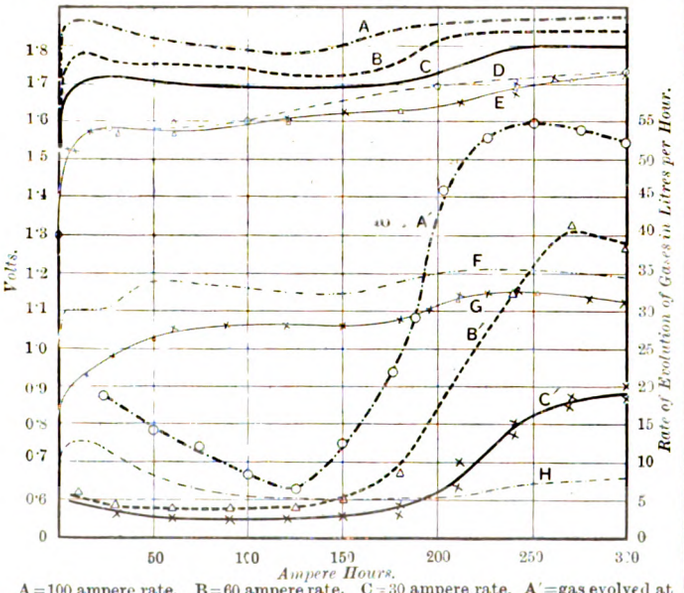
and then a long gradual fall recovering most of the practical discharge of the cell, and again a very rapid fall almost down to the vertical. Mr. Hibbert, in a Paper read before the Institution in 1892 in conjunction with the late Dr. Gladstone* on the causes of changes of E.M.F. in the storage cell, ascribed all these potential changes to variations of the strength of the electrolyte. Here was a cell in which one of the great points was that there were none of these variations, and yet the curves were almost similar. It seemed to him a point that wanted a little explanation. He rather fancied that in both cases the first rapid fall was due to the peroxide products in the cell, and the final fall to the specific resistance of the active materials. The intermediate fall was due to the slight variations in the concentration of the electrolyte, but still he thought these points wanted a little more elucidation. Then the point as to the remarkable way in which the potential curves were maintained at very high discharge rates. He did not notice that any specific explanation of this was given in the Paper, but it must be fairly obvious on the face of it. Some experiments which he had made on the lead cell seemed to confirm that point of view. He thought that if a more porous active material could be obtained it would be possible to do away with the reduction of capacity at high discharge rates, which at present existed with the lead cell, and bring it more up to what the Edison cell gave. He had lately prepared some lead cells with three or four times the porosity of the ordinary cell, and the discharge rate was very much the same as in the Edison cell. This showed it must be the exhaustion of the electrolyte in the lead cell that brought down the output at the high rates, and the absence of that caused it to be maintained in the Edison cell, because there was no reduction of the strength of the electrolyte. Everyone would accept Mr. Hibbert's results of his actual tests, but some inferences which he had implied with regard to lead cells should not be so implicitly accepted.

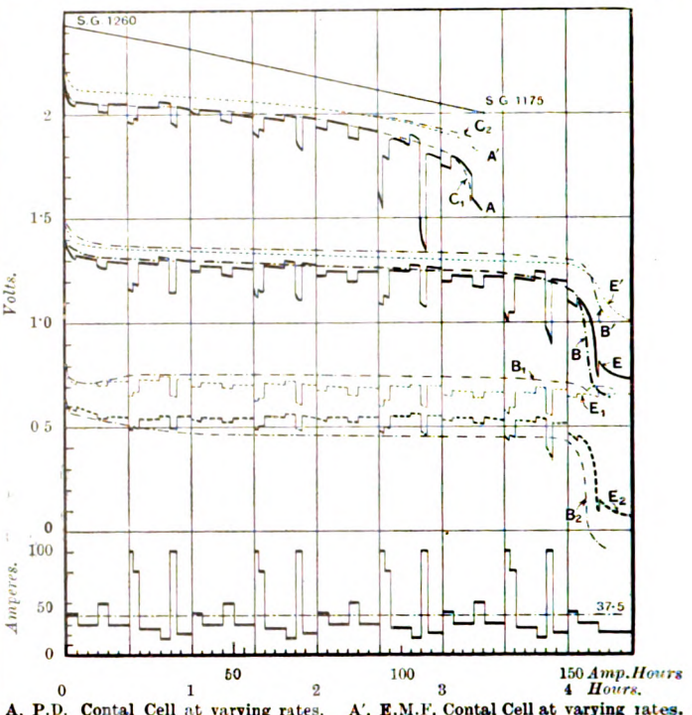
Mr. H. L. JOLY said that he had had an Edison cell in his laboratory since the beginning of December, 1903, and that the results of his tests were in accordance with those made by Messrs. Hibbert, Hospitalier and Janet. He did not know of any cell in which Peukert's coefficient was so low, and he came to the conclusion that it was perfectly safe to take it at 1·1; as far as he knew, this was the lowest figure on record. Dr. Fleming had said that the only indication they had of the Edison cell being fully charged was by measuring its E.M.F., and that when this became constant the cell was fully charged, but his (Mr. Joly's) experiments had led him to a different conclusion. The curves shown in Fig. 1 represented charges given to an Edison cell at three different



A=100 ampere rate. B=60 ampere rate. C=30 ampere rate. A'=gas evolved at 100 ampere rate. B'=gas evolved at 60 ampere rate. C'=gas evolved at 30 ampere rate. D=E.M.F. at 100 ampere rate. E=E.M.F. at 60 and 30 ampere rates. F=P.D. between iron electrode and case at 100 ampere rate. G=P.D. between iron electrode and case at 60 and 30 ampere rates. H=P.D. between nickel oxide electrode and case, common to 100, 60 and 30 ampere rates.

FIG. 1.—EDISON CELL CHARGE.

rates, curve A showing the rise in P.D. when charging at 100 amperes, curve B when charging at 60 amperes and curve C at 30 amperes. Immediately under these three curves were two others, that marked D showing the rise of E.M.F. corresponding to a charging current of 100 amperes, and that marked E to charging currents of 60 and 30 amperes. Now, it would be seen that the P.D. remained practically constant after the cell had received 250 ampere-hours, but the E.M.F. continued to rise, and this lead him to think that the E.M.F. was not a true indication of the state of affairs. Moreover, the curves A', B', C', which represented respectively the rate of evolution of gas, when charging at 100, 60 and 30 amperes, in litres per hour, showed a downward tendency after the 250 ampere-hour point. This was probably due to a diminution in the quantity of free H_2O in the electrolyte, and everything tended to show that the cell was fully charged when it had received 250 ampere-hours, and it was, therefore, unnecessary to go as far as 300 ampere-hours. The curve F represented the P.D. between the iron electrode and the case at the 100 ampere rate, G represented the P.D. at the 30 and 60 ampere rates, and H showed the variation of P.D. between the nickel electrode and the case at all three rates of charge. He believed that careful gas analyses would prove of considerable value in investigating the internal behaviour of the cell and he had obtained some endrometric data, which tended to confirm this opinion. He also thought it interesting to investigate fully the comparative behaviour of the plates by means of an auxiliary electrode; cadmium was tried, but the use of the container itself gave more reliable figures. This method showed a drop on the negative electrode—indicated on Fig. 3—and a rapid recovery, at the same time as the P.D. dropped on the nickel plate and settled at the lower level. From some experiments it appeared that one might anticipate a second flat on the P.D. curve, if the iron electrodes had a smaller capacity than the nickel oxide plates, this flat being then due to the iron. The time necessary to form



A, P.D. Contal Cell at varying rates. A', E.M.F. Contal Cell at varying rates. C_1, P.D. Contal Cell at flat rate 37·5 amps. C_2, E.M.F. Contal Cell at flat rate 37·5 amps. E, P D. Edison Cell at varying rates. E', E.M F. Edison Cell at varying rates. E_1, P.D. Negative Electrode to case. E_2, Positive Electrode to case. B, P.D. Edison Cell at flat rate. B', E.M F. Edison Cell at flat rate. B_1, Negative to cell. B_2, Positive to cell.

FIG. 2.—EDISON CELL AND "ELECTRICIA" (CONTAL) AT VARYING RATES (37·5 AMPERES HOURS PER HOUR).

the plates he did not regard as excessive, and, as a matter of fact, it was not more than was required by a lead battery when the plates were bought dry. A Jungner cell containing five nickel and four iron plates tested by M. U. Schoop last year, both in Sweden and in Germany, had lost 10 per cent. of its capacity in transit. Regarding Mr. Hibbert'

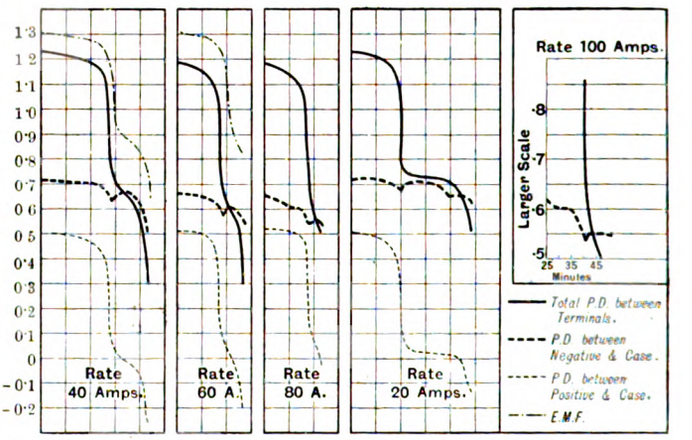


FIG. 3.—ENDS OF P.D. CURVES ON DISCHARGES AT CONSTANT CURRENT SHOWING INDIVIDUAL BEHAVIOUR OF ELECTRODES.

figure of 600 miles as being the average life of a lead battery, he was afraid he could not agree with this. He knew that a battery having a capacity of 140 ampere-hours, and working at a rate of 30 amperes, would run for 4,000 ton-miles without washing. The specific gravity of the acid in this case would be 1·250 to 1·260, each cell would weigh 23lb. and the battery would run 28 miles per day on the average. A lead cell of this type, discharging for three hours at the rate of 37·5 ampere-hours per hour, obtained by a series of varying rates, as shown in Fig. 2, would give 112·5 ampere-hours, and taking the average voltage as 1·93, the watt-hours worked out at 217. An Edison cell working for four hours at the same rate would give 150 ampere-hours, and this, multiplied by the voltage, which might be taken as 1·26 (though this was higher than in the

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experiments), became 189 watt-hours. Each lead cell would weigh 10kg., and, as there would be 44 cells in the battery, the total weight would be 440kg. Each Edison cell, on the other hand, would weigh 7·7kg., but there would have to be 70 cells in the battery in order to obtain the same voltage, and the weight would therefore be 539kg. Some people had said that the voltage variation of the Edison cell was a serious disadvantage; but when calculated out it was perfectly obvious that this accusation fell to the ground. For instance, in the lead cell, the voltage at the beginning of the discharge might be taken as 2·1, and at the end as 1·75; this showed a variation of 0·35, and with 44 cells in the battery there would be a total variation of 13·2 volts. The beginning of the discharge of the Edison cell might be said to commence at 1·3 volts, and finish at between 1 and 1·1 volts; this was a variation of 0·2 volt, and when multiplied by the number of cells in the battery the total drop worked out at 14 volts. In a lead cell with which he was acquainted, the electrodes were wrapped in asbestos, and after a 6,000-mile run with a battery composed of these cells, not the slightest trace of mud was discovered. In some cells of that type used in the laboratory the efficiency fell off about 7 per cent. in 18 months.

Mr. W. R. COOPER said the Paper was interesting from two points of view—one as a cell and the other from the point of view of automobilism. Everyone hoped that electric automobiles had a future, except those misguided individuals who went in for petrol. Mr. Hibbert had given details of some experiments on an electric runabout, but unfortunately they were not as interesting as they might be, because the runabout seemed to have been badly designed for the work. It was much heavier than runabouts generally were for the length it could go. It only went 34 miles on one charge, which was very little. However, the author had proved most of his points except that dealing with heavy discharges. He had related one experience which he said he would never forget, but there was only that one experience to go on apparently. He thought it depended upon the basis on which one took these discharges. If the weight of the cell was taken as the basis, then the discharges were certainly heavy, but the tendency in automoble work was to diminish the weight quite as much as to increase the capacity and, therefore, the capacity should be taken into account rather as a basis, and the discharges should be considered from that point of view. In these circumstances the discharges were not heavy. But as Dr. Fleming had dealt with this point he would not go into it. The interesting point was the extra discharge at low voltage. Mr. Hibbert had said that if it had not been for that he would not have got home at all. But he (Mr. Cooper) was not sure whether that extra low voltage discharge had really been relied upon or not. Was there a voltmeter on board and could any information be given from that? Then Mr. Hibbert mentioned the effect of temperature on the E.M.F., and the effect he thought he got he ascribed simply to the change of internal resistance. This seemed odd, because capacity must principally depend upon consumption of active material. Generally, raising the temperature increased the rate, and he did not see why raising the temperature of the cell should not increase the rate of electrochemical reaction and have the same sort of effect. Mr. Hibbert also mentioned the effect of short-circuits, and said he gave a long charge after short-circuit. No particulars were given of that long charge, but the efficiency of the cell was lower than would be expected under the circumstances, seeing that there was no local action. The efficiency of the motor, too, was put at 85 per cent., which seemed to be too high a figure for that size motor, and nothing was said as to whether there was gearing or not. He joined with Mr. Wade in being sorry that nothing was said as to the theory of the cell, because Mr. Hibbert had been so very much concerned with the theory of lead cells. Unfortunately, he gave only two equations at the end of the Paper, one of which appeared to be wrong. He would like to ask if Mr. Hibbert had been able to verify the composition of the oxides. And would Mr. Hibbert give any idea as to the calculation of the E.M.F. from thermo-chemical data? In this cell one could neglect the potash altogether, as it did not enter into the matter. Therefore, the E.M.F. was simply due to the heat of exhaustion at the two ends. The heat of the exhaustion of the iron by itself was sufficient to account for the E.M.F., and in order to get the E.M.F. there would have to be subtracted from that the heat formation of the other oxide. The heat of the formation of the iron was not so much above that as to leave very much to spare. It left a very small amount indeed, much smaller than one would expect.

Mr. W. H. PATCHELL said he had been concerned with cells which weighed tons, and not pounds, as this one did. These he had found perfectly satisfactory. With regard to the exhaustion of the electrolyte either in the plate or near the plate, when he first took up battery work they were in the thick of trying to make paste porous. They had all sorts of messes and combinations, but none of them gave good results in practical working mainly due to the local action. In those days it was not recognised how pure the materials really ought to be. Therefore, he thought that battery work was greatly improved, mainly due to the great care taken in the materials used and also in the question of circulation. In the early days, too, narrow forks were utilised. Many batteries were spoilt in those days through the forks being too close, and one of the factors of success had been due to the wider spacing. He regretted that none of the men who made batteries were present to speak in the discussion.

Mr. HIBBERT, in reply, said it would explain a good many lapses in the Paper if he stated that he had left a good many things out because he did not know. He did not know anything about the formation of the cell. It was sent to England with the liquid poured out so that the plates were freely exposed to any oxidising action of the air, and the long charging operations that had to be given to the cell when it was first put into use was not, strictly speaking, the formation corresponding to that which might or might not occur in the laboratory when the cell was made. He knew nothing of that. Dealing then with the speakers in their order, he could add one or two instances to the one mentioned by Dr. Fleming in which he analysed the active material drawn out of the pockets after working for some time. He had done it by breaking one up, which, in consequence of some very violent behaviour, had come to grief. The treatment of this cell on the London cab upon which it had been placed was of such an order that he had been led to make a protest. It was broken open and analysed. The result was that the proportion of the active material found at the bottom of the cell was one two-thousandth of the whole, and the cell had done something like 3,000 miles. The proportion of graphite and of oxide of nickel found was almost identical with that found by Dr. Fleming's colleague—viz., about one-fifth of the stuff which had been ejected. With regard to Dr. Fleming's experiment for two months on the rusting of iron in alkali, he himself was lucky in having been the observer of an experiment which lasted for 30 years. In 1874 he joined the staff of the Royal Institution, and he remembered very well that amongst the things in the museum there were certain bottles which had been sealed up by Faraday at least 30 years before that. These bottles contained brightly-polished steel and iron immersed in alkali, by Faraday, in order to study that very question. The steel in these bottles was as bright now as on the day they were sealed up. There might be some misapprehension as to the degree of interest which this particular subject had for chemical researchers, but within the last two or three years there had been some Papers on it, and the existing theories had been challenged, but he was pretty well assured that there was no reason to suspect that there would be any danger to the Edison cell from the rusting of the materials. Next, as to the possible objection to testing single cells. On the automobile he had worked 38 and then increased them to 60, and although he did not know the number of cells distributed over Europe, it must be quite 80 or 90. In view of this fact, and remembering also that all who had tested them had found results which had been almost repetitions, it seemed to him that the single cell testing objection had already fallen to the ground. Mr. Wade had remarked on the fact that all the data given in the Paper referred to external circumstances. This was simply because he knew nothing about the internal. The chemical data were vague. They were vague even with reference to the oxides of nickel which had been prepared by pure chemical processes and were amenable to straightforward examination, and he suspected that when the task of examining these electrochemical oxides had really been carried through it would be found that a higher proportion of nickel oxides existed than had been indicated in the formula he had used. Mr. Wade had asked him to explain Fig. 2. The variations were similar to the curves of a lead cell and at the first glance it might be supposed that the same explanation would apply to both, but it had to be remembered that that anticipation was initiated by the fact that there was a distinctly known verified change in the one case which did not occur in the other. There was a change in the density of the acid in the porous plate at the beginning of a very rapid order and also at the finish of a very rapid order. There were also changes in the density of the acid in the middle charge, which were not of a very rapid order, and changes in the density of the acid were known to be obtained to bring changes in the E.M.F. of the lead cell, and it was fair to suppose this to be the case. There was one point in the behaviour of the lead cell in this connection which had a very strong bearing on the whole subject. A 10 per cent. increase in the capacity could be obtained by an increase in the temperature. Temperature could be taken as sufficient cause for the rapid fall in the P.D. at the end of the discharge, and he was justified in regarding the changes in the lead cell as due to changes in the density of the acid liquid. On the other hand, there were no such changes in the density of the electrolyte in the Edison cell. His experiments showed that at the end of a discharge the resistance of the cell was going up very quickly indeed. Mr. Joly had spoken of his quoting only 600 miles as the capacity of the lead battery on an automobile. This figure was given on the authority of a very fair number of gentlemen engaged in the industry who had been asked this very question. Mr. Cooper had asked several things about the runabout. He had to take this as he found it. It was not a bit too heavy for the work it was given to do, for the wheels came off a quarter of an hour after he turned it up at the London garage, and he was very glad it had been made as solid as it was. The voltmeter was not read in the storm referred to, but if the remarks which he had made in connection with that particular journey were read carefully, it would be found that he gave up trying to observe. He could not see the voltmeter for the wind and the rain. Mr. Cooper had remarked that the capacity of the cell had been deduced and not ascertained. What he had to say about this was that when he tried to estimate the output in ampere-hours, he had made a self-denying ordinance that the figure he gave would be a very low minimum indeed, but if he had given his own unbiassed opinion he would have put it at a very much higher figure. But he thought it only wise under the circumstances to put the figure as low as he possibly could. Similarly with regard to the 85 per cent. efficiency of the motor. He had put the case as strongly as he could against the cell. He had no information on the possible changes produced by temperature on the active materials or alkali, except that the change of resistance of the potash solution with temperature was known to be of the order of 2 per cent. per degree centigrade, and therefore he could only refer to that well-known figure in this connection. It would be remembered that he said in his verbal epitome of the Paper that, after he had done with the cells and had resumed his ordinary winter's work, they were placed on a cab in London, which was given special duty with the object, if possible, of knocking the cells to pieces. Practically the instruction was that they were to break them down by running them about if possible. Well, five out of the 60 had been somewhat injured as regards capacity. They were distinctly lower than at the time he turned them over. Since then he had had nothing to do with them, but that afternoon he had made an experiment on one of the cells whose capacity had fallen from 160 ampere-hours to 70 or 80. By

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a tolerably simple process of regeneration he had brought it back to 122, and he anticipated that when the process to which he had subjected it had been repeated several times it would be brought back much nearer to its original capacity. The process of regeneration consisted in giving it a big discharge and a reversed current for a fair length of time. Another anticipation of his was that, by a fairly simple procedure, he could prevent the mischief which had brought down the capacity. If they joined the fact that he had already restored 40 per cent. of its lost capacity with the fact that he was hoping to prevent the reduction of its capacity in the future, it should lead, not to a diminution, but to an increase of confidence in the cell.

The PRESIDENT said that the applause rendered it unnecessary for him to propose a vote of thanks to Mr. Hibbert for his very interesting Paper.

ELECTRICITY IN MINES.

The following is an abstract embodying the main points contained in the report by the Departmental Committee on the Use of Electricity in Mines, which has just been issued. The proceedings of the Committee were reported in *The Electrician*, Vol. L., pp. 652, 819 and 937, and Vol. LI., pp. 78, 125 and 168 :—

Fifty-six witnesses were examined—viz., 13 scientific experts, electrical engineers and manufacturers of electrical apparatus; 19 colliery proprietors and managers; 17 miners' agents and miners; seven safety and electrical fuse makers, &c., and representatives from an insurance company. The Committee paid visits to several collieries for the purpose of seeing existing electrical installations. They selected one in the South Wales district, two in the Midlands and two in the North of England. On March 4th they inspected the installation of the Tredegar Iron and Coal Co. (Ltd.), near Tredegar, on March 12th the installations at the Florence and Sneyd collieries, near Stoke-on-Trent, on March 20th that at Messrs. Pease and Partner's Eldon colliery, near Bishop Auckland, and on November 20th that at Messrs. Pope and Pearson's colliery, near Altofts. On the latter day they also witnessed a repetition of some of the experiments detailed in Mr. Garforth's evidence. (*The Electrician*, Vol. LI., p. 125.) The report continues:—

Use of Electricity.

During the hearing of the evidence one point in particular impressed us—namely, the very large part that electricity is likely to play in mines in the future. It is no part of our business to decide whether continuous or alternating-current is the best for use in mines. The alternating system, in spite of its greater complications, especially when three-phase current is employed, seems well adapted for long-distance transmission, and we also had evidence as to the successful working of heavy winding and pumping machinery by it in Germany. The general tendency in American mines is, however, to the use of continuous-current plant. Possibly this is influenced by the large use of locomotives on this system. It seems very probable, therefore, that the solution, at any rate for large schemes, will be alternating current for generation and transmission. As regards the kind of current likely to be used for motors, up to the present those which have to be frequently started and stopped have been most successful on the continuous-current system, but we hope that the progress now being made in the improvement of alternating-current motors will lead to the development of a thoroughly reliable motor without commutator or rubbing contacts, which can be started and run without causing a disturbance on the system or necessitating elaborate starting gear. It is evident that for use in fiery mines a motor without parts liable to sparking is preferable to one with such parts, no matter how well designed the boxing-in may be. On a visit to Messrs. Pope and Pearson's Altofts colliery, near Normanton, we saw a coal-cutter which daily cut 250 tons of coal, holing under the face to a distance of 6ft. The machine is driven by a three-phase induction-type motor, and has worked well for some years. The use of the three-phase system has been somewhat restricted in this country, but it seems probable that in the near future its employment will be largely extended, owing to the advantages it presents for transmitting power from a central generating station to scattered collieries, and its adaptability for obtaining varying voltages by means of transformers. In our opinion, this system deserves the careful attention of all who intend to instal electricity in mines.

Dangers of Electricity.

Electricity, when properly installed, presents, we think, no features of such danger as would justify its prohibition. Explosives in mines may not only cause accidents to those engaged in using them, but might cause explosions of fire-damp unless properly handled, and yet it is not too much to say that they present features of danger greater than any that are likely to be found in electricity if properly employed. When we reflect upon the mitigation of severe and exhausting labour, and the far greater efficiency that the use of electricity is likely to produce, and which ought to result in benefit to the miner, the consumer, and the coal owner alike, we have no hesitation in saying that this new agent ought to be welcomed. The representatives of the owners and of the miners fully appreciate these views, and of the numerous witnesses who appeared before us there was not one, whether owner, engineer, manager or miner who offered the least objection to the use of electricity when proper precautions were taken. But although we are prepared to advise that the fullest latitude should be given to the great development of electrical machinery in mining which we believe is about to take place, we desire to record our emphatic opinion that those who are to use it, and to be exposed to any dangers that may arise from it, have a right to demand that every precaution should be taken that is reasonably possible to secure their safety.

Necessity for Regulations.

While, therefore, we anticipate great advantages from the use of electricity, and believe that it will lessen the severity of the toil of the miners and the labour of getting coal, we are convinced of the necessity of taking precautions against avoidable accidents and of laying down rules for the use of electricity in mines. The practice and opinions of engineers differ considerably, and it is, therefore, by no means easy or desirable to prescribe too rigidly the systems that ought to be employed. Bad work, even in the first instance, does not save 20 per cent. of prime cost, and always ends in occasioning far more loss than the initial saving. In the record of accidents which have occurred, the cause can almost always be traced to bad plant or arrangements. The reason of the unsatisfactory condition of the plant in many mines is, we think, to be found in the fact that the electricity was introduced by instalments and upon a small scale. This timidity has led in too many instances to insufficient power being supplied, and to the work being done in a temporary manner. But when once it has been introduced it has almost invariably proved so successful that its auxiliary and temporary character has passed away, and it has become not only a permanent necessity, but a prime factor, with the consequence that the capacity of the plant as first introduced has been strained to the utmost, and has not unfrequently broken down under these adverse conditions, and ultimately had to be replaced entirely by larger and more perfect appliances. Admitting that the pioneers in the adoption of any new scientific application must necessarily suffer for being the first to carry out progressive ideas, some of the accidents in the past must be considered as having arisen through lack of experience, and happily this class of accident is diminishing in number. We think that one of the chief causes of this is due to the fact that the use of high voltages has been regarded as dangerous, and low voltages as quite safe. The consequence has been that while high voltages have been altogether proscribed, low voltages have been used recklessly. In adopting a pressure of 500 volts as a maximum, the fact has too often been lost sight of that, though generally a shock at this pressure would not be fatal, yet under the peculiar conditions of mining work, a shock at a very much lower pressure might easily cause death. To such an extent did the idea prevail that safety had been secured by the use of low voltages, that men and boys were in the habit of frequently giving each other shocks from the power plant, and in one pit we visited we were told that a particular pony was sometimes got to move by the application of an electric shock. In fact, the electric installation has often been treated as a plaything, and the imagined safety has proved one of the chief dangers. On the Continent, on the other hand, it has been recognised that danger may arise from electricity at as low a pressure as 100 volts, and consequently the whole electric installation has been treated as being a source of potential danger, and is so protected as to make it difficult, except in the case of a wilful act, for anyone to receive an injury. It becomes herefore, of great importance to consider what restrictions should be put on the pressure at which electricity should be used. At the face we consider that a reasonable limit would be medium pressure, not in any case to exceed 650 volts. But in the rest of the mine, if proper precautions are taken, we have no reason to think that there would be undue danger in much higher voltages. As for danger from shock, it is in a wet mine nearly as great with a medium voltage as a high one, and bad apparatus is capable even at low voltages of causing fires or exploding gas. When once, however, the apparatus is of excellent quality, well installed, and completely protected, there seems no reason to apprehend undue danger either in mines or factories from the use of high voltages, and we do not see why in the United Kingdom any more stringent limits should be imposed than have been found necessary on the Continent.

General Principles Governing Installations.

Though we do not wish to imply that the risks attendant on the use of electricity, where an installation is properly put in in the first place and maintained in good order, are comparable to the dangers which are and must be attendant on the use of explosives, at the same time we cannot shut our eyes to the fact that if an installation is not of thoroughly good quality and also maintained in a state of efficiency, it must add one more to the several dangers which it is the lot of the miner to face in his daily occupation. We think that the general principles which should govern the employment of electricity in mines are as follows:—

1. The electric plant should always be treated as a source of potential danger.

2. The plant, in the first instance, should be of thoroughly good quality, and so designed as to insure immunity from danger by shock or fire; and periodical tests should be made to see that this state of efficiency is being maintained.

3. All electrical apparatus should be under the charge of competent persons.

4. All electrical apparatus which may be used when there is a possibility of danger arising from the presence of gas should be so enclosed as to prevent such gas being fired by sparking of the apparatus; when any machine is working every precaution should be taken to detect the existence of danger, and on the presence of gas being noticed such machines should be immediately stopped.

Application of Electricity.

We will now pass on to make a few observations on the various applications of electricity to mining work, and formulate the general principles which should be followed. For this purpose we will divide our subject into nine groups, viz.:—(1) Generating stations; (2) cables, switches, fuses, &c.; (3) stationary motors; (4) portable motors for coal-cutters, drills, &c.; (5) electric locomotives; (6) electric lighting; (7) shot-firing; (8) signalling; (9) electric re-lighting of safety lamps.

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Generating Stations.

As the effective working of any plant must depend on efficient supervision at the source of power, it is of great importance that the generating station should at all times be in charge of a competent person. Familiarity with the dangers of electric shocks does not prevent accidents from occurring to skilled men at generating stations, and past experience shows that, unless suitable precautions are taken in protecting the live parts of electric apparatus, such accidents are bound to recur. The two defects most commonly met with are:—

1. Insufficient room at the back of switchboards to enable a man to carry out an alteration or repair without risk of contact with a live part.

2. Absence of protection from contact with live metal work charged at any pressure above the limits of low pressure.

Many modern switchboards are so arranged that there is no live metal work on the front of the board, and there appears to be no valid reason why this practice should not be universal where contact with live metal might be dangerous. We may add, that in all places where conductors at a high voltage exist, it is very desirable to paint them some distinctive and conspicuous colour. As the majority of breakdowns arise from a leakage of current to earth we consider that all currents should be, as far as practicable, insulated from earth. Each generating station should be provided with an instrument to indicate leakage to earth, and a record should be kept detailing its readings periodically.

Cables, &c.

The risks to be guarded against, so far as the installation of cables is concerned, are three—namely, liability of shock to workmen, liability of setting fire to woodwork or other inflammable material, and the possibility of originating a gas explosion. The conditions met with in mining work are generally more unfavourable than those experienced elsewhere. The atmosphere is generally warm and sometimes damp, and frequently the presence of acidulated water adds to the difficulty of maintaining an effective insulation. The insulation, moreover, is liable to abrasion from such external causes as a fall of roof or the derailment of trams. All witnesses agreed that, while the greatest care should be taken that the cables are of sufficient size for their work, the selection of any particular method of laying them must be entirely governed by the conditions of the particular mine concerned. We feel, therefore, it is not possible for us to advocate any particular system of wiring as being the best under all circumstances, but we have arrived at the conclusion that the following general principles should be observed:—

1. To secure immunity from shock and fire, and to obtain security against explosion, bare cables are undesirable, and their use ought to be restricted to special cases. Cables should be properly and substantially insulated, all contacts covered, and in places where danger from gas is to be feared all parts of the system at which sparking is probable should be enclosed in flame-tight covers, which, if metallic, should be efficiently earthed.

2. Cables should be placed so as to be as little liable as possible to be touched by any person or passing traffic, and when carrying a current at a pressure exceeding the limits of low* pressure, they should be well armoured with a strong earthed metallic sheathing or casing, unless they are fixed at such a distance apart or in such a manner that there shall be no danger of shock.

3. The system of cables and junction boxes should be so arranged as to afford facilities for examination or repair.

4. Cables when suspended from the roof or sides of roads should be allowed sufficient sag to yield when struck, and should be suspended by means of suitable materials, so arranged as to give way before the cable can be seriously damaged in the event of a fall.

5. Cables should in all cases, whether at terminals or junction boxes, be so secured mechanically that any outside strain coming upon them may not be taken by the contact which carries the current.

6. When junction boxes are used to connect cables with metallic covering, special care should be taken to ensure the continuity of the covering by bonding it to the box on each side.

7. Except where electric locomotives are employed, or under other very special circumstances, an earthed-return is inadmissible.

8. Evidence has been given that cables ought to be taken down the down-cast shafts. This, as a rule, is preferable. But there may be cases where it is better to take them down the up-cast, as, for instance, where the down-cast is much encumbered with timber. It seems therefore impossible to make a hard-and-fast rule on this subject.

9. Subsidiary cables, from the nature of their employment and situation, are of necessity more subject to damage than main cables. The restricted size of subsidiary roads, the constant need of alterations and extensions, and the greater liability to damage from falls, all tend to greater wear and tear, and call for even more care to ensure their being kept in good order than is the case with main cables. A frequent cause of the failure of subsidiary cables is the multiplication of motors in special parts of the mine until finally the cables become overworked. In no portion of a mine is this more likely to occur than near the coal face, when a subsidiary cable originally installed to convey power to one or two machines may have its insulation badly damaged by too heavy a current. These causes—namely, the risk of damage by abrasion and casual overloading which are specially incidental to subsidiary cables—render it desirable that, in order to reduce to some extent the risk of shock, the voltage allowed in subsidiary cables should be limited. We think that this maximum voltage might reasonably be fixed at a pressure not exceeding the limit of medium pressure.

10. One of the many difficult problems that the application of electricity to mining work has brought to light is the provision of efficient trailing cables. They must be extremely flexible, and at the same time of sufficient sectional area to carry the abnormally heavy current which will arise under certain working conditions—*e.g.*, when a coal-cutter jams; and, moreover, as the cable is used trailing on the ground and sometimes trodden under foot, the insulation must be protected from abrasion with special care. Though we cannot recommend any particular form of covering, we feel that some such covering should be employed, and that frequent inspection should be made to detect the commencement of any serious damage, and that when such abrasion has been discovered, the faulty cable should be disconnected. We recommend that a spare cable should be kept near for replacing a damaged one in order to minimise the temptation to continue working with a cable so damaged as to be a source of danger.

11. Though cables may be thoroughly good when first installed, it is of the utmost importance that their efficiency should be maintained, and that any defect of insulation should be speedily discovered and repaired. To secure this end we think that periodical insulation tests should be made, and that a proper record should be kept of the results. We must point out, however, that with unarmoured cables suspended in a roadway the insulation may become perished or damaged at some place between the points of suspension. In this case no leakage would occur until an "earth" was made at that particular place, and, consequently, the insulation test might prove misleading, while on a similar test with a continuously-armoured cable such a defect would be immediately discovered. We think, therefore, that in addition to the insulation test, it is important that periodical inspections of all exposed cables, more particularly those not armoured, should be made.

12. In addition to the switches at the motors it is advisable that facilities should be afforded by which a branch line can be cut out when that section of the wiring is under repair, or not being used for the conveyance of a current. Without the employment of such switches the risk of accident to men engaged in overhauling motors or repairing sections of the line is increased. The switches themselves, however, may prove a source of danger unless properly protected, and special precautions should be taken that the switch handle or lever is so arranged that it cannot be accidentally moved from the "off" to the "on" position, and so turn on the current while the alterations or repairs are in progress.

13. Switches, fuses and automatic circuit-breakers should be secured from being tampered with, and should only be accessible to authorised persons. Their covers should be of uninflammable material, and if of metal should be efficiently earthed when used with any pressure from which a shock might be dangerous. The following precautions should also be observed:—When there is a possibility of the presence of gas their enclosure should be flame-tight. Freedom from risk of firing gas by the spark which occurs on breaking a circuit can be secured by arranging that the break takes place in oil. All fuses should be clearly marked to indicate their current-carrying capacity, and if of plain wire they should be provided with proper lugs to go under the clamping screws. Spare fuses should be kept at the fuse boxes, but should only be replaced by an authorised person, who should always cut off the current by the switch before inserting the new fuse. On circuits carrying heavy currents automatic circuit-breakers are preferable to fuses, and the same conditions as to their breaking under oil or being enclosed in flame-tight boxes should obtain. The use of such devices as fuses or circuit-breakers is of great importance, not only to protect the cables but the motors. For instance, in coal-cutting machines, in the event of the cutter meeting a hard substance or becoming retarded or jammed an increased current will pass through the coils of the motor to enable it to overcome the extra resistance, and if some limit be not placed on the amount of current a point will be reached at which the insulation of the coils will give way, and they will be burnt out. When gas is likely to be present it is obvious that the burning out of a coil must constitute a great danger.

(To be concluded.)

* We have adopted in our report and code of rules the division of pressures which we understand has been recently settled by the Board of Trade, viz.:—

Low, under 250 volts.
Medium, from 251 to 650 volts.
High, from 651 to 3,000 volts.
Extra high, anything above 3,000 volts.

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(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Handbuch der Elektrotechnik," Vol I., Parts 2 and 3, "Die Elektrischen Ausgleichvorgänge der Ferromagnetismus," by Dr. C. Heinke; "Die Theorie des Elektromagnetismus," by D. H. Ebert (Leipzig: S. Hirzel.) 25 marks.

"Elektromechanische Konstruktionselemente." Edited by Dr. G. Klingenberg. Part 4. (Berlin: Julius Springer). 2.40m.

Society of Engineers.—At a meeting of the Society of Engineers on Monday last, the following premiums for Papers read during 1903 were announced:—The President's Gold Medal to Mr. Douglas Mackenzie for his Paper on "Motor Transport for Goods," the Bessemer Premium of Books to Mr. Robert J. Thomas for his Paper on "Road Maintenance and Administration," and a Society's Premium of Books to Mr. Albert Gay for his Paper on "Mechanical Stokers for Electricity Generating Stations." Mr. J. Patten Barber, the retiring president, then introduced Mr. D. B. Butler, the president-elect, who subsequently delivered his inaugural address.

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THE EDISON STORAGE BATTERY.

After a long period of suspense and speculation the mystery connected with the famous Edison storage battery has at last been solved, and engineers have now some definite and reliable data to work upon. Some months ago the manufacturers of this cell, in America, sent samples to various European storage battery experts for examination and report; the experts included Mr. W. HIBBERT, Dr. J. A. FLEMING, MM. HOSPITALIER and JANET and Dr. GEORGE FINZI of Milan. The first-named gentleman, in addition to furnishing a report, also read a Paper before the Institution of Electrical Engineers (see *The Electrician* of November 27, 1903), but, owing to lack of time, the discussion was postponed until January 28th, and, as a consequence, interest in the matter had, to a large extent, died out. Before Dr. FLEMING opened the discussion, Mr. HIBBERT announced that a new type of cell had been brought out by Mr. EDISON, in which there were six negative and 10 positive plates, and that this was superior to the old form. Curiously enough, however, M. JANET, in his Paper before the Société Internationale des Electriciens, stated that the new type contained 20 positives and 10 negatives, so that there is evidently a discrepancy somewhere. But the vital fact remains, nevertheless, that Mr. EDISON has seen fit to change the original peculiar arrangement of an equal number of positive and negative plates, which we criticised on a previous occasion. If, indeed, the relation between the capacity and weight of the new cell is represented by so high a figure as 13·7 watt-hours per pound, and this is not at the expense of durability, a great advance has certainly been made in storage battery construction.

Dr. FLEMING'S remarks tended to confirm the information given in Mr. HIBBERT'S Paper, but beyond that there was very little that was new or fresh. He expressed unbounded confidence in the cell, and introduced certain interesting figures and diagrams, which we reproduce. The absence of local action is an exceedingly important point, and permits of the use of very thin plates, which, being more or less flexible, are not so susceptible to mechanical shock. Dr. FLEMING'S opinion, that it is an immense gain to get rid of dilute sulphuric acid and use a metal containing-vessel with caustic potash instead, will probably meet with objectors. Sulphuric acid is not agreeable stuff to work with, but caustic potash is immeasurably worse. Acid may be removed from the hands by simple immersion in water, but the application of water to the alkaline solution tends to spread it over

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a larger area, and thus increases the annoyance; it also has a destructive effect on the skin. The use of a metal containing-vessels makes it essential that the cells do not touch each other, but this is not a very onerous condition to fulfil. One point that no speaker mentioned in the discussion was that, in spite of the gravity valve, a good deal of potash solution is ejected from the cell, but this, again, is a defect for which a remedy may be found without difficulty.

Mr. WADE touched upon points uppermost in the minds of most storage battery engineers—viz., the theory and internal working of the cell. There is, even now, a good deal of mystery attached to the lead cell, and no one accurately understands all that goes on throughout a complete cycle of operations, but it is perfectly safe to say that far less is known of what takes place within the nickel-iron cell. Even the oxides of nickel are hypothetical, and no change of density occurs in the electrolyte during charge and discharge. The P.D. curve of the lead cell is explained by the changes in the density of the electrolyte, but although the P.D. curve of the Edison cell is similar in character to that obtained with a lead cell, it cannot be explained in the same way, for the density remains the same all through. Of course, it is quite possible that the specific gravity of the electrolyte may change in the pores of the active material so slightly as not to affect the mass of the liquid sufficiently to obtain a difference in hydrometer readings; at the same time, it may be just enough to cause the gradual intermediate fall in E.M.F., as indicated by the characteristic curve. When this mystery is solved many of the other difficulties will probably disappear simultaneously. Mr. HIBBERT was wise to say nothing of which he was not absolutely certain, but we rather fancy that he knows a good deal more than he cared to say, and it is by no means improbable that the Institution, or another scientific society, will have the opportunity, at no distant date, of listening to the result of further investigations.

Mr. JOLY'S contribution to the discussion was really the most valuable of all, as his researches were quite disinterested and not inspired in any way. From the practical man's point of view, his finding of the Peukert coefficient at so low a figure as 1·1 is of extreme importance. But it appears that the new type of cell gives even a better figure than this. For automobile work, then, the cell is admirably suited, for it matters little whether it be discharged at high or low rates, as its capacity remains practically the same in every case. There is a difficulty in determining the point at which the cell is fully charged, and Mr. JOLY'S curves, given on another page of this issue, show that it is not correct to assume that this point is reached when the E.M.F. ceases to rise. With lead batteries it is the custom to cut off the charging current when the E.M.F. has risen above a predetermined value and when both plates are giving off gas freely. But the Edison cell gases throughout the entire charge, slightly at first and increasing as time goes on until a certain point is reached, when the evolution of gas begins to diminish. It is at this particular point that the P.D. remains stationary, and the natural inference is that the cell has then become fully charged, all further energy put into it being simply wasted, in spite of the fact that the E.M.F. continues to rise. The diminution in the volume of gas given off may, as Mr. JOLY suggests, be ascribed to decrease in the quantity of free water in the electrolyte. It would thus appear that the efficiency of the cell may be slightly greater than that credited to it by various authorities.

The loss of capacity which takes place when the cell is left standing for any length of time, or after it has been emptied of electrolyte, is not a serious matter, and the time required for formation is not a feature to which great importance need be attached. This difficulty exists in the case of lead batteries, and unless the plates receive very careful treatment they are often ruined by being left out of the electrolyte for any considerable period. From available data it does not appear that the Edison plates suffer any permanent loss of capacity through exposure to the atmosphere, but it is common knowledge that there is danger of such permanent loss as well as mechanical damage when a lead cell is subjected to similar treatment.

Although there is yet much to learn concerning the new battery, it must be admitted that records of tests have shown it to be possessed of certain features too important to be overlooked. Before authoritative information was available there was a good deal of scepticism, and, considering the published reports of alleged performances, this scepticism was undoubtedly fully justified. The public was lead to believe that Mr. EDISON had invented an appliance which would cause a revolution in electric traction, and it was reported that he had driven an electric vehicle for 1,000 miles on one charge. These, and similar concoctions, were eagerly devoured by the layman and laughed at by the engineer. So absurd and frequent did they become that electrical engineers in this country came to look upon the Edison cell as an "invention" of quite another nature, and began to despair of ever beholding a specimen. However, after several years of patient waiting the cell has been seen, tested and worked to the satisfaction of English secondary battery engineers, and it only remains to say that, although it is not in the least likely to effect a revolution in accumulator traction, there does not remain a shadow of doubt that it has many features which are superior to those possessed by the lead cell. Provided the price is not excessive the outlook is bright, and we congratulate Mr. EDISON on having produced a battery which marks another stage in the progress of the industry.

OBITUARY.

WALTER GEORGE McMILLAN.

It is with deep regret and with a sense of personal loss that we announce the death of Mr. W. G. McMillan, Secretary of the Institution of Electrical Engineers. At the last meeting of the Institution it was announced that Mr. McMillan had been ill, but was well on the road to recovery. He was laid up with a chill a little over a fortnight ago, which developed into an attack of pleurisy. Although recovery was retarded by the inclement weather and the strain which had been induced by recent overwork, it was anticipated last week that Mr. McMillan would be well enough to resume his usual duties in a few days, but on Monday last came the sad news that he had suddenly and unexpectedly died of heart failure on the previous night.

Walter George McMillan was born in January, 1861, and was therefore only 43 years of age at the time of his death. He was educated first at King's College school and then at King's College, obtaining the Daniell Research Scholarship at the College in 1880. Mr. McMillan made a special study of metallurgy, but on leaving college he wisely worked for about a year with an accountant in order to obtain an acquaintance with business methods. He then returned to the College as private assistant to the Professor of Metallurgy, and in 1883 he was appointed Demonstrator in this department. He remained in this position until 1888, when he accepted a five years' appointment under the Indian Government as chemist and metallurgist to the Cossipore Ordnance Factories, near Calcutta. Immediately on his return to England he was elected to the lectureship of metallurgy at Mason College, Birmingham, and he held this position until 1897, when he

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was appointed secretary of the Institution of Electrical Engineers on Mr. F. H. Webb's retirement.

Mr. McMillan has written much on electrochemistry and electro-metallurgy, and his most recent work in this direction was the writing of two articles on these subjects for the supplement of the "Encyclopædia Britannica." Among his other writings were a "Treatise on Electro-metallurgy" for Messrs. Griffin's "Scientific Text-book" series in 1890, and a translation with notes of Dr. Borchers' "Electro-metallurgy" in 1897. Whilst in India he was examiner in chemistry at the Calcutta University, and at the time of his death he was examiner in electro-metallurgy for the City and Guilds of London Institute. Mr. McMillan was a Fellow of the Institute of Chemistry and of the Chemical Society, and was vice-president of the South Staffordshire Institute of Iron and Steel Works Managers in 1897. Mr. McMillan leaves a widow and two young children.

During the six years that Mr. McMillan has been secretary of the Institution of Electrical Engineers he has carried out his duties in an energetic and enthusiastic manner, and his unfailing courtesy and his earnestness and thoroughness in whatever he set his hand to won for him the esteem of every member of the Institution, from the President down to the youngest student. Although he came almost as a stranger to the majority of the members, he became extremely popular almost from the day he was appointed. For the part he took in the successful organisation of the Local Sections of the Institution the Council and members owe him a debt of gratitude, and the excellent arrangements for the visits of the Institution to Switzerland, Paris, Germany and Italy were examples of his untiring energy and perspicacity in matters of detail. We ourselves have always found Mr. McMillan ready and willing to assist us in all matters connected with the Institution, and since he assumed the office of secretary have never had a moment's disagreement with him. At the offices of the Institution everything was found in perfect order at his death, which was characteristic of his systematic method of executing the duties allotted to him.

The funeral took place yesterday at St. Leonard's Church, Streatham. Several prominent members of the Institution of Electrical Engineers were present, including Mr. R. Kaye Gray (President), Prof. S. P. Thompson and Major-Gen. Webber (Past Presidents), Dr. J. A. Fleming, Messrs. J. Gavey and J. E. Kingsbury (Vice-Presidents), Messrs. Robert Hammond, H. E. Harrison, W. M. Mordey, W. H. Patchell and J. H. Rider (members of Council), Mr. W. R. Cooper, Mr. H. Moir (Vice-Chairman of the Newcastle Local Section), the Secretary of the Institution of Mechanical Engineers, the Editor of *The Electrician*, and Messrs. P. S. Rowell, R. Tree and A. Tree (members of the secretarial staff of the Institution). After the service the remains were cremated at Golder's Green.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Telephony. A Manual of the Design, Construction and Operation of Telephone Exchanges. By ARTHUR VAUGHAN ABBOTT. Vols. I., II., III. and IV. (New York: McGraw Publishing Co.) 1903. $1.50 per volume or $6 per set of six volumes.

The four volumes that have been published by Mr. Abbott, although relating more or less to "telephony," contain very little with regard to "the design, construction and operation of telephone exchanges," in spite of the fact that this has been chosen as the sub-title of the book. We look forward with all the more pleasurable anticipation to the appearance of the remaining two volumes of the series, for the author has had experience as chief engineer of a large telephone company that should be worth recording. Volume I., "Location of Central Offices," opens with a chapter of definitions and a long and unnecessary explanation of the need for a telephone exchange, following which are a number of chapters, illustrated by spots on squared paper, of the method of determining the position for an exchange. This investigation, if of any value at all, can merely be of academical interest, and it is only this latter fact that excuses the introduction of differential equations to prove the law for the best position of an exchange, which is almost self-evident under the assumption made that the area to be served is entirely covered with streets at right angles to one another, and that the position of the subscribers is known. It is true that later on the effect of obstacles and diagonal streets in destroying the sweet simplicity of this law is pointed out, together with the manner in which the mileage of wire may be decreased by the employment of sub-exchanges and junction wires, but, just as in the earlier chapters of the book, the treatment of the subject as an algebraical instead of as an engineering problem destroys the practical utility of all these investigations. A few interesting figures are given as to the number of messages per diem in districts of different sizes and character, and these would have been still more valuable if specific examples had been cited and the actual load curves shown. An instructive table, comparing the time taken to effect junctions on the two systems is given. According to the author's experience with "signal" junctions, 12 seconds elapses on an average between the time the first operator answering the call and the wanted subscriber being rung, and but five seconds with the more modern call-wire systems, which the author names "reverse call circuit trunks." Six and three seconds respectively are the average times given for the subsequent clearing, after a two minutes' conversation.

More than one-third of the second volume, "Construction of Underground Conduits," is taken up with a specimen specification for an underground conduit system, and the remainder contains descriptions of the various makes of ducts employed in the United States. These are illustrated chiefly with street pictures; good plans and sections would have been still more useful. Some tables of costs are also given, applying, of course, to American conditions. Vol. III., "The Construction of Cable Plant," is also chiefly taken up with a specification—in this case for underground cable, joints, terminals, &c. In this volume and Vol. IV., "The Construction of Aerial Lines," we had hoped to find an account of the work which has been done in the United States in investigating practically the effect of distributing induction coils throughout long-distance lines. Heaviside's mathematical investigations in this direction have been taken up by Prof. Pupin in America, and it was stated a few years ago that numerous applications of the principle were being made by the Bell telephone companies. The only results of tests given in the book, however, are those obtained a short time ago in Germany, and these are already familiar to our readers. Vol. IV. is the best of the four volumes, containing many details with regard to overhead work, and even the inevitable "specification" is of an intensely practical nature and is illustrated with drawings and sketches.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Wave-length of N-Rays.—R. Blondlot contributes a Paper of great importance on the refraction and dispersion of N-rays and the value of their wave-length which may be deduced therefrom. It appears that, contrary to the earlier conclusions drawn from their pronounced refrangibility, the N-rays have an excessively small wave-length, and its determination opens up a vast region of the spectrum hitherto unexplored owing to the absorption of the extreme ultra-violet rays by every known substance. The new glass described by Zschimmer (see *The Electrician*, January 15th, p. 493) transmits light down to 248$\mu\mu$. The smallest wave-length measured by Blondlot is 8$\mu\mu$, or five octaves beyond the extreme ultra-violet hitherto explored. The region lying between the "extreme" ultra-violet and the longest N-rays is probably covered by absorption bands. The author formed the spectrum of the N-rays by means of aluminium prisms, and corroborated the refractive indices thus found by means of aluminium lenses. Aluminium was chosen because, while refracting the rays, it does not store them. The source of the rays was the light from a Nernst lamp, sifted through two plates of aluminium, two sheets of black paper,

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and a wooden plank 2cm. thick. All the necessary screens and slits were made of moistened cardboard, which completely intercepts the rays. The author discovered eight different lines of N-rays, for which aluminium has refractive indices ranging from 1·04 to 1·85. The prisms and the lenses gave practically identical results. The author then passed on to the determination of the wave-length. He isolated one of the lines by means of a slit of moist cardboard having an opening of 1·5mm. width, and proved by means of a fine line traced with calcium sulphide that the beam of N-rays was narrow and sharply defined. He then diffracted the beam by means of a Brunner grating with 200 lines to the millimetre. He thus obtained a series of diffraction fringes, very sharply defined, but lying much more closely together than in the case of ordinary light. This showed at once that the wave-length was extraordinarily short. Owing to their closeness, it was found necessary to measure the distance between two fringes of the tenth order on different sides of the centre. Each wave-length was determined by three series of measurements made with three different gratings. The shortest wave-length measured was 8·13$\mu\mu$, and the longest 17·6$\mu\mu$. The refractive index of aluminium for the former was 1·04, and for the latter 1·85, so that we have here the anomaly that the more refrangible rays have the greater wave-length. To confirm the measurements by means of an entirely independent method, the author used the method of Newton's rings, and obtained figures which do not differ by more than 5 per cent. from the preceding ones. He adds that the fact that ground glass and ground mica do not transmit N-rays already disposes of the supposition that their wave-length is of the order of the heat-rays. If the increase of luminosity of a small flame under the influence of N-rays must be attributed to their transformation into luminous radiations, that is not in contradiction with Stokes' law.

[R. Blondlot, *Comptes Rendus*, January 18, 1904.]

Emission of N-rays by Plants.—In connection with Charpentier's researches on the emission of N-rays by nerves and muscles, E. Meyer has examined plants and animal tissues free from nerves in the same direction. He announces that the emission of N-rays by plants is easily proved with a little practice. In observing the effects of different parts of the same plant on the fluorescent screen, it is found that the brightness is feeble in the case of the flower, and much more pronounced in the case of the green portions, especially the leaves, and also the roots. But plants free from chlorophyll, such as onions and mushrooms, also emit N-rays. A slight compression of the tissue suffices to produce a notable increase in the luminosity. The phenomena appear to be connected with the activity and state of development of the vegetable protoplasm. A test tube containing seedlings of cress will produce a well-defined increase in the luminosity where a similar tube containing non-germinated cress seeds will not. A striking difference is observed in the behaviour of a set of seedlings before and after they have been chloroformed. The suspension of the vital activity by the chloroform produces also an inhibition of their power of emitting N-rays. If two similar tubes are observed at the same time, one containing chloroformed seedlings and the other seedlings without chloroform, the former tube does not affect the luminosity of the screen, while the latter does. Many of these observations were observed and confirmed by Charpentier.

[E. Meyer, *Comptes Rendus*, January 11, 1904.]

N-rays in Physiology.—A. Charpentier gives further information concerning the part played by N-rays in the animal organism. He describes a striking experiment in refutation of the theory that the N-ray effects are simply due to heat. A cold-blooded animal, such as a frog, may at this season of the year be kept at a temperature considerably below the temperature of the room. The N-rays emitted by it, and their effect upon the fluorescent screen, are not modified by doing so. A similar experiment may be made with a warm-blooded animal by heating the screen to about 40deg. The screen then shines more brightly than before, but its luminosity increases still further by bringing the animal up to it, although it can only cool it, if anything. Living screens, such as those prepared from certain bacilli by Prof. Macé, also brighten up under the rays emitted by muscles, nerves and nerve centres, although their phosphorescence diminishes on heating them. The spinal column may be traced all the way down by means of a sensitive screen. The effect of a muscular action, such as the bending of the arm, may be traced to its motor centre in the brain or the spinal marrow. The activity of the brain itself may be gauged by the intensity of the N-rays it emits. An effort of mental activity is accompanied by an increase of luminosity of the screen. A mere effort of will produces the same effect, not directly, of course, but through the accompanying increase of N-ray emission. A person may even watch the radiation effect of his own thoughts, or, as the author puts it, he may "see himself think." A specially distinct effect is produced by the activity of Broca's centre, which is concerned with articulate speech.

[A. Charpentier, *Arch. d'Électr, Méd.*, January 25, 1904.]

Action of Radium Rays on the Resistance of Bismuth.—R. Paillot exposed a coil of bismuth, mounted after Lenard between two thin plates of mica, to the rays emitted by 0·03 gramme of radium bromide contained in a thin-walled glass tube. He found that the resistance of the coil was thereby diminished. The experiments, repeated a great number of times and at intervals of several days, gave, with a distance of 0·5mm. between the radium and the bismuth, a diminution of the resistance amounting to 0·0052 ohm. The action of the rays was practically instantaneous. It did not vary on keeping the tube for a length of time in the vicinity of the bismuth. On increasing the distance between them, the effect diminished rapidly, ceasing at a distance of 1cm. The interposition of a sheet of black paper or aluminium diminished the action without making it disappear.

[R. Paillot, *Comptes Rendus*, January 18, 1904.]

Eletrochemical Equivalent of Silver.—The various determinations of the electrochemical equivalent of silver made by Mascart, Kohlrausch, Lord Rayleigh and Mrs. Sidgwick, Pellat and Potier, Kahle, Patterson and Guthie, and Pellat and Leduc have yielded results varying from 0·011156 (Mascart) to 0·011195 (Pellat and Leduc). In view of the legal importance of the figure, G. Van Dijk and J. Kunst have thought it advisable to make a redetermination by the most accurate method available. They used a tangent galvanometer for determining the strength of the current. Owing to the high degree of accuracy with which the constant of the instrument and the horizontal intensity of the earth's magnetic field and its space and time variations may be determined, this method is well adapted for a laboratory which has been built without iron, and in a place where no vibrations or stray currents in the earth are to be feared. The authors adopted Kohlrausch's bifilar method. The cathodes consisted of platinum, being either cup-shaped or in the form of a cylinder ending in a hemisphere. A silver rod served as an anode. Two voltameters were placed in series in order to ensure that no irregularities occurred in the deposition of the silver. The final mean value obtained from 24 measurements was 0·0111818, which the authors believe to be accurate to within one part in 10,000.

[Van Dijk and Kunst, *Proc. Akad. Wet.*, Amsterdam, Jan. 21, 1904.]

Iron and Steel Institute.—The annual general meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on Thursday and Friday, May 5th and 6th. The annual dinner will be held in the Grand Hall of the Hotel Cecil on Friday, May 6th, Mr. Andrew Carnegie in the chair. The Carnegie Research Scholarships will shortly be awarded. In accordance with previous announcements, the autumn meeting will take place in New York on October 24th, 25th and 26th next. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburg, Cleveland, Niagara Falls, and Buffalo, returning to New York on November 10th. Full particulars can be obtained from Mr. Bennett H. Brough, the secretary, at 28, Victoria-street, Westminster.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from p. 575.)

Radium furnishes valuable evidence of the stage of the disintegration at which the β-ray is produced. It will be recalled that in the case of uranium the α-radiation is produced in the first change of uranium into uranium X and the β-radiation in the subsequent disintegration of uranium X. The cases of thorium and radium are less simple. With regard to the former it is doubtful if a complete separation has yet been effected of the matter causing the imparted activity from thorium X. Now, the imparted activity gives β as well as α rays, and it is possible that the β-radiation of thorium X is due entirely to this source. The emanation (compare p. 403) is known to give only α-rays, and the same is true of the non-separable activity of thorium. The lower the emanating power of a thorium compound, that is, the more the emanation is retained by the compound to produce the imparted activity within it—the greater the proporton of β-radiation from the compound. Although it has not been definitely proved, the facts are in agreement with the view that the β-radiation of thorium occurs only in the last stages of the disintegration, as in the case of uranium.

In the case of radium the evidence is more definite. If the radium emanation is introduced into a vessel, the walls of which are thick enough to completely absorb the α-rays, and thin enough to allow the β-rays to pass through, it is found that at first there is no external radiation from the vessel—*i.e.*, there are no β-rays produced (Curie, *Comptes Rendus*, 1902, 135, p. 857; Rutherford and Soddy, *Phil. Mag.*, 1903, VI., 5, p. 456). In a short time after the introduction of the emanation, an external or β-radiation is produced from the vessel, and this rapidly and regularly increases, attaining a practical maximum in three or four hours. If the emanation is then swept out of the vessel by a blast of air, the value of the external radiation from the vessel is not suddenly affected, but commences to decay regularly, falling to half value in 30 minutes. Thus the radium emanation gives only α-rays. The β-rays are produced after it has changed into the matter causing the imparted activity. Since the decay of the β-radiation of the latter is regular, falling to half value in 30 minutes, it follows that the β-rays are produced in the later changes of this matter. We have seen that the first change suffered by the matter causing the imparted activity is very rapid, and the time-constant characteristic of the change of the β-radiation—to half value in 30 minutes—is that of the last change that can be experimentally traced. Hence in both uranium and radium, and probably also in thorium, the β-rays only appear at the last stage of the disintegration. Now the γ-rays accompany the β-rays, and are probably always produced with them (Rutherford). Hence we must regard the α-ray as being the essential feature of radio-activity, and the β and γ-rays as less important and probably, to some extent, secondary. Polonium, for example, gives only α rays, showing that the β and γ-rays are not essential to the phenomenon. Atomic disintegration in the majority of instances we know of, when the separate stages are considered each by itself, proceeds with the expulsion of α rays alone.

An important issue, which seems destined to lead to questions of a very fundamental character, arises in consequence. If an electrically neutral atom, like thorium or radium, goes through a series of disintegrations, each of which is accompanied by the expulsion of a positively-charged particle, how is the fundamental law of the equivalence of electric charges satisfied? According to the universally-held belief, the production of a positive charge necessitates the simultaneous production of a negative charge of equal value. Hence we should expect, when a radium atom expels a positively-charged particle, the atom of the emanation remaining should be negatively charged at the moment of its production. It is to be expected that this atom will, like the gaseous ion, give up its charge easily, for example, to the walls of the containing vessel, and will again become neutral. When it, in turn, disintegrates a second positively-charged particle is expelled, and the atom of the matter causing imparted activity should again be negatively charged at the moment of production. Now, there is evidence in the case last considered that the atom is charged at the moment of its production, for it moves in an electric field and can be concentrated on one of the electrodes. Unfortunately, however, for the theory the charge it carries is not negative, but positive, as it is attracted to the *negative* electrode. We have, therefore, evidence that in the disintegration of the atom of emanation, both of thorium and radium, two positive charges are simultaneously produced from the neutral atom, instead of one positive and one negative, as would be expected.

Additional evidence, which, however, is still rather vague, is furnished by the actinium emanation. When produced the atom of the actinium emanation probably carries a positive charge, which endows it with certain peculiarities which for various experimental reasons are not exhibited by the radium and thorium emanation. Debierne (*Comptes Rendus*, 1903, 136, pp. 446 and 767) showed that the actinium emanation moves to the negative electrode in an electric field, and Giesel (*Ber. der D. Chem. Gesel.*, 1903, 36, p. 343) showed that the emanation from his "emanation substance," which we have seen is probably identical with Debierne's actinium, shows the same property. The experiments of Geisel may be described. He placed the active substance in a metal cylinder, open at one end, 5cm. to 10cm. from a zinc-blende screen negatively charged by means of an influence machine. Under these circumstances the particles of emanation are attracted to the screen and travel to it in straight lines, so that a phosphorescent image of the opening of the cylinder is formed on the screen. From this image "secondary emanation" streams away, lighting up the screen surrounding. A blast of air now does not affect the phosphorescent image, but only the "secondary emanation." Thus the emanation in an electric field travels to the negative electrode in straight lines like a "ray," and Geisel proposes the term "E-ray" for this phenomenon. Having given up its charge, it is no longer controlled by the electric field, but can be blown away, so that it seems probable that what Geisel calls "secondary emanation" consists of the emanation that has given up its charge, but has not yet disintegrated. The probable reason why this phenomenon is not observed for the radium emanation is that the average life of each atom in this case is from 10,000 to 100,000 times longer than in the case of the actinium emanation, so that the latter has a much shorter time in which to lose its charge. The exact bearing of these facts on the question under discussion cannot be foreseen until the nature of the ray which accompanies the change of actinium into the emanation has been investigated. It is not yet known for certain that it is an α, or positively-charged particle, which is produced in this case. Still, the existence of a positive charge on the actinium emanation bears out the view that the products of atomic disintegration are probably electrically charged at the moment of production. In the cases most exactly studied—the disintegration of the emanation into the matter causing imparted activity—the charge on the particle of the latter is opposite to what the theory of electrical neutrality would seem to require. This discrepancy cannot be at present explained. It is possible that the extra positive charges do not result from the disintegrating atom itself, but are supplied from the outside by the ionised gas always present. On the other hand, it must be remembered that the theory of the simultaneous production of opposite electric charges may not apply for the case of the chemical atom disintegrating. In the change from the atom of radium, assumed divalent like barium, to the atom of the radium emanation, assumed non-valent like argon, there is a change of chemical valency. Now, atoms are known to be capable of carrying charges proportional to their chemical valency. If the charge carried by the monovalent hydrogen atom or ion is assumed to be unity, the charge on the divalent iron ion is two, and on the trivalent iron ion is three. Is it possible that, in the production of a non-valent atom from a divalent, for example, the change may be accom-

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panied by the appearance of excess of one kind of electricity, so that the products of disintegration of a neutral atom, instead of being oppositely, are similarly charged? In the present state of our knowledge it is only possible to keep an open mind with regard to this possibility, especially as the question can be readily attacked experimentally.

Chemical Actions of the Radium Rays.—The radiations from radium are so much more powerful than those of uranium and thorium that they produce many effects not strong enough to be appreciable in the latter cases. They are able, for example, to bring about many chemical changes. The most important actions noticed are the conversion of oxygen into ozone (Demarçay), the conversion of yellow phosphorus into the red variety (Becquerel), the decomposition of water into hydrogen and oxygen (Giesel), and the colouration of glass violet or brown (Curie). In the conversion of oxygen to ozone and the decomposition of water a large absorption of energy occurs, and it was from evidence of this nature that the large amount of energy continuously emitted by radium was first recognised. A gramme of pure radium bromide in solution in water will evolve about 10 cubic cm. of mixed hydrogen and oxygen per day, which corresponds to the production of 20 gramme calories of heat per day. This evolution goes on steadily month after month at constant rate. The conversion of oxygen into ozone by the radium rays accounts for many oxidising actions effected by radium or the emanation in presence of oxygen. Mercury is converted into the yellow oxide and carbon dioxide is produced if carbonaceous matter is present when the emanation is stored in an atmosphere of oxygen (Ramsay and Soddy, *Proc.* Roy. Soc., 1903, 72, p. 204). The effect of the rays on the photographic plate is, of course, to be classed under the chemical reactions of the rays. Various fluorescent substances, as barium platinocyanide and zinc-blende, are changed by prolonged action of the rays and then become more or less insensitive. Willemite is probably one of the most lasting fluorescers we possess, and does not deteriorate appreciably even after long exposure.

(To be continued.)

THE NEW TRUNK TELEPHONE EXCHANGE.

During the last few years the inter-urban or "trunk" lines in this country have been extended so rapidly, and the traffic over them has increased so considerably, that both the space allotted to them in the trunk line exchange at the Central Telegraph Office and the system employed there have become inadequate. The Post Office Telephone Department therefore decided to erect an entirely new exchange for their trunk service, and the change-over from the old exchange in St. Martin's-le-Grand to the new switchroom in Carter lane was successfully effected last Saturday.

Although we published a few years ago (*The Electrician*, Vol. XLII., pp. 85 and 494), in an article describing the system then in use for trunk-line switching, a clear account of the functions of the central trunk exchange, for the sake of completeness we will briefly recapitulate the duties which are relegated to this part of the telephone system of the country. The lines of telephone subscribers are connected to local exchanges, of which there are 66 in the "London" district (56 National and 10 Post Office), one large National Telephone Co.'s exchange and some sub-exchanges in every large town, four municipal exchanges, a few small provincial Post Office exchanges and an exchange of the National Company in practically every other town of the United Kingdom. All the exchanges in the London district are connected together by "junction" lines, and in the same way the large exchanges in provincial towns are connected by junction lines to their sub-exchanges, but to speak from one town to another use must be made of the "trunk" lines of the Post Office, which connect together all the principal towns, and a large number of which radiate from London.* It is not expedient to connect the trunk service directly to each of the local exchanges, and, therefore, a special trunk line exchange is established and this is connected by junction lines (frequently called trunk junction lines to distinguish them from ordinary junction lines) to all the metropolitan exchanges. Thus, between the trunk exchange and the Post Office "Central" exchange, there are 20 trunk junction lines, to the "Avenue" exchange of the National Telephone Co. there are 30, to the "Gerrard" exchange 20, and so on, the total number of junction lines entering the trunk exchange being no less than 203. The demand for a trunk line is transmitted by the operator at the local exchange to an operator sitting at the "record table" of the trunk exchange, who notes the demand, together with the number of the two subscribers who are to be put into communication. She fills in a ticket with the necessary particulars, and this ticket is passed on to the operator who is in charge of the trunk line in question. The demands are taken in rotation by this operator, for at busy times of the day there are frequently several subscribers awaiting their turn to use a trunk line. When the trunk circuit is available, the controlling trunk operator obtains connection with the subscriber who originated the demand, and simultaneously requests the operator at the distant trunk exchange to ring up the required subscriber, the connections at each end being completed through the trunk junction circuits to which we have already alluded. Thus it is seen that the demand for a trunk line, no matter from which end of the line it originates, is always treated as an "out-going" junction call at the trunk exchange. It should be added that "service" or "call" wires are employed in connection with all the larger exchanges, that lamps are employed for all the calling and clearing signals in conjunction with a central battery system, the "engaged" test being also given by a glowing lamp, and that all clearing signals are automatic, so that for simplicity and speed of working the arrangements leave little to be desired. To attain this simplicity in operation, however, a fairly complicated system of relays and other connections must be employed, the essential parts of which we shall endeavour to make clear to our readers.

Starting with Fig. 1, which shows the trunk circuit, before tracing out the various connections we will first explain the meaning of the words "concentration" section and "ordinary" section. Five trunk lines are brought to each operator's position on the main switchboard. During the busy hours of the daytime, an operator is necessary for each of these positions; during the less busy hours one operator can attend to the trunk wires of the two positions, which form together one section of the board. At night time and Sundays, however, it is unnecessary to have one operator for every 10 trunk lines, and means are therefore provided on certain sections of the board to take over the trunk lines from the other sections. The former sections, on which 30 trunk lines can be "concentrated" if necessary (*i.e.*, 10 in addition to the five normally worked from each operator's position) are called "concentration" sections, and thus at night-time 60 trunk lines can be served by one operator sitting between two sections of the board. Each trunk line dealt with at an ordinary section of the switchboard ends at the main springs of an 8-point jack (marked 1 in Fig. 1) and is also branched to a jack on the "concentration" section (also marked 1 in Fig. 1), from which it is operated at night-time. During the daytime an insulating plug of vulcanised fibre is placed in the latter, and a similar plug is placed in an auxiliary jack (No. 2) on the ordinary section. Then it is seen the trunk wire is simply through to the ordinary section, and is insulated at the concentration section. When the time for concentration arrives, the insulating plug at the ordinary section is removed from No. 2 jack and inserted in No. 1. A current then flows from the 22-volt battery (at the bottom of the diagram) through the 30-ohm coils of the pilot relays at the "ordinary" and "concentration" sections and through the signalling lamps, shown between the jacks, to the movable springs at the side of the No. 2 jacks. Thence, through the inner and long spring of the No. 2 jack on the "concentration" section to the long spring of the corresponding jack of the ordinary section, and through one of the inner springs of this jack and back to the

* In this article the term "trunk" line is employed to indicate an inter-urban line, and "junction" line a line connecting two exchanges in the same town. In America these latter lines are usually designated "trunk" lines, and inter-urban lines are termed "long distance" lines.

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earthed side of the battery. The pilot relays act at the same time in the usual manner, and the pilot lamps and the two signalling lamps glow. The operator at the "concentration" section then removes the insulating plug corresponding to the glowing lamps from jack No. 1 and inserts it in jack No. 2, thus restoring the signalling circuits to their normal condition, and leaving jack No. 1, which is connected to the trunk line, free for operating.

"B" (which we will call the indicator for the sake of brevity). The needle of the indicator is thus held over to the right, indicating that the line is clear. At the same time, there are two opposing 24-volt batteries on the line, one at the provincial end through the coils of the relay R8, and the other at the London end through a double-wound retardation coil and the inner and main springs of the jack. The relay

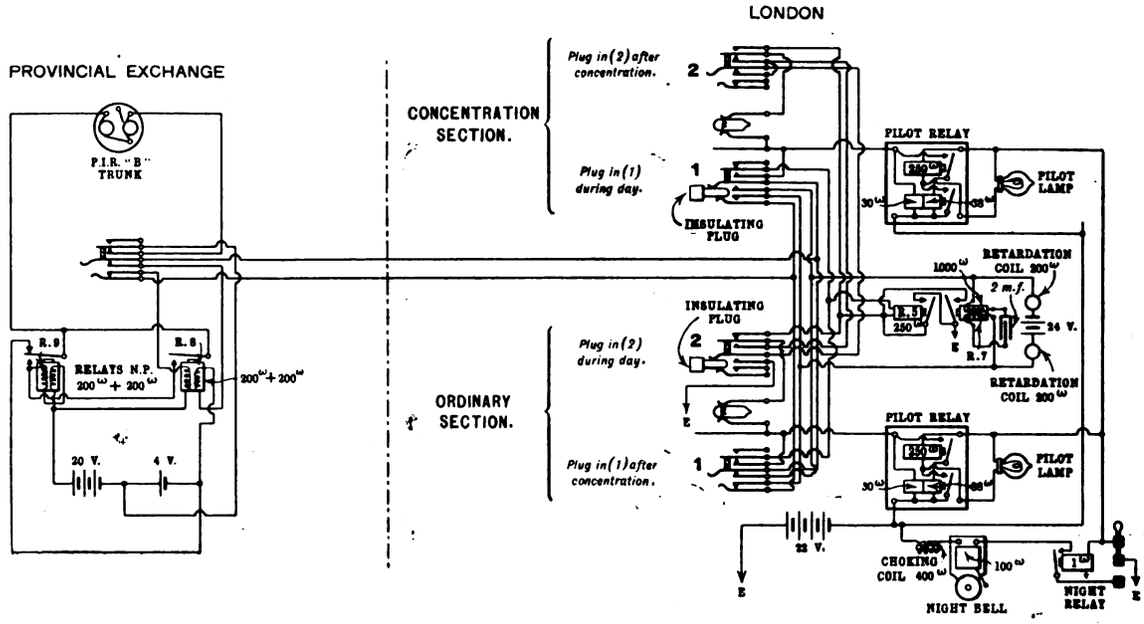

FIG. 1.—CONNECTIONS OF TRUNK CIRCUIT FOR LONG LINES.

Now to trace out the course of the current during the operation of a trunk connection. Fig. 1 represents the connections of a long trunk line over 150 miles in length; in the case of shorter circuits some simplifications are introduced. In the provincial exchanges the "Polarised Indicating Relay" has been retained as an indicator as to whether the trunk line is free or engaged and to give the calling signal, but although its R8 is "biassed" against small currents that may flow through its coils owing to slight inequalities in the E.M.F. of the opposing batteries and leakage on the line. To call from the London end, a plug is inserted in the jack and the speaking key associated with the plug is drawn forward. Placing the plug in the jack removes the 24-volt battery from the line at the London end, by pressing out the line springs

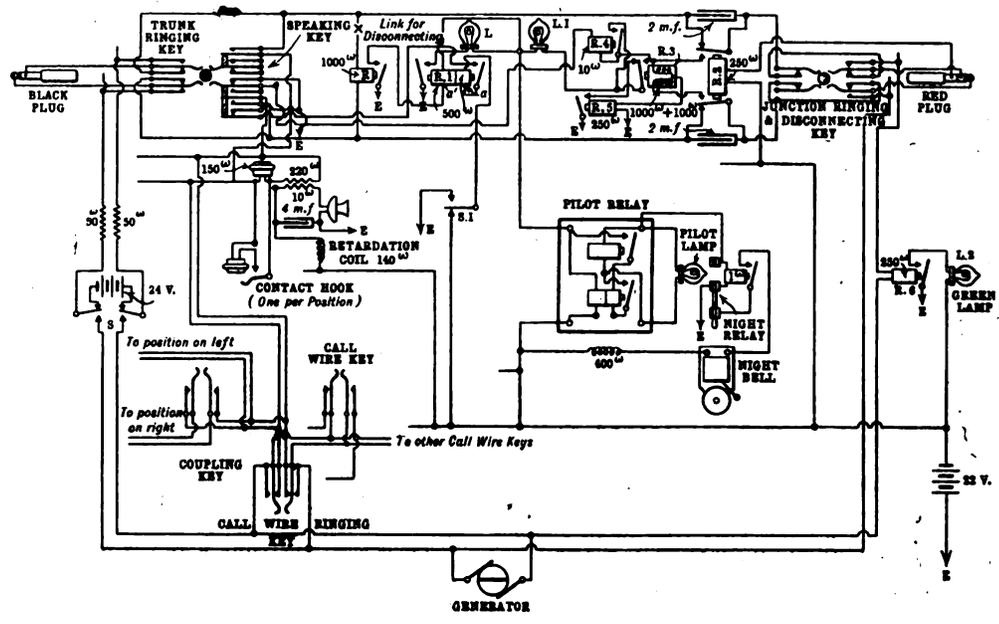

FIG. 2.—OPERATOR'S CORD CIRCUITS ON TRUNK SWITCHBOARD.

external appearance is the same as that of the relays on the original trunk system, it is employed in a slightly different manner in connection with two extra non-polarised relays. Referring to the left-hand side of Fig. 1, representing the provincial exchange, normally the armature of the non-polarised relay R9 completes the circuit of a 4 volt local battery through the "Polarised Indicating Relay," P.I.R., of the jack; at the same time a 1,000-ohm non-polarised relay, R (Fig. 2), is bridged across the cords and when the speaking key is pushed back the operator's speaking set is also joined across the circuit in parallel with the relay.

The relay R8 at the provincial exchange is biassed against this current also; but when the trunk ringing key (Fig 2) is pressed forward, the 24-volt battery in London is applied to

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the line in the reverse position to the former one, so that the batteries at the two ends are in series and a strong current is sent through R8. This relay closes the circuit of the 20-volt battery through the relay R9 and the indicator, and it will be seen that R9 acts as a retaining relay by its lower contact. The indicator deflects to the left, and at night-time closes a local bell circuit (not marked on the diagram). The provincial operator who receives this call inserts a plug in the jack at this end and interrupts the indicator circuit, the indicator falling to its middle position implying that conversation is in progress. In the case of shorter circuits, the bias against leakage currents is not required, and the intermediate relay R8 is dispensed with.

If the provincial operator clears first, this connects the 24-volt battery to the line at that end, and a current flows through the relay R (Fig. 2) in the London trunk operator's cord circuits, actuating the relay R1 so that the lamp L glows. It is to prevent a false calling signal that the relay R8 is biassed against the single battery current and is only actuated when the London battery is placed in series with the local battery as explained above.

If the London trunk operator clears before the provincial operator, an indicator in the cord circuit at the latter end will be deflected. The operator will then withdraw the connecting plug, and the line indicator will return to its position to the right actuated by the local 4-volt battery, for the two 24-volt batteries are again put in opposition at the inner springs of the jack No. 1 at the London end.

At night-time this system of permanent-current working is dispensed with, and a self-restoring indicator, "telephone exchange galvanometer" and ringing key are connected on at the provincial exchange in place of the arrangement described, the line being worked on the ordinary "open circuit" system, with a magneto-generator for ringing up from that end.

To call up London from the provincial exchange, whether at day or night, a magneto ringer is employed, connected to a ringing key on the provincial operator's keyboard circuit. This sends an alternating current to the line, which actuates the 1,000-ohm relay R7 at the London end (Fig. 1), which is permanently bridged across the line through the inner springs of jack No. 1 until a plug is inserted. This relay closes the circuit of the 250-ohm retaining relay R5, and actuates the calling lamp and pilot lamp, the circuits through the pilot relay being as usual.

We have already referred to the cord connections on the London trunk keyboard, but some further explanation of Fig. 2 will doubtless be welcomed by those who desire to study the arrangements closely. The apparatus is arranged in such a way that when one trunk circuit is joined through to another trunk circuit the connections from plug to plug are direct, and the signalling relay R only is brought into use. When the apparatus is used for joining a trunk circuit to a junction circuit the connections are completed through condensers, and further relays are brought into use for the local subscribers' clearing signals.

In addition to the signalling relays and lamps, two 3-position keys are associated with each pair of plugs and cords. The first key on the left of each pair is used for ringing on the trunk circuit when the lever is pulled forward, and for speaking when the lever is pressed back. The second key is used for ringing on the junction circuit when pulled forward, and when pressed back it disconnects the junction circuit from the operator's speaking set, as well as from the trunk circuit. This latter arrangement secures the trunk operator against interruptions from the London subscriber while she is gaining the attention of the subscriber at the distant exchange.

Normally, the relay R is operated by the permanent current battery connected at the distant exchange when the corresponding plug is inserted in the jack of a trunk circuit. The current from this battery causes the armature of relay R to be attracted; the latter actuates a second relay, R1, with which it is associated; and a lamp, L, connected in the local circuit of the latter glows. To call the distant exchange the London operator inserts the black plug in the jack of a trunk circuit, presses the corresponding 3-position key momentarily into the battery-ringing position, and then waits for a reply. Pending the insertion of a plug in the jack at the distant end of the circuit the lamp L remains glowing. When the lamp darkens it indicates that the distant operator is in attendance, the permanent-current battery being cut off when the latter inserts a plug to reply.

The clearing circuits have already been explained. At night, when the permanent current batteries are disconnected, and all the trunk lines are worked on "open circuit," the switch S is reversed to connect the generator in place of the battery for trunk calling and clearing purposes. The switch S1 is also turned to bring the retaining coil of relay R1 into operation. If, now, a transitory clearing signal be given on relay R when the corresponding plug is in use, the armature of relay R1 will be actuated as described, and it will be held down by means of the current passing through its retaining coil. The lamp L will then glow until attention is given by the operator. When the corresponding key is turned to the speaking position, the circuit of the retaining relay is broken, its armature is released and the lamp L darkens. The switches S, S1 are not provided independently for each cord equipment, but are common to the whole exchange.

(To be continued.)

THREE-PHASE WORKING, WITH SPECIAL REFERENCE TO THE DUBLIN SYSTEM.*

BY WILLIAM BREW.

(Concluded from page 535.)

Sub-stations.—In the case of three-phase sub-stations we have a variety of combinations of plant open to us. For instance, the transformers may be connected in delta or star on both H.T. and L.T. sides, or delta on one side and star on the other. Then, again, three single-phase transformers may be used, one on

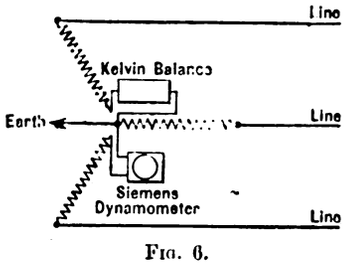

FIG. 6.

each phase, or one single three-phase transformer may be used to take the place of the three single-phase transformers. In any particular case the considerations governing the choice of single-phase or three-phase transformers will generally be: (1) Capital cost per kilowatt installed; (2) weight per kilowatt installed; (3) efficiency; (4) suitability as regards working conditions.

As regards (1), the average cost of a three-phase transformer appears to be about 20 per cent. less than that of a single phase transformer of the same output and type. On the other hand,

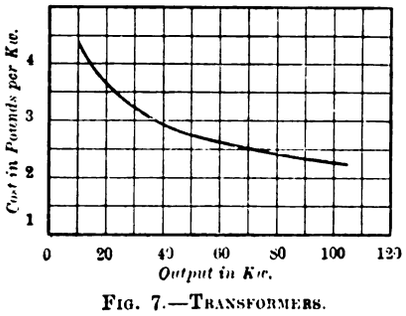

FIG. 7.—TRANSFORMERS.

a certain amount of spare plant will always have to be provided, and if three single-phase transformers be used one spare transformer will act as an efficient spare to all three, whereas if three-phase transformers be used it would, in most cases, be as economical to completely duplicate the plant as to multiply the number of transformers by using small ones of less efficiency and greater cost per kilowatt. The curve (Fig. 7) shows how rapidly the cost

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers.

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of transformers per kilowatt installed increases as the output is diminished. For instance, a 90kw. transformer would cost about 28s. per kilowatt, whereas three 30kw. transformers installed in place of it would cost 46s. per kilowatt.

As regards (2). Where a number of sub-stations are distributed over a large area the question of weight is of some importance as regards transport and appliances for moving the transformers in the

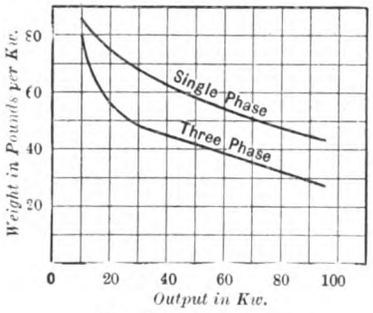

FIG. 8.—TRANSFORMERS.

sub-stations. The curves (Fig. 8) show that the three-phase has the advantage of the single-phase transformer in this respect.

phase sub-stations are of the oil-cooled type and British Westinghouse Co.'s manufacture. The results of tests of some of these transformers are given in Table V.

Table V.—*Test of Oil Transformers 50 ~ Single-phase.*

Output of transformer in kw.	250	50	50	40	30	20
Ratio (volts)	5,000 / 2,000	5,000 / 2,000	5,000 / 200	5,000 / 200	5,000 / 200	5,000 / 200
Magnetising watts	2,100	380	462	438	308	292
Copper watts	3,084	623	660	512	510	265
Total watts	5,184	1,003	1,122	950	818	557
Per cent loss	2·08	2·0	2·24	2·37	2·73	2·78

The arrangement of the overground sub-stations L.T. cables will be seen in Fig. 10. It will be noticed that the neutral wire from each cable dividing box is joined to a copper earth bar which is connected through a recording ammeter to an earthed plate. This earth-bar is situated in a cable trench in front of the L.T. board, where it is joined to three of the tails from the transformers star connected and forms their neutral point. The remaining three transformer tails are connected through fuses and switches to three 'bus bars, indicated by colours, as the red, blue and green phase

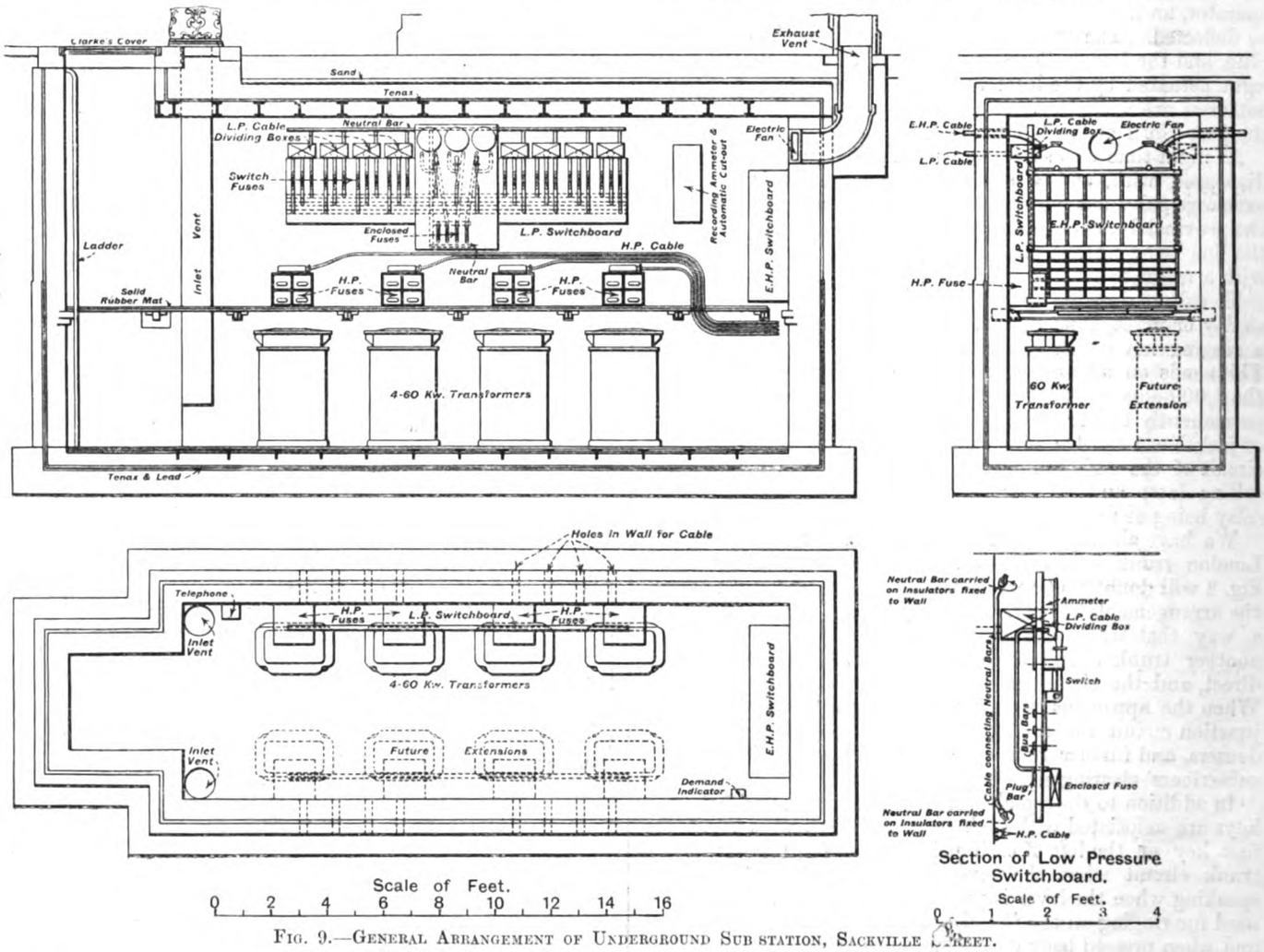

FIG. 9.—GENERAL ARRANGEMENT OF UNDERGROUND SUB STATION, SACKVILLE STREET.

As regards (3). The efficiency of the three-phase is usually less than that of the single-phase transformer. In good designs, however, this difference does not usually much exceed 1·5 per cent.

As regards (4). The three-phase transformer possesses the advantage of equalising the pressure upon an unbalanced load. On the other hand, if a fault occurs in a transformer, three or more times the amount of plant is thrown out of use thereby than would be the case with a fault with single-phase transformers.

I might mention here that in Dublin we have not had the slightest difficulty as regards the banking of single-phase transformers in delta or star connection, transformers of 25kw. output sharing the load proportionately throughout the range with transformers of 250kw. output when banked with them delta and star-connected. A general arrangement plan of a Dublin underground sub-station is shown in Fig. 9. The transformers in each of the 21 new three-

respectively. Special attention has been paid to the arrangements for switching in a spare transformer with ease and certainty as regards its phase relationship to the other transformers. The conditions to be satisfied will be evident from the diagram, Fig. 11. If A, B, C, represent the H.T. 'bus bars and + − the spare transformer terminals. The connection must be made in one of the three ways shown to correspond to one of the three phases on the L.T. side. The arrangements made for carrying out these connections in practice are shown in Fig. 12. In the centre of both H.T. and L.T. boards are placed plug connections of the well-known split tube Ferranti type, actuated by a bayonet socket handle. All that is then necessary for the operator to do, to replace a transformer, say, on the red L.T. phase, is to insert plugs on the H.T. board in the two positions marked red, and the single plug on the L.T. board, making connection with the red phase, and then close the switch.

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The smaller sizes of Dublin sub-stations are connected with the central distributing station at Fleet-street by a 0·04 sq. in. three-core sub-feeder and spare. This cable, we have seen, possesses a Y capacity

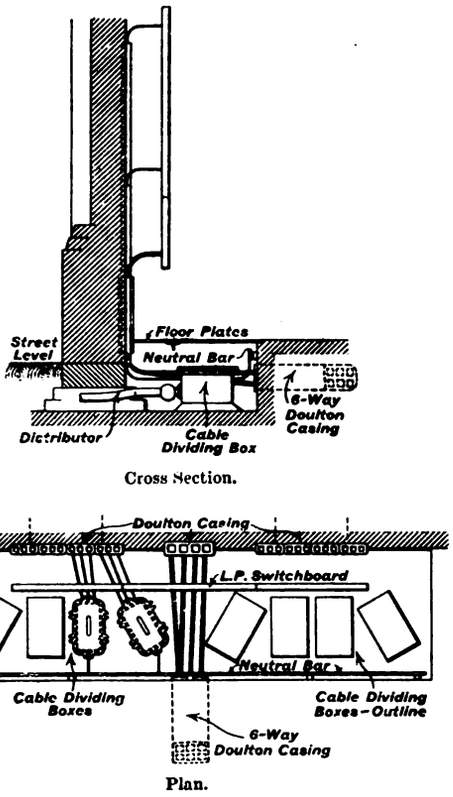

FIG. 10.—SKETCH SHOWING ARRANGEMENT OF CABLE-DIVIDING BOXES.

of 0·298mfd. per mile. In the case of a sub-station taking a magnetising current of 0·27 ampere per phase and coupled to a length of 1 mile of this cable, we have L=34 henrys and K=0·298 × 10^{-6} farads.

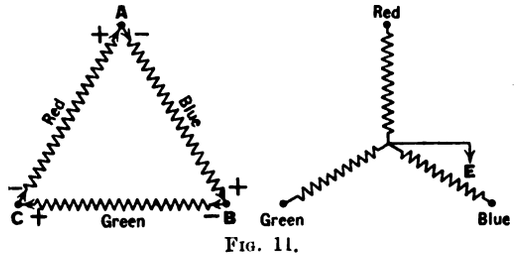

FIG. 11.

The natural frequency of oscillation f of this circuit is, therefore, $f=\frac{1}{2\pi}\sqrt{\frac{1}{LK}}=50$, which corresponds to the frequency of the supply.

The above conditions are very nearly attained with three 40kw.

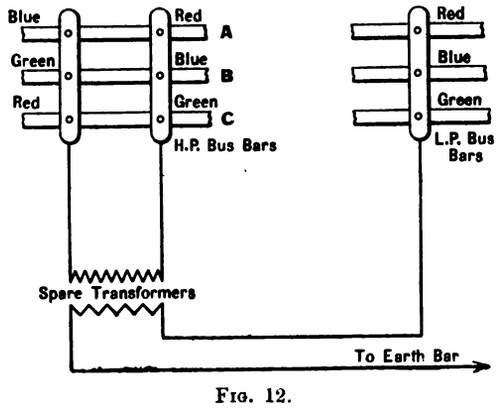

FIG. 12.

transformers coupled in delta in one of the Dublin sub-stations. The feeder to this sub-station was switched on and off on several occasions, however, without any visible indication of resonance.

(To be concluded.)

AN ELECTRICALLY-DRIVEN PIANOFORTE FACTORY.

Some 18 months ago extensions to the already large pianoforte factory of Messrs. J. Broadwood & Sons, at Old Ford, London, E., were carried out, electricity, both for power and lighting purposes, being introduced at the same time. A special advantage of electric driving in such factories lies in the fact that the manufacture can be carried on in a uniform direction, no transporting to and fro of partly finished parts from one tool to the other being necessary. With belt drive from countershafting, on the other hand, the machine tools must be near to the driving shafts, which are comparatively few in number, and cannot always be placed in their most suitable position. On occasion of the completion—at least, for the time being—of the alterations referred to, a party of Press representatives were invited to an inspection last Tuesday.

Since so much highly-inflammable material is used in a pianoforte factory, the electrical equipment had to be of a specially substantial and safe nature, and on this account, although no departure from approved standard lines has been attempted, a description of the electric plant as carried out will no doubt interest our readers. The factory is a large one, employing 500 hands.

Continuous-current at 230 volts is generated in the engine room, situated at the north-eastern end of the works, by an 80kw. vertical high-speed Belliss-Crompton generating set and by two 40kw. sets, consisting each of a vertical high-speed Peache engine directly coupled to a Crompton compound-wound dynamo. A fourth steam engine, built by Davey, Paxman & Co., and indicating about 100 H.P., serves for driving the large mill and the metal-working shops. Steam at 120lb. per square inch is produced in the adjacent boiler house by three boilers of Davey, Paxman & Co.'s locomotive type and by one Babcock and Wilcox boiler, the latter being designed to burn wood chips and saw dust. The feed-water is heated by a Boby-Chevalet heater and detartariser and is conveyed to the boilers, the feed-heater, separator and the elevated feed-water tank by means of a system of pumps and duplicate piping. No condensers are employed, as the exhaust steam is used for various purposes of manufacture.

From the main switchboard in the engine house current for light and power is distributed to the various parts of the buildings by three concentric vulcanised rubber and armoured cables (37/16 and 37/17) laid in enamelled steel tube, and by two concentric lead-covered, steel-armoured and paper-insulated cables. Other main conductors of 19/16, 19/14, &c, size, run from the main switchboard to the different motors. The rubber concentric cables end in special junction boxes from which twin rubber cables are taken to the electric motors and distributing fuse boards for the lighting. Except in the offices and those places where lead-covered paper-insulated cables are used, the conductors are drawn through enamelled steel tubes. No joints were made, both wires and cables being looped in. Where wires and cables run outside the buildings, or in exposed places, they are protected by screwed iron barrel. There are altogether 19 motors, nearly all totally enclosed and ranging in power from ½ H.P. to 26 H.P. Some have been adapted for directly driving various machine tools, such as saws, polishing lathes, planing machines, and so on. Others serve to drive short lengths of shafting from which the machine tools are driven by belts. Five operate lifts and two actuate the fans which are used in connection with the pneumatic system for sucking sawdust, chips, &c., from the machine tools and benches. By means of zinc pipes, this wood waste is conducted to a cyclone receiver, placed near to the Babcock and Wilcox boiler mentioned above.

By far the biggest motors are installed in the wood shop. Here two enclosed compound-wound Crompton motors of a power of 20 H.P. and 26 H.P. respectively are used for driving the heavy circular saws. A 15 H.P. motor is employed for the 2-ton crane locomotive stationed in the yard. The useful radius of operation of the crane is approximately 14ft. All movements, both of the crane and of the locomotive itself, are derived from the one motor by means of gearing and clutches. Current is taken from an overhead line by means of a Dickinson trolley. About 1,000 incandescent lamps have been installed, no arc lamps being used. Every workbench has one, and many of them have two lamps, mostly of 32 c.p. The lamps are, as a rule, hung from hooks in the ceiling by means of wooden poles, and are fed by flexible conductors. If the workman changes his position, all he has to do is to hook his pole on the nail nearest to his new position. About 1,250,000 cubic ft. of space is lighted, the floor area amounting to more than 100,000 sq. ft.

A 25-way telephone system, with a central exchange in the general office, and with two intermediate switchboards, one in the factory and the other in the managing director's office, has been installed. As a precaution against accidents, a system of engine-room signals has been provided, by means of which the three signals, "Stop," "Start" and "Full Speed" can be sent from the engine room to each shop where heavy machinery is in use, and vice versa. A special push, signalling "Stop," to the engine room is fixed, moreover, in various other paras of the building. Uniform time throughout the factory is assured by a system of about 20

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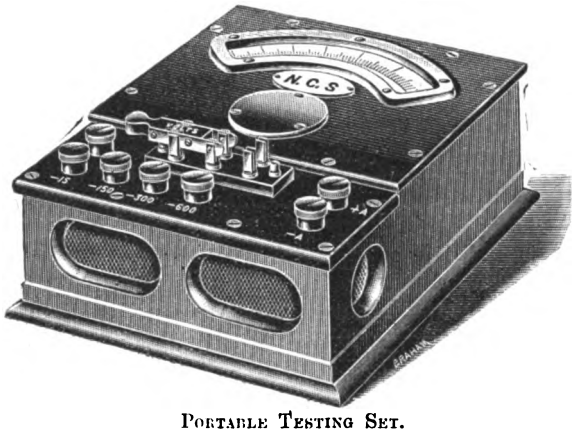
electric clocks, supplied by the Synchronome Co. They receive every 30 seconds an impulse from a master clock. The four time-recorders at the works entrance are operated from the same circuit.

Mr. W. W. Beaumont and Mr. R. W. Weekes were consulting engineers for the work, the contractors for the wiring and fittings were Messrs. Ward Bros., the motors and switchboard being supplied by Messrs. Crompton & Co.

A NEW PORTABLE TESTING SET.

Messrs. Nalder Bros. and Thompson (Ltd.) have recently placed upon the market a new portable testing set which contains many points of novelty. This set has been specially designed to meet the demand for an instrument that can be used in an engine room, and can be placed anywhere without the danger of obtaining erroneous results owing to interference by stray fields. The screening of the instrument has received very careful attention, and is so efficacious that it is almost impossible for the reading to be affected, even if the instrument be placed quite close to a dynamo or motor. The instrument is of the moving coil type, being absolutely dead-beat; it is fitted with a white enamelled metal scale and a metal mirror. Voltmeter resistances are carried in the instrument itself, and current shunts in another case.



Portable Testing Set.

Measurements up to 1,500 amperes and 600 volts can be made, and, as a double-pole change-over switch is provided, resistances can be measured by the practically simultaneous observation of current and E.M.F. The voltage required to deflect the instrument to the top of the scale on the ammeter side (terminals AA) is only 0·12, and, as the scale is divided into 120 divisions, each division corresponds to 0·001 volt, so that the fall of volts on rails, joints, &c., can be conveniently tested. The current shunts are of a new design, with facilities for connecting up with a minimum amount of trouble, in addition to which they are light and compact, a complete set up to the 600-ampere size going into quite a small box. The overall dimensions of the instrument are 11¾in. by 9⅜in. by 4¼in.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, January 28.

Mr. W. G. SHADRAKE, chairman of the Leyton Urban District Council, complained of the want of intercommunication between the outside districts of lines and the tramways serving the City. There was also a great need for further railway facilities, and it was for this reason that the Leyton Urban District Council had supported the promotion of the City and North-East Suburban Electric Tube Railway last year.

Mr. R. H. SCOTTER, who compared the practice with regard to tramway and other powers in England with that on the Continent, said that in England it was time that the interest of the individual was made subordinate to the interests of the general community. The effect of this policy on the Continent was to be seen in the Paris Underground Railway, the abolition of accumulator traction in Germany and the experiments upon the military railway at Zossen. These, he considered, were examples of work carried out in a national spirit. The latest illustration of this spirit was the action of the Prussian Minister of Railways in extending the franchise of the Berlin Tramway Co. from 1922 to 1944, although the Berlin City Council had decided to run all its street railways under municipal control. The idea of municipal control on the Continent, however, was very different to that in England. Continental municipalities for the most part were content to construct the permanent way, and to grant a long lease to a private company or companies to equip and work the lines. Further, it was the universal practice to grant the greatest possible facilities to tramway and railway companies for bringing passengers and goods from the country into the towns and vice versa. One feature which did not exist on the Continent, however, was the equivalent of the local inquiry by the Light Railway Commissioners, but from the success which had attended his, he suggested the advisability of constituting a similar tribunal for dealing with all secondary lines in London, including tramways, light railways, urban tubes and subways. This tribunal should have upon it expert engineers able to advise both theoretically and practically upon all traffic problems. On the Continent the local veto as defined in England by the Tramways Act did not exist. The local authority had the fullest deference paid to its wishes by every promotor seeking a concession within its area, and it could suggest any number of improvements or alterations in the schemes submitted. All these suggestions and modifications received the fullest consideration by the higher authority which existed in most of the Continental countries but in no case could the objection of the local authority absolutely prevent any scheme going forward. In many States it was the duty of the municipal or provincial council to submit the scheme of the promoters to the Government. Witness then handed in a list of towns on the Continent showing the period for which concessions were granted and the authority which sanctions them. In many cases, after consideration by the local authority, the final decision was left with the Government, whilst in some others the local authority gave the final consent. Various periods were granted, from 99 years to 40 and 50 years. In many cases, too, at the end of the period of franchise the system reverted to the Government without compensation to the company. In others, a valuation was made of the plant, &c. Continuing, he said that there were very few instances of local authorities financially assisting schemes on the Continent. There were, however, various systems of indirect help, such as the remission of taxation for the first few years. As to repairs, he said the repair of the roadway, for 1ft. 6in. on either side of the track was usually insisted upon at the expense of the tramway company. The price of land taken for the purpose of a tramway was invariably fixed by the valuation of an expert, or, failing agreement by this method, the matter went to arbitration. In no case had he found the principle of "betterment" allowed to influence the price. A list of towns was also handed in, giving the percentage of the receipts paid to the various municipalities by the tramway companies.

Friday, January 29.

Mr. H. L. CRIPPS, of the firm of Messrs. Dyson & Co., who has been for 30 years a parliamentary draftsman and parliamentary agent, said he was of the opinion that the present method of dealing with bills before the two Houses of Parliament was quite satisfactory. During the whole of his experience he had not known of a single instance of substantial injustice. In fact, the present procedure favoured the promotors rather than the opposition, and if any alteration was necessary it should be in the direction of strengthening the position of the opposition. This opinion was held by many with whom he came into contact. There was great advantage in having bills considered by two committees, as it was impossible for the points and details of a large scheme to be grasped at one hearing. Whilst agreeing that the question of locomotion in London was a complicated one, he did not think so far as railways and tramways were concerned, that there was any greater complication now than there was 20 or 30 years ago. In 1892 he advised the London County Council, for which body he was then acting, that the question of locomotion in London should be dealt with in a comprehensive manner, but since that view had been stated numerous other railway lines had been passed, and the opportunity for so dealing with this proposition had now passed, as the greater number of principal routes had now been taken up by promoters. He disagreed with the proposal to establish a special tribunal to deal with matters appertaining to London locomotion, as it would tend to exclude from Parliament schemes which, he maintained, it ought to decide. As to Standing Order 22 he contended that this was a mistake and ought to be dispensed with. If, however, the standing order was retained there should be some easy method of dealing with the question of local consent. Perhaps the best way to deal with the matter would be to make the Unopposed Bill Committee a permanent body which could decide whether or not the local consent should be obtained. He was not opposed to the appointment of a special tribunal provided it had not the power to sanction proposals. The Light Railway Commission had created certain disadvantages. The act worked well when applied to agricultural districts where travelling facilities were scarce, but it had interfered with important railway interests on one or two occasions. One instance he could give was that of a railway already authorised by Parliament, but not yet constructed, which would have to be considerably modified owing to the network of lines which had been constructed, partly under light railway orders over practically the same route since its promotion. This was the Manchester–Middleton Railway.

The Commission adjourned.

CORRESPONDENCE.

THE DE FOREST WIRELESS TELEGRAPH SYSTEM.

[Translation.]

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In a letter which appeared in *The Electrician* of December 18, 1903, we claimed that the arrangements embodied in Mr. de Forest's system as described in *The Electrician* of December 4, 1903, were infringements of our patent rights. We wish to call special attention to the following points as being covered by our patents:—1. The arrangement of the transmitter connections. 2. The arrangement of the receiver connections. 3. The construction of the electrolytic receiver.

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Mr. de Forest has repudiated our assertions in a very general and superficial way, referring, in connection with point 1, to Lodge and Marconi, and with regard to point 3 to an English patent granted to him. Point 2 was not mentioned by him at all. We have obtained possession of the patent specifications referred to and shall proceed to prove the correctness of our statement in a more particular and definite manner.

With reference to the arrangement of the *transmitter* connections as employed by de Forest, this is covered by our British patents No. 1,862 of 1899 and No. 15,522 of 1901. The former covers, quite generally, the setting up of oscillations in an air-wire by means of a closed exciter circuit, containing Leyden jars and a spark-gap; the second one refers to the advantageous tuning of the wave-lengths of both systems.

The objection that in a patent of Lodge of 1897, Leyden jars were already used in connection with a transmitter, carries no weight. Indeed, in our German patent, special reference is made to the arrangement of Lodge. Later on, in 1902, an action was commenced challenging the validity of this transmitter patent, but the German patent office decided that it was valid, and that what it protects is: The employment of a closed oscillatory circuit for the production of oscillations in an air-wire, the electric dimensions of the closed circuit being the determining factors of the frequency of the radiated wave. In an arrangement by Lodge, on the other hand, the frequency of the radiated waves is determined by the electrical dimensions of the air-wire, the Leyden jars being a device for charging same. Mr. de Forest refers also to the Marconi patents, and, presumably, this reference is to infer that it is only those patents, if any, which he infringes. Concerning questions of patent rights, Marconi himself judges differently. In a lecture before the Queen and King of Italy he agreed that the employment of the closed exciter circuit for transmitters is due to Braun, and that these patents possessed priority over his own. He maintained his priority only in connection with the tuning of both oscillating systems.

Referring to the second point, by using the described arrangement of the receiver connections Mr. de Forest infringes our British patents No. 23,155 of 1900, and No. 15,522 of 1901. These protect a circuit containing the detector and tuned to the frequency of the transmitter, and branching off from the air-wire by means of metallic conductors.

The electrolytic detector used by Mr. de Forest and represented diagrammatically in Fig. 2 (*The Electrician*, December 4th, p. 240) is covered by our British patent No. 12,119 of 1903. Mr. de Forest certainly possesses a British patent for an electrolytic receiver—namely, No. 12,452 of 1902, which is even older than ours, and we also readily believe that he has been working with electrolytic cells since 1900. Dr. Neugschwender possesses a German patent concerning an electrolytic receiver dating even from the year 1898, but this is of no concern. The point is the form of the electrolytic cell, as described by Mr. de Forest in *The Electrician* of December 4th, and regarding which he states to be unable to give details owing to patent rights not being settled. This cell is sketched in such a way that anybody may gather that the positive pole forms a small point which dips into the electrolyte. Such a cell has nothing to do with the British patent of Mr. de Forest mentioned above, wherein quite different electrolytic coherers are described, but it is identical with the one described in our patent No. 12,119 of 1903, the date of publication of which is May 27th for England and March 13th for Germany.

Possessing, obviously, no serviceable material for proving his case, Mr. de Forest refuses to give a definite retort, and makes more or less mysterious accusations against us.—Yours, &c.,

COUNT ARCO.

Berlin, Jan. 27.

THE DISSIPATION OF ENERGY BY EDDY CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With regard to Prof. Ernest Wilson's communication dated January 21, 1904, the case in which his experiments would more strictly apply is in the instance of small motors up to 5 H.P., where solid cores are usually employed. But here the eddy losses in the teeth are of such magnitude that the core eddy losses are negligible compared to them. In the larger sizes an annular ring is used for the core and one can hardly assume (without direct experiment) that here the stream lines are very much the same as in a solid cylinder. An experiment to test this matter would be of great value in the estimating of core losses. However, the curves 1—5, Fig. 1, mentioned by Prof. Wilson, were calculated for the instance only where each particle of the iron mass went through the same cycle of flux density. This, of course, is not the case for a solid cylinder, as shown by Prof. Wilson, and I do not believe it strictly applies to the case of an annular ring. The conclusion as to the core was only arrived at by inference from the mathematical work. I do not presume that Prof. Wilson would wish one to believe that the eddy losses in the teeth follow any other law but that assumed in Fig. 1. It may be interesting to remark that in modern design the teeth eddy losses bear to the armature core losses the ratio usually of $1\frac{1}{2} : 1$, but this is on the assumption that the core losses follow the same law as the teeth eddy losses. It is just possible that the core losses follow some very much simpler law and that the ratio of losses ought rather to be $1\frac{1}{2} : \frac{3}{4}$ or $\frac{1}{2}$ instead of $1\frac{1}{2} : 1$.—Yours, &c.,

London, N., Feb. 1. A. PRESS.

SINGLE-PHASE MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the letter of Mr. Latour of January 2nd, published in *The Electrician* of January 8, 1904, I beg to state, in the name of Mr. G. Winter and also in my own name, that we have worked absolutely independently and without any knowledge of Mr. Latour's work.—Yours, &c.

Berlin, N.W., Jan. 30, Dr. FRIEDRICH EICHBERG.

Extensions of Power Plants and Steam Turbines in Switzerland.—In order to meet the increased demand for electrical energy, Berne, the Swiss capital, is at present erecting a steam-driven power station, which, after completion, is to work in parallel with the existing water-power station on the Kander. This station, which was fully described on the occasion of the Institution visit to Switzerland (*The Electrician*, Vol. XLIII., p. 737), supplies three-phase current to the Burgdorf-Thun Railway, as also to Berne (25 miles distant) and some of the intermediate towns, the line pressure being 16,000 volts. Outside Berne the voltage is reduced to 3,000 volts, while in the town itself a further transformation to 250 volts is effected. The motors in Berne are connected on the three-phases, and the lighting is carried out by a 2×125-volt three-wire network on each phase. According to the *Schweizerische Elektrotechnische Zeitschrift*, the new station is to be supplied with two Brown, Boveri-Parsons steam turbines directly coupled to three-phase alternators of the same firm and capable of supplying together 970kw. single-phase or three-phase. The guaranteed steam consumptions per kilowatt-hour are 20lb. at full load and 23·8lb. at half-load. From the same publication, the following particulars are taken concerning the steam consumption of a Brown, Boveri-Parsons 1,400kw. turbo-generator, supplied last October to the power station in Rheinfelden (see *The Electrician*, Vol. XLIII., p. 521), for supplementing its water-power plant. When delivering 1,440kw. and 720kw. respectively, the voltage being 6,000 volts in both cases, the steam consumptions were 15·3lb. and 17·3lb. per kilowatt-hour. The demand for electric energy in Lucerne has also outgrown the supply available from the two existing stations, and it was decided to supplement them by a third, situated in Engelberg, 17½ miles distant. Water turbines of a total power of 14,000 H.P. are coupled to Oerlikon three-phase generators. The transmission voltage is 27,000 volts. As will be remembered from our description of the two stations referred to above (*The Electrician*, Vol. LXIII., p. 672), the older one of them, in operation since the year 1885, is situated on the River Emme at Dorenberg, and generates single-phase current at 2,300 volts. In Lucerne (about 2½ miles distant) the pressure is reduced to 120 volts. The second station is the Rathausen works, from which power is bought by Lucerne. Energy is conveyed from this station to Lucerne at a voltage of 3,000, which is reduced outside the town to 2,000 volts.

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PARLIAMENTARY INTELLIGENCE.

The Standing Orders Committee of the House of Commons have decided that certain portions of the London County Council Tramways Bill have not complied with standing orders. In the case of the Tottenham Court-road tramway the necessary road consents have not been obtained. Other lines which will also have to come out of the bill were proposed in Marylebone, Paddington and Streatham.

The Cheshire Electricity and Power Gas Bill has been passed as having complied with standing orders.

Yesterday (Thursday) the chairmen of committees (Lord Morley and Mr. J. W. Lowther) agreed upon the allocation of private bills as follows:—

To originate in the House of Lords: Bristol Corporation, Bristol Tramways (extensions), Leicestershire and Warwickshire Electric Power and North Wales Electric Power.

To originate in the House of Commons: Llanelly Tramways and Improvement, North Staffordshire Railway, North Western Electricity and Power Gas, Portmadoc, Beddgelert and South Snowdon Railway and Wolverhampton Corporation.

MARYLEBONE ELECTRIC LIGHTING.

At a special meeting held on Monday, the delegates appointed to interview the Metropolitan Electric Supply Co. with a view to coming to an arrangement to remove the present deadlock, presented a report, dated February 1st, which will be considered and discussed at a future meeting. The report is as follows:—

We have had two meetings with representatives of the company since our appointment on January 25, 1904.

The company has now expressed willingness to take bonds bearing interest at 3¾ per cent. in payment of the award of £1,212,000, and on the new capital expenditure to the end of this year, roughly estimated at £150,000. This includes the £60,000 cheque paid by order of the Court on account of capital expenditure incurred since the date of purchase, but not any of the legal expenses, amounting to nearly another £60,000.

The company is prepared to pay as rent interest at 3¾ per cent. on these bonds, and to pay the whole expense of their issue and to contribute, as additional rent, £7,000 per annum which would go as a contribution towards the Council's sinking fund, and, further, that from January, 1913, the company would give the Borough Council 10 per cent. of their total net profits, after deducting 4½ per cent. on their total capital employed, and 1½ per cent. for depreciation.

The lease to the company would be for 27 years, or a shorter time if competition were allowed by Parliament and the company required us to release them. They would continue for two years from the date of their notice to determine, and, on such determination, the borough would be obliged to take current in bulk from the company up to 1931 to supplement any deficiency which could not be made by our own generating stations. The price would be the same as is now agreed, namely, "by agreement, if possible, and, if not, by arbitration of the Board of Trade."

In the event of the determination of the lease, or at the expiration of the lease, the borough would not be liable to re-imburse the company for capital expenditure outside the borough area, but only for the capital expenditure within the area. This capital expenditure within the area would be paid by the borough, either at the valuation or at a fixed depreciation of 1½ per cent. per annum.

(Signed) H. Russell Wakefield (Mayor),
Ernest R. Debenham
(Chairman of Electric Supply Committee),
G. J. Elgood,
A. Forbes Sieveking.

At the same meeting the Electric Supply committee reported that they had considered the position of the Marylebone Electric Lighting Bill, 1904, and the offers of the Metropolitan Electric Supply Co., and of the General Electric Co. (Ltd.):—

We recommend that the Council resolve to undertake that, if the poll of electors with reference to the promotion of the St. Marylebone Electric Lighting Bill shall decide in favour of the promotion of that bill, the Council will, before attempting to work the undertaking themselves, take all necessary steps and use their best endeavours

(*a*) To make some satisfactory arrangement with the Metropolitan Electric Supply Co. (Ltd.), or

(*b*) To enter into an agreement with a company of sufficient financial ability to temporarily or permanently work the undertaking on behalf of the Council, in accordance with the principles of the letter from the General Electric Co. (Ltd.), to the Council of Jan. 19, 1904.

That, inasmuch as it is necessary to continue the promotion of the bill for the purpose of enabling the Council to negotiate terms with the Metropolitan Electric Supply Co. or to carry out an arrangement on the principle of the offer of the General Electric Co., the Council strongly recommend that the bill be proceeded with.

Mr. E. R. Debenham proposed that the recommendations of the committee be agreed to.

Mr. G. J. Elgood seconded.

Sir Edwin Galsworthy opposed. If the bill were passed negotiations with the company would cease immediately, for they would say "you have the power to get the money; do so, and pay us." He preferred to leave the matter entirely to the Courts to settle.

Mr. Edwin White also opposed.

A desultory and irrelevant discussion followed, and the recommendations of the committee were then agreed to by 34 votes to 9.

At the Borough Council meeting last evening the following motions by Councillor E. White were to have been discussed, but at his request were adjourned to the next meeting of the Council:—

That it be referred to the Legal and Parliamentary committee to prepare and submit to the Council a bill to be introduced in the next session of Parliament to relieve the Borough of St. Marylebone from the obligation of purchasing the Marylebone portion of the Metropolitan Electric Supply Co.'s undertaking upon equitable terms.

And further

That Mr. Boulnois, M.P., be respectfully asked to introduce the bill, and the president of the Local Government Board be requested to assist in passing the bill into law.

Nothing was mentioned concerning the progress of negotiations, and pending the poll of the ratepayers, which is to take place next Monday, matters electrical are quiet for the moment in Marylebone.

LEGAL INTELLIGENCE.

The King v. Justices of London.

This case came before a Divisional Court (the Lord Chief Justice and Justices Wills and Kennedy) on Wednesday. During the Long Vacation Mr. Justice Bucknill granted a rule nisi for a writ of prohibition directed to the Justices of London to stop further proceedings on informations against two Post Office employés named Baily and Byott, and the question was whether the rule should be made absolute. It appeared that Baily and Byott were engaged in repairing and underground telegraph cable in Aldersgate-street, City, and had with them two trucks which, the police complained, were unnecessarily left standing in the street from 11 a.m. until 7 p.m., being sometimes unattended, which, it was alleged, caused such an obstruction as to be a nuisance. Before the summonses were disposed of, prohibition proceedings were taken on the ground that the men were in the public street under a Crown privilege, and therefore could not be dealt with by the justices.

Mr. DANCKWERTS, K.C., argued that the Crown could not have the privilege of authorising the committal of a nuisance. Even if the Postmaster-General had the right to obstruct the thoroughfare for a period to repair a cable, counsel complained that there was excessive use of the privilege.

The SOLICITOR-GENERAL said that if it had been a proceeding instituted to raise the question whether the Postmaster-General or his employés had acted in excess of the powers given to them by the Telegraph Act he should not have offered any opposition, because, though that act gave them certain rights, yet it was quite plain that there must be no excess of obstruction. The present summonses could not, however, possibly raise that question, because these men had not taken the trucks with them for loading or unloading, as mentioned in the summons, but only to carry their tools.

The Court held that on the facts the case must go back to be heard, the question of costs to be reserved.

The SOLICITOR-GENERAL said he would undertake, if his friend succeeded on the summons, to pays the costs.

The rule for a prohibition was, therefore, discharged.

Grant v. Fenner, James & Co.

On Friday last, in a debenture-holders' action heard in the High Court by Mr. Justice Swinfen Eady, a receiver and manager of the defendant company (manufacturers of electric accumulators) was appointed. The appointment of manager was limited to one month, when further application to the Court must be made.

Re Bright's Light and Power Co.

Mr. Justice Swinfen Eady on Friday heard a motion to appoint Mr. H. S. Foster receiver and manager of this company. The company offered no opposition, but the River Plate Electricity Co., who had a prior mortgage, had been joined as defendants. It was a debenture-holders' action, brought apparently for the purpose of enforcing a subsequent security, and plaintiffs did not offer to redeem the River Plate Company. Mr. Eve, K.C., M.P., therefore, on their behalf, opposed the motion.

His lordship refused to sanction the appointment.

Williams-Bulkeley v. Portmadoc, Beddgelert and South Snowdon Railway Co.

In the Chancery Division on Friday, Mr. Eve, K.C., moved for an injunction to restrain defendant company from further proceeding under a notice to treat. The company has power to construct a railway line in Carnarvon and Merionethshire, and to erect stations and necessary appliances, and to compulsorily acquire land. They have also permission to construct an electric railway, and had served plaintiff with notice to treat in respect of land on which they proposed to construct a generating station and to lay pipes to carry water from the lakes. Plaintiff contended that these did not come within the purposes for which defendants were entitled to take land compulsorily.

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His LORDSHIP said defendants' act contemplated that the railway would be electrical. A generating station and a supply of water would consequently be necessary, and defendants were entitled to acquire land compulsorily for these purposes.

The motion was accordingly dismissed with costs.

Colwell and Others v. St. Pancras Borough Council.

This was an action to restrain defendant Council from causing a nuisance to plaintiffs in the working of their electricity generating station and dust destructor works at King's-road, Camden Town, N.W. The matter was argued before Mr. Justice Joyce on Wednesday and yesterday, and the further hearing will be continued to-day (Friday). A report will appear in our next issue.

Stocks v. Oldham Corporation.

At Manchester Assizes on Monday Mr. Acton mentioned this case to Mr. Justice Jelf. The claim was in respect of damages alleged to have been sustained through vibration caused by the Corporation electricity works. The Corporation were advised that they had a perfect defence, but agreed to pay a small sum towards plaintiff's costs without admitting liability. No payment was made in respect of damages. The record would, therefore, be withdrawn.

Smith v. National Electric Wiring Co.

At the Northampton County Court last week, plaintiff (Mr. H. W. Smith) sought to recover £3. 14s. 5d. for goods supplied, and for testing electrical work at Northampton Arcade. There was a counterclaim by defendants for the return of certain documents and £4 for their detention. Plaintiff said he was instructed to inspect installations put in by defendant company. A number of documents were given to him for facilitating his examination. After completing his work he asked for his fees, but failed to obtain them. He was asked to report favourably, but he was unable to do so as some of the work was not up to standard.

For the defendants it was submitted that this statement was untrue and that the company received no adequate report from plaintiff.

George Barnham, formerly with defendants, said the company were confident of the efficiency of their work, and wanted an independent report immediately. Plaintiff, however, made excuses until the time when the report was of no use.

Ultimately, judgment was given for plaintiff for the amount claimed, plaintiff being ordered to return the papers to the company.

MUNICIPAL, FOREIGN, & GENERAL NOTES

APPOINTMENTS VACANT AND FILLED.

An engineer is wanted for the workhouse of the parish of St. Pancras. Salary £3 per week, with increments of 5s. to £3. 10s., &c. Candidates should be practical engineers, capable of taking charge of engineering plant and executing repairs, &c. Application (on forms from the clerk, Mr. Alfred A. Millward, Town Hall, Pancras-road, London, N.W.) must be in by Feb. 11. See advertisement.

A switchboard attendant is wanted immediately for Chester electric lighting department. Applications to the city electrical engineer (Mr. F. Thursfield). See advertisement.

Doncaster Corporation invite applications for the position of borough electrical engineer and tramways manager. Salary £300 per annum. Applications to town clerk by noon Feb. 9.

A draughtsman is required for the locomotive, carriage and waggon department of Ceylon Government Railways, preferably with experience in electric lighting and power transmission. Applications to Crown Agents for the Colonies, Whitehall, London, by Feb. 15.

A medical officer is required to take charge of the electrical department of Charing Cross Hospital, London. An assistant physician is also required for the dermatological department to take of cases requiring treatment by light, X-rays and other radiation. Applications to the secretary (Mr. Arthur E. Reade) by 15th inst.

The following staff appointments have been made at Pigeon House electricity works, Dublin:—Mr. Reginald Knowles, works superintendent, salary £200; Mr. C. H. M'Keown, shift engineer, £117; Mr. Lythgoe, sub-station foreman, £117; Mr. Wilkinson, engineering clerk of works, £5. 5s. per week from Corporation, with further remuneration from the consulting engineer (Mr. R. Hammond).

Mr. A. Eardley has been appointed (out of 100 applicants) manager of the Stockport electric tramways at £300 per annum. Mr. W. E. Preston, of Rochdale, has also been appointed senior clerk in the tramways office.

Aston.—The resident engineer and the borough surveyor are preparing plans, &c., for the extension of the power station and for the provision of another 750kw. generating set.

Bexhill.—As the result of a poll, the Bexhill Improvement Bill, which included various electric lighting powers, has been defeated.

Bradford.—The Tramway committee, who have been considering the rate of pay of their servants, recommend the Council that drivers should start at 6d., rising to 6½d. after six months' service, 6¾d. after 12 months, and 6¾d. after 18 months, conductors to receive 1d. less.

Brazil.—A concession has recently been granted to Mr. Eujenio de Andrade for the construction and working of an electric tramway between Rio de Janeiro and Petropolis. Work is to be begun within two years.

Brierley Hill.—The Board of Trade have deferred for a year the consideration of the revocation of the electric lighting order, 1900.

Broxburn (N.B.).—A plebiscite of ratepayers is to be taken as to adopting electric lighting for Broxburn and Uphall.

Burnley.—Manchester-road and Todmorden-road tramway routes were opened for traffic yesterday (Thursday). The new refuse destructor works adjoining the electricity station were opened on Monday.

Calais (France).—This town is only indifferently served in the matter of tramway communication. The cars are horse drawn, and the service needs development. A short time back the municipal authorities were granted a concession by the French Government to establish an electric tramway system, the estimated expenditure being about £125,000. 16 miles of line (8 miles within the municipal area and 8 miles of extensions) were to be converted and constructed. The work was to have been put in hand in March, 1904, and the whole system to have been in operation within 12 months from the date of commencement. These calculations have been upset by the death of the contractor, whose executors are now endeavouring to dispose of his rights.

Carnarvon.—Another syndicate has submitted proposals to the Council for the erection of electricity works. The syndicate offer to erect and lease the works for seven, 14 or 21 years and to loan the Corporation the necessary capital at 3½ per cent., or, alternatively, they would supply electricity in bulk at 2½d. per unit. An application to the Light Railway Commissioners for a light railway order was also suggested.

Cheltenham.—A special meeting of the Council will shortly be held to consider the report of the borough electrical engineer (Mr. H. Kilgour) on the present system of charging for electric current, &c.

Clevedon.—The Council have given formal consent to the application by a company for a provisional electric lighting order.

Dublin.—The Lighting committee report that since the opening of the new Pigeon House works 383 consumers, representing an equivalent of 21,000 8 c.p. lamps, have been connected to the mains that applications are coming in rapidly, and that several large institutions are negotiating for supply. Four iron doors have been erected between the engine room and boiler house at £36, resulting in a reduction in the rate charged for insurance. A short length of tramway from the Pigeon House to the foreshore for the conveyance of ashes is to be constructed. Extensions of mains have already been carried out.

Electrical Engineers (R.E.) V.—On Saturday evening last a Bohemian concert was held at the headquarters, Regency-street, London, S.W., under the presidency of the commanding officer, Major R. S. Erskine. 350 members and friends were present. The Entertainment committee, who were responsible for the concert, arranged an excellent programme, which was much appreciated by the large audience. Several members of the corps contributed items. During the evening it was announced that the first regimental ball would be held in the Kensington Town Hall, London, on 26th inst.

"Free" Wiring.—On Monday a conference of borough council delegates will be held at Hackney Town Hall, to urge the London County Council to make further application to Parliament for powers to enable borough councils supplying electrical energy to expend moneys on the wiring and fitting of consumers' premises, &c.

Fulham (London).—At the Council meeting on Wednesday it was resolved to make a trial, at an estimated cost of £200, of 25 incandescent electric lamps and 25 Nernst lamps, in place of 50 existing gas lamps; that in 40 cases the present lanterns be used, and in the remaining 10 suitable brackets be obtained.

The Council have accepted the offer of the Granville Theatre of Varieties to take the whole of the electric current for the theatre from the Council for seven years at 3d. per unit with a minimum consumption equivalent to £450 per annum. The borough electrical engineer (Mr. A. J. Fuller) reported that the charge at the Council's present scale would be 3¼d. per unit.

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Glasgow and South-Western Railway.—In the draft provisional order deposited at the Scottish office by the Glasgow and South-Western Railway Co. powers are sought to construct about 6 furlongs of new lines, to widen about 4½ miles of existing lines, and to enable the company to at any time work by electrical power the traffic on its railways.

Gorton.—The Board of Trade have allowed the Council until June 30 for carrying out the terms of their provisional electric lighting order 1899.

Greenwich.—The Council on Wednesday approved the plans for the erection of the generating station of the London County Council on the old Woolwich-road.

Grenoble (France).—This city has now completed its electric lighting system, current being generated by water-power in the valley of the Romanche. During 1903 the tramways from Grenoble to Sassenage, Uriage-les-Bains and Vizille were converted from steam to electricity. At the latter town the famous old chateau is being converted into a first-class hydro-electropathic establishment to be opened next season.

Halifax.—The Town Council have declined to permit the construction of a tramway line between Halifax and Huddersfield via West Vale and Elland, joining the Halifax tramways at their present terminus at Salterhebble.

Herts. Light Railways.—In connection with the Barnet light railway, the order for which has been granted to Herts. County Council in conjunction with the North Metropolitan Tramways Co. (to whom it is proposed to lease the line when constructed), the Board of Trade have inserted a provision relieving the Council from the obligations to charge ½d. fares. In assenting to the amendment the Board have required an undertaking from the company to afford certain facilities as to cheap fares over the through lines worked by them.

Hull.—The borough electrical engineer (Mr. H Bell) has submitted his estimate of expenditure for year ending March, 1905:—

The capital expenditure of £10,000, for which borrowing powers are to be obtained, is for plant, mains, &c., sufficient to deal with the anticipated load for next winter. It will be necessary to set aside £1,500 to provide for modifications to the old high-tension switch gear. Provision is made for an increase in rents, rates and taxes from £1,750 to £3,320; interest, £10,140; sinking fund, £8,270; meters and switchboard depreciation, £2,900; total, with other items, and including balance of £2,061, £45,491, against £41,789 last year. It is estimated that the receipts from sale of current will be £44,148, compared with £40,364 last year; public lighting, £343, against £324; total (including £1,000 for meter rental), £45,491, compared with £41,789 last year.

India.—Under the new Indian Electricity Act, which came into force on Jan. 1, rules have been made regulating the generation, supply and use of electric energy and for carrying out the purposes and objects of the act, and are published in the "Official Gazette." These rules are based upon those issued by the Board of Trade in this country.

Islington (London).—On Wednesday the Finance committee issued a report upon the recent communication from the London County Council as to the conditions upon which the County Council had given sanction to loans for electric lighting, and intimating that they regarded the creation of a renewal fund as desirable in the interests of prudent finance.

The committee reported that they had been approached by the Lighting committee with a suggestion that the question of providing such a fund should be deferred until the end of the current financial year, when it was hoped the finances of the electricity undertaking would be in a better position, and the Finance committee had agreed to this, on the understanding that the question of providing a reserve fund should then be dealt with. They accordingly recommended that the County Council be informed

"That the views of Islington Borough Council coincide with their views as to the necessity of providing a reserve fund; that the formation of such a fund was under consideration, and that up to the present all renewals which had been necessary had been provided out of revenue."

The Lighting committee reported that they have reconsidered their report of July 22, 1903, recommending that the charge for public arc lamps be increased to the exact cost to the undertaking of generation and maintenance. Having regard to the long hours during which electricity was used for public arc lighting, and to the fact that the committee proposed, with the approval of the Council, to transfer from the electricity account to the general rate for the next half-year an amount of £1,200 to provide for carbons and labour, the committee think that the charge of 3½d. per unit is a reasonable one and should be adhered to.

An expenditure of £490 for main extensions and of £397 for circulating oil gear, additional stores accommodation and fireproofing of engine room were also recommended.

The Parliamentary and General Purposes committee recommend that the London County Council be asked to introduce legislation to enable borough councils to purchase electric motors for letting on hire, to wire consumers' premises, &c.

King's Norton.—The Council have rejected the terms of the City of Birmingham Tramways Co. for working the suggested tramways extensions from Selby Oak to Northfield. The Council refuse to grant a lease for a longer period than June, 1911. The company asked for 21 years.

Light Railway.—An inquiry was held on Wednesday into the application of the North Wales Power and Traction Co. for an order to construct light railways in the Snowdon district. The Commissioners decided to grant the application.

Lincoln.—The Corporation have sealed an agreement with the Lincoln Tramways Co. for the purchase of their undertaking at £10,437.

London County Council.—At Tuesday's meeting, loans for electric lighting were granted to Hackney (£7,406) and Stepney (£1,998).

Tramway Accounts.—The auditors' report on the Council's accounts for 1902-3 contained the following:—

"The balance on the tramways appropriation account at the beginning of the year amounted to £45,182. At the end of the year the balance was £29,869. During the year £45,000, part of the surplus balance for 1901-2, was carried from tramways account to the special county account in relief of rates, £8,100 being in respect of the southern system and £36,900 in respect of the northern system. At the end of the year the southern system revenue account had a deficiency of £2,251 and the northern system a surplus of £37,794. In consequence of the decision of the House of Lords (Feb. 7, 1902), that the Council had no legal power to run omnibuses, the horses, vehicles and other property used in connection with the omnibus service have been disposed of. The original cost was £29,266. 3s. 5d., and as the amount realised by the sales and set aside for sinking fund only amounted to £23,820. 17s. 5d., there is a sum of £5,445. 6s. in respect of the omnibus service, capital outlay now included in the debt outstanding on tramway account. I understand that arrangements will shortly be made to reduce this debt by the sum in question."

Electrification of the Northern System of Tramways.—The Highways committee submitted a report dealing with the difficulties which have confronted them with regard to the electrification of the northern tramway system leased to the North Metropolitan Tramways Co. On July 7 last the Council adopted a scheme, but it was referred back to them to obtain the views of the local authorities. On Oct. 13 the committee submitted a scheme for those lines which should be reconstructed for the conduit system, and these plans were now under the consideration of the Board of Trade. The North Metropolitan Company had been asked if they desired to make any suggestions for the carrying out of the work, and had replied that until they knew more as to the working of the conduit system they could not offer any suggestions to the Council in respect to the adoption of the underground system of electric traction on any of the lines now leased to them. The committe, in conclusion, say:—

"We feel that the Council is under an imperative duty to do all in its power to expedite the adaptation of the northern lines for electric traction, and we hope very shortly to submit definite proposals to enable the reconstruction of the first section of the tramways to be commenced at an early date. With regard to the employment of overhead traction on portions of the lines, we have to report, after communicating with the ten metropolitan borough councils concerned, that eight of the local authorities are opposed to the adoption of this system of traction, one authority has expressed qualified approval of the Council's proposals so far as it is affected, while no definite opinion has been expressed by the remaining local authority. We have under consideration the question of the course which in the circumstances should be adopted in view of this expression of opinion as to the use of the overhead trolley system where it appears to be necessary, and we propose also to report at an early date with regard to the question of the reconstruction of the lines, over and above the 22¾ miles above referred to, on which it is proposed to instal the conduit system. We regard the electrification of this system as of pressing urgency. The Council will, however, see that with the North Metropolitan Company, on the one hand, refusing to assist in the installation of the conduit system of traction on any of the lines the subject of the lease, and the Borough Councils, on the other hand, refusing, under the powers given to them by the Electrical Power Act, 1900, to have any other system within their districts than the conduit system, the difficulties which have faced us in dealing with this question have been of a most serious and complicated character."

Mr. BEACHCROFT thought the idea underlying the report was that delay was due to the company. As a matter of fact, it was within the power of the Council under the lease to come in and electrify the lines.

Mr. BENN said the company was entitled to quiet enjoyment of their lease, and if they attempted now to electrify on the conduit system they would do so in the face of the company.

The Southern Tramway System.—It was agreed, as a temporary expedient, to obtain the supply of power needed for the cable tramways between Kennington and Streatham from the existing cable machinery, and to accept the offer of Mr. B. Thomas to supply and erect, for the sum of £580, the low-tension switchboard required.

Maidstone.—Mr. E. E. Hoadley, resident electrical engineer, has been appointed manager also of the electric tramway undertaking.

Manchester.—The following increases of salaries of employés in the electric light and tramway departments are recommended:—

Mr. J. T. Oakes, traffic superintendent, £350 to £400; Mr. A. A. Blackburn, car sheds superintendent, from £218. 8s. to £240; Mr. J. Eades, junr., car works manager, from £220 to £250; Mr. H. Mattinson,

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assistant permanent engineer, from £235 to £250; Mr. L. R. Lee, mains superintendent, from £300 to £325; Mr. J. A. Cookson, surveyor of mains, from £250 to £275; Mr. E. Bolton, sub-station engineer, from £200 to £225; Mr. F. H. Whysall, resident engineer (Dickinson-street and Bloom-street stations), from £175 to £225; Mr. W. A. Jackson, installation inspector, from £180 to £220; Mr. A. N. Moore, shaft engineer, from £150 to £180; Mr. H. Lamb, Mr. T. Baxendale, Mr. E. J. Constable and Mr. W. J. Bamber, shift engineers, from £150 to £175; Mr. H. A. Ratcliffe, testing assistant, from £150 to £175

The poll on the Corporation's tramways bill has resulted in a decisive majority in favour of the measure.

Municipal Telephony.—Swansea Corporation have received a communication from the secretary to the Postmaster-General stating that, in accordance with sec. 5 of the order of Sept. 26, 1899, he had satisfied himself that the number of subscribers actually working on the Corporation system was more than one-quarter of the subscribers of the National Telephone Co. in the Swansea exchange area, and under these circumstances the Corporation were entitled to require the National Company to afford mutual intercommunication between their subscribers and those of the Corporation. It is stated that there are now 566 subscribers connected with the municpal system, and 245 awaiting connection. The total number of lines and instruments working is 661.

Newcastle-on-Tyne.—At the City Council on Wednesday the Tramway committee were authorised to purchase a new generating set at £4,400 for providing energy for lighting the public buildings. The set has been in use for some time, having been accepted in an emergency on hire with the option of purchase within one year.

Newport.—The estimates of the Corporation tramways department for the year ending March 31, 1905, will be presented on Tuesday. The estimated income is £29,500, working expenses £18,865, balance £10,635. After paying interest, sinking fund, &c., there will be a net profit of £10,035. On the electricity account it is estimated there will be a surplus of £1,962.

Nottingham.—On Monday the Town Council agreed, on the recommendation of the Electricity committee, to apply for sanction to a loan of £100,000 for extensions of the electricity undertaking. The money is required to meet estimated expenditure during the next three years.

Personal.—Mr. A. E. Aspinall is leaving the service of the British Westinghouse Co. to take up the position of manager of the costs department of the De Beers Consolidated Mines (Ltd.), Kimberley. Mr. Aspinall leaves for Africa on the 11th inst. Mr. Aspinall commenced his business career with the White Star Line at Liverpool, and in seven years passed through every commercial department. He next accepted a post under the Smelting Corporation (Ltd.), Ellesmere Port, near Chester, and acted as manager of the costs department during the erection of new works, and for two years afterwards. After a short sojourn with Messrs. Brunner, Mond & Co., Mr. Aspinall joined the staff of the British Westinghouse Co. and has been actively engaged in the manager's department for the past 2½ years. During this time he organised and had control of the correspondence department.

Mr. R. A. Dawbarn left on Saturday last in the "Dunottar Castle" for Johannesburg. Messrs. Mordey and Dawbarn are consulting engineers for the municipal electric lighting and tramways undertaking of the golden city.

Portishead.—The application of the Western Electric Distributing Corporation for a provisional electric lighting order has been sanctioned by the Council.

Presentation.—On Saturday the employés of the Birkenhead Corporation tramways department presented Mr. A. R. Fearnley, who has been appointed manager of the Sheffield tramways, with a silver table lamp. Mr. R. S. Pilcher made the presentation.

St. Helens.—The Tramways committee have decided to rel-ay the tramway track from the toll bar on the Prescot-road to Porticolane, Eccleston, at a cost of £6,000.

Shoreditch (London).—The Electricity committee recommend the Borough Council to lodge a petition against the East London and Lower Thames Electric Power Bill.

Sidcup.—The ratepayers of Sidcup and Foots Cray are to be polled on the lighting question.

Sweden.—The electric tramways now under construction in Stockholm are to be completed this year, the total amount expended being £160,000. The question of converting the horse tramways in the towns of Gefle, Malmo, Norrköping, Sundsvaal, &c., to electric traction is under consideration.

Theatres and the Telephone.—London County Council Theatres and Music Halls committee have notified the lessees and managers of all licensed buildings in the administrative county of London where performances are regularly given that these must be at once placed in direct telephonic communication with the nearest fire brigade station.

Tottenham.—On Tuesday the Electricity committee reported that the consulting engineers, Messrs. Hawtayne and Zeden, had prepared alternative electricity supply schemes.

The first was for joint electricity and refuse destructor works. There would be sufficient steam available from the destructor for running a 200kw. steam dynamo, and they recommended that the Council put down a unit of that size, together with similar unit as a standby. The top load of the plant would only be reached during two hours out of the 24, and they considered it desirable that the Council should put down additional boiler plant in connection with the refuse destructor boilers, so that the engine-house units might be increased from 200kw. to 300kw. The Council have decided to erect 129 arc lamps in the main streets. It is estimated that in the main thoroughfares of the compulsory area there would be a demand for about 8,000 8 c.p. lamps for private lighting. The estimated cost of the scheme was £25,240, including proportional cost of site, shaft, generating plant, underground mains, meters, engineering and legal expenses, and extras for providing the necessary transformers, high and low-tension mains, &c.

By scheme 2 an additional capital expenditure of £4,000 would be required to run 300kw. units, together with additional boiler power to increase the generating plant, bringing up the total capital expenditure to £30,000. On this assumption the estimated revenue would be £5,422. 16s. per annum, and this, deducting £3,113 for works cost and repairs, would leave a gross profit of £2,309. 16s. Interest and sinking fund would require £1,654. 5s., or 6½ per cent. per annum on £25,450, leaving an estimated net profit of £655. 16s. If the Council accepted the North Metropolitan Electric Power Supply Co.'s offer for supplying arc lamps, &c., approximately £4,000 would have to be added to the capital expenditure.

The committee recommended the Council, in the event of the adoption of the scheme, to make application for sanction to a loan of £30,000. After discussion the matter was referred to the Council in committee.

Transvaal Imports.—For the first 10 months of 1903 electric cables, wires and fittings were imported into the Transvaal to the value of £58,000, compared with £36,000 in the same period of 1902. Tramway material was similarly imported to the value of £69,000, compared with £25,000.

Walton.—The Council have discussed a report by Col. Crompton upon the scheme of the Urban Electric Supply Co. for the public lighting, and on his advice it has been decided to ask the company to erect, as an experiment, a number of arc and incandescent electric lamps to ascertain their respective merits.

Wednesbury.—The Council have taken up a loan of £11,000 for electricity supply.

Mr. F. J. Warden-Stevens has been retained as consulting engineer to supervise the working of the electricity undertaking for 18 months. The Corporation anticipate being shortly in a position to supply current, and the adoption of prepayment meters for small consumers has been decided upon.

Whitley.—The profit on the electricity undertaking during the past year was £56. 10s. 1d., compared with a deficiency of £433 in 1902-3. The total capital expended was £26,240 out of £28,000 sanctioned. It has been decided to employ electric motors for pumping at the sewage outfall works.

Wireless Telegraphy.—The Admiralty are establishing a wireless telegraph station on the Marconi system at Portpatrick, Wigtonshire, and tenders have recently been invited for the erection of a 150ft. mast, instruments and signal rooms, signal semaphore, &c., on the north cliff near the harbour. The work is to be completed within four months from date of acceptance of tender. The site of the new station commands the Irish Channel, and the object is to establish signalling communication in connection with the naval manœvres, and also for the benefit of merchant vessels in these waters.

York.—In a report by the Electric Lighting committee, presented to the City Council on Monday, it was stated that during the past nine months the receipts from the sale of electric current amounted to £6,051, expenditure £3,290, showing a gross profit of £2,700 to meet sinking fund and interest.

The Finance Committee has been requested to consider the bill of the Lincolnshire and Yorkshire Electric Power Co., and, if necessary, they have been authorised to join with other local authorities in opposing the bill.

TRADE NOTES AND NOTICES.

[Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.]

TENDERS INVITED.

The Metropolitan Borough Council of *Islington* will meet on Feb. 26 to consider tenders for stores, including arc lamp columns, arc lamps, arc lamp renewal parts, carbons, integrating watt-hour meters, cables, earthenware conduits and pipes, transformers, incandescent lamps, mains, sundries and fuses, terminal boxes, &c.,

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fittings and wiring accessories, insulating material, electrical sundries, oils and lubricants, belting, ropes, &c., rubber and asbestos, emery cloth and sundries. Further particulars are given in an advertisement. Forms of tender, &c., at the Town Hall, Upper-street, London, N., after 15th inst. Tenders must be in by noon Feb. 25.

Islington (London) Lighting committee also invite proposals from contractors for carrying out of wiring for and the supply of motors to the Council's consumers on a system of simple hire or hire-purchase. Proposals to the electrical engineer (Mr. Albert Gay), 56, Eden-grove, Holloway, N., by Feb. 17. See also advertisement.

Islington (London) Borough Council also invite tenders for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple core high-tension feeders and low-tension distributors, and pilot cable with feeding junction and service boxes. Tenders to the town clerk (Mr. Wm. F. Dewey) by noon Feb. 24.

Bermondsey Metropolitan Borough Council invite tenders for stores for one year from March 31, including arc lamp carbons, electricity meters, demand indicators and main fuses, engine oils, incandescent lamps, indiarubber cables and jointing material, lead-covered cables and meter boards. Samples at the electricity works upon application to the borough electrical engineer, Mr. W. H. Vincent. Tenders to the town clerk (Mr. Fredk. Ryall), Town Hall, Spa-road, London, S.E., by noon Feb. 16. See also advertisement.

The Baths sub-committee of the Borough of *Camberwell* invite tenders for the supply and erection at Camberwell Baths of new engine and dynamo, &c. Particulars, &c., from the borough engineer, Mr. W. Oxtoby, Town Hall, Camberwell, London, S.E. Tenders by 6 p.m. Feb. 16. See advertisement.

Preston Corporation invite tenders for laying a complete system of feeder mains on the drawn-in system. Specifications, &c., from the consulting and resident engineer (Mr. Walter H. Tittensor), 25, Burrow-road, to whom tenders by Feb. 15. See advertisement.

Hammersmith (London) Borough Council invite tenders for various stores for twelve months ending March 31, 1905. Tenders to the town clerk (Mr. H. Thompson) by 4 p.m. Feb. 10.

Sunderland Corporation invite tenders for a travelling crane and a storage battery. Tenders to chairman of Electric Lighting committee, Town Hall, Sunderland, by noon Feb. 26.

Bedford Electrical committee invite tenders for supply and erection of a high-tension switchboard. Tenders to chairman, Cauldwell-road, Bedford, by noon Feb. 9.

West Ham Corporation invite tenders for various engine-room stores, cable, recording wattmeters, house cutout boxes, transformers, incandescent lamps, &c Tenders to town clerk, Town Hall, West Ham, E., by 4 p.m. Feb. 11.

London County Council Asylums committee invite tenders, by 10.0 a.m. Feb. 17 for 12 months' supply of stores, including electric lighting sundries.

London County Council invite tenders by Feb. 16 for five tubular fuel economisers, &c., for Greenwich electricity generating station.

Swindon Corporation invite tenders for wiring Euclid street Elementary School. Tenders to secretary, Education committee, by noon Feb. 15.

The Northern Counties (Ireland) committee of the *Midland Railway Co.*, Belfast, invite tenders by Feb. 10 for telegraph iron work, batteries, &c.

Middlesex County Council Light Railways committee invite tenders by March 14 for permanent way construction, &c., of light railways. Tenders to Middlesex Guildhall, Westminster, S.W.

Colne and *Holme* Joint Isolation Hospital committee invite tenders for telephones, &c. Tenders to 8, Cloth Hall-street, Huddersfield, by Feb. 15.

Battersea (London) Council invite tenders by noon Feb. 15 for a 750kw. steam dynamo and electric pump and pipe work.

Leeds Corporotion invite tenders by Feb. 10 for wiring the branch library, Wesley-road, Armley.

Stockton-on-Tees Corporation invite tenders by Feb. 16 for 12 months' stores for the electricity department.

TENDERS RECEIVED AND ACCEPTED.

Brighton Corporation have accepted the following tenders:—

Stewarts and Lloyds (steel poles), £969. 11s. 6d.; F. Smith & Co. (trolley wire), £325. 5s. 2d.; Rowland Carr & Co. (bases and section pillars), £313. 15s. 7d.; J. Needham & Sons (cast-iron fittings), £42. 2s.; Dick, Kerr & Co. (pole brackets), £173. 4s.; W. Wood & Co. (overhead line fittings), £97. 9s.; F. Smith & Co. (span and guard wire), £15. 10s. 6d.; W. Wood & Co. (switch gear), £38. 7s. 6d.; British Insulated and Helsby Cables (Ltd.) (feeder, distributing and telephone cables), £3,209. 15s. 3d.; R. W. Blackwell & Co. (rail bonds), £580. 19s. 2d.; Acme Wood Flooring Co. (wood-paving blocks), £7,100; Brooks Limited (granite setts), £615.

The following tenders were received by Chiswick District Council for a refuse destructor and auxiliary plant. The estimate of the consulting engineers (Messrs. Swinburne, Cooper and Baillie) was £6,000:—

Horsfall Destructor Co. (with Custodis chimney) (*accepted*)	£5,637 0 0
Ditto	5,837 0 0
Goddard, Massey and Warner	7,469 19 0
Heenan and Froude	6,924 10 0
Meldrum Bros.	6,540 16 0
Refuse Destructors Limited	5,584 8 11
Hughes and Stirling	5,214 0 0
W. F. Mason (Ltd.)	3,235 15 0
Joseph Baker & Sons (part only)	2,900 0 0

The Council have also accepted the tender of the Horsfall Co. for additional works, making a total of £7,481.

The Underground Electric Railway Co. has accepted the tender of the Sir Hiram Maxim Electrical and Engineering Co. for the supply of 100 miles of stamped steel troughing for use in the electrification of the Metropolitan Railway.

For the pipe work in connection with the cooling towers about to be erected at Oldham electricity station by Messrs. Arthur Koppel, the tender of the Sir Hiram Maxim Electrical and Engineering Co. has been accepted.

Bradford Corporation have accepted the undermentioned stores for their tramways department for 1904:—

Harrison and Singleton (poplar wood blocks), Thornton and Crebbin (cast-iron brake blocks and miscellaneous castings), Brooksbank & Co. (raw linseed, boiled and lubricating oil and petrol), H. Smith (paraffin oil), Green Mount Oil Co. (motor grease), Samuel Miller (colza oil, cotton waste and sponges), Kimberley Bros. (cleaning cloths), P. S. Jennings (brushes), Stephenson Bros. (brushes and washleathers), Raynes, Porter and Seddon (polishing paste), Hy. Barrett & Son (best wrought and ordinary merchant iron), J. Light & Sons (turpentine).

The British Westinghouse Co. have received an order (through Messrs. Frank Suter & Co.) for two gas engines and auxiliaries for Tiverton Corporation. The engines are of 125 B.H.P. each and of the three-cylinder (15in. by 14in.) type.

May-Oatway Fire Appliances (Ltd.) have accepted the tender of Carrick and Topping for wiring the Govan Ropeworks, Govan, and the offer of Wylie and Lockhead (Ltd.) for wiring James Templeton & Co.'s premises in Greenhead and West-street, Glasgow, for May-Oatway compensated automatic fire alarms.

The National Provincial Electrical Corporation has accepted the tender of the Sir Hiram Maxim Electrical and Engineering Co. for the complete equipment of their generating station at Bridgewater, including the whole of the machinery for the station, and also for the distributing and feeder cables, for the sum of £13,000.

Chesterfield Corporation have recently ordered a 400kw. steam dynamo, together with switchboard and auxiliary apparatus, a Babcock and Wilcox water-tube boiler and a Worthington jet condenser, from the British Westinghouse Co.

The Fife Electric Power Co. have accepted the offer of Bruce Peebles & Co. (Ltd.) for generating machinery of 2,000 H.P. (including engines, alternators, boilers, switch gear, &c.) for their Dunfermline generating station at £23,590.

In addition to the contract for the Walthamstow tramways secured by W. T. Henley's Telegraph Works Co. (Ltd.) at about £75,000, the firm have also obtained an order for supplying and laying cables (including three-phase cables) for the Sydney (N.S.W.) tramways.

Eastbourne Electric Lighting committee have accepted the following tenders for motor 'buses:—Clarkson & Co., single-deck 'bus, £735; double-deck, £807; Milnes-Daimler Co., single-deck 18 H.P., £825; double-deck, 20 H.P., £900.

The tender of the Sir Hiram Maxim Electrical and Engineering Co. has been accepted by the contractors (W. O. Rooper & Co.) for the pipe work in connection with the electric installation for the Royal Naval Hospital, Portland.

As sub-contractors to the British Westinghouse Co., the pipe work for the New Bath tramway station has been carried out by the Sir Hiram Maxim Electrical and Engineering Co.

Newcastle-on-Tyne Tramways committee have accepted the tender of Bolckow, Vaughan & Co. for 2,000 tons of tramway rails at £5. 4s. 9d. per ton, the lowest tender submitted.

The tender of the British Westinghouse Co. for electricity meters at prices ranging from £8 to £17. 17s. 4d. each, has been accepted by Dublin Lighting committee.

Dewsbury Council have accepted the tender of the Sir Hiram Maxim Electrical and Engineering Co. for the supply of steam, feed and exhaust pipes at their electricity works.

The following are among the recent orders obtained by W. H. Allen, Son & Co. (Ltd.), Queen's Engineering Works, Bedford:—

One engine coupled to dynamo, for H.M.S. "Canopus"; five engines coupled to dynamos, for H.M. ships "Albion," "Glory," "Ocean,"

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"Vengeance" and "Goliath"; and two engines coupled to dynamos, for H.M.S. "Thames."

Two engines for direct-coupltng to centrifugal pumps, for the Deptford station of the London Electric Supply Corporation.

Two engines for coupling to E.C.C. dynamos, for Portland Hospital (through W. O. Rooper & Co.).

Two engines for direct-coupling to centrifugal pumps, for Yoker power station (through British Westinghouse Co.), and one engine for direct-coupling to a British Westinghouse dynamo, for Messrs. A. H. Briggs & Co. (Bradford).

Twenty-one engines for H.M. ships "Liffey," "Moy" and "Ouse" (through Laird Bros.).

One enclosed engine for coupling to a General Electric dynamo, for the Ansell Brewery Co., Birmingham.

Fourteen engines for H.P. ships "Colne" and "Chelmer" (through J. I. Thornycroft & Co.).

Fourteen engines for H.M. ships "Ness" and "Nith" (through J. S. White & Co.).

BUSINESS NOTICES.

Mr. G. F. Metzger, A.M.Inst.C.E., M.I.E.E., who has recently been appointed consulting engineer to Manchester Corporation for the completion of the work initiated by him as their city electrical engineer, has started practice as consultant in electrical and mechanical engineering at 3, York-street, Manchester.

The Paul Heater and Condenser Co., 63, Queen Victoria-street, London, E.C., have appointed Messrs. Herbert and Gilchrist, 146, West Regent-street, Glasgow, their agents. The London offices of the company are now under the management of Mr. R. H. Haylock, one of the directors of the company, who was for many years chief engineer of the Sturtevant Engineering Co.

An amalgamation of the undertakings of Peto and Radford (Ltd.) and the P. and R. Storage Battery Co. (Ltd.) has been effected, and a new company has been registered, with the title of Peto and Radford (Ltd.), which will take over the two companies as a going concern as from Jan. 1, 1904. The new company will discharge all liabilities and collect all moneys due.

The head offices of the South Lancashire Electric Traction and Power, the South Lancashire Tramways and the Lancashire Light Railways Companies have been removed to 9, North John-street, Liverpool.

The continued increase of their business in the Midlands necessitates the Hart Accumulator Co. (Ltd.) opening a branch office at Princes Chambers, Corporation-street, Birmingham. Mr. F. R. Hill has been appointed local manager.

The Electric and Ordnance Accessories Co. (Ltd.), Stellite Works, Cheston-road, Aston, Birmingham, have recently appointed Mr. V. J. Delebecque as their chief representative in the British Isles. Mr. Delebecque will shortly call upon the trade in the various centres, in order to submit the latest productions of the company, including motors, ammunition hoists, switch gear, fittings, telephone, &c.

Messrs. Royce (Ltd.) have appointed Mr. E. C. Amos, M.I.M.E., 20, Bucklersbury, London, E.C., their sole representative for the London district.

LIQUIDATIONS, BANKRUPTCIES, &c.

In the bankruptcy of Gardner Bros. & Co., electrical engineers Horninglow-street, Burton-on-Trent, the first meeting of creditor will take place on 10th inst. at 47, Full-street, Derby, and the public examination on 17th inst. at the Court House, Burton-on-Trent.

The liquidator of Hands Limited, 21, Garlick-hill, London, E.C., has been released.

The Electric Traction Co. (Ltd.), is to be wound up voluntarily, Mr. W. B. Peat, 3, Lothbury, London, E.C., is liquidator.

Bankruptcy Petition.—A petition in bankruptcy has been filed against the Electrical Contract and Maintenance Co., and will be heard in London on Feb. 12.

Manufacturing Premises, &c., for Sale—Messrs. Farebrother, Ellis, Egerton, Breach, Galsworthy & Co. will sell by auction at the Mart, Tokenhouse-yard, London, E.C., on March 24, at 2 p.m., in one lot, the part freehold and part leasehold railway signal works occupying about 8 acres and situate in Canterbury-road, close to Maida Vale and Kilburn railway stations. The property has a frontage of 285ft., abutting on to the London and North-Western Railway, and is eminently suitable for engineering works, electricity generating station or as a motor factory. Particulars from Mr. Geo. Terrell, 14, Copthall-avenue, London, E.C.; at the Mart; and of Messrs. Farebrother, Ellis & Co, 29, Fleet-street, London, E.C. See also advertisement.

An exceptionally well-built, fireproof factory warehouse (over 14,000 superficial feet), in close proximity to Liverpool-street Station, London, E.C., is to be let or sold. Further particulars from Messrs. W. J. Bush & Co. (Ltd.), Ash-grove, Hackney, London. See advertisement.

A wharf with good river frontage at Battersea is to be let. Applications to Mr. Harold Griffin, 54, High-street, Battersea, London, S.W. See also advertisement.

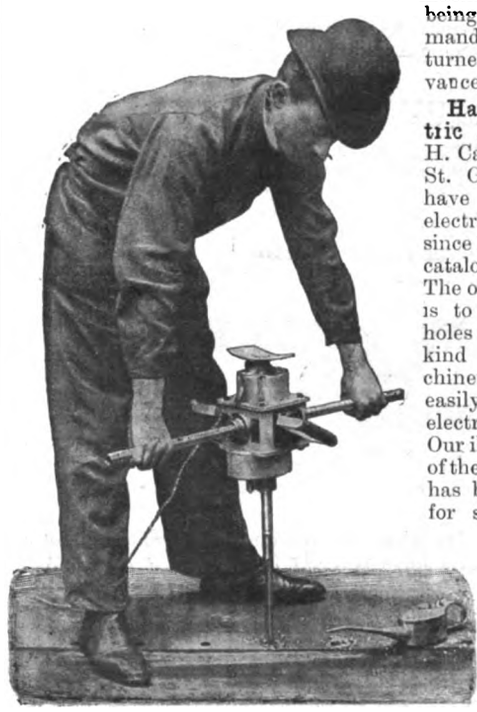
Compact engineering works, with good modern light engineer's plant, are advertised for sale in another column.

Plant for Sale.—Some electric lighting plant (comprising a Cornish boiler, a high-speed horizontal engine, a Parker dynamo, storage battery of 63 cells, two enclosed motors, &c.) is advertised for sale in another column. Applications to Mr. F. Gilman, High Park-road, Smethwick.

Alternator Wanted.—A 50kw. alternator is wanted, for 2,000-volt circuit, periodicity 50 and speed 750 revs per min. Quotations to Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C. See advertisement.

"Royal Ediswan" Motor Delivery Van.—To overcome the delays experienced in getting stocks of their lamps, &c., quickly delivered, the Edison and Swan United Electric Light Co. are adopting motor vehicles for this purpose, and a regular service has been established between the Ponder's End works and the head offices in Queen-street, London, E.C. From this point supplies are delivered by motor vehicle to the various supply contractors in other parts of London. The return journey to Ponder's End in the evening finds the vehicle furnished with a load of empties and raw material. The vehicle is rated as a 9½ H.P. 2-ton lorry, and is 16ft. 11in. long by 6ft. 5in. wide overall. The new motor vehicle supplements the company's horse-drawn vehicles engaged in their delivery service.

Electrically-driven Machinery.—The Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C., have ready an interesting pamphlet describing the advantages of separate electrical driving for tools, lathes, &c. The illustrations show a large number of tools equipped with motors for separate electrical working. These show both light and heavy machines, and include a slotting machine for slotting armatures, especially designed for large continuous-current machines, the armature being fixed on the vertical mandril, which can be turned as the work advances.



Cadiot Portable Electric Drill.

Hand Portable Electric Drills.—Messrs. E. H. Cadiot & Co., 12, Rue St. Georges, Paris, who have made hand portable electric drills a speciality since 1896, forward a new catalogue of these machines The object of the machine is to enable small drill holes to be made in any kind of material or machinery which cannot be easily transported to large electric drilling machines. Our illustration shows one of these small drills, which has been on the market for some time and has met a steady and increased sale. Messrs. Cadiot have recently introduced some powerful machines of this class, which, however, retain all their portable features.

"Union" Excello Lamps—On the occasion of the holding of the "Union Jack" Club Ice Carnival yesterday, a number of "Union" Excello intense flame arc lamps were installed. The carnival was visited by the Prince and Princess of Wales.

Copper Bonds.—Many inventions have been made relating to copper bonds for connecting rails of electric tramways and railways, and many patents have been taken out in connection with these bonds. In the majority of cases, however, the bonds were either technically weak or the cost of construction and method of fixing was so expensive as to preclude their use in practical work. Of the few types of bonds which have proved their title to be classed as practical entities in this branch of the electrical industry may fairly be mentioned the "Neptune" bonds made by Messrs. Felten and Guilleaume at Mulheim and supplied by Messrs. W. F. Dennis

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& Co., their agents in this country. These bonds are made either of one solid wire (called solid bonds), of small connecting wires of rectangular section, or of small round wires forming a strand or rope (termed cable laid rope). In the latter every shank of the strands of the ropes is again composed of strands consisting of a number of small wires (in the ordinary construction the shanks of the strands of the ropes are made up of single solid wires) whereby

Fig. 1.—Heavy Section Bonds.

high flexibility is obtained. These bonds are accordingly called "flexible" and "extra flexible." The flexible or extra flexible bonds for use either under or over fishplates are made with the three different types of heads and with either ordinary or long sockets. These bonds are manufactured under Messrs. Felten and Guilleaume's patented process (Nos. 15,119 and 18,493) which ensures absolute and perfect integrity of the wires with the heads all through,

Fig. 2.—Loose Bond Heads.

a great advantages. Both ends of the bonds being open during the process of drop-forging the wires and head together, any air inside is removed. The numerous types of bonds manufactured by this firm are in use on hundreds of electrical tramways and railways, including most of the tube and underground railways in London. For one of these lines special bonds of very heavy section (see Fig. 1) have been supplied for fixing in the base of the rails. For special purposes, for connecting the rails to cables, bond heads are supplied loose in different models (Fig. 2.) Fig. 3 shows the

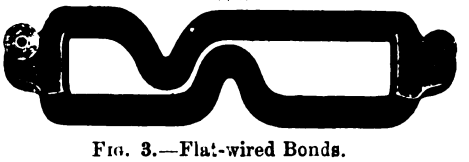

Fig. 3.—Flat-wired Bonds.

"Neptune" Flexible Copper Railway Bonds.

Neptune bond with flat wires for use under fish-plates. Messrs. Felten and Guilleaume have recently issued a new bond list, of which copies can be obtained by interested parties on application to Messrs. W. F. Dennis & Co., 49, Queen Victoria-street, London, E.C.; or in other countries from the firm's appointed agents.

Catalogues.—A new price list of single-phase transformers has been issued by Messrs. Crompton & Co. containing the usual information and data with regard to their standard types of small and medium-sized core transformers, built for a primary voltage of 2,000, a secondary voltage of 110 or 220 volts (four secondary terminals are provided), and for frequencies of 50 or 100 cycles per second. Most of the types enumerated are of the totally-enclosed pattern, the others being of the enclosed ventilated design. In the former the protection consists of a cast-iron cover, through which the cable passes by means of a special cable gland the stoneware collars of which give additional insulation and prevent the cable from becoming loose and being chafed. The full-load efficiencies are high, ranging from 93 per cent. for 1kw. transformers to 98·4 per cent. for the 140kw. type. Judging from these figures, the half and quarter-load efficiencies may be expected to be high also, and they might have been added to the tables as being of some value in practice. The weights of the transformers, too, have been omitted. Single and polyphase transformers for other voltages and frequencies than those mentioned in the price list are also supplied by Messrs. Crompton & Co.

"Pickquick" coal-cutting machines (Hurd's patent), fitted with direct-current electric motors, with three-phase electric motors, or with compressed air motors, are fully illustrated and interestingly described in a catalogue just issued by Messrs. Mavor and Coulson, 47, King-street, Mile End, Glasgow. The latest types of coal-winning machinery are attractively shown and the details technically explained. This catalogue, with its diagrams of electrical connections, &c., forms the most complete description of this class of machinery ever issued. Hints to intending users of this machinery will be found serviceable, as will also a group of electrical memoranda. The pamphlet is made complete by some good illustrations of slow-speed and high-speed engines and direct-current dynamos, electric haulage gears, pumps, &c.

We have received from the Knowles Steam Pump Works, 179, Queen Victoria-street, London, E.C., a copy of their 1904 catalogue, comprising descriptions and illustrations of a large variety of pumps for every class of pumping work. Copies of the catalogue will be sent free to those interested on application.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Jan. 27 to Feb. 2 with the ports of destination:—

Africa—Alexandria, £315; Cape Town, £225; Delagoa Bay, £650; Durban, £1,459; East London, £30. *Argentina*—Buenos Ayres, £61. *Australasia*—Adelaide, £68; Fremantle, £84; Launceston, £1,537; Lyttelton, £12; Melbourne, £220 (telegraph material); Otago, £58; Perth, £123; Sydney, £883. *Azores*—£2,800 (telegraph instruments). *Belgium*—Antwerp, £274. *Ceylon*—Colombo, £163 (including £14 telegraph material). *Channel Islands*—£326. *Chili*—Valparaiso, £11. *China*—Shanghai, £176; Tientsin, £859. *France*—Paris, £131. *Gibraltar*—£180 (telegraph material). *Holland*—Amsterdam, £117; Flushing, £40; Rotterdam, £15 (telegraph wire). *Hong Kong*, £264. *India*—Bombay, £106; Calcutta, £2,368; Karachi, £34 (telegraph apparatus); Madras, £310. *Japan*—Yokohama, £130. *Portugal*—Oporto, £49. *Russia*—St. Petersburg, £40 (telegraph cable). *Straits Settlements*—Singapore, £140,083 (including £140,000 telegraph cable). *U.S.A.*—New York, £2,043 (telegraph material). Total £156,236, against £11,350 in the corresponding week last year (Jan. 28 to Feb. 3).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by Messrs. Mewburn, Ellis and Pryor, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December 10, 1903.

27,032 H. Chitty. Dynamo-electric machines.
27,038 H. Liddle. Newcastle-on-Tyne. Sand valve, gear, and tramp for use on electric cars.
27,044 G. G. M. Hardingham. Submarine and submergible boats. (Electric Boat Co., U.S.)*
27,060 A. Cotis. Arc lamps.
27,079 C. C. Fontaine. Induction coils for medical and other purposes.

December 11, 1903.

27,118 R. Bostock. Halifax. Collector pulleys of overhead electric railways.
27,131 J. W. Wilkinson. Manchester. Trolley poles.*
27,133 E. H. Harnack. Protective device applied to X-ray or radiant matter tubes.
27,142 D. Burns. Burglar alarms for safes and strong rooms.
27,153 J. T. Mitscherling. Controlling apparatus for electric signalling devices.*
27,171 H. Chitty. Insulating electrical coils and the like.
27,172 Sherard Cowper-Coles & Co. Hardening of metals and alloys.
27,173 W. H. Kelsey. Connector for electric circuits.
27,189 J. Deutsch. Controlling the voltage from an electric generator.*
27,194 A. G. Bloxam. Manufacture of lead peroxide. (Société Anonyme d'Etudes Electro-Chemiques, Switzerland).
27,196 C. E. Hunter. Switches.*
27,199 F. M. Lewis. Arc lamps.
27,213 R. O. Heinrich. Method of winding moving coils for electrical measuring instruments.*

December 12, 1903.

27,249 P. Garuti and C. R. Pompili. Collecting, separating, drying or similarly treating oxygen and hydrogen generated by electrolysis of water.

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27,265 Sir O. J. Lodge and A. R. Hardie. Telegraph, &c., cables.
27,267 L. Milne. Suspending electroliers.
27,274 Warwick Machinery Co. Governing valves for intermediate stages for intermediate stages of elastic fluid turbines. (G.E.Co., U.S.)
27,275 Warwick Machinery Co. Nozzles for elastic fluid turbines. (G.E. Co., U.S.)
27,276 Warwick Machinery Co. Relief mechanism for elastic-fluid turbines. (G.E. Co., U.S.)
27,283 F. Biermann. Counters for electricity.
27,285 E. G. P. Bousfield. Manufacture of ozone.

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1902.

26,966 De Kandó. Controlling liquid resistances by compressed air.
27,618 Siemens Brothers & Co. and Siemens. Devices for varying the resistance of an electric circuit.
27,676 Petch. Hydraulic press for assembling parts of electrical commutators, tightening ends of commutators, and pressing together the discs of armatures.
27,756 Carolan (G.E. Co., U.S.) Convertible cabs for railway cars.

1903.

1,067 Carolan (G.E Co., U.S.) Electrical measuring instruments.
2,695 Lucas. Insulating materials and subetitutes for ebonite.
2,740 Heyde. Machines for winding a length of wire around two or more wires for the purpose of connecting same.
2,879 Loebl, Scott and American Electrical Novelty and Mfg. Co. Electric clocks.
2,963 Mansbridge. Telegraph and telephone cables and the like.
15,841 Viale. Arc lamps.
21,404 Siemens Brothers & Co. (Siemens and Halske A.G.). Electricity meter for alternating currents.
21,700 Beez. Electrical measuring instruments.
22,365 Baxter. Electro magnets. (Date applied for, Nov. 21, 1902.)
23,057 Lamme. Single-phase alternating current motors. (Date applied for, Oct. 31, 1902.)
23,302 Bowell and Pearson Fire Alarm. Automatic fire alarm systems.
24,127 Zwiebel. Electric bath tubs and electrodes therefor.
24,212 Haddan (Zielcuziger). Controlling arc lamps.
24,302 Bloxam (Schoeller). Magneto electric induction apparatus.
24,396 Risac. Galvanic batteries.

Erratum.—The patent "822 Edison. Storage batteries and manufacture thereof," included in the list of Specifications Published, on p. 585 of last week's *Electrician*, should read: "322 Edison. Storage batteries and manufacture thereof."

COMPANIES' MEETINGS AND REPORTS.

City and South London Railway Company.

The thirty-ninth ordinary general meeting was held on Tuesday, under the presidency of Mr. Charles Grey Mott.

The SECRETARY (Mr. W. F. Knight) read the notice calling the meeting.

The CHAIRMAN, in moving the adoption of the report and accounts, said:—I regret very much that I have to meet you to-day with so large a decrease in the dividend, but, as you will have learned from the report, the decrease has been caused by exceptional circumstances. In comparing with the corresponding half of the previous year, I would remind you that at that time the old horse tramways which we had had competing with us since the commencement of this railway had been purchased by the London County Council and were in course of conversion into electric tramways. During the process of conversion the ordinary traffic of the tramways was very much interrupted, and the consequence was that a large amount of traffic was exceptionally thrown on this railway during the half-year ended Dec. 31, 1902, and up to the middle of February, 1903. Since May we have been competing with a new and improved system, which was very attractive to the public, who have used the electric tramways extensively from the first, and, indeed, up to the present time. Moreover, their minimum fare was ½d. as against our minimum fare of 1d. Then, comparing with the corresponding period of 1902, we have been affected this last half-year by the fact that we had to pay in the early part of last year a very large sum, as you know, being the balance of the award in connection with the Church of St. Mary, Woolnoth. This half-year we have to meet the full interest on stocks then raised. All these things combined together have tended for the moment to cause this large decrease in the dividend, but the case is not by any means so hopeless as it looks. Our traffic is improving. We are getting back steadily the traffic we lost by the competition of the electric tramways, and if you will compare the traffic of the first five weeks of this year with the traffic for the same period of two years ago, when the horse tramways were working, and when we had exactly the same length of line and were working in every way as we are to-day, only that we had the old horse tramways and the working of the electric tramways had not come into force—if, I say, you compare the results of the first five weeks' working of this year with the results of the same period two years ago, you will see that we show an increase of nearly £1,000 in our receipts, notwithstanding the competition of the electric tramways. Anyway, I think I may prophesy that our future condition will be certainly a decided improvement on this past half-year. As regards our capital account we have received a very small amount; we have only issued £1,000 of debenture stock, and we have received, with the premium, £1,090. 5s. 8d. on that account. The expenditure has also been small, amounting to only £4,269. Our excess of expenditure over receipts for this period is therefore only £3,178. 14s. 6d., which has been practically paid out of revenue for the time being; it is temporarily advanced from revenue. Taking the revenue account, the decrease in the number of passengers carried has been 1,166,137, and the amount of the decrease is £10,957. From parcels there has been a decrease of £10 and from transfer fees a decrease of £28, making the total diminution £10,995. On the other hand, there was an increase in the number of our season tickets by 1,952, but I will refer to this matter a little later on. The increase in the receipts in season tickets was £1,112. Rents were £39 more and sundry receipts were £15 more, making a total increase of £1,166, thus making a total net decrease of £9,829. On the expenditure side there has been a decrease in the maintenance of way of £21, in locomotive and generating power of £905, in carriage repairs of £270, in traffic charges of £310, in law charges of £87, in rates and taxes of £115 (this is the first time we have ever had a decrease in rates and taxes), and in passenger duty of £17, making a total decrease of £1,725. On the other hand, there is an increase in general charges of £295, so that we show a total net decrease on the expenditure side of the revenue account of £1,430. That reduces the decrease in the receipts on revenue account to £8,399. On the other hand, we have an increase in debenture stock interest of £923, but against that there is a decrease of £825 in interest and the amount charged to renewals. We have charged in this half-year £1,500 to renewals instead of £2,000, because we had cleared off the old debt, and £1,500 was considered ample. There is £325 less also on general interest account. That reduces the amount of the balance of net revenue by £8,497, and then there is a difference compared with last year in the balance brought forward of £250. This makes the total amount available for dividend smaller by £8,747. The net amount available for dividend is £28,296. 10s. 4d. The preference dividends absorb £14,250, and to pay a dividend at the rate of 2 per cent. on the ordinary stock will take £13,300, making together £27,550, and leaving a balance to carry forward of £746. 10s. 4d. That is the result of those accounts. The number of actual trains run has been 99,168, against 102,185 in the December half of 1902, so that we have run rather fewer trains, and the train mileage is reduced from 625,883 in the corresponding period of 1902 to 607,402 in the past half-year. The reduction in the number of passengers I have already mentioned. The number of passengers per train-mile was reduced from 96·66 to 87·84. That, of course, is a matter of necessity consequent on the large decrease in the number carried. The receipts per train were reduced from 16s. 1d. to 15s. 3d., per train-mile from 2s. 7d. to 2s. 4d., and per passenger from 1·93d. to 1·88d. The ratio of working expenses was increased from 44·04 to 47·86 per cent. That, of course, is owing to the decreased traffic; the less traffic we have, the greater the ratio of expenses. We got it down last year to the extremely low figure of about 44 per cent., including the lifts and all other expenses. It is still very low at 47 per cent., but I hope that we shall see it very much lower in the future. The expenses per train-mile have been exactly the same as they were in the corresponding period, because we have reduced the expenses slightly as well as the train mileage. The locomotive charges are very nearly the same; they are reduced from 4·55d. to 4·33d., and the traffic expenses are the same—6·3d. Knowing the decreases we were suffering from in the past half-year everything was done to see in what way we could bring about an improvement, and make the advantages of the line more attractive. We tried in the first place a reduction in the fares over a portion of the line—the portion between the City and the north, and we have had a large increase in the number of passengers from that reduction, but, I am sorry to say, no increase in the receipts. We are, therefore, carrying all this large additional number of passengers without getting any return, and it is therefore clear to us that our future does not lie in a reduction of fares. It does not produce a sufficient amount of increased receipts to compensate us for the reduction. We have, therefore, not attempted any further reductions over the rest of the line, but what we have done is to make the season tickets much more attractive. We have reduced the charges for season tickets issued for six months and three months to the same proportionate rate as those for 12 months, and we have also introduced the issue of monthly season tickets. That has only been in force for two months, but it has been eminently successful. We have had a very large number of monthly tickets without causing any decrease in the number of tickets issued for longer terms. The number of our season ticket holders is, therefore, very largely increased, and this is making our line decidedly more popular in every way. We are also arranging more and more for through bookings. The Great Northern and City Railway will be opened next week, we hope, and we have arranged with them for through bookings over their system from Finsbury Park all over our line. We are also going to arrange for through season tickets over their line. Then, we have made arrangements for through bookings over a portion of the South-Eastern Railway, and we hope shortly to have through bookings over the Metropolitan. We have a joint station with the Great Northern and City at Old-street, and there is a short staircase at the Moorgate-street station connecting our line with theirs. Therefore the connection between the two systems will be very intimate, and I have no doubt that it will do both of

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them good. As regards the question of the extension to Euston, we attach very great importance to it. We believe that the cost of working it will be small, that the capital expenditure is not excessive, and that we shall get a very large traffic from the five railway companies (to say nothing of the local traffic) that we propose and hope to exchange traffic with. There is the Great Northern Railway at King's Cross, and the Brompton and Piccadilly Railway to Finsbury Park also have a station at King's Cross. We shall also have an exchange with the Midland at St. Pancras, with the North-Western at Euston, and also at Euston we shall have an exchange with the Hampstead and Charing Cross line, the construction of which is now being proceeded with very rapidly. All these connections ought to bring us a very large traffic, and to make our line still more important and less liable to the adverse effects of competition by tramway or other services. We have found that the longer the line is, the less we suffer from local competition. We are proceeding with our appeal to the House of Lords against the decision in the St. Mary Woolnoth Church case. I now propose the resolution.

Mr. C. SEYMOUR GRENFELL seconded the motion.

Mr. HOLT: A few years ago I put the question whether it was at all in contemplation to extend the line to Tooting. I wish to renew the question to-day. Those who live in that neighbourhood or are acquainted with it will, I think, agree with me that the time is certainly drawing very near when this line should be extended to Tooting.

Mr. McKAY: There is one thing I notice with reference to the Chairman's speech—namely, that instead of there being a profit on the traffic to the Angel there is a loss. Can it really be the case that you have been working at a loss on that particular section of the railway?

The CHAIRMAN, in reply, said: As to an extension to Tooting, our experience of the result of these electric tramways has been rather serious at first, and I want to see a little more how we are going to work out in the future before we decide about extensions. We have the City and Brixton Bill, and that line is on the road to Tooting. I have no doubt the City and Brixton line would be a good thing, but in the present position of the finances of the country, and of our own finances, it would be most imprudent to attempt to raise the very large capital that would be required for the construction of such an extension. We propose to build the Euston extension first, because that will only involve a very moderate capital sum—£400,000 odd—and we are quite certain from our knowledge of the thing that that is an extension which will pay us very handsomely. As to the working of the Angel extension, I did not say anything about a loss on it. I merely referred to the result of lowering the fare. The reduction in the fare has thus been of no advantage to us. With regard to reducing fares generally, I may say that in the busy time of the day our trains are full, and it would be of no use for us to reduce our fares in order to overcrowd the trains. We have had great experience in the working of this line, and we have tried many experiments. This last reduction was an experiment which we thought we would try, but it has taught us a lesson on the subject.

The resolution was then carried unanimously, as were resolutions approving the dividends, re-electing the retiring director (Mr. Charles Grey Mott), and re-appointing the retiring auditors. The proceedings then terminated.

Charing Cross and Strand Electricity Supply Corporation (Ltd.).

The annual general meeting was held on Wednesday, Mr. W. F. FLADGATE in the chair.

The SECRETARY (Mr. Edward Wilmot Seale) read the notice calling the meeting, and the report of the auditors.

The CHAIRMAN then said: I think, gentlemen, that we may consider that our progress for the past year has been, on the whole, most satisfactory. In the two districts—the West End and the City area—we have altogether added no less than 146,700 8 c.p. lamps, in round figures, or 13,000 lamps more than in 1902, and I believe I am perfectly accurate in saying that in no other metropolitan district has so large an increase of lamps ever been made in any one year. Our combined number of lamps is now no less than 578,044, being, I think you will all agree, an exceedingly respectable amount. I need not, however, point out to the shareholders who are present that an increase of this kind, which must be always anticipated and must always be thought of beforehand, could not possibly have been made without the use and the expenditure of a very large amount of capital, capital not only in the City but also in the West End, and although we, as a Board, do all that we can to keep in check the demands of our engineer—sometimes we think rapacious demands—we have always found that those demands, however rapacious at first sight they appear to be, have been perfectly justified by the work which has been a follower of the expenditure we have made. Taking for one moment the City undertaking, £2,060 is at present unproductive. That is represented by the crop which we have ever hoped and ever believed we shall hereafter reap in the general profits of the undertaking for lighting the City of London. We have, however, in the West End also a considerable amount of capital which we, for present purposes, can only consider as unproductive. This amounts to £923,000. Coming to the decrease in the West End, the lamps have increased to the extent of 55,326, bringing up the number to the end of last year to 335,031. That increase has continued in each of our districts. Turning to the revenue account for 1903, this amounts to £110,083, an apparent shrinkage. The revenue for 1902 was £114,358. It is absolutely a fact that there is an apparent shrinkage, but that shrinkage is in the supply which the West End undertaking was obliged to make to the City undertaking. In 1902 our City works were by no means complete, and consequently in the course of that year we had to sell at comparatively small profit to the City energy to the amount of £8,000, whereas in 1903 we only sold energy to the City of £1,063. The result of these figures is this, that whereas the total revenue was somewhat less, the actual revenue received from outside sources was appreciably more. The net figures come out for 1903 at £109,020, for 1902 at £106,196, being an increase in the gross revenue between the two years from outside sources of £2,442, and we have every hope that during the current year it will increase in a more satisfactory way. Turning to other points on the revenue account of some interest to the shareholders, I should mention in particular, coal, the consumption of which has again been exceedingly satisfactory. The proportionate cost of coal to our unit is again down, and I believe that I am not inaccurate in saying that we now hold the best—at any rate, one of the best—places among metropolitan companies as regards the proportionate consumption of coal per unit generated. Rates and taxes, as they always do, have gone up. When we have put to depreciation account £10,000 we think that sufficient for the current year. We have got the whole question of depreciation very clearly before our eyes with a view to considering how it should be dealt with in the future. The net revenue account brings forward a total of £39,111. The other accounts are, for practical purposes, as they were in 1902. Share premium account has increased by £281, and debenture premium account by £2,075, and our grand total of reserves now amounts to no less than £202,788, a very respectable and very solid figure. Turning to the balance-sheet, there are only two items to which I should like to call your attention. There is the £200,000 invested in the ordinary shares of the Charing Cross and City Electric Company. That is, in effect, an investment in the profits of the City undertaking, and that is an investment in which I for one have the very greatest faith. It is going to bring you in a very good amount of revenue and a large amount of income in the near future. The other item is £160,500 debentures of the same company, which are merely a temporary measure. They are only the gross account between the two companies upon which we are receiving interest. Now, gentlemen, as to the net revenue and the recommendations which were made by the Board in sending out their report. We suggested the payment of a dividend at the rate of 12 per cent. for the half year, making, with the interim dividend declared a rate of 10 per cent. for the whole year and making a carry forward of £3,140 on the revenue account. Well gentlemen, it is not competent for shareholders to ask for more than their Directors suggest to them. It is competent for shareholders to take less. If we had recommended a smaller dividend, however much you might have rebelled, or thought that we were over-prudent, you could not have altered it. In recommending 10 per cent. dividend it is either in the discretion of the Board to reconsider their judgment or it is in the power of the shareholders to suggest a reduction. Now, gentlemen, the question of your dividend has been receiving, day by day since our accounts have been completed, the very gravest and the most careful attention, and not only of your Board but also of their advisers—our auditor in particular. We have earned sufficient to pay a 10 per cent. dividend—the money is there. Our auditor advises that we are perfectly justified in paying it, but we have had a very serious consideration of the whole matter, and we have come to the conclusion that in the solid interests of the shareholders, and in the solid interests of the Company, it will be better to hold a certain amount of the dividend in hand for the moment. The carry-over of £3,000 is a respectable carry-over, but it is not a large one. As regards the past year there was inaccuracy on one point, and our prognostications have not been fulfilled in that we have had brighter weather. Other factors which we cannot guess might arise which might not make the working of the present year any more satisfactory than the working of the last. Under the circumstances we have decided, in moving the report and accounts, to move as an amendment to our own report the reduction of the dividend by 2 per cent. I may remind all the shareholders that I have from this chair, from which I have now had the honour of addressing you for several years, always warned you that at some time the effect of our inroad into the City would be to somewhat reduce our dividends. The result will be that instead of carrying forward £3,140 we should carry forward £10,140 on revenue account. Well, gentlemen, now as to the City undertaking. The progress of that undertaking has been most satisfactory. When I had the pleasure of addressing you last year I ventured to suggest that our sales for the year 1903 would bring in a gross revenue of £60,000. Our gross sales have brought in upwards of £56,000. Our generating station at Bow and distributing stations at Fenchurch-street, Upper Thames-street, and at Ludgate have all fulfilled our anticipations, and the station at Beach-street, the site of which we acquired some time since, we have built and are now installing machinery in, so that in the course of this year it will be in working order. Our view has always been that there is ample room in the City of London for two companies, and the fact that in the short space of time which we have been able to supply energy we have got no less than nearly a quarter of million lamps is, I think, a sufficient proof that our views were not inaccurate. The question of depreciation is one we are considering, only in the City everything is being built up, so we have not at present any depreciation fund. That, however, during the current and next year must receive careful consideration. I should not like to conclude the few words I have been saying without an appreciation, which I give from my heart, to those who are doing the hard work of this Company, to our secretary, Mr. Seale, who, unfortunately, from illness, was away from us for some time this year, but who was replaced by another member of our staff who did the work well. We thank Mr. Patchell for the indefatigable way in which he has mastered the problems from time to time put before him, although sometimes, as I said before, we think he asks us too much. I move formally the reception of our report

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and accounts, and that they be adopted. When we come to the proposal to distribute the dividend I shall propose to move it with the reduction I have intimated in my address.

Mr. G. H. BROUGHAM GLASIER (Vice-Chairman) seconded.

Mr. A. LAURIE expressed his disappointment at the reduction in the dividend, but had implicit confidence in the Directors, who had shown marked ability in the carrying on of the Company's business. He was pleased to learn that there was plenty of work for both companies in the City of London and he hoped that the two companies would see their way to work harmoniously together and forget all the past. Thus over-competition might be avoided, and the business which was growing from day to day could be shared.

The resolution was carried unanimously.

The CHAIRMAN then moved the payment of a dividend at the rate of 8 per cent. for the year, and this was carried. The re-election of the retiring Directors and of the retiring auditors was approved, and an extraordinary meeting followed at which a motion increasing the capital of the Company by £500,000 was carried unanimously.

A hearty vote of thanks to the Chairman terminated the proceedings.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The report of the directors states that the total receipts from July 1 to Dec. 31 (including £1,468. 0s. 8d. from last account) amounted to £189,373. 8s. 8d. The traffic receipts show a decrease of £13,324 compared with half-year ended Dec. 31, 1902. The expenses of the half-year, including repair of cables, &c., amounted to £67,744. 17s. 4d., an increase of £3,530. 11s. 2d. over the corresponding period of 1902. £7,192. 15s. 1d., expended during the half-year on the repair of the 1873 cable, has been charged to renewal fund. The directors have, before declaring the net profits, set apart £12,000 to renewal fund, leaving £109,628. 11s. 4d. Interim quarterly dividends of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock were paid in November, absorbing £52,500, leaving £57,128. 11s. 4d., out of which the directors recommend final dividends of 16s. per cent. on the ordinary, £1. 10s. per cent. on the preferred, and 2s. per cent. on the deferred stock, payable Feb. 13, amounting together to £56,000, making a total distribution for the year of £3. 1s. per cent. on the ordinary, £6 per cent. on the preferred and 2s. per cent. on the deferred stock. The balance (£1,128. 11s. 4d.) will be carried forward. The cables and land lines of the company are in good working order.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The report of the directors for the year ended Dec. 31 last states that energy has been supplied to the St. James' and Pall Mall Electric Light Co. and to the Westminster Electric Supply Corporation throughout the year to the extent of 2,601,087 units. Cost of production has fallen rapidly as supply has grown, and the directors are assured that they will henceforth be able to produce on a large scale with very satisfactory results. It has been necessary to charge 3d. per unit during the past year, but it is anticipated that this price will be largely reduced in the early future. £38,782 further debenture stock has been issued during the year, the premium, after deducting expenses, being carried to capital reserve. The net earnings for 1903 were £3,902. 6s. 11d., and the balance forward £500. 13s., making £4,402. 19s. 11d., which the directors propose to carry forward.

CENTRAL LONDON RAILWAY CO.—The chairman (Sir Henry Oakley on Wednesday said that, compared with the corresponding half-year of 1902, a decrease was shown in the receipts of £6,545, owing to 650,000 fewer passengers having been carried. The traffic of the previous year was, however, abnormally swollen by the multitudes of people who flocked to London for the Coronation and its attendant festivities and attractions. The reduction was not due to competition. The net result of the six months' working was that the board were enabled to pay dividends on all classes of stock at the rate of 4 per cent. per annum, to add £10,000 to reserve (now £30,000), and to carry forward £36,000, or £9,000 more than was brought into the accounts from 1902. About 12 months ago it became necessary to consider the question of making a radical change in working owing to complaints of vibration, which was ascertained to be due to the weight of the engines in use. They had to abolish the engines and to adopt the system of having motors under the carriages at either end of the trains. For several months experiments were made with two trains fitted with motors, and the result was so satisfactory that, ultimately, orders were given to the British Thomson-Houston Co. for 64 motor carriages. The Board of Trade inspectors satisfied themselves that if motor carriages were substituted for the heavy engines the vibration would cease. He was pleased to state that the new system had answered admirably. The motor carriages were more economical and quite as reliable as the engines. The new sub-station at Bond-street was for separating the lighting and the power required for the lifts from the motive power for running the trains, so that in the event of accident, the tunnels could be lighted from end to end and passengers be taken up or down the lifts. The large fan at Shepherd's Bush was in regular working order, and it had effected a great improvement in the ventilation of the tunnels. This ventilation was not, however, yet perfect, but it was hoped still further to improve it. Owing to complaints as to overcrowding during the busy hours of the day, the number of trains run between 8 and 10:30 in the morning had been increased. A final settlement with the Electric Traction Co. had been arrived at. After three years' experience, the works had been found to be substantial, and did credit to the contractors. The capital expenditure of the half-year was about £44,000, mainly on works already commenced. The estimate of further capital expenditure was £160,000, but there was nothing to lead the board to suppose that such a sum would be required for the present. In fact, no serious addition to the capital was contemplated.

DUBLIN UNITED TRAMWAYS CO.—Mr. Wm. M. Murphy, at the meeting last week, said the net result of the company's working showed an increase in receipts of £8,346 and an increase in working expenses of only £216. £48,950 was at disposal for distribution, which included £2,857 from June account. After paying 6 per cent. on the preference and 6 per cent. on the ordinary shares, they were able to place £4,000 to reserve, £2,000 towards maintenance, £1,000 to an accident insurance fund and to carry forward £6,775. The total traffic receipts for the half-year were £134,648 and receipts from all sources £140,595. The receipts from parcels delivery, which had proved a great convenience to citizens, continue to increase, and reached in the last six months £2,873. There was no other city in the kingdom with such a tramway parcel delivery as Dublin possessed. The actual cost to the company for electrical energy to propel a car for one mile was only 0·438d. The cost of electric generation they certainly could not hope to improve upon unless they could largely increase their output, which now reached over 7½ million units per annum. They were constantly being applied to supply would-be consumers with current, but, owing to their agreement with the Corporation they were unable to give this supply, although in many cases the demand was for direct current, which the Corporation had made no provision for supplying. Besides being prohibited from supplying that demand which the Corporation could not themselves supply, they contributed the largest individual share to the loss on the costly Pigeon House station of the Corporation. They paid in rates £10,071 in the half-year, or £386 more than in the corresponding period of 1902. That taxation was entirely exclusive of wayleaves, in respect of which they paid £7,193 during the half-year.

GIANT'S CAUSEWAY AND PORTRUSH ELECTRIC TRAMWAY CO.(LTD.)—The report presented at the annual meeting on Tuesday stated that there was a small increase in the receipts compared with the previous year. The net profit on the year's working was £1,241. 14s. 8d., against £1,263. 2s. in 1902 and £1,059. 14s. 11d. in 1901. The improved condition was due to the successful working of the new overhead system. The balance on revenue account (£1,241. 14s. 8d.) had enabled the directors to pay 4 per cent. on £13,750 debenture stock and 4 per cent. on the mortgage for £10,000 borrowed for the construction of the Causeway extension and £139. 2s. 8d. interest on temporary loans.

GREAT NORTHERN AND CITY RAILWAY CO.—The chairman (Sir Charles Scotter) in moving the adoption of the report (set out in our last issue) on Tuesday, congratulated the shareholders that the line between Finsbury Park and Moorgate-street was to be opened for traffic. The construction of the railway was commenced at the beginning of 1899, so that this important undertaking had been practically four years in construction. He thought the contractors and the engineers were to be congratulated upon this fact. The line was about 3½ miles in length, but it would be a little longer when they extended it to the Bank. The fact that their Moorgate-street station adjoined the station of the City and South London Railway was a very important feature of the undertaking, because negotiations were pending between the two companies for through bookings, so that for the first time in connection with London railway enterprise passengers would be able to book through, and be conveyed swiftly and cheaply from north to south London, and vice versa. The Old-street and Essex-road stations were in good positions and very busy centres. Their Highbury station was not yet completed. So far as the running road was concerned it made no difference whatever, but the actual station works at Highbury were not completed, and would not be, perhaps, for the next six months. The Drayton Park station was the only surface station they had. At that point they were at the ground level. This was originally to have been their terminus, but they had continued on to Finsbury Park. For that part of the design and construction of their line great credit was due to Mr. Alexander Ross, chief engineer of the Great Northern Railway, who was the engineer for the work, and also to Messrs. Pearson & Son (the contractors) for hurrying on and completing that portion of the work. The Bank extension had not yet been commenced, and those acquainted with the City and with financial matters would readily understand the reason for this delay. The special feature of their railway was that they had the largest tunnel of any underground railway in the world. The diameter of the tunnels on the City and South London was 10ft. 6in. On the Waterloo and City, Central London, and Brompton and Piccadilly 11ft. 8in., on the Baker Street and Waterloo 12ft., whereas their tunnel was 16ft. in diameter. The advantages of a big tunnel would, he felt certain, be appreciated as soon as the line was opened. The comfort, convenience and safety of the public were, beyond question, in the large tunnel, and if they combined those three things there was no reason why the railway, with these large tunnels, should not ultimately prove a great success. He denied certain statements which had been made as to a war of rates between the company and the North London and Metropolitan Companies. He was able to state that Col. Yorke, on behalf of the Board of Trade, and Major Druitt and Mr. A. P. Trotter (the electrical expert of the Board) had made a careful inspection of the entire railway, and expressed their opinions to the engineers that it was much in advance of any other tube railway at present constructed. Owing to a few minor details in connection with the signalling, Col. Yorke had arranged to make a final inspection to-morrow (Saturday) when it was fully anticipated that permission would at once be given to open the railway for public traffic. The main factor in connec-

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tion with that railway, and all tube railways, in fact, was to remove, if possible, the idea that there was necessarily any element of danger in them. A scare was created in consequence of the deplorable accident on the underground railway in Paris. He was told, on authority, that few, if any, lives would have been lost on that occasion had it not been that all the lights went out, causing panic. He wanted to assure them and the public that their own particular railway would be about the safest place that anybody could travel in. The electric lighting on the Great Northern and City Railway and also at the stations was absolutely distinct from the motive power which worked the trains. If the motive power should fail at any time, the stations would all still be lighted by electricity. Supposing the electric power and the separate system of electric lighting should both fail they had a system of gas installation, and one man, stationed at every exit, had nothing to do but to turn a tap and the whole station would be at once illuminated with gas. If a train was stopped from any cause whatever between the stations, there was provision made for passengers to alight at any place and at any time; there was plenty of room in the tunnels, and they could get out at either end of the train, or at the sides, on to a concrete gangway between the rails, and walk as on an ordinary street pavement without the slightest risk or danger from electricity. All the tunnels, platforms, signal cabins, offices, and porters' rooms were fireproof. Everything in fact was built of fireproof material, and a fire on the line or in the stations was practically impossible. Their is a proposal to run a three-minutes service of trains, and the time occupied from Finsbury-park to Moorgate would be from 13 to 14 minutes.

LANCASHIRE ELECTRIC POWER CO.—The chairman (Mr. F. E. Gripper) stated at the meeting on Wednesday that a site of about 20 acres, situate on the Irwell at Radcliffe, with railway siding accommodation and adjacent to the Outwood Colliery, had been obtained on long lease. The plant was due for delivery in the autumn, and the company should be in a position to supply current early next year. Negotiations were in progress with a number of local authorities anxious to have supply of electricity in bulk.

LIVERPOOL OVERHEAD RAILWAY CO.—The report for the half-year to Dec. 31, 1903, states that the gross revenue amounted to £44,145. 4s. 3d., working expenses to £33,210. 8s. 2d. The number of passengers carried during the half-year was 5,896,503—766,160 first class, 3,670,404 second class, and 1,459,939 workmen, compared with 5,514,089 in June, 1903, and 5,440,304 in December, 1902. The working expenses have been augmented by the cost of re-laying a portion of the permanent way. Part of this has been charged to revenue, and the balance (£1,000) to renewal fund. The agreement with the Lancashire and Yorkshire Railway is now signed, and it is hoped the work will be completed before the end of the year. The receipts from passenger traffic amounted to £43,277. 16s. 5d., and miscellaneous receipts and interest came to £868. 7s. 10d. After deducting working expenses (£33,210. 8s. 2d.) and interest (£3,800), and adding balance from June, 1903 (£3,747. 5s. 10d.), £10,882. 1s. 11d. is available for dividend, out of which the directors recommend the payment of the 5 per cent. preference dividend (less tax) and 1½ per cent. per annum on the ordinary shares, leaving £4,132. 1s. 11d. to be carried forward.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—The fourth ordinary general meeting of this company was held on Tuesday. Major S. Flood Page presided, and said that the efforts of the board during the past year had been chiefly directed towards obtaining a permanent basis for profitable business in the future, and a very considerable further extension of the operations of the company had resulted. When they last met there were only 25 ships connected with the Marconi system, as compared with 54 now. If they could only get a few more land stations in some of the countries of the Continent, there would soon be an increase in that number of vessels. Wireless telegraphy was still, apparently, to the public something mysterious and untangible, in spite of all that Mr. Marconi had done and of the fact that its practicability and utility was evidenced by the numerous connections which were working regularly and commercially. It was, therefore important that when, through their efforts, there was almost a universal popular demand for this new system of communication, they should be in a position to meet it on such terms as would tend to exclude the competition of other so-called inventions. A conference was held in Berlin last August for the purpose of endeavouring to come to a settlement as to the use of wireless telegraphy throughout Europe, but the proposals were mainly put forward, they believed, by the German Government with a view to helping German manufacturers to pursue the business on lines on which this company had been the pioneers. Having established at great expense a world-wide organisation of shore stations for ship telegraphy, extended through agreements with Lloyd's, the British, Italian, Canadian and other Governments, which offered shipping companies taking the Marconi apparatus a large choice of ports with which to communicate, it was only fair that this advantage, which they had gained through the merits of their system and by their business enterprise, should not be artifically removed by legislation. The German Government talked about having another conference on the same subject, and by international legislation to practically place this company's whole organisation at the disposal of any person who was able to get his apparatus adopted by a shipping company. It was obvious that anything of the kind would inflict a great injustice on this company, and the board protested against such proposals. There was, however, no reason to believe that the English Government would support any such confiscation as would thereby be involved. At the present time nearly every big line of steamships—all those crossing the Atlantic, including the two principal German lines and the Compagnie Transatlantique, and also the Belgian Mail Packet service—were fitted with the Marconi system. When the company had stations in Spain and Portugal they would, doubtless, get all the companies whose vessel traded to the East and to South Africa. Since the issue of the report the board learned from the manager of the Canadian Company that the Minister of Marine of the Canadian Government had consented to contract with them for the equipment of wireless telegraph stations on the St. Lawrence river. With regard to the statement of the auditors in their certificate, that "We are unable to verify the value of the shares in the associated companies," he explained that these shares had been taken into the accounts at the price paid for them, and the directors believed that they were worth that price.

METROPOLITAN RAILWAY CO.—At the meeting on Friday the chairman (Col. J. J. Mellor) said that in 1899 they reached the high-water mark of their passenger traffic, when they carried 92,000,000 passengers. In 1900, when the Central London Railway was opened, and in the year following they felt the full effects of competition. They set to work to meet that depletion of their business, and in the year just closed they carried 94,000,150. Although they deemed it prudent to reduce fares to meet the competition, there had not been a single week that those reduced fares had not yielded increased receipts. In the six months ended December, 1902, the percentage of working expenses to gross receipts was 51·93, but in the six months just expired the percentage was only 50·31, notwithstanding the increased number of train-miles that had been run. The new Harrow and Uxbridge line was now nearly completed and would soon be open for public traffic. Referring to the electrification of their system, their power house at Neasden was practically completed and was ready for receiving the generating machinery. The main high-tension cables were being delivered to time, and about 12 miles had been laid. The conductor rails were being placed in position, and some miles of that work had been completed. The question of obtaining sites for sub-stations on the Circle had proved a difficulty, but had been surmounted. They might reasonably expect some portion of their system to be running electrically by midsummer.

NORTH METROPOLITAN TRAMWAYS CO.—The report for the half-year ended December states that the gross receipts amounted to £330,821 and expenditure to £311,817, leaving £19,003 net profit. Adding £407 from last account and £2,625 received from Metropolitan Electric Tramways (Ltd.) for interest, the balance is £22,035. After providing for interest it is proposed to pay a dividend at the rate of 4 per cent. per annum on the ordinary shares. The number of passengers carried was 68,454,670, a decrease of 11,255,759. Traffic receipts amounted to £321,777, a decrease of £56,948.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 25 1/16d. per oz. (Feb. 4). Consols 87 13/16—87 15/16 for money, 87 13/16—88 1/16 for account; 2½ per cent. annuities 87½—87¾ (Feb. 4). Consols Pay Day, Mar. 1; Stocks and Shares Continuation Days, Feb. 9 and 23; Ticket Days, Feb. 10 and 24; Pay Days, Feb. 11 and 25; Mining Share Carry-over Days, Feb. 8 and 22.

BATH.—The Council have asked the Local Government Board to consent to the issue of Bath Corporation 3 per cent. redeemable stock for raising £30,000 for electric lighting, repayable in 25 years.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—Subject to final audit, the directors have decided to recommend a dividend on the ordinary shares at the rate of 7 per cent. per annum for the half-year to Dec. 31 making a total of 5½ per cent. for 1903, carrying forward about £1,100.

HARROW ROAD AND UXBRIDGE RAILWAY CO.—At the meeting on Friday, Col. J. J. Mellor stated that the works were in a forward state, and that it was expected the line would be opened in April. It was not proposed to work the line electrically at first, but its electrification was well in hand and would be ready by the time the Metropolitan Railway was run electrically.

MORLEY ELECTRICAL ENGINEERING CO. (LTD.)—At the annual meeting at Bradford on Wednesday the report and accounts were approved, and a dividend of 10 per cent. (tax free) was declared.

NATIONAL TELEPHONE CO. (LTD.).—Subject to final audit, the directors recommend the following dividends for the half-year ended Dec. 31, after payment of the preference dividends:—At the rate of 6 per cent. per annum on the preference and at the rate of 5 per cent. per annum on the deferred stock (less tax), carrying £110,000 to reserve and about £10,500 forward. The transfer books will be closed from 8th to 18th inst. inclusive.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LTD.).—Subject to final audit, the directors recommend a dividend on the ordinary shares at the rate of 3 per cent. for the past year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee has ordered the further issue of £21,979 sterling 500 year 4 per cent. redeemable debenture stock of the *Commercial Cable Co.*, and the further issue of 17,500 £1 fully-paid 5 per cent. cumulative preference shares of the *London United Tramways (1901), Ltd.*, to be quoted. Application has also been made to the committee to allow a further issue of £18,287 5 per cent. first mortgage debenture stock of the *Perth Electric Tramways (Ltd.)* to be quoted.

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BLACKPOOL AND FLEETWOOD TRAMROAD CO.—The report for the half-year ended Dec. 31 states that the profit, after providing for interest, was £10,677. 10s. 8d., and a dividend at the rate of 9 per cent. per annum is recommended, absorbing £6,750. £1,500 has been placed to depreciation reserve and £500 to general reserve, leaving £1,927. 10s. 8d. to be carried forward. The number of passengers carried during the half-year was 1,469,964, and the total receipts £21,404. 8s. 5d.

DUBLIN AND LUCAN ELECTRIC RAILWAY CO.—The total receipts for the half-year ended Dec. 31 show an increase of £212. 12s. 5d. compared with the corresponding period of 1903. The expenditure shows an increase of £113. 3s. 9d. There was a reduction in most classes of expenditure, but maintenance and repairs cost more than in the corresponding half-year. The amount of directors' fees (£225), accrued for some time past, has been relinquished by them. After providing for interest the available balance is £1,426. 11s. 11d., and it is proposed to pay the dividend on the 5 per cent. preference shares (absorbing £475), and that £700 (compared with £300 in each of the two last half years) be placed to reseve for payment on account of electrical equipment, leaving £251. 11s. 11d. to be carried forward.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The Right Hon. Sir Alfred C. Lyall, G.C.I.E., K.C.B., K.C.S.I., has accepted a seat on the board of this company.

LIVERPOOL OVERHEAD RAILWAY CO.—During the past week this company invited subscriptions for 6,000 5 per cent. perpetual preference shares of £10 each.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)—The report of the directors for the year ended Dec. 31 announces that current has been distributed from the company's Carnaby-street and Mason's-yard stations to a total of 254,468 8 c.p. lamps, an increase of 21 783 for the year. 6,662,228 units were generated at the stations, and 1,118,082 units were purchased from the Central Electric Supply Co. An agreed price, to cover the abnormal cost of production during the initial stages of working, has been paid to the Central Company for the current supplied, and to meet this extra charge on the year's working £2,500 has been transferred to net revenue from the contingency fund specially provided for this purpose. The net profit applicable to dividend for the year 1903 was £35,952. 5s. 3d., brought forward from 1902 £2,792. 11s. 8d., making £38,744. 16s. 11d. The interim dividends in August absorbed £13,500, leaving £25,244. 16s. 11d. The directors now propose to pay the balance 7 per cent. preference dividend (£3,500), a balance dividend on the ordinary shares of 7s. 6d. per share and a bonus of 2s. per share, making a total distribution of 14½ per cent. for the year (£19,000), carrying forward £2,744. 16s. 11d.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—The gross profit for 1903 amounted to £6,691, an increase of £625, and the gross receipts increased by £750. After providing for interest and other charges (£2,530), placing £2,000 to reserve and £1,500 to depreciation, the balance was £3,662. 13s. 11d., including £1,350. 18s. 7d. from last year. The directors propose to pay a dividend at the rate of 4 per cent. for the year (£2,400) and to carry forward £1,262. 13s. 11d. A uniform price for current supplied to the shops in the markets was adopted in the spring of 1903, and has proved advantageous to the company. The cost of production has again been reduced. The new generating set referred to in the last report was installed in October and is working satisfactorily, and the cost has been met without raising further capital. At Dec. 31, 1903, there were 389 consumers, representing an equivalent of 31,177 8 c.p. lamps, compared with 371 and 27,694 in 1902.

WATERLOO AND CITY RAILWAY CO.—According to the report for the half-year ended Dec. 31, the gross receipts (less Government duty) amounted to £17,296. 13s. 3d., and the working expenses to £8,032. 13s. 5d., or 46·44 per cent., compared with 44·45 per cent. for corresponding period of 1902. The balance available for dividend, after payment of interest, is £8,454. 16s. 8d., and a dividend at the rate of 3 per cent. per annum on the ordinary stock will absorb £8,100, leaving £354. 16s. 8d. to be carried forward. The number of passengers carried during the past six months, exclusive of season ticket holders, was 2,240,864, a decrease of 66,277 compared with the corresponding period of 1902. The season ticket holders on Dec. 31 numbered 1,434, against 1,243.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

STATUTORY RETURNS.

ARON ELECTRICITY METER CO. (LTD.)—In return to Dec. 24 the capital is given as £250,000 in £1 shares (125,000 preference). 125,000 ordinary and 124,896 preference shares have been taken up. £1 per share has been called up on the preference. £124,948. 10s. has been received, including £52. 10s. paid on 104 forfeited shares. Ordinary shares considered as fully paid. Mortgages and charges, £56,900.

BULLERS LIMITED.—According to return to Dec. 18 the capital is £400,000 in £10 shares (20,000 preference). 15,000 ordinary and 15,000 preference have been taken up. £10 per share has been called up on seven ordinary and 15,000 preference shares, and £150,070 has been received. £149,930 is considered as paid on 14,993 ordinary. No mortgages or charges.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC CALIBRATED FUSE CO. (LTD.)—Issue on Jan 25 of £300 debentures, part of series created Dec. 4, 1903, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, J. Lang. No trustees. Previously issued of same series, £750.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)—Issue on Jan. 19 of £400 debentures, part of series created June 3, 1896, to secure not more than two-thirds of the paid-up capital for time being, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £31,700.

UNITED ELECTRIC LIGHT AND POWER SUPPLY CO. (LTD.)—Issue on Jan. 14 of £825 6 per cent. first mortgage debentures, part of series created March 17, 1903, to secure £3,000, charged on company's undertaking and property, present and future, including uncalled capital and buildings, machinery and other property at Guimaraes, Portugal. No trustees. Previously issued of same series, £1,550.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Jan. 30	1,058	+ 269	35	43,049	+ 8,268
Ayr Corporation	,, 30	170	+ 25	37	11,034	+ 167
Barnsley	,, 22	150	+ 6	3	449	- 30
Bexley District Council	,, 29	111	...	17	2,622	...
Birkenhead	,, 31	966	+ 89	...	...	...
*Birmingham Tramways Co.	,, 31	5,117	+ 310	4	20,236	+ ‖1,665
*Blackburn Corporation	,, 29	747	+ 94	§44	37,278	+ 1,652
Blackpool Corporation	,, 28	263	- 7	§43	89,047	- 219
Blackpool and Fleetwood	,, 31	181	- 19	5	781	- 44
Blackp'l, St. Anne's & Lytham	,, 28	141	+ 127	‡13	1,875	+ 1,296
Bolton Corporation	,, 31	1,625	+ 107	44	80,383	+ 8,793
Bournemouth Corporation	,, 27	777	...	4	3,361	...
*Bradford Corporation	,, 31	3,534	+ 360	42	164,777	+ 21,810
Brighton Corporation	,, 31	688	- 47	43	89,879	+ 2,642
Brisbane Tramways	Dec. 16	2,610	+ 193	24	56,907	+ 1,084
*Bristol Trams & Carriage	Jan. 29	4,372	+ 176	10	45,368	+ 2,241
*Buenos Ayres & Belgrano	,, 3	3,479	+ 14	11	38,244	+ 1,788
Burnley Corporation	,, 30	808	+ 154	44	43,452	+ 7,613
Burton Corporation	,, 31	282	...	26	9,128	...
Calcutta Tramways Co.	,, 30	R35,414	- R9,626	5	R186,559	+ R35,698
Camborne-Redruth	Feb. 1	95	...	13	7,577	...
Cardiff Corporation	Jan. 30	1,811	+ 250	44	85,995	+ 21,891
Carlisle Tramways Co.	,, 28	471	+ 88	4	1,975	+ 427
Central London Railway	,, 30	6,992	- 12	5	34,794	+ 118
Chatham & Dist. Lt. Rys.	,, 28	471	+ 88	4	1,975	+ 427
City & South London Rly.	,, 31	3,258	- 57	5	16,049	- 943
Cork Electric Trams Co.	,, 28	385	- 3	4	1,595	+ 30
Darwen Corporation	,, 29	205	+ 2	44	9,958	- 242
Devonport & Dist. Trams.	,, 22	462	+ 98	3	1,468	+ 233
Dover Corporation	,, 30	161	- 8	†44	9,844	+ 54
Dublin & Lucan Railway	,, 31	92	+ 5	5	405	+ 24
Dublin Southern District	,, 29	702	+ 7	¶4	2,896	
Dublin United	,, 29	3,619	+ 84	¶4	15,173	+ 743
Dudley—Stourbridge	,, 22	711	+ 95	3	2,192	+ 102
Dundee Corporation	,, 27	781	+ 27	4	3,447	+ 206
East Ham Council	,, 30	582	+ 105	†44	29,111	+ 8,039
Gateshead & Dist. Trams	,, 22	851	+ 95	3	2,692	+ 129
Glasgow Corporation	,, 30	13,420	+ 1,502	35	478,756	+ 50,931
Gravesend—Northfleet	,, 22	200	+ 51	3	638	+ 103
Greenock & Port Glasgow	,, 22	458	+ 95	3	1,466	+ 172
Halifax Corporation	,, 20	1,086	+ 204	‡3	57,986	+ 6,182
	,, 27	1,074	+ 79			
Hartlepool Tramways	,, 22	248	+ 51	3	775	+ 108
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 30	1,985	+ 284	†44	83,656	+ 6,196
Ilkeston Corporation	,, 27	110	...	11	1,806	...
Ipswich Corporation	...	...	...	...	...	...
Isle of Thanet Co.	,, 30	199	- 83	...	...	...
Kidderminster & District	,, 22	92	+ 2	3	282	- 27
Kirkcaldy Corporation	,, 27	190	...	48	8,666	...
Lanarkshire Trams Co.	,, 28	559	...	4	2,441	...
Leeds Corporation	,, 30	4,978	...	44	240,398	...
Liverpool Corporation	,, 23	9,557	+ 668	4	88,406	+ 1,998
*Liverpool Overhead Rly.	,, 31	1,505	+ 89	5	7,732	+ 423
*London County Council	,, 23	8,906	+ 1,499	†43	421,135	+ 75,745
Lowestoft	,, 30	125	...	¶25	6,168	...
Manchester Corporation	,, 30	10,808	+ 2,682	33	382,334	+ 179,258
Mersey Railway	,, 30	1,440	+ 371	4	5,782	+ 1,466
Merthyr	,, 22	191	+ 38	3	567	+ 57
Middleton	,, 22	237	+ 30	3	746	+ 7
Newcastle-on-Tyne Corp.	,, 30	3,506	+ 445	4	13,857	+ 2,140
Newport (Mon.)	,, 23	413	+ 126	17	7,388	+ 3,792
	,, 30	433	+ 234			
Oldham, Ashton & Hyde	,, 22	479	- 13	3	1,511	- 181
Perth (W. A.) Elec. Trams.	,, 29	1,355	+ 163	4	5,872	+ 846
Peterborough	,, 22	104	...	3	339	...
Poole and District	,, 22	221	+ 6	3	688	- 1
Portsmouth Corporation	,, 30	1,237	+ 10	†44	76,596	+ 5,006
*Potteries	,, 22	1,592	+ 112	3	4,863	+ 133
Reading Corporation	,, 28	485	...	...	...	...
Rothesay	,, 22	37	+ 9	3	156	+ 10
Salford Corporation	Feb. 1	3,686	+ 935	44	167,969	+ 47,337
Sheerness	Jan. 20	45	...	3	136	...
Sheffield Corporation	,, 31	4,102	+ 141	†45	184,710	+ 17,152
*Southampton Corporat'n	,, 28	811	+ 11	4	3,356	+ 110
Southend Corporation	,, 27	182	+ 15	43	13,787	+ 2,155
Southport Tramways	,, 23	231	+ 47	3	736	+ 67
S. Staffordshire Trams.	,, 22	691	+ 87	3	2,164	+ 122
Sunderland Corporation	,, 31	1,072	+ 58	44	53,438	+ 2,584
*Swansea Trams	,, 22	426	+ 29	3	1,397	- 14
Taunton Trams	,, 22	44	- 2	3	146	- 7
Tynemouth and District	,, 22	195	+ 14	3	636	+ 22
Tyneside Trams Co.	,, 27	272	+ 60	4	1,038	+ 258
Wallasey District Council	,, 30	571	+ 52	†44	30,143	+ 3,680
Weston-super-Mare	,, 20	24	+ 5	3	58	- 8
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 22	323	+ 22	3	974	- 28
Wrexham	,, 22	97	...	3	294	...
Yorkshire Woollen District	,, 28	516	...	3	1,609	...

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Feb. 2.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Feb. 2. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅞—5⅛	4 15 1	April, Oct	5	4⅞
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
10	10/0	Barcelona Tramways Ord.	7⅛—8⅛	5 17 8	..	..	..
10	5 0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	† Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..
100	5%	† Do. 5 per Cent. Debs.	95 —98	5 2 0	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	2½	2⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	97½	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref (fully paid)	10¼—10½	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 —82	3 12 9	..	81	80¾
St.	5%	Do. Pref. Ord. Stock	91 —94	5 6 2	..	92½	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..
4	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅞	4 7 0	..	104	103¼
100	4½	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	11 —11½	6 19 2	..	11⅝	11⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—11⅝	5 2 2	Feb, Aug	11⅝	11⅝
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	..	..
5	..	Buenos Ayres and Belgrano Ord.	3 —3½	..	..	..	..
5	3/0	Do 6 per Cent. "A" Cum Pref.	5¾—5¾	5 4 0	..	..	..
5	3/0	Do. "B"	4¾—5¼	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	105¾	105½
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	..	..
5	2 6	Calcutta Tramways	6½—7	4 12 10	..	6⅞	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 —107	4 4 2	..	106	..
1	1/0	Cape Electric Tramways Shares	1⅞—2	8 10 0	..	..	..
St.	4%	Central London Ordinary Stock	94 —97	4 4 3	June, Dec	97	..
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	4 0 4	..	101½	98
St.	4%	Do. Deferred Stock	91 —94	4 8 11	..	94	..
100	4%	Do. 4 per Cent. Debs.	113 —116	3 9 0	..	..	..
5	2/6	City of Birmingham Trams.5% Cm. Prf	4¾ - 5¼	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2½%	City and South London Rly. Con Ord.	50 —53	4 9 7	Feb, Aug	51½	49½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	126 —129	3 18 7	Feb, Aug	..	..
St.	5%	Do. (1896)	123 —126	4 0 4	..	..	..
St.	5%	Do. (1901)	120 —125	4 1 1	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	102 —105	4 16 5	..	..	..
10	5 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 - 16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.of Aust.6%Cm.Prf	3¾—4¼	6 13 4	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 —8	3 15 0	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., Spever Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..
10	6%	† Do. 6 per Cent. Pref.	14½—14¾	4 2 10	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	3⅝	3⅜
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	Liverpool Overhead Railway Ord.	4⅛—5	2 10 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98½ -100½	3 19 10	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref..	11¼—11⅞	4 5 1	..	11⅞	11⅝
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	104½	103½
St.	..	Mersey Con. Ord. Stock	8 —11	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅜—⅝	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	103 —105	4 17 1	..	..	..
100	4½%	† Do. Sterling 4½% Debs. (1922)	104 —106	4 4 11	..	..	..
5	..	New General Traction Ord.	⅛	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1¼—2½	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1stMt.Db.Stk.	99 —102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½—9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..
St.	3¾%	Waterloo and City Ord.	91 —94	3 9 8	Jan, July	..	..
					June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2¾—3⅛	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	50 —53	6 0 9	F,My,Ag,N	51¾	..
St.	30/0	Do. Preferred	95 —97	6 6 2	F,My,Ag,N	98½	95½
St.	1/0	Do. Deferred	7⅜—8½	0 12 6	F,My Ag,N	7⅛	7⅛
100	8%	Commercial Cable Capital Stock	180 —190	4 4 5	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 —91	4 8 3	Jn Ap,Jy,O	91½	90
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—8½	5 17 8	April Oct	8	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝—101⅝	4 9 1	Jan, July	..	..
20	3/0	†Direct United States Cable	10 —10½	6 3 10	Ja,Ap,Jy,O	10⅝	..
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	98 —101	4 9 1	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	119 —124	5 12 11	Ja,Ap,Jy,O	121	119½
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 —91	3 16 11	Ja Ap,Jy,O	88	..
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	107	105½
10	2/6	Eastern Extension	10¾—11½	6 4 5	Ja,Ap,Jy,O	11	10⅞
St.	4%	† Do. 4 per Cent. Deb. Stock	104 —107	3 14 9	Feb, Aug	104⅜	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	98 —101	4 0 0	Feb, Aug	101½	101½
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 11	May, Nov	..	..
10	5/0	Great Northern of Copenhagen	23½—24½	5 2 1	Jan, July	..	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	12 6	Indo-European	38 —41	6 1 11	May, Nov	..	..
100	6%	London Platino-Brazil. 6% Debs., 1904	100—103	5 19 5	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	†West African Telegraph Shares	5 —6	1 13 4	..	..	..
2½	..	West Coast of America	⅜—½	..	..	1/16	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	11¾—12½	5 14 8	Mr,Jn,O,D	12	11⅞
100	5%	* Do. 5% Debs. (2nd Series, 1906)	99 —102	4 18 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 3	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5¼	5 9 1	..	..	..
10	2/0	†Globe Telegraph and Trust	8¼—8⅝	4 11 5	Ja Ap Jy O	8⅝	8¼
10	3/0	† Do. 6 per Cent. Pref.	12¼—13	4 12 4	Ja Ap,Jy,O	12⅞	12½
8	4/0	Reuter's	6¾—7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	5 0 0	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Feb. 2.	Rate per Cent. Yielded.	Dividend Due	Business Week to Feb. 2. Highest.	Lowest.
		TELEPHONES.		£ s. d.			
5	8/0	†Chili Telephone (fully paid)	4⅜—5⅛	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	102 —104	5 18 0	..	103½	102½
St.	5%	Do. Def. Stock	78 —81	6 1 2	..	79½	78½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13½—14½	4 2 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	14 —15	4 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅛—5⅜	4 13 0	Feb, Aug	5⅜	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 —97	3 18 2	June, Dec	..	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	100 —102	3 18 5	..	..	101½
1	0/7½	Oriental	1—1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
5	3/0	United River Plate	5½—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝—5⅞	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 - 105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	¾—1	..	..	..	..
1	..	Do. 7% Cum. Pref.	1⅛—1⅜	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	114 —117	3 17 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	9½	9½
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—10⅝	4 13 0	..	..	..
5	3/6	Do. 7 per Cent. Pref.	9⅝—10½	3 8 4	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord. ex rights	6 —7	4 12 10	..	..	5⅜
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	106 - 109	3 13 8	..	..	108½
5	4/0	Charing Cross & Strand Electric Sup.	8½ - 9	5 11 1	Feb, Aug	9⅛	9⅛
5	2/3	Do. 4½ per Cent. Pref.	5½—6	3 15 0	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	..	4½
St.	4%	Do. 4% Deb. Stock (red.)	103 —105	3 16 8	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5⅜—6½	4 8 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	105 —108	4 8 8	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10½—10⅜	6 19 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	103	102½
10	4/0	County of London & Brush Prov. Ord.	8 - 9	4 8 11	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 — 110	4 1 10	..	..	..
St.	27.6½	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5⅜—6½	4 0 0	..	..	..
St.	4½%	† Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 8	..	..	..
10	..	Havana Electricity Co. Shares (£8 paid)	7½—8½	..	..	..	..
3	6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	11 —12	4 3 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	102 —105	3 16 9	..	..	..
3	..	London Electric Supply Ord.	1⅜—2½	..	..	2⅛	2⅛
5	8/0	Do. 6 per Cent Pref.	5½—6	5 0 0	..	5⅜	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 1	Mr,Jn,S,D	97½	96½
10	8 0	Metropolitan Electric Sup. Ord.	18 —19	4 1 7	April, Oct	18⅜	17⅞
5	..	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	..	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..	..
St.	3¼%	Do. 3¼ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 4	..	95	..
100	4½	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6 0	Notting Hill Electric Ord.	13 —14	4 5 9	March	13⅜	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5½—5¾	4 15 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 3	..	..	..
1	..	Rand Electric	⅜—⅞	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
5	5 0	St. James's and Pall Mall Electric Ord.	14½—15½	4 13 9	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	98½	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3½—3⅝	3 6 8	..	3½	3⅜
St.	4%	† Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	1/9	South London Electric Supply Ord.	3⅜ - 4⅛	4 2 4	..	3⅜	..
5	2/6	Urban Electric Supply Ord.	4⅜ 5	5 0 0	..	..	..
5	2/6	Do. 5% Cum. Pref.	4⅛—5⅛	4 17 7	..	4⅛	..
5	6/6	Westminster Electric Supply Ord.	12½—13½	4 16 4	Mar, Sept	13½	12⅞
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½—¾	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅜—⅝	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3/0	† Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
St.	4½%	British Thomson-Houst'n 4½% 1st Mt. Db.	103 —105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	4 —4½	6 13 4	..	4⅜	4⅜
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 3 4	..	95½	93½
2	..	Brush Electrical Engineering	¾—1½	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—1¾	6 17 2	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	98 —101	4 11 2	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	75 —80	5 12 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5⅞	4 6 11	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅛—¼	6 17 2	..	⅛	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
1	0/7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	7 10 0	Jan, July	1⅛	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	97⅝—100⅝	5 0 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8½—8¾	..	..	8⅝	..
5	..	Do 6 Cum. Pref.	5¼—5½	..	..	..	..
St.	4½%	Do. 4½% Deb. Stock	103—105	4 5 9	..	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	¼	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	⅜—½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6½	5 12 0	H'lf-yearly	6⅛	5⅞
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅝—6¼	4 16 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 4 11	..	104½	..
2	1/2½	†Electric Construction Co.	1⅜—1⅝	6 8 0	Jan, July	..	..
2	2.9⅜	Do. 7 per Cent. Cum. Pref.	2⅜—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	½—¾	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 8	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¼—10	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 —98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	11 —12	8 6 8	Feb, Aug	12½	11¾
5	2/8	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 8	Feb, Aug	18½	18½
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 8	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11½	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33 —36	6 13 4	Mar, July	35½	33⅜
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 —103	3 17 8	Jan, July	..	..
5	3/0	Williams and Robinson Ord.	4 —5	6 10 0	Apr, Oct	4⅜	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅛—6	5 0 0	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 5	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. The London Stock Exchange Committee have refused to quote these.

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NOTES.

SINCE the inception of public electric supply from electricity works, there have been many cases of action for injunction on account of vibration "nuisance." It is well understood, and has been affirmed by several Judges, that, although occasionally a small amount of latitude may be given on account of an electricity undertakers' statutory obligation to supply, there is actually nothing in the ordinary form of Provisional Order or in the Electric Lighting Acts which will exempt them from any liability for nuisance. Thus it is a matter for some surprise that cases of this nature still appear in the Law Courts when the undertakers admit nuisance and appeal for exemption from the inevitable injunction or for a certain amount of "grace." In most cases they would be better advised to come to terms with the complainants out of court.

THE judgment given by Mr. Justice JOYCE in the case of "Colwell and others *v.* St. Pancras Borough Council"—a report of which will be found in our "Legal Intelligence" columns—is, therefore, not open to criticism. In fact, the Judge has shown considerable leniency by virtually suspending the operation of the injunction for six months. The case brings out one interesting point, however. The Borough Council itself had apparently, some time ago, acquired the freehold of the property upon which the affected houses stand, and it is, therefore, not unreasonable to suppose that they had endeavoured either to come to terms with the tenants or to acquire the lease of the houses themselves. Whether proper negotiations took place to this end was not disclosed in the evidence before the Court, but it is clear that, had the tenant asked unreasonable terms, the Borough Council would have had no redress in the present state of the law. A short Act empowering an electricity undertaking to bring a dispute of such a nature compulsorily to arbitration would, therefore, be welcome. Doubtless certain safeguards would be necessary to prevent unreasonable application of these powers, in view of the fact that the majority of the undertakers are now local authorities; but there is little doubt that, on the whole, the result of an Act of this nature would be beneficial to all concerned.

IN this issue will be found an illustrated article describing the electric lighting and electrical stage appliances at Drury Lane Theatre Royal. From this article it may be gathered that the new installation complies to the fullest extent with all modern ideas as to safety and immunity from fire risk. Since the calamitous theatre fire in America, the authorities in this country have become aware that the electric lighting equipment of many English theatres is not all that might be desired. The fire at the Iroquois theatre, it will be remembered, was caused by inflammable material coming into contact with the arc of a stage projector, but as to why the arc was not properly protected there is nothing to show. All stage arc lamps at Drury Lane are contained within asbestos-lined iron cases and it is, therefore, quite impossible for such an occurrence to take place even if inflammable material were employed; but, as a matter of fact, everything of this nature has been rendered thoroughly fireproof. The London County Council, in whom is vested the duty of safeguarding public life and property in London theatres, are, very properly, strict in their demands as to the methods of lighting such buildings. It is doubtful, however, whether certain of their regulations could be legally enforced by the Council; for instance, in clause 1 it is specified that "before any alterations or additions to the electric installation are commenced, the sanction of the Council shall be obtained."

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DRURY LANE THEATRE may be supplied either from special theatre mains or from the ordinary network. It is true that both sets of mains belong to the Charing Cross Company, but, being supplied by separate plant, they are, to all intents and purposes, independent systems. Moreover, should the theatre generating plant fail, it is possible to switch the huge batteries of the Charing Cross Company on to the theatre mains. In spite of these facts, the London County Council contend that the theatre should derive its supply from two separate undertakings, but clause 8 of their regulations only provides that the supply *may* be taken from the mains of independent companies. And although two of the newest theatres in London are lighted by electricity only, yet the Council demand the retention of gas and oil at Drury Lane, in addition to the admirable system of electric lighting described in our columns. In this instance the Council may be justly accused of being "blind guides which strain at a gnat and swallow a camel," for it is absolutely certain that by using naked flame of any description, such as gas or oil, the risk of fire is enhanced even if the risk of panic is slightly reduced.

WE publish this week an interesting article by Prof. F. G. BAILY, on "The Efficiency and Colour of Osmium Lamps." From tests which he has conducted, the author comes to the conclusion that the osmium lamp has about twice the efficiency of the ordinary carbon lamp, and he attributes this to the temperature which the filament is able to withstand without fracture, and to the fact that it is a slightly more efficient light radiator than carbon, especially at comparatively low temperatures. Some experiments in the same direction have been made in Naples by Prof. LOMBARDI, the results of which also appear in this issue. Prof. LOMBARDI finds that the temperature of the osmium lamp is less than that of the carbon lamp, and yet its light-giving properties are greater. It is remarkable that there should be this difference of opinion as to the temperature of the filament, but it is not so remarkable that there should be a difference of opinion as to the increase in efficiency of light radiation at the same temperature. This is a point upon which there has always been room for much difference of opinion.

THE ratepayers of Marylebone have wisely decided to allow the Bill which is before Parliament to proceed. Since the date of the statutory mass meeting, and up to the moment the result of the poll was declared, considerable doubt existed as to what would be the ultimate issue, for undoubtedly a large proportion of the Marylebone ratepayers, and among them some of the most influential, are opposed to the Marylebone Borough Council becoming the electric supply authority in the district. The Council are already pledged to buy the Marylebone portion of the Metropolitan Electric Supply Co.'s undertaking, however, for a sum fixed as the result of the recent arbitration proceedings, and the present Bill can in no way affect this obligation. Its object is merely to overcome a legal point which has been raised as an obstacle to their borrowing money for the purpose of buying the undertaking; by an Act of Parliament passed in 1901 they are bound to buy, but the Act, it appears, did not state with sufficient clearness how the money for the purpose should be borrowed.

THE present Bill, therefore, leaves the actual question of liability to purchase unchanged. It is, however, open to the Council, as it has always been, to come to terms with the company if the latter, for instance, should be willing to give way in return for compensation of a satisfactory nature. The matter is therefore not closed by the decision of the ratepayers that the Bill should be proceeded with, and we therefore recommend that these long-suffering individuals should keep a sharp check on their Council's actions, especially as overtures by other companies to run the undertaking are now under consideration.

THE description of a new process for producing electric current, which we give in another column of this issue, hails from America, and if our contemporary has published all that is known of the process, we fear that its future is not a very bright one. As a matter of fact, it is exceedingly unlikely that such an arrangement would work at all, and the attempt is only worth recording to remind our readers that the subject of generating electricity directly from coal is still a live one.

A SHORT note in another column records the refusal of the Local Government Board to sanction a loan of £12,000 for extending the Portsmouth municipal telephone system. The Telephone committee in communicating this to the Council do not give the Board's reasons for coming to this conclusion. They offer no explanation why, having spent a large amount of money and pledged the credit of the ratepayers for developing a telephone system in competition with the one already working efficiently in the town, they are now brought to a standstill at the moment when they are contemplating an increase in their business. A portion of the £12,000 applied for has already been spent.

Royal Society.—Among the Papers down for reading yesterday were the following:—"A New Method of Detecting Electrical Oscillations," by Dr. J. A. Ewing, F.R.S., and L. H. Walter; "On the High Temperature Standards of the National Physical Laboratory," by Dr. J. A. Harker, communicated by Dr. R. T. Glazebrook, F.R.S.

Newbury Electricity Works.—We regret that an incorrect statement was made last week in our note with regard to the opening of the Newbury electricity works. The battery to be installed will consist of 250 D.P. cells of the "Lumford" type, each containing 23 plates, which will be capable of giving a capacity of 1,500 ampere-hours. It is not a Tudor battery, as we stated.

Signalling on the Metropolitan District Railway.—We are informed that the Underground Electric Railways Co. have decided to use an American system of signalling on the 15 miles of double track of the Metropolitan District Railway. The contract has been given to the Westinghouse Brake Co., and will be on the Westinghouse electro-pneumatic system. There are 200 signal points, the service in the tunnels being arranged for trains running at intervals of about 1¼ minutes. A new form of combined signal motor and arm will be employed. The system has been already in service on the Ealing and Harrow branch of the District Company's line.

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Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Anjer—Kalianda	Aug. 2, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
St. Lucia—St. Vincent	Sept. 19, 1902 ..	Feb. 9, 1904
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Oran—Tangier	Feb. 3, 1904 ..	—

The Fire at Beckenham.—The report published in a daily paper to the effect that the municipal electricity works at Beckenham had been burned down is incorrect. A fire occurred at New Beckenham on Friday, destroying the Mid-Kent Battery Works, the property of the Universal Battery Co., who are makers of small accumulators and dry cells. The entire building, together with machinery and stores of this small works were destroyed. Mr. A. J. Hedgcock, resident engineer for the British Insulated and Helsby Cables (Ltd.), who are running the Beckenham electricity works for the Urban District Council, informs us that as a result of the report to which we have referred above, he received numerous offers of assistance, several well-known firms having proffered help both with material and labour, and he appreciates the kind enquiries and sympathy which have come to to him from all parts of the country.

International Electrical Congress at St. Louis.—Recently 280 special letters of invitation have been issued on behalf of the Committee of Organisation to prominent electricians and electrical engineers, signed by the president and the general secretary of the committee, requesting Papers for the Congress in the various sections. Of these, 146 have been sent to foreign authors and 134 to American authors. There has not been time to receive replies from more than a few foreign authors, but 21 acceptances have up to date been received from abroad, and 46 acceptances from North America. A considerable further number of invitations to contribute Papers have yet to be issued. It is hoped that the Congress will convene with a full programme in each section, and that at least half of the Papers may be from foreign countries. According to the plans of the Committee, Papers for the Congress programme are specially invited, but Papers voluntarily offered will be considered. All communications should be addressed to the general secretary, Dr. A. E. Kennelly, Harvard University, Cambridge, Mass., U.S.A.

Accident at the Smithfield Markets Electric Supply Works.—An unfortunate accident occurred in the generating station of the Smithfield Markets Electric Supply Co. on Tuesday morning. Afew minutes before 5 a.m. a boiler was opened out to a steam main to which three other boilers were already connected. From some cause, at present unexplained, a fracture occurred in the body of the 5in. isolating valve in the branch from this boiler (*above* the isolating valve itself), and the four boilers discharged through the gap thus formed. A coal trimmer, W. Lonergan, was about 15ft. away from the fractured pipe, and, in spite of all efforts, he could not be found for about 15 minutes, when he was conveyed to the hospital badly scalded. Over an hour elapsed before the stop valves could be approached and the fractured part blanked off. The supply was stopped from 5 a.m. until 12:20 noon. Part of the system was, however, restored at 10:45 a.m. Lonergan was the only man injured, but unfortunately he died soon after admission to the hospital. Although only supplying the Smithfield Markets, the company is by no means a small undertaking, the number of lamps connected with the mains being equivalent to 37,000 8 c.p. lamps, and the capacity of the generating plant 965kw. We are indebted to Mr. Eustace Ridley, the company's engineer, for the above information.

Bristol Association of Engineers.—The third meeting of the session was held at the Imperial Hotel, Clifton, on Saturday last, the president, Mr. J. S. Martin, H.M. Inspector of Mines, in the chair, when a Paper on "The Development of Electrical Machinery" was read by Prof. Robertson, of the Merchant Venturers' Technical College. Starting with Faraday's discovery in 1821 of continuous motion, produced by an electric current, the author traced out the various stages in the development of electrical motors before the discovery that "motor" and "generator" were converse functions of the same machine. He then went back to Faraday's other great discovery of induced currents in 1831, traced the gradual development of this idea until, with the researches of Hopkinson in 1884, modern electrical engineering may be said to have dawned. A number of illustrations of the Siemens, Pacinotti, Gramme, Hopkinson, Brown and other historical machines were shown by the author, who then explained the typical constructions of the present day and some of the difficulties that are now met with in connection with very low E.M.F.s, very high E.M.F.s and high-speed machines for turbine driving, and pointed out the chief ways in which they are being overcome. In the discussion which ensued, Mr. Frank Brain gave an account of his experiences of electrical driving in the colliery he is connected with. About 20 years ago, using the old "A" Gramme machine, electrical driving had been adopted, and the speaker stated that even that old plant had saved its cost in a couple of years' working.

Osmium Lamps.—Prof. L. Lombardi has determined the temperature of the filament of the osmium lamp by employing Prof. H. F. Weber's method as expounded at the congress at Frankfurt in 1891, and his results will be found in the table below, which is reproduced from the *Elektrotechnische Zeitschrift* of Jan. 21st.

Volts.	Amps.	Ohms.	Watts consumed	Mean horiz. c.p.	Watts per c.p.	Temp. Centigrade.
12·0	0·519	23·1	6·23	0·17	37·10	1,088
16·0	0·619	25·8	9·90	0·77	12·80	1,180
20·0	0·712	28·1	14·24	2·22	6·42	1,250
24·0	0·800	30·0	19·20	5·02	3·82	1,310
28·0	0·884	31·7	24·76	10·19	2·43	1,360
32·0	0·964	33·2	30·84	18·42	1·67	1,404
36·0	1·040	34·6	37·44	30·2	1·24	1,443
40·0	1·113	35·9	44·51	45·3	0·98	1,477
44·0	1·187	37·1	52·20	66·9	0·78	1,510
48·0	1·257	38·2	60·30	89·6	0·67	1,539

Prof. Lombardi draws particular attention to the fact that the mean temperature of ordinary incandescent glow lamps, when running in normal conditions, is about 135°C. higher than that determined by his experiments for osmium lamps. Nevertheless, the ordinary lamp is less efficient than the osmium lamp.

The ratio of the mean horizontal c.p. to the mean spherical c.p. was nearly the same for all osmium lamps examined by Prof. Lombardi, namely 0·80.

Junior Institution of Engineers.—At the meeting of this Institution held on Friday a Paper was read by Mr. Hal Williams on "Producer Gas Power for Factories, Cold Stores, and Freezing Works." The Paper described briefly the three systems of generating producer gas now in use, drawing attention to the principles which must be observed, and the errors which must be guarded against in designing a satisfactory power gas installation. Some interesting remarks were made regarding the recovery of by-products from bituminous plants, and it was pointed out that while the only two by-products available were sulphate of ammonia and steam, it did not pay to recover the former from plants of a smaller power than from 3,000 H.P. to 4,000 H.P. Steam, however, could be generated as a by-product from any gas engine over 50 H.P., the method being to employ a boiler patented by Mr. Wilson, which was placed on the exhaust pipe of the gas engine, and acted really as an exhaust silencer. With this boiler as much as 2lb. of water should be evaporated and steam raised to 100lb. pressure per brake horse-power hour. The author dealt at some length with the suction gas plant, and pointed out its numerous advantages. With this type of plant one brake-horse-power-hour, he said, could be generated from 1lb. of anthracite coal, with the great advantage that gas is only generated by the engine as it is required, and that consequently there is no waste. Comparative costs of power between electricity taken from the supply companies' mains, between gas taken from the gas companies' mains, and that generated from a producer plant were then cited. After numerous practical

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hints upon the working of gas engines, the Paper concluded with a brief reference to the plants for generating fuel gas from wood, it being stated that as much as one brake-horse-power-hour could be obtained from the destruction of 4lb. of wood.

Electric Light and Power Stations in America.—A report on the above subject has recently been issued by the United States Census Office. Although the period covered by this report is the year ending June 30, 1902, the figures quoted and the deductions from them are of sufficient interest to warrant brief mention. Table I. gives some data relating to electricity stations during the period in question. Plants used solely for private purposes have been omitted. Their number is estimated at 45,000 to 50,000. The report mentions that, notwithstanding the control which gas companies have in many instances secured over competing electric stations, and the fact that the gas industry in the United States dates back from 1806, while electric stations have been in existence only since 1879, the latter industry is becoming the more important. This is shown by the figures given in Table II. for the two industries as obtained at the last enumeration.

Table I.—*Central Electric Stations: 1902.*

Items.	Total.	Private stations.	Municipal stations.
Number of stations	3,620	2,805	815
Cost of construction and equipment	$504,740,352	$482,719,879	$22,020,473
Earnings from operation	$84,186,605	$77,349,749	*$6,836,856
Income from all other sources	$1,514,000	$1,385,751	$128,249
Gross income	$85,700,605	$78,735,500	$6,965,105
Total expenses	$68,081,375	$62,835,388	$5,245,987
Salaried officials and clerks:			
Average number	6,996	6,046	950
Salaries	$5,663,580	$5,206,199	$457,381
Wage-earners:			
Average number	23,330	20,863	2,467
Wages	$14,983,112	$13,560,771	$1,422,341
Power plant equipment:			
Steam engines—			
Number	5,930	4,870	1,060
Horse-power	1,379,941	1,232,923	147,018
Water wheels—			
Number	1.390	1,308	82
Horse-power	438,472	427,254	11,218
Generating plant equipment:			
Dynamos—			
Direct cur., const. voltage–			
Number	3,823	3,405	418
Horse-power	442,446	418,913	23,533
Direct cur., const. ampge.–			
Number	3,539	2,957	582
Horse-power	195,531	157,768	37,763
Alternating and polyphase current—			
Number	5,122	4,300	822
Horse-power	987,003	896,315	90,688
Output of stations:			
Kilowatt hours-total for year	2,453,502,652	2,257,598,213	195,904,439
Total number of arc lamps	385,698	334,903	50,795
Total number of incandes. lamps	18,194,044	16,616,593	1,577,451

* Includes estimated income from public service.

Table II.

Items.	Central electric stations, 1902.	Gas plants, 1900.
Number of establishments	3,620	877
Cost of construction and equipment	$504,740,352	*$567,000,506
Cost of supplies, materials, and fuel	$22,915,932	$20,605,356
Salaried officials and clerks:		
Average number	6,996	5,904
Salaries	$5,663,580	$5,273,500
Wage-earners:		
Average number	23,330	22,459
Wages	$14,983,112	$12,436,296
Income	$85,700,605	†$75,716,693

*Capital. †Value of products.

While the statistics for the two industries do not cover the same year, the periods, nevertheless, correspond sufficiently for a general comparison. There were 827 cities and towns in which one or more gas plants were in operation at the twelfth census, and in 1902 there was an electric station in operation in all but 153 of these places. Table III. is instructive regarding the respective distribution of gas and electric plants.

Table III.—*Distribution of Central Electric Stations and Gas Plants in Cities of different Population.*

Population of cities in which located.	Central electric stations, 1902.	Gas plants, 1900.
Total	3,620	877
Less than 5,000	2,714	200
5,000 to 25,000	675	484
25,000 to 100,000	128	124
100,000 to 500,000	73	39
500,000 and over	30	30

The fact that 75 per cent. of the central electric stations are in places of less than 5,000 inhabitants, as compared with 22·8 per cent. of the gas plants, indicates the wider distribution of the electric stations which have enabled the inhabitants of the small places to enjoy illuminating facilities confined heretofore to the larger cities and towns.

A Singing Vacuum Tube.—Mr. W. J. Hammer, in writing to the *Electrical World* of New York, describes a curious occurrence in connection with a damaged vacuum tube. He says that, recently, he had the misfortune to perforate the target or anode of a Röntgen-ray tube, and this, in addition to destroying its focussing power, caused the vacuum to lower as the occluded gases in the platinum were driven out. The tube was one of the Queen self-regulating type with the platinum plate of the anode backed by nickel. A few evenings after, he was on the point of packing this tube in a large cardboard box filled with "Excelsior" when it occurred to him to see if its vacuum had changed and to what extent. After heating the target or anode red hot he laid the tube down upon the closed cardboard box, taking up a new tube and placing it in the holder. Suddenly he heard a low but very clear musical note corresponding to A on the musical scale, and which came from the damaged tube. On placing his hand on the tube at various parts he could feel it vibrating violently. He timed the duration of the sound on three separate tests and the musical note lasted respectively 5, 15 and 17½ minutes; in other tests made afterwards it lasted from 5 to 17½ minutes. Sometimes the tube did not start when first laid down, but invariably tilting and letting it fall back lightly would start it up. Sometimes after it had stopped he could start it again a second or third time without connecting to the coil. The pitch of the sound was always the same save on two occasions, when several persons were talking near the tube; the pitch then varied, but when the room became quiet it resumed its usual pitch. The amplitude of the sound varied, but could usually be head plainly in an adjoining hall or room from 20ft. to 30ft. distant. At the time the tube was singing, the induction coil, which was supplied from the street continuous-current lighting circuit of 117 volts, was not running, nor was there anything else near to affect the tube either by an electrioal or mechanical vibration; besides, the box and "Excelsior" packing were a perfect cushion. By reason of the fact that it was necessary first to warm up the platinum plate by the cathode stream, and as the anode tube was not only perforated but part of its edge expanded away from the nickel backing, one would naturally be led to think the phenomenon was akin to the well-known "Trevelyan Rocker" effect, in which the vibrations produced by a heated brass rocker resting on lead give out a clear musical note, although it is impossible to detect the rocker vibrating. Mr. Hammer wonders whether it were possible that the conditions of vacuum and perhaps other characteristics of the tube were such that, after the energy supplied electrically had set the tube going, it may have been so extremely sensitive that it responded to some etheric vibration which kept it active until it got out of step. This would soon occur, as the conditions were changed by the cooling of the electrode.

Steam Turbines in a Private Plant.—In a recent issue of the *Electrical World* of New York there is an interesting article describing the steam turbine installation of the B. F. Goodrich

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Co., rubber manufacturers, of Akron, Ohio. The original plant of two 500kw. generators and one of 150kw. driven by reciprocating engines, was installed in the central station and space reserved for another 500kw. generator. It soon proved inadequate, however, owing to factory extensions, and in order to instal a sufficient additional capacity of the same type as those in use, an addition to the power house would have been required. It was found, however, that in the space reserved, two turbo-generators could easily be installed, one of 750kw. and another one of 400kw. Should further increase of power be necessary the 150kw. engine machine may be replaced by two 400kw. turbo-units. It will thus be seen that a power house originally laid out for an ultimate capacity of three 500kw. and one 150kw. machines may, with turbine machinery, be arranged to accommodate 2,950kw., or an increase of 80 per cent., and still retain the two original 500kw. engine units. Both steam turbines are of the Westinghouse parallel flow type, the smaller being a single-cylinder and the larger a double-cylinder machine. Both are directly connected through semi-flexible mechanical couplings to two-phase, 220-volt, 60-cycle dynamos, arranged at the switchboard to operate in parallel with the three engine-type generators. The smaller machine operates at 3,600 revs. per min., and the larger at 1,800 revs. per min. An overload capacity of 50 per cent. is provided by by-pass valves at the side of the turbine. These also enable the machines to carry full load continuously should the condensing system break down. In the case of the 400kw. unit, no foundation was constructed, the turbine being supported partly upon a brick wall which had been part of the former building foundation and partly upon I beams spanning the condenser pit. This unit rests directly upon the power-house floor. The 750kw. unit rests at the four corners upon four brick and concrete piers, 12ft. in height, tapered from a width of 2¾ft. at the top to 4ft. at the bottom. Both turbines operate condensing in conformity with the remainder of the plant, and are connected to a single condenser located immediately beneath, in a concrete-lined pit in the basement. The aggregate electrical plant now installed comprises 2,300kw. in generating machinery and about 4,000 H.P. in motors, divided in the approximate ratio of 3 to 7 between continuous-current, variable-speed and alternating-current, constant-speed, induction motors respectively. The entire generating plant is 220-volt, two-phase, 60-cycle, furnishing current to one switchboard, from which part is delivered directly to an alternating-current distribution system and part converted into 320-volt continuous current by two 200kw. rotary converters, these in turn supplying a continuous-current, three-wire distribution system. The buildings are usually divided into five independent sections, each served by a secondary 'bus bar. These are fed by heavy cables carried from the power house 'bus bar through a system of tunnels used in common with the factory distribution systems for water, air, steam, signals, &c. In cases of especially concentrated loads, such as occasioned by the 200 H.P. and 300 H.P. motors, special feeders are run from the power house in order to secure better voltage regulation upon the remainder of the motor and the lighting systems. In a few instances variable speed with inverse torque is obtained by means of an adjustable pulley. Large induction motors of 150 H.P. to 300 H.P. are geared with a ratio of 1:5 directly to massive crude rubber rolls, one motor being usually located between two rolls, which it drives. The large continuous-current motor drives are of interest by reason of the variable-speed feature. The motors are installed in a concrete pit and geared to the rolls through a heavy Morse "silent chain" reduction gear. Further speed reduction is accomplished by massive toothed gearing. The motors are of 100 H.P. capacity, and each is provided with a standard controller located in front of a motor panel containing switches, circuit-breaker and instruments. The controller has nine points, giving 18 different speeds, with the two voltages available upon the three-wire system—namely, 160-320. Resistance in both armature and shunt winding are employed to effect the proper gradation of speeds, which range from 100 to 500 revs. per min. The adjustment of the turbine governor for steady loads is quite distinct from that for fluctuating loads. The former is a question of spring tension and the latter of spring stiffness. The tension adjustment may be made while the machine is running, as the entire spring mount is attached to a sleeve surrounding the governor spindle and working between ball bearings. This tension adjustment enables any divisions of load to be secured as indicated by the switchboard meters. It is also used for synchronising. In practice, however, this is accomplished by a simple method, as follows:—The speed of the turbine is brought a little above that of the engines already running, so that a slow blinking of the synchronising lamps is observed. By resting the finger lightly upon some part of the governor mechanism the speed may be brought down sufficiently to produce absolute synchronism for as long a period as desirable, even as long as one minute if the load happens to be steady. By this means the tension adjustment need never be changed, as the slight excess speed necessary to synchronise is not appreciable when the machine is under load. In this instance the large turbine is usually given more than its share of load owing to the controlling influence exerted upon the engine plant. Sudden loads which would perceptibly check the engines prove imperceptible in the case of the turbines, a beneficial result which is felt throughout the entire motive-power system. No synchronous motors are employed, but rotaries and induction motors are more or less sensitive to fluctuations induced by sudden loads. Striking proof of the low-friction losses in the steam turbine is offered by the fact that if the vacuum is maintained at the closing of the turbine throttle, these machines will continue to revolve for 30 to 40 minutes.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 12th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, South Kensington, when Dr. R. T. Glazebrook, F.R.S., president, will deliver his address.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, S.W. Paper to be read "The Electricity and Destructor Station at Plumstead," T. S. Nash.

SATURDAY, February 13th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

3 p.m. Visit to the Central Telephone Exchange of the General Post Office. Meet at Addle Hill entrance.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

7:30 p.m. Meeting at Heriot-Watt College, Edinburgh. Paper to be read: "New Methods of Electrical Winding Gear for Collieries and Allied Purposes," by Maurice Giorgi. In the afternoon a visit will be paid to Messrs. Bruce Peebles & Co.'s works.

TUESDAY, February 16th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7:30 p.m. Meeting at Owens College. Paper to be read: "Manchester Tramways Equipment: Line and Rolling Stock," by J. M. McElroy.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be submitted for discussion: "The Forms of Turbines most suitable for Low Falls," by A. Steiger.

WEDNESDAY, February 17th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

7:30 p.m. Meeting in the University. Paper to be read: "Notes on Steam Engine and Dynamo Testing," by R. Morcom.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, S.W. Paper to be read: "The Testing of Alternating Current Machinery," by R. J. Kaula.

THURSDAY, February 18th.

INSTITUTION OF ELECTRICAL ENGINEERS: LEEDS LOCAL SECTION.

7:30 p.m. Meeting in the Yorkshire College. Paper to be discussed: "Alternators in Parallel," by H. Bohle.

FRIDAY, February 19th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Annual General Meeting at Storey's Gate. The Council's report will be presented, after which the conclusion of the discussion will take place upon "The Heat Treatment of Steel." Time permitting, the following Paper will also be discussed: "The Motion of Gases in Pipes, and the Use of Gauges to determine the Delivery," by Prof. R. Threlfall, F.R.S.

SATURDAY, February 20th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture I. by the Right Hon. Lord Rayleigh, F.R.S., on "The Life and Work of Stokes."

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THE ELECTRIC LIGHTING OF DRURY LANE THEATRE ROYAL.

Considerable comment having been made lately in the daily Press regarding the risk of fire in the historic playhouse known as Drury Lane Theatre, it may not be out of place to review briefly the electric lighting arrangements, and to describe in detail the improvements which have just been completed. Some time ago the directors became alive to the fact that the installation was not in such perfect condition as it might have been, and immediate steps were taken to provide a remedy. Those who have had experience in theatre lighting know only too well what rough treatment the various appliances are subjected to, and that specially designed apparatus have to be employed to withstand the wear and tear. Until the present alterations were commenced all leads, both on the stage and in the auditorium, were carried in wood casing, and although this was excellent in many respects, yet there was a certain element of danger in this method, as far as the stage lighting was concerned. Of course, the matter was on quite a different footing as regards the auditorium; the casing was on the surface, easy of access, and, being fitted very substantially in the first instance, was satisfactory in every respect. New distribution boards and quick-break switches have, however, been fixed, and all are quite fireproof.

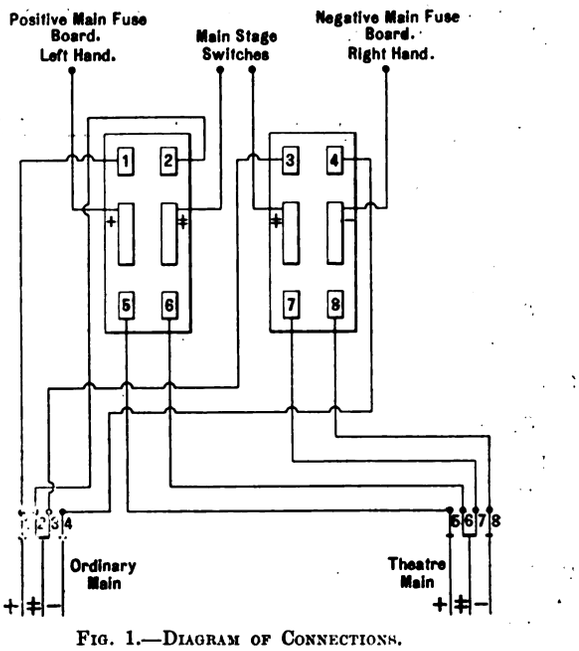

FIG. 1.—DIAGRAM OF CONNECTIONS.

The stage, on the other hand, has been re-wired from the point at which connection is made to the company's mains to the lamps themselves. And the work has been done in such a way as to eliminate risk to the greatest possible extent. Every safeguard known to modern engineering has been adopted, no expense has been spared, and it is difficult to imagine how a fire could occur. It is perfectly safe to say that Drury Lane Theatre will never be destroyed by fire originating from an electrical source, so complete are the precautions. But, so as to make assurance doubly sure, an elaborate system of fire alarms has been installed, and, side by side with the glass-covered alarm boxes, are water hydrants all ready equipped with hose. A staff of professional firemen is always in attendance, and the breaking of a glass causes signals to be conveyed to various parts of the building, amongst them being the theatre fire station. The point of the outbreak is automatically indicated to the attendant, and he merely has to proceed to that point and turn on the hydrant. On this occasion, however, we are chiefly concerned with the electric lighting of the building, for which current is obtained from the Charing Cross and Strand Electricity Supply Corporation's mains.

There are two separate and distinct sources of 2×100-volt main supply to the theatre. In an underground fireproof brick chamber there are fixed all the main switches, disconnecting fuse and distribution boxes, meters, &c. On the right-hand side of this chamber are the special theatre mains of the Charing Cross Company, and on the left-hand side are those taken off from the ordinary distributing network of the same company. These mains are brought in from the street through separate earthenware conduits, and at no point do they come into contact with each other. They are encased with sheet-iron boxes, fastened to the wall and filled with sand, and in this chamber, at least, there is absolutely nothing inflammable, with the exception, of course, of the cable insulation, and as this is all buried in sand it may be considered non-inflammable. Referring to Fig. 1, it will be seen that immediately on entering the building the middle wire of each set of three is divided, fuses, marked 2, 3, 6 and 7, being inserted in the branches. Two separate two-wire circuits are then taken to the main two-way switches, and pass from thence direct to the stage switchboard. By means of this arrangement it is possible to obtain the entire supply for the theatre from either the special theatre mains or from the ordinary network, and if one of the middle wire fuses should go only half the lights are extinguished. Moreover, by inserting the fuses in the middle wire *after* it has been divided, dangerous rises in pressure on one side of the system, due to failure of a single middle wire fuse, are avoided. There is also the possibility of obtaining supply for, say, the positive side from the ordinary network and the negative side from the theatre mains, or *vice versâ*, but, as a matter of fact, such an expedient is never resorted to, the entire supply usually being taken from the special theatre mains. The main two-way switches have a capacity of 1,000 amperes each and were made by the Electric and Ordnance Accessories Co. The two pairs of main cables consist of 91/12 gauge 2,500 megohm cables, and are arranged for a working density of 600 amperes per square inch. From the time that they leave the main two-way switches, all conductors are encased in steel conduit, screwed and earthed. Stranded cables containing 61/14's are employed for the rest of the house, and the distribution boards for these, as well as the battens and batten boxes, were supplied by Messrs. Pinching and Walton.

After leaving the underground chamber the main cables pass to a switchboard on the stage level, which is a great advantage over those situated in the flies or some other inconvenient position. The board at Drury Lane is so placed that the operator commands a full view of the entire stage, and owing to the fact that a new recess has been built for it there is no inconvenience caused to any of the company or stage operatives. At the end of the recess is fixed a polished slate board (Fig. 2), carrying three quick-break switches which control all the white, red and blue lamps respectively. These switches are in the middle wire. The outer conductors of the three-wire system are taken directly to four distribution boards, fitted with fuses and seen above the regulator shown in Fig. 3. By means of counter-weights, the heavy lids of the iron boxes containing these distribution boards may be held open or kept closed at will, and this is a most commendable feature, considering their position and the conditions attendant upon theatre lighting. From Fig. 1, it will be observed that there are two main circuits running from the underground connecting chamber, and hence the three main switches in the middle wire on the stage board have each two poles, one for each middle wire, but both poles are, however, at the same potential. And as the whole of the switchgear and regulators are in the middle wires, there is no difference of potential between any parts of them, and hence no possibility of obtaining accidental short-circuits. The only part of the board at which a difference of potential does exist is at the outer conductor distribution boards referred to above, and as these need only be opened when a fuse blows, it will be seen that the whole arrangement is about as "fool proof" and immune from danger as any apparatus for the purpose could be.

The method of connecting the cables to the board is also an ingenious one. Under the London County Council regulations

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it is necessary to have all the connections within sight and at the front of the board. In order to comply with this, the cables are carried from their respective steel barrels to the point of connection in steel conduit of channel section, from which they emerge through side holes efficiently bushed; to the end of each cable is sweated a thimble, and this is fastened, by means of a nut, to a brass strip on the front of the board, and projecting slightly beyond the edge. Thus no conductors pass through the slate base of the board, but are all insulated by air. All points at which cables enter or leave the steel barrel are also bushed with insulating material, and inspection boxes are fitted at all bends, as well as at frequent intervals in the straight runs. Messrs. Johnson and Phillips supplied all the cable.

The board carrying the various circuit switches and fuses is a very fine piece of work, and consists of polished slate panels It is shown in Fig. 2. There are four rows of quick-break switches, the top row controlling all the white lamps, the second all the red, the third all the blue, and the bottom various colours for special purposes. It is mainly divided into two parts, that on the left controlling all the lamps on the positive side of the system, and that on the right all those on the negative. It should be remembered, however, that all these are in the middle wire. On the top of the board carrying the three main double-pole switches are two voltmeters and two ammeters. The bottom row of switches serves a very useful purpose; it is frequently necessary to leave one particular set of lamps on in a certain position, when all the rest of the stage is in darkness. Imagine that, during what is called a "dark change," it is required to keep the blue lamps alight in the float, and that all the rest of the stage is to be plunged into total darkness. Under ordinary conditions the circuits would have to be switched off separately, and this would spoil the effect. To overcome this difficulty a separate 'bus bar has been fixed, which is not controlled by the main

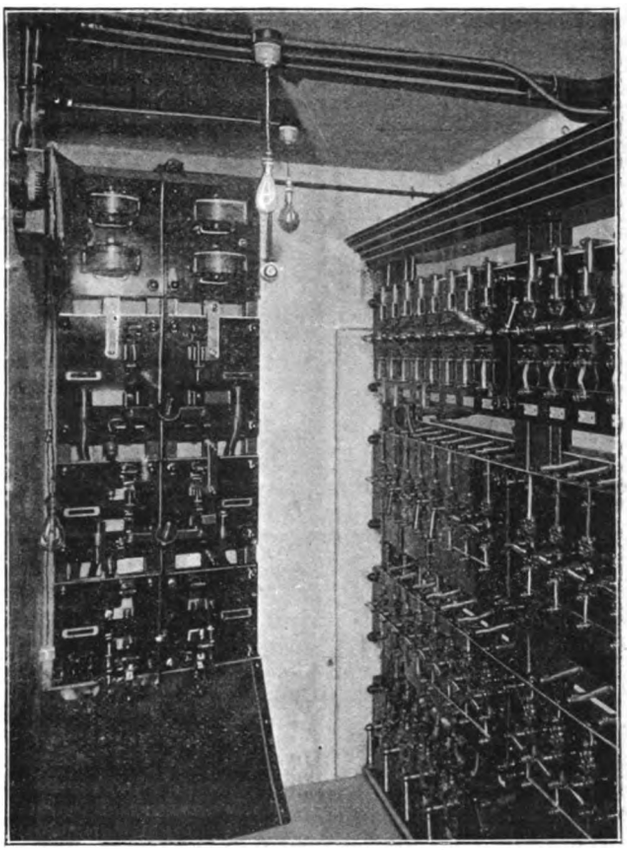

Fig. 2.—Stage Switchboard.

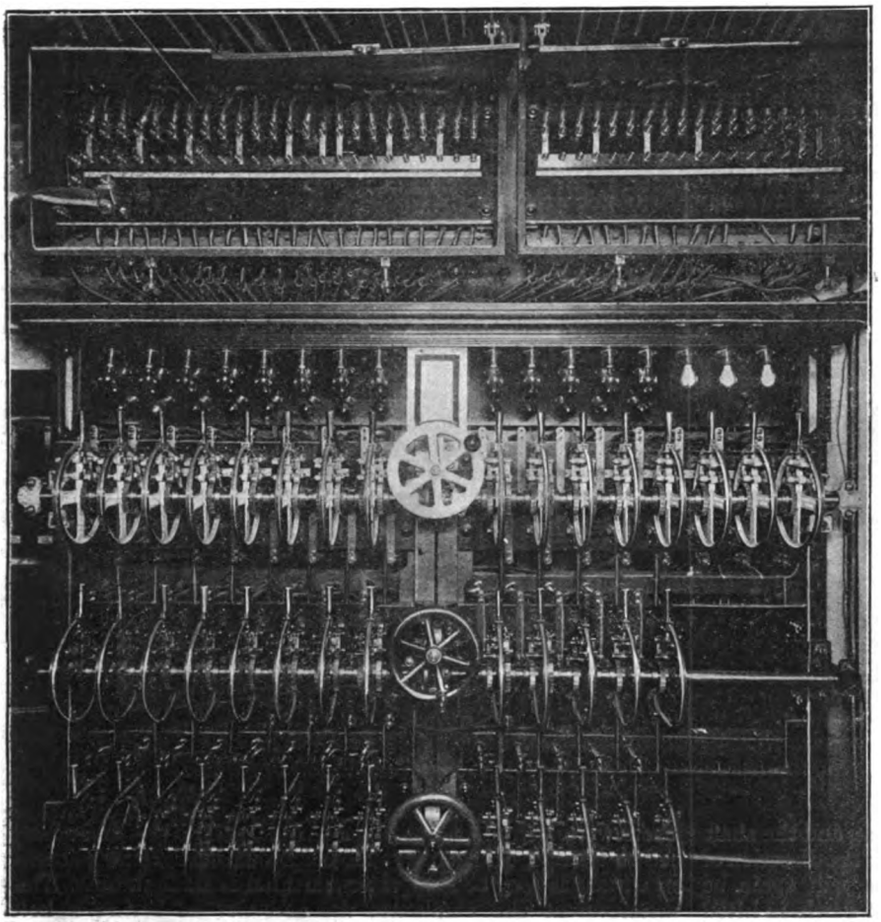

Fig. 3.—Regulator.

switches, and is, therefore, always alive. Before receiving the order "lights out," the attendant puts the "float blue" auxiliary switch on, and then, during the time the main switches are off, he has time to re-arrange the ordinary switches for the next scene. On receiving the order "lights up" he merely has to close the main switches, and the desired effect is obtained.

To the right of the switchboard is the regulator (Fig. 3), which possesses several features of unusual interest. Similarly to the board, the regulator is divided into two main parts—one for the positive circuit and the other for the negative. The wheels for the individual circuits are also arranged in positions corresponding to those of the circuit switches, the top row controlling the white lamps, the second row the red lamps, and the third the blue. Fig. 4 shows the general arrangement of the regulator, and Figs. 5 and 6 one of the movements in two different positions. In principle, the whole apparatus consists of a number of wheels mounted upon a common shaft, it being possible to operate the "dimmers" or liquid resistances either collectively or individually by rotating the wheels simultaneously or singly.

Referring to Figs. 5 and 6, it will be seen that each wheel is fitted on the shaft between a pair of ratchet wheels with teeth set in opposite directions. The ratchet wheels are fixed to the shaft by keys, but the wheels are mounted so that they rotate freely on the shaft, but are kept in position by the two ratchet wheels, which therefore act as collars in the usual manner. Each wheel carries two pawls, mounted one on each side and pointing in opposite directions, and these pawls are arranged to engage with the ratchet wheels, but their movement is so controlled that when the shaft is rotated with both pawls engaged, a rotary movement in one direction will turn the wheel with the shaft by transmitting the motion through one ratchet

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wheel and pawl, and when the shaft is rotated in the other direction, the motion will be transmitted by the other ratchet wheel and pawl. The pawls are fitted with springs which cause them to engage with the ratchet wheels, and the wheels each carry two levers which are connected to the pawls by links. The levers act as stops on the wheel, and limit its rotation in either direction by coming into contact with two fixed stops, suitably mounted upon the frame of the regulator. These fixed stops are in the form of an inclined plane, and are so placed that when the ends of the levers engage with them, motion is imparted and the pawls are lifted by means of the links and are disengaged from the ratchet wheels, one set of parts coming into action at each end of the movement of the wheel. By means of the arrangement described, the wheels are automatically disconnected from the shaft as soon as they have reached the limit of their movement, although they may be locked to the shaft in different relative positions, and the shaft may continue to rotate. On the other hand, if the direction of rotation of the shaft is reversed, the motion will again be transmitted to the wheels, as only one set of pawls is lifted at one time, and the other set is ready to take up the motion on the direction of the rotation being reversed. In order to allow for any regulator being operated independently of the remainder, each wheel is provided with an arrangement for lifting and holding both pawls clear of the ratchet wheels simultaneously, this ingenious arrangement taking the form of a quick pitch screw, at right angles to the shaft, carrying a nut which engages with the two pawls by means of their respective connecting links, the screw being fitted with a small lever by which it is turned and which projects from the side of the wheel. This arrangement also allows for any wheel or wheels being left in one position while the remainder are operated by means of the main shaft. The wheels are fitted with short-circuiting switches in the usual manner. The shaft is fitted with worm gearing so as to obtain a steady movement of the generators. Both the switchboard and the regulator were made by Messrs. Ernest F. Moy (Ltd.).

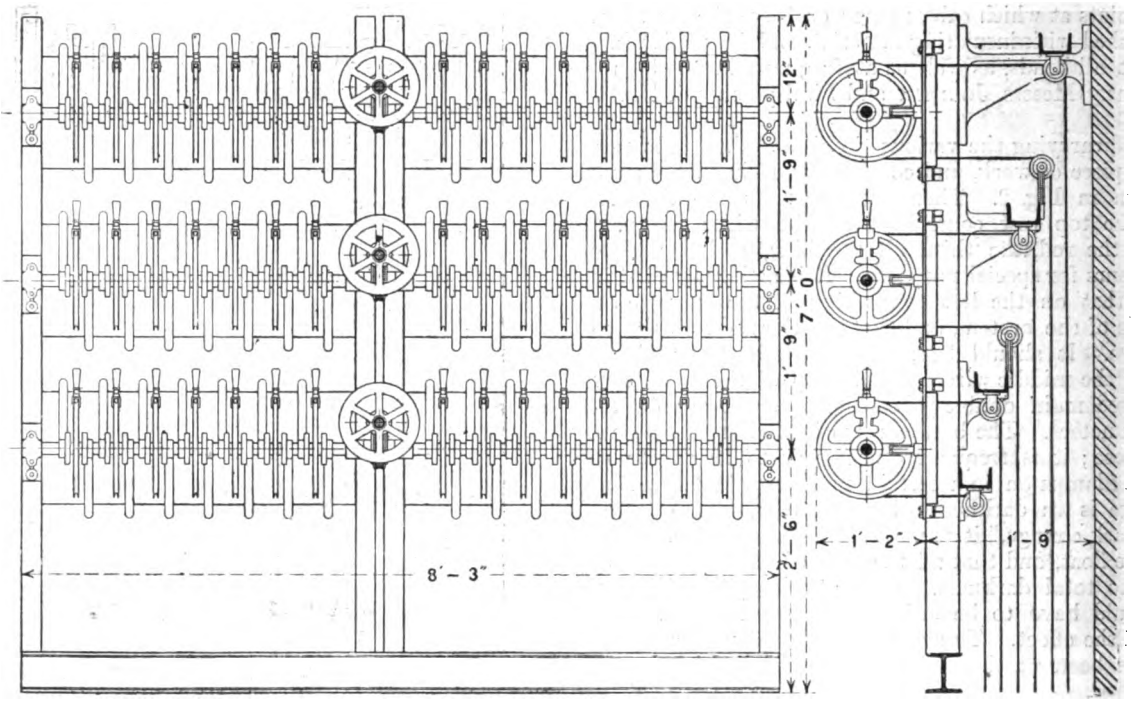

FIG. 4.—GENERAL ARRANGEMENT OF REGULATOR.

Fig. 7 is a photograph of the dimmer room, which is situated immediately under the regulator, and Fig. 8 is a section of one of the new type of dimmer shown on the left-hand side of Fig. 7. In the old type it was necessary to make the connection to the lower electrode in the liquid itself, and as this frequently led to trouble, Messrs. Moy have introduced the new pattern, in which, as may be seen, the connection is made in air. This arrangement also eliminates the necessity of boring a hole near the bottom of the vessel, through which to pass the conductor, and thus a fruitful source of leakage is done away with. The terminals to which the flexible leads are connected are

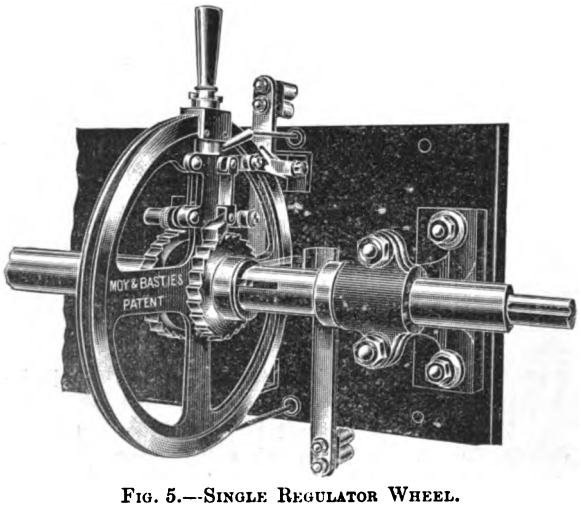

FIG. 5.—SINGLE REGULATOR WHEEL.

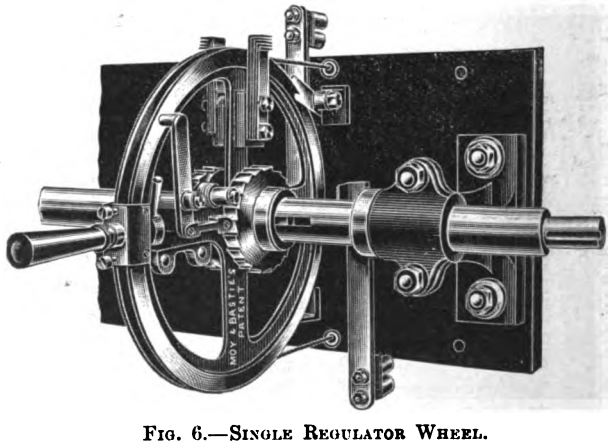

FIG. 6.—SINGLE REGULATOR WHEEL.

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mounted upon solid pieces of porcelain fastened to the wall. When the movable electrode reaches its lowest position it makes metallic contact with the fixed electrode, but as the electrical contact is not absolutely perfect a short-circuiting switch is provided on each regulating wheel, as described above.

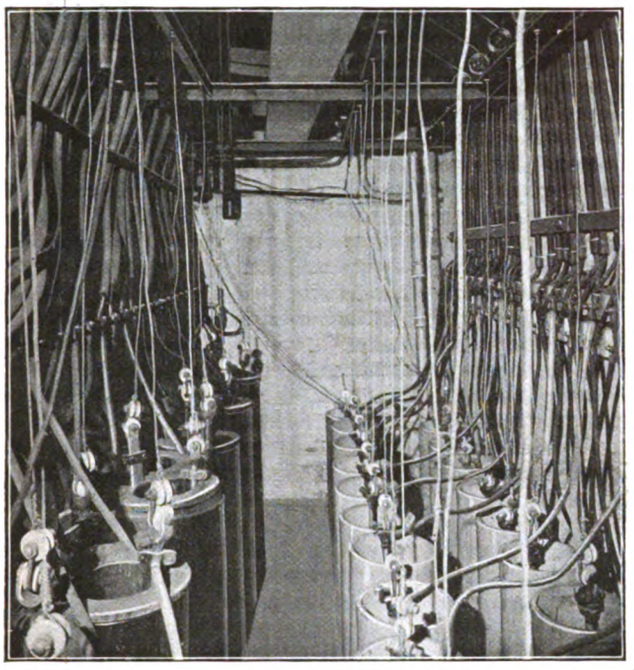

FIG. 7.—"DIMMER" ROOM.

There are, on the stage, five front battens, 48ft. in length, each of which contains 250 lamps; these are said to be the longest battens in this country. In addition to these, however, there are also six back battens 38ft. in length. The leads for the battens are taken up from the switchboard to the flies in steel barrel and there enter distribution boards encased in iron and provided with heavy iron lids which are hinged at the top and, therefore, close by gravity. Opposite poles are on separate panels, Mordey fuses are used, and the holes in the sides of the cases, through which the conductors pass, are bushed with insulating material. The 'bus bars are divided for the three different coloured lamps and there is a separate pair of leads for each circuit, no common return being employed. The conductors, which must necessarily be flexible to allow of the battens being raised and lowered, are enclosed by a canvas fire hose. The stage plugs, which are of a very substantial pattern were supplied by Messrs. Moy.

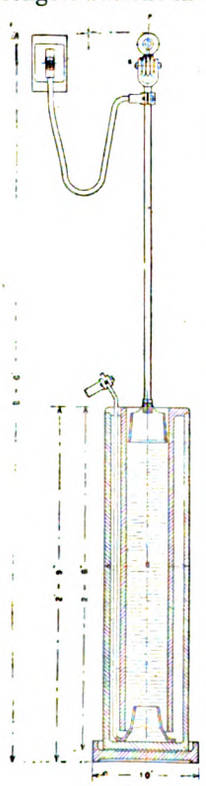

FIG. 8.
SECTION OF "DIMMER."

There are, altogether, about 5,000 lamps on the stage, exclusive of stage arcs, &c. One "effect" is obtained in a very ingenious manner and is due to the theatre engineer, Mr. Chas. V. Bretherton. In the kitchen scene it is desired to represent a very large roaring fire over which certain vessels are suspended. Of course, real flames would be quite out of the question, and to obtain the desired effect two rectangular wooden frames have been constructed, over which wire netting is stretched. Under the netting are fixed 16in. ¼ H.P. electric fans, so arranged as to cause a very strong updraught, and tied to the netting itself are strips of very thin red silk gauze. Some red lamps between the fans and the netting, produce the requisite colour. When the fans are rotated the gauze is blown out vertically, and at a distance of only a few feet it is exceedingly difficult to convince oneself that they are not real flames; added to this is the "whirr" caused by the fans, and the whole result is most realistic. There are many other devices operated electrically, but it would not be fair to divulge anything further.

In the "prompt corner" is a set of small red and green lamps in series with which are similar lamps in various parts of the building; by means of these, visual signals may be conveyed to indicate to operators the precise moment at which certain things should be done. Thus noise is eliminated, and owing to the lamps being in series, the excuse for non-execution of an order, that the signal was not received cannot be advanced.

In *The Electrician*, Vol. XLII., p. 325, there appeared a very complete description of the highly ingenious arrangements whereby practically the whole of the stage may be raised or lowered at will. At Drury Lane there are four "bridges" or lifts, two worked by hydraulic and two by electric power. The former possess a certain advantage over the latter in that they can be moved or fixed at any angle, whereas the electric lifts can only be operated horizontally. Mr. Edwin O. Sachs

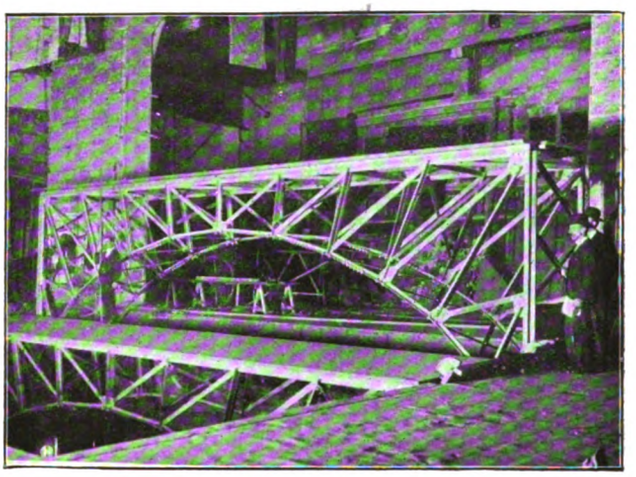

FIG. 9.—ONE OF THE BRIDGES.

was the consulting engineer for this part of the work, which was executed some years ago. Fig. 10 shows the electrical hoisting gear, by means of which the two huge bridges are safely and noiselessly raised or lowered so as to facilitate the setting of scenes without having recourse to the old-fashioned method of building up the stage by means of wooden platforms. The dead weight of the bridges is taken by counterweights, and provision is made for operating by hand in case the current should fail. Each section (Fig. 9) measures 40ft. by 8ft., and the total weight is about 6½ tons, of which 4½ tons is counterweighted. The length of travel is from the mezzanine floor, situated 8ft. 6in. below the stage, to 10ft. 6in. above the stage. The legs of the girders are of considerable length, and slide in angle irons attached to steel stanchions. The mechanism which elevates the bridges is situated entirely below them (see Fig. 11), and each bridge has a set of motors and gear to work it. Energy is supplied to four-pole enclosed shunt-wound motors, each of which develops 7½ H.P. at 520 revs. per min. These machines were made by the Thames Ironworks Co. Speed is reduced in the ratio of 104 to 1 through large worm gearing, the worm wheel being geared to a shaft which carries two winding drums making 5 revs. per min. Upon these drums are wound steel wire ropes, which pass over guide pulleys and are connected at four places to the legs of the bridges—one near each corner. The normal speed of lifting is 16ft. per min., which may, however, be reduced to 6ft. per min. New starters of the "Perfecta" type have recently been fitted, and there is also a magnetic brake.

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The re-wiring of the theatre was commenced some considerable time ago, and it was not until a great part of the work had been completed that the London County Council suggested that alterations should be made. As a matter of fact, the London County Council have no legal authority to compel the proprietors of Drury Lane Theatre to comply with their regulations, as the theatre is worked under a Royal patent; but the directors have, in their own interests and in the interests of the public, taken every precaution to make the theatre as immune from fire risk as possible, and they have, in so doing, complied with the Council's regulations to the letter.

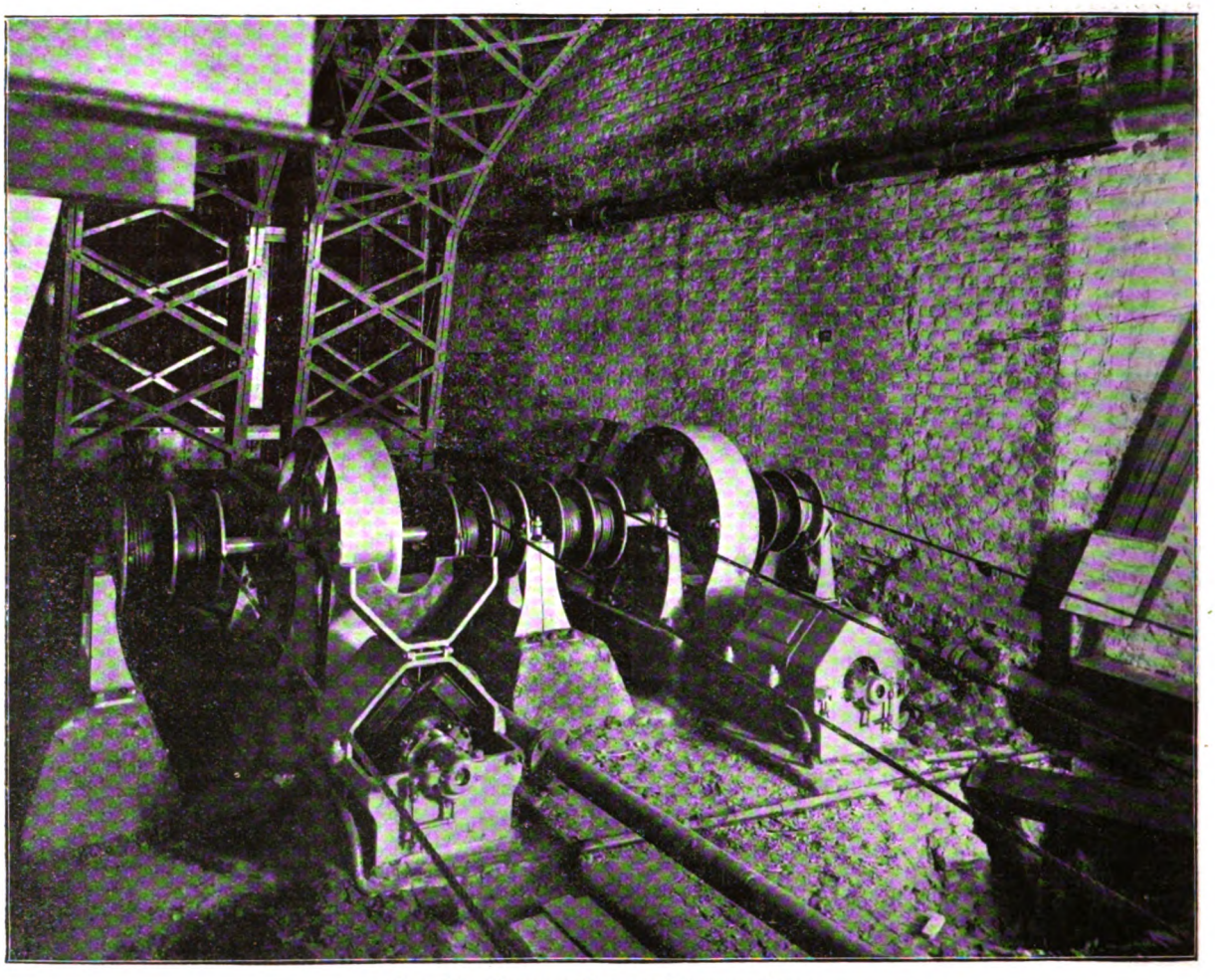

Fig. 10.—General View of Hoisting Gear.

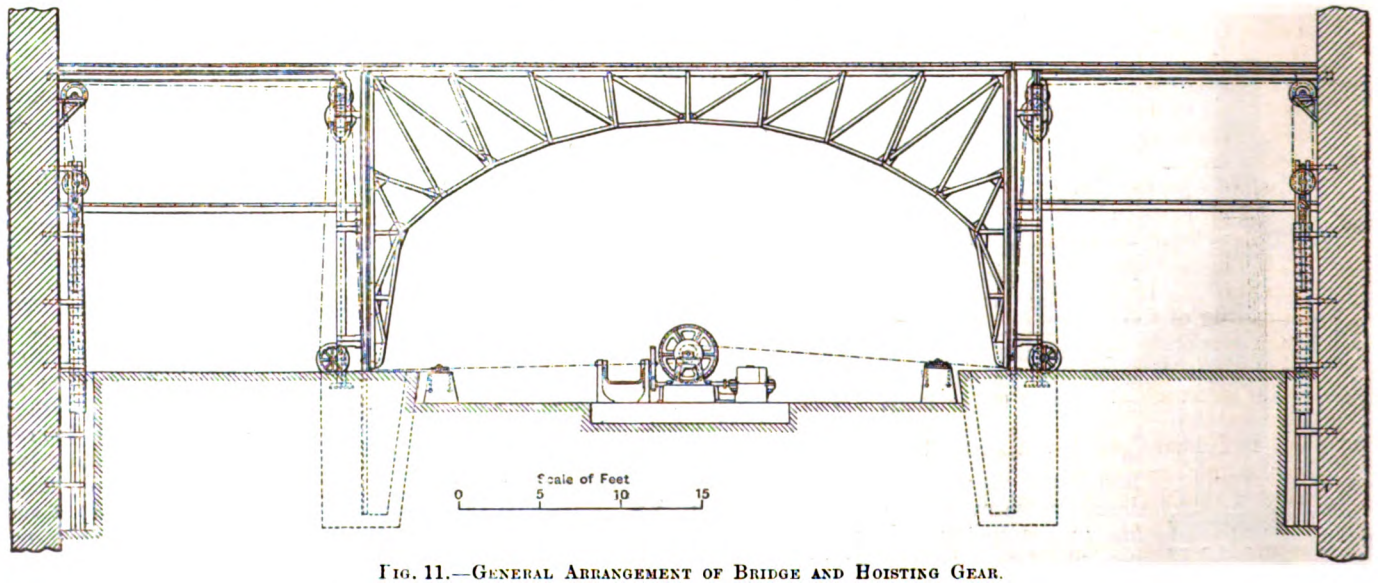

Fig. 11.—General Arrangement of Bridge and Hoisting Gear.

We are indebted to Mr. Adrian Collins, consulting engineer to the Drury Lane Theatre, for his courtesy in showing us over the theatre, and also to Mr. Chas. V. Bretherton, under whom the entire work has been carried out by the permanent staff, and from whom we obtained much of the detailed information contained in this article.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from page 615.)

The Energy of Radio-active Change.—Rutherford and McClung (*Trans.* Roy. Soc., 1901, 196, p. 55) deduced from a determination of the energy required to produce an ion in air, and from the number of ions produced by uranium, that 1 gramme of uranium oxide must radiate every year energy equivalent to 0 03 calorie as a minimum estimate. This amount would raise a weight of water equal to that of the uranium compound 1°C. in 30 years. The determination by Rutherford of the mass and velocity of the particle constituting the α-ray of radium (compare p. 297) enabled him to calculate the kinetic energy of the individual α particle. This is $\frac{1}{2}mv^2$, where m is the mass and v the velocity of the particle. J. J. Thomson has shown (compare p. 132) that in 1 cubic cm. of hydrogen gas there are $3{\cdot}9\times10^{19}$ molecules $=7{\cdot}8\times10^{19}$ atoms. One gramme of hydrogen, therefore, contains $11{,}200\times7{\cdot}8\times10^{19}=8\,7\times10^{23}$ atoms, and the mass of the hydrogen atom is $1{\cdot}15\times10^{-24}$ gramme. The mass of the α-ray particle is 1·6 times that of the hydrogen atom $=1{\cdot}91\times0^{-24}$ gramme, $v=2{\cdot}5\times10^{9}$ cm. per sec. and $\frac{1}{2}mv^2=6\times10^{-6}$ erg. The energy of the α-ray particle is thus between one-hundred-thousandth and one-millionth of an erg.

The energy emitted by radium compounds has recently been experimentally determined by Curie and Laborde (*Comptes Rendus*, 1903, 136, p. 673). Two methods were employed. In one a known quantity of the radium compound was placed in a Bunsen ice calorimeter, and the heat evolved in a definite time measured by determining the quantity of ice melted in the usual way. In the second the radium was placed in a metal block and temperature of the block above that of the surrounding air-bath determined. The radium was then replaced by a coil of wire that could be electrically heated, and the current measured which it was necessary to pass through the coil to maintain it at the same temperature above the surroundings as was maintained by the radium. The quantity of heat supplied in unit time could be determined from the electrical measurements, and this was equal to that supplied by the radium. Curie and Laborde give as the result of their measurements that 1 gramme of radium evolves about 100 gramme-calorics of heat per hour, or sufficient to raise its own weight of water from the freezing to the boiling point every hour. In about 40 hours sufficient energy is evolved to decompose its own weight of water completely into its constituents, hydrogen and oxygen. Now in this reaction, the change of hydrogen and oxygen into water or vice versa, more energy is involved, weight for weight of matter employed, than in any other chemical reaction known. Hence, in two days the radio-active change of radium evolves more energy than is ever evolved by the same quantity of matter in ordinary chemical change. The change of radium, however, in two days is quite inappreciable by ordinary measurement. Now, on the disintegration theory, it is to be expected that the heat-emission from a radio-active substance will be proportional to the α radiation from it. For the latter is a measure of the amount disintegrating. This conclusion has been directly proved by Rutherford and Barnes (*Nature*, October 29, 1903). They measured the heat effect from a quantity of solid radium bromide which had been kept for some weeks in the solid state. They then removed the emanation by heating it and condensed the emanation by liquid air in a glass tube, which was then sealed. They found that the heat evolution from the radium was much reduced by this treatment, and decreased further for the first few hours, as the imparted activity in the radium compound decayed until a minimum of about 30 per cent. of the original was attained. From this point the evolution of heat commenced to slowly increase. The emanation sealed up in the glass tube gave, on the other hand, a large heat evolution, so that the sum total of the heat given out by the radium and the emanation together was at any time equal to that given out from the radium originally. In a few hours after separation, the heat effect of the emanation, and of the activity imparted by it to the walls of the tube, equalled 70 per cent. of that originally given by the radium. The heat effect from this point slowly decreased at the same rate as the activity of the emanation decayed. About 6 per cent. of the emanation was not removed from the radium by the heating. Therefore, the heat effect is at all times proportional to the α-radiation, and follows the same changes as the latter when the emanation is removed. The extreme importance of this result in another direction must not be overlooked. The actual quantity of emanation obtainable from radium is almost infinitesimally small, being for any available quantity of radium compound a practically invisible bubble of gas. Yet 70 per cent. of the large heat evolution is not due to the radium but to the presence of this gas. This is an unanswerable argument in favour of the view that the energy emitted by radium comes from the internal energy of the atom when it disintegrates, and is not derived from a hypothetical external source, which radium alone has power to respond to.

The argument may be pushed one stage further. It is probable that by far the greater part of the energy liberated in disintegration appears as the kinetic energy of the α particle expelled. For if one atom of radium disintegrates into one α particle and one atom of emanation, by a well-known mechanical principle, after disintegration the momentum of the α ray particle will be equal and opposite to that of the emanation particle. The velocities will, therefore, be inversely proportional to the masses. From evidence of the rate of diffusion of the emanation, to be considered later, it is probable that the atom of emanation is at least 50 times heavier than that of the α particle, and the velocity of the latter will therefore be 50 times greater. The kinetic energy is, however, proportional to the square of the velocity, so that the kinetic energy of the α particle must be at least 50 times greaterthan that of the rest of the atom. If more than one α particle is produced by the disintegration, the probable result would be that an even less proportion of the energy is received by the heavier particle, for the expulsion of two α particles in opposite directions would neutralise each other's effect, leaving the heavy nucleus at rest. Hence, on the disintegration theory, all but a few per cent. of the heat effect must be due to the bombardment of the matter of the radium and the walls of the containing vessel by the α particles expelled.

Hence, if we divide the energy emitted by radium in unit time by the energy of the individual α particle we obtain as a result the number of α particles expelled by a given mass of radium in unit time.

100 gramme-calorics $=4{\cdot}2\times10^{9}$ ergs.

Kinetic energy of the α particle $=6\times10^{-6}$ erg.

$\therefore$ Number of α particles expelled by the gramme of radium in one hour $=7\times10^{14}$.

Number expelled per second $=2\times10^{11}$.

In uranium and thorium the number is probably of the order of 10^{-6} of this, or 2×10^{5}. To find the number of atoms breaking up per second in these elements it is necessary to know how many α particles are expelled from each atom. Now in the case of radium and thorium there are known to be at least five stages in the disintegration, each of which occurs with the expulsion of at least one α particle. Hence five is the minimum possible number of α particles produced from each atom in these cases. On the other hand, if the original atom is entirely resolved in α particles by the disintegration, not more than 150 could be produced, assuming that the mass of the products is equal to the mass of the original atom. Hence within these limits we may find the number of atoms disintegrating per second. In radium there are 2×10^{11} α particles expelled per gramme per second, which must be divided by 5 and by 150 to obtain the maximum and minimum number respectively.

Maximum number $=4\times10^{10}$ per gramme per second.

Minimum number $=1{\cdot}33\times10^{9}$ per gramme per second.

Internal Energy of the Radium Atom.—In 1 gramme of radium there are 225 times less atoms than in 1 gramme

* These articles are based on a series of 12 lectures which Mr. Soddy has delivered at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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of hydrogen, or $3{\cdot}9 \times 10^{21}$. We can divide this number by the number disintegrating per second, and the quotient multiplied by the number of calories produced by radium per gramme per second will give the total energy evolved during the complete disintegration of a gramme of radium. The result is $2{\cdot}8 \times 10^{9}$ for the minimum and $8{\cdot}4 \times 10^{10}$ for the maximum value. The energy produced in the formation of 1 gramme of water from its elements is approximately 4×10^{3}. We thus see that in the atomic disintegration of radium about a million times as much energy on the minimum estimate is produced as is produced in any known chemical change. The question naturally arises whether this energy is only possessed by radium, or is not common to heavy elements in general. The normal character of radium as a chemical element and its close resemblance to the other elements of the same family which are not radio-active—viz., barium, strontium, &c.—points to the conclusion that the internal atomic energy of the inactive heavy elements is probably of the same order of magnitude as in radium, but the absence of change in these cases prevents our obtaining any information concerning it. In the case of uranium and thorium, the internal energy must be regarded as of a similar order of magnitude to that of radium, and their relatively feeble radio-activity is to be ascribed solely to their slow rate of disintegration. These considerations force us to the conclusion that there is associated with the internal structure of the atom an enormous store of energy which, in the majority of cases, remains latent and unknowable. For the heaviest elements the property of spontaneous atomic disintegration reveals its existence and enables its amount to be calculated.

The Probable Life of the Radio-elements.—If the number of atoms in a gramme of radium is divided into the number of atoms disintegrating per second, the quotient is the proportionate amount breaking up per second—that is, the radio-active constant λ. This is, therefore, between 10^{-11} and 3×10^{-18} for the case of the element radium. For thorium the value of λ may be taken as being 10^{-6} of this—viz, between 10^{-17} and 3×10^{-18}. For uranium, owing to the existence of only one stage in the disintegration giving α-rays being known, the limits are somewhat wider—viz., between 5×10^{-17} and 3×10^{-18}. This result gives us, between certain fixed limits, the lives of the three "permanent" radio-elements, which are too long to be directly determined experimentally. We see that in a year not more than one thousand-millionth part of thorium can undergo change, so that it would require, as a minimum estimate, seven hundred million years for one-half of the total amount originally present to undergo change. In the case of radium, between one three-thousandth and one hundred-thousandth changes per year, so that it would require between two thousand and seventy thousand years for the quantity to be reduced by one-half.

In the following table the radio-active constants of the most important types of radio-active matter have been arranged in order :—

		λ
Thorium emanation		$1{\cdot}16 \times 10^{-2}$
Thorium X Radium emanation		2×10^{-6}
Uranium X		4×10^{-7}
		Calculated values.
Radium	between	10^{-11}
	and	3×10^{-13}
Uranium	between	5×10^{-17}
	and	3×10^{-18}
Thorium	between	10^{-17}
	and	3×10^{-18}

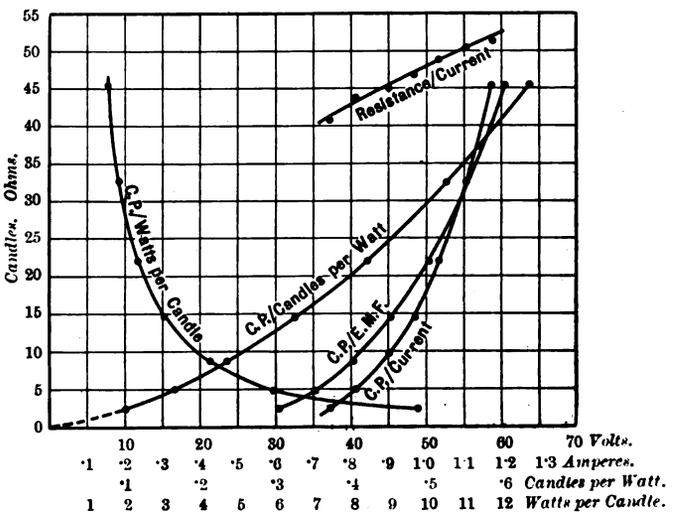
This way of regarding the subject brings into prominence a question of great importance. The energy of radio-active change is enormous, judged by that of any other change we know of, but it is not inexhaustible. When we consider an element like radium, which is exhausting its store at the rate of 100 gramme-calories per hour, it is certain that it cannot last for any very lengthy period of time. The considerations just deduced show that it cannot have been in existence for more than a few hundred thousand years at most, if it has been radiating its energy at a constant rate continuously. But we must assume that the minerals of the earth's crust have been in existence as such far longer than this, so that it appears certain that the radium we find in pitchblende either has not been in existence so long as the mineral containing it, or else it has not been disintegrating in the past so fast as at present. It might be thought that the latter offers the more probable solution of the difficulty, but a broad review of the facts as at present known, certainly favours the first alternative as the more philosophical explanation. The disintegration theory requires that we should regard all radio-activity as being due to the steady break-up of a specific elementary form of matter. Whether the radio-activity is "permanent" or "temporary" is a question merely of degree. There is no more difficulty in regarding radium itself as the disintegration product of a heavier element in pitchblende, than there is in regarding the emanation as a disintegration product of radium. Until this has been experimentally disproved it is the easiest way of regarding the question. But the difficulty is in the end the fundamental one, connected with all theories of cosmical evolution. If a steady change is going on in one direction, either a complementary change in the opposite direction must be proceeding simultaneously, or the age of the universe must be limited with reference to the past. The point is that if the existence of radium at the present stage of the earth's history can be accounted for in the manner suggested, the cases of uranium and thorium are less pressing. The limit of age can be put so far back as to be in agreement with the requirements of other sciences, and the additional assumption that there is a process of upbuilding of the heavy elements from the lighter ones going on in the universe is not absolutely necessary in the present state of knowledge. A further discussion here would be unprofitable, as the question, so far as radium is concerned, is certain to be experimentally settled in the near future.

(To be continued.)

THE EFFICIENCY AND COLOUR OF OSMIUM LAMPS.

BY PROF. F. G. BAILY, M.A.

The new osmium lamps, invented by Herr Auer von Welsbach, show such a high efficiency that, though their low resistance renders them inconvenient for use as single lights,



it may be found desirable to substitute them for carbon lamps when groups are required. At present they are made only for E.M.F.s up to 55 volts, and at that pressure the smallest size of lamp is 32 British standard candles. The writer has recently examined several of these lamps, and the results are given below, as they may be of interest.

The examples were all 32 c.p. 55-volt lamps, made by the Gasglühlicht und Elektricitäts-Gesellschaft of Vienna. They are fitted with the Edison screw cap, and have much the same size and shape as a 32 c.p. carbon lamp. There are three loops of wire, each anchored at the end, the total length of wire

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being 40cm. with a diameter of 0·1mm. The specific resistance at the normal temperature of use—a bright yellow heat—is 10^5 C.G.S. The wire is very hard, and as brittle as glass, with a dull greyish-white surface.

Five lamps in all were tested, and as the variation between the five in candle-power and efficiency was very slight, it will be sufficient to give the mean values obtained. The lamps were tested for candle-power against a standard Edison and Swan 16 c.p. lamp by a Lummer-Brodhun photometer in the ordinary way. The results were as follows, candle-power being taken to mean candle-power in a plane perpendicular to the axis of the lamp :—

E.M.F.	Current.	Candle power.	Watts per candle.	Candles per watt.	Resistance in ohms.
30·3	0·744	2·3	9·8	0·102	40·7
35·4	0·812	4·81	6·0	0·167	43·7
40·4	0·90	8·76	4·26	0·235	45·0
45·5	0·97	14·5	3·04	0·330	46·8
50·5	1·032	22·0	2·37	0·422	48·8
55·6	1·106	32·6	1·89	0·529	50·2
60·6	1·178	45·4	1·57	0·637	51·4

These results are embodied in the diagram. It will be noted that in general the curves resemble those of the carbon filament lamp, but the agreement is not exact. The resistance increases with the temperature, while that of carbon between a red heat and a yellow heat slightly diminishes. Therefore, the watts absorbed, as the E.M.F. is raised, increase more rapidly for the osmium than for the carbon lamp. Nevertheless, the increase of candle-power is more rapid in the carbon than in the osmium lamp. Thus it varies as the sixth power approximately in the former, while the curve shown above is of the form c.p. $= 3{\cdot}5 \times 10^{-6} E^6$. The relation of efficiency (candles per watt) to candle-power for the osmium lamp is $e = 0{\cdot}065 P^{0{\cdot}62}$, as against $0{\cdot}028 P^{0{\cdot}7}$ for a carbon lamp. Thus the improvement of efficiency is more rapid in the carbon lamp than in the osmium, a result which is corroborated by further tests given below.

The important point about the lamps is their efficiency, which at the normal pressure of 55 volts is 1·9 watts per candle. There has not yet been time to take tests of life, but a report by Dr. Wedding, of the Berlin Technical School, in June, 1903, deals fully with this matter. Eighteen lamps were tested, and gave an average of over 1,900 hours, while some ran for upwards of 4,000 hours. The average thickness of wire in his tests was apparently slightly greater than that in mine, but the efficiency he obtained was 1·7 watts per British candle, so the conditions of the test were not relaxed in favour of a long life. The average candle-power at the end of the life was about 80 per cent. of the initial value, and the efficiency averaged 2·1 watts per candle. This life and maintenance of efficiency would scarcely be attained by a carbon lamp starting at 4 watts per candle, so the osmium lamp may be considered to have at least twice the efficiency of the carbon lamp under equivalent conditions.

An attempt was made to determine the colour of the light. On comparing the spectra of the two no appreciable difference could be detected by the eye. A carbon lamp was then adjusted until the light given by it was of the same colour as that of the osmium lamp, the photometer being used for the comparison. The candle-power and efficiency of the carbon lamp were then determined. The lamp used was a 32 c p. 105-volt high-efficiency lamp.

E.M.F. on osmium lamp.	Watts per candle, osmium lamp.	Watts per candle, carbon lamp.	Ratio.
55	1·9	2·1	1·1
50	2·4	2·65	1·1
45	3·2	3·9	1·2

A second lamp of a different make gave 2·0 watts per candle when giving the same colour as the osmium lamp at 55 volts.

The values for the carbon lamp are not very precise, as a change of about 5 per cent. in the E.M.F. was required, in order to reverse the relative colours of the two lamps. The point of equality of colour was taken to be midway between these values. However, repetition of readings gave fairly concordant results. It is clear that the cause of the high efficiency of the osmium lamp lies mainly in the higher temperature which the metal will stand, but it seems to be a slightly more efficient light radiator than the carbon, especially at the lower temperature, though the ratio is probably reversed at higher temperatures. This result also follows from the first set of experiments, where it was found that the efficiency of the carbon lamp increased more rapidly than that of the osmium lamp, as the E.M.F. and candle-power were raised.

The colour may be defined as similar to that of a carbon lamp running at 2·1 watts per candle. The lamps should form excellent secondary standards of light, because of the whiteness of the light, the small deterioration of the candle-power, and, lastly, because of the smaller variation of candle-power with change of E.M.F., rendering error of adjustment of E.M.F. less serious than in the case of the carbon standard lamp. On this account they should be adjusted to a definite E.M.F., not to a definite current.

ON THE MAGNETIC DISPERSION IN INDUCTION MOTORS, AND ITS INFLUENCE ON THE DESIGN OF THESE MACHINES.*

BY DR. HANS BEHN-ESCHENBURG.

(Continued from page 527).

In the same way we have to consider the combination of a limited number of phases in the stator and rotor windings. There are slight fluctuations, on the one hand of the self-induction of the combined stator windings and of the combined rotor windings, and on the other hand of the mutual-induction between the stator and rotor windings, fluctuations which depend on the different positions of the rotor and on the variations from instant to instant of the primary current. In a motor with three-phase stator windings and three-phase rotor windings we must distinguish two particular positions of the rotor and two particular moments in the periodical changes of the current. In the first position, the three phases of the rotor winding correspond exactly to the three stator phases; in the second position the rotor phases are displaced one-sixth of the pole switch. Further, the first moment in the changes of the current is taken when the current of one phase is at its maximum, the second moment when it is at its zero value. If we compare the mean value of the self-induction of the three stator phases, in these four cases, with the mean value of the mutual-induction between the three stator phases and the three rotor phases, we observe a small difference, which diminishes rapidly with an increase in the number of slots; for example, for six slots per pole this difference may amount to 1·2 per cent., for 12 slots to 0·4 per cent. We have here further to consider the influence of the wave-form of the primary currents on these effects, which we put together under the designation of "winding-coefficient."

However complicated the relation between the winding-coefficient and the primary and secondary numbers of the slots in the parts may be, yet it must always be smaller the larger the number of the slots, of the primary on the one hand or of the secondary on the other. Let us denote by N the mean value between the primary and secondary numbers of slots per pole-pitch, then broadly, as we are here dealing with the subject, this coefficient, which we will denote by σ_1, may be set out by the expression

$$\sigma_1 = 1{\cdot}3 \frac{K_1}{N^2}; \quad \ldots\ldots\ldots \quad (4)$$

where K_1 has the meaning of a function of N to be determined experimentally from case to case, but which generally differs but slightly from the constant value of unity, and, in general, also expresses all those influences which may arise from the various distributions of the winding in different parts of the phase, and from the winding pitches. In the coefficient K_1 are also contained the effects of the form of slots or teeth upon these phenomena, and on the influence of the inequalities of magnetic reluctance in different positions.

In the cases hitherto considered, we have, indeed, discriminated between primary and secondary systems, but it is immediately evident that, in the motor, each of the two winding systems, stator or rotor, has for the carrying out of this calculation to be regarded as at one time acting as primary, and at one time as secondary.

The value of σ_1 according to formula (4) may now at once be inserted in formula (3), since, as above explained, we may put the maximum value of the induction as proportional to the coefficient

* The researches described in this communication were imparted in April, 1903, to Prof. Silvanus P. Thompson, on whose suggestion they were communicated in their present form to the Institution of Electrical Engineers in the summer, and have since been translated into English. The Paper was read in abstract by Prof. Thompson at the meeting of the Institution on January 15, 1904.

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of self-induction L, and the mean value as proportional to the coefficient of mutual-induction M. Therefore we have

$$\frac{L-M}{L}=\sigma_1+\Delta;$$

where Δ denotes a residual term which arises from other relations than those described under the name of winding-coefficients. We now discover as a further cause for the difference L – M, the occurrence of the so-called magnetic stray fields or magnetic dispersion, as will be described in the following sections.

§ 2. Peripheral Dispersion (*Mantelstreuung*).

In every motor there come into operation several considerable magnetic dispersions or leakages, which we will separate into two stray fluxes. One of these, the so-called peripheral dispersion, runs along the face of the bore of the stator, and along the face of the cylindrical periphery of the rotor, since between the tops of the iron teeth of each single system, over the openings of the slots, there occurs a leakage of magnetic lines. These stray fluxes along the peripheral surface will bear to the mean total flux F the same proportion as the magnetic reluctance of the path followed by the flux F bears to the magnetic reluctance which is interposed in the path of the stray magnetic flux between the tops of the teeth. The magnetic reluctances between the tops of two neighbouring teeth or the magnetic reluctance of the opening of a slot may, for open slots, be assumed to be about proportional to the width X of opening of the slot; further, it is, of course, inversely proportional to the tooth-length in the axial direction, or to the iron-length b of the core, and inversely proportional to the thickness of the layer in which the passage occurs. This thickness may be set down tentatively for the usual forms of slots as 0·1cm. In order to take into account the influence of the special forms of slots in particular cases, we will further introduce a coefficient, K_2, which will require to be experimentally determined. Then we may set

$$\rho=\frac{X}{0{\cdot}1\times b\times K_2}.$$

For closed slots, in place of the air-slit in the peripheral surface there is a very thin bridge of iron. The thickness of this iron bridge will amount to about 0·1mm. at the thinnest place. These iron bridges ought, under normal running, to become completely saturated by the stray flux, so that for their resistance we may reckon them tentatively to have a permeability as low as $\mu=100$. If now the length of the iron bridge at its thinnest place amounts to, say, Xcm., then the magnetic resistance for the closed slot may be set at

$$\rho'=\frac{X}{b\,.\,K_2}.$$

The stray flux along the peripheral surface of the iron cylinder forms a magnetic circuit surrounding the primary coils which will be distributed in the slots over a third of the pole-pitch. The chief resistance in this circuit is constituted by the paths of passage at the openings of all those slots which at the peripheral surface include one primary coil. If, as before, N denotes the number of slots in one pole-pitch, then one primary coil is included or bridged over by $\frac{N}{3}$ slot openings. The resistance of the magnetic circuit of the stray flux f is, therefore, about equal to $\frac{N}{3}\times\rho$. The resistance in the path of the main flux F which passes out of the primary system into the secondary is approximately

$$R=\frac{3\delta}{2\tau\times b};$$

where δ is the air-gap length from iron to iron, b the axial length of the iron core, τ the length* of the pole-pitch at the face.

We may denote by the coefficient σ_2 the quotient of the stray flux by the main flux F, and obtain approximately

$$\sigma_2=\frac{f}{F}=\frac{R}{\frac{N}{3}\times\rho}=\frac{K_2\delta}{2N\times\tau\times X},\text{ for open slots;}\quad\ldots\quad(5)$$

and

$$\sigma'_2=\frac{5K_2\delta}{N\times\tau\times X},\text{ for closed slots.}\quad\ldots\quad(5A)$$

§ 3. Flank Dispersion (*Stirnstreuung*).

A second kind of magnetic dispersion which also occurs in every motor consists of the magnetic flux which exists outside the iron core. Those parts of the winding which constitute the end connections between conductors in the slots, and which project as curved winding-bunches or bends at the flanks of the stator and rotor cylinders, give rise to a magnetic flux outside the iron core bodies. This flux surrounds these curved connections in such a manner generally that only a small fraction of the flux created by the bends of the one system intersects the bends of the other system. These bends, or end connections at the flanks of the motor, are, in the motors of ordinary construction, more or less closely or completely surrounded by the solid iron parts which form the housing, the casing and the clamping plates for the laminated core bodies. Yet it is possible so to choose the distance between the winding and these iron structures that only a small part of the stray flux created by these parts of the coils (and which we shall call flank-dispersion) passes into iron.

In the main this stray flux is equal to the magnetic flux which would be created by an independent group of coils of a form similar to the two projecting bends at the two flanks if put together as a coil. What is necessary is, therefore, to determine the self-induction coefficients of similarly-constructed coils, and the coefficients of mutual-induction between such coils if placed in such positions relatively to one another as would about correspond to the respective positions of the projecting bends in the stator and the rotor.

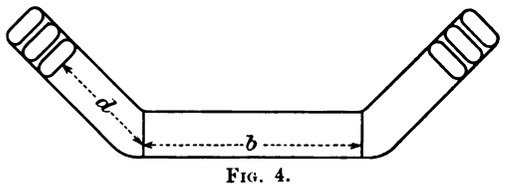

Fig. 4.

There was undertaken a series of self-explanatory measurements on variously-shaped coils of this sort, away from any iron cores, in order to obtain practically for the various forms reasonable estimates of the influence of the lengths of the windings, the distribution of the windings in separate coils and the mutual-induction between the coils. In this investigation one is chiefly concerned with two shapes of coil, viz.:—

(i.) With coils the end bends of which are straight out, or in approximately the same (cylindrical) surface as that in which lie those portions of the coils that are placed in the slots;

(ii.) With coils the end bends of which are bent up or down out of this surface.

Fig. 4 depicts a group of three straight-out coils nested against one another; Fig. 5 a group of three coils having the bent ends turned up. The details of the research of the different forms of coil may here be passed over. The results can be assembled in the following practical rules

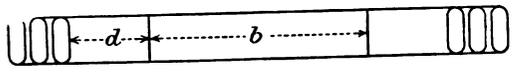

Fig. 5.

The coefficient of self-induction of a single coil which consists of W turns having a mean length of one turn l, is, approximately, for all forms existing in practice

$$\lambda_1=6W^2\times l.$$

The coefficient of self-induction of a group of coils, which are laid within one another at small distances apart as are the coils in motors, having a total number of turns W and a mean length of turn l, amounts approximately to

$$\lambda_2=c\times 6W^2\times l;$$

where c varies between 0·7 and 0·55 for groups of two to five coils, or on the average $\lambda_2=3{\cdot}6W^2\times l$.

If into the neighbourhood of the coils iron bodies are brought which may represent the nearest iron parts in the neighbourhood of the bent ends at the flanks of the motor, then the coefficient of self-induction will be increased about 20 per cent. The mutual induction between the end bends of the stator and rotor may diminish the value of the self-induction by 20 to 50 per cent. according to the arrangement of the bends.

The coefficient of mutual-induction of straight-out coils, which are held at the usual distance from one another, amounts to about 50 per cent. of the coefficient of self-induction; the coefficient of mutual-induction between a straight-out and a bent-up coil, or between two coils bent up in opposite directions, amounts to about 20 per cent. of the coefficient of self-induction.

As a mean value for the coefficient of self-induction of the end bends, which cause the flank dispersion, after taking account of the influence of the iron masses and of the mutual induction, we may write

$$\lambda=K_3\times 3{\cdot}5\times W^2\times l;$$

where the coefficient K_3 relates to the influence of the winding arrangements and of the iron structures, so far as these depart in special cases from a mean value. For l, the mean length of one winding of the end bends lying outside the slot, we deduce from the dimensions of the motor an approximately generally valid relation which may again in special cases require to be reduced to a mean value by the insertion of a coefficient.

The length of the bend of one coil comprised at the two flanks is equal to double the length of the pole-pitch τ, increased by adding four times the distance which the end bends project beyond the core

* For motors in which the peripheral surface is interrupted by openings of slots, the length τ must be reduced by about the total width of all the openings of slots within one pole-pitch, corresponding to the increase of no-load current produced by these openings.

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body But the length of this projection is itself approximately proportional to the pole-pitch, since the coils must stand out so much the further the more the intervening coils over which the end winding has to span. So we put

$$l = 3\tau \times K_4,$$

and so get approximately

$$\lambda = K_5 \times 10 \times W^2 \times \tau; \quad \ldots\ldots\ldots (6)$$

in which the constants K_3 and K_4 are comprised in the constant K_5.

In order to ascertain how much this species of self-induction contributes to the dispersion-coefficient σ, this coefficient of self-induction λ must be divided by the coefficient of self-induction, L, of the whole winding.

Now, according to the known formulæ, we have approximately

$$L = \frac{4\pi \times W^2 \times b \times \frac{2}{3}\tau}{2\delta} = \frac{4W^2 \times b \times \tau}{\delta},$$

and the flank-dispersion, therefore, has a dispersion-coefficient σ_3 defined* by

$$\sigma_3 = \frac{\lambda}{L} = \frac{2{\cdot}5 \times K_5 \times \delta}{b} \quad \ldots\ldots\ldots (7)$$

Since K_5 signifies, just as K_3 did, a constant needing to be determined experimentally, we shall in that which follows write simply K_3 in place of K_5.

To the losses of magnetic flux indicated under the preceding sections, § 1, § 2 and § 3, there may in special cases be adjoined other losses not here specifically considered. For the following experimental investigation we confine ourselves to these three sources of loss, and collect together for the estimation of σ the results now obtained.

By formula (3)

$$\sigma = 2\frac{L - M}{L}.$$

By formula (4)

$$\frac{L - M}{L} = \frac{1{\cdot}3 \times K_1}{N^2} + \Delta.$$

Now Δ consists, on the one hand, of the cofficient σ_2 indicated in formula (5)

$$\sigma_2 = \frac{K_2 \times \delta}{2 \times X \times N \times \tau};$$

and, on the other hand, of the coefficient σ_3 of formula (7)

$$\sigma_3 = \frac{2{\cdot}5 \times K_3 \times \delta}{b}.$$

Therefore we obtain

$$\sigma = K_1\frac{2{\cdot}6}{N^2} + K_2\frac{\delta}{X \times N \times \tau} + K_3\frac{5 \times \delta}{b}. \quad \ldots\ldots (8)$$

The individual constituents of σ we may for simplicity of exposition denote thus

$2\sigma_1 = K_1\frac{2{\cdot}6}{N^2}$ is the winding-coefficient (see equation 4);

$2\sigma_2 = K_2\frac{\delta}{X \times N \times \tau}$ is the peripheral dispersion;

$2\sigma_3 = K_3\frac{5 \times \delta}{b}$ is the flank dispersion;

and

$$\sigma = 2\sigma_1 + 2\sigma_2 + 2\sigma_3. \quad \ldots\ldots\ldots (9)$$

It is now easy to discern how these three coefficients may be separated in the experimental way. The coefficient σ_1 is dependent only on the number of slots of one phase of the pole-pitch; the coefficient σ_2 alone depends on τ and X; the coefficient σ_3 alone depends on b; while σ_1 alone is independent of δ.

We have, therefore, to compare the experimentally-found values of σ for different types of motors, in which one of these dimensions varies while the remaining dimensions are kept constant.

Now, the Oerlikon Machine Works has at its disposal a large number of motors in which this variation of single dimensions has been carried out systematically; as, for example, having slots alike but with different lengths of core-body, or having slots alike, and core-body length alike, but with different numbers of poles, and so forth. Moreover, the air-gap and the width of slot-openings were systematically altered in a number of similar individual motors. Further, researches were at hand upon different numbers and forms of slots; and it was, therefore, possible to make, from the collection of test-schedules, which in recent years had been recorded about three-phase motors, a selection such as would afford an insight into the values of the various coefficients, and a determination of the separate factors. It is, withal, to be remarked that the material in this investigation is not exclusively comprised of values ascertained by observation taken with the greatest accuracy, and the direct object of comparisons of this sort. It is rather concerned in general with values which, in accordance with the practice of a factory laboratory, are ascertained in the first instance for the purpose of a rapid and convenient estimation and control of the efficiency of the machine to be delivered. Any way, a suitable selection from the very large number of machine tests may, in respect of practical usefulness, and the availability of the mean values of existing materials, partially replace the scientific preference of systematic researches.

We employ for brevity the following symbols:—

P = number of poles.
N_1 = number of slots of the stator.
N_2 = number of slots of the rotor.
D = diameter of the bore, in centimetres.
δ = air-gap, in centimetres.
b = axial length of core-body, in centimetres.
τ = pole-pitch, in centimetres.
X = width of opening of the slots.

The values of σ inserted are the quotients of the no-load current J_o, and the short-circuit current J_k taken direct from the readings, without regard to the ohmic resistance of the windings and the no-load losses. For J_o those values only were considered as reliable which showed a regular proportion between current and voltage, so that J_o should be really dependent only on the magnetic resistance of the air-gap. Therefore, we have:—

$$\sigma = \frac{J_o}{E_o} \times \frac{E_k}{J_k};$$

where E_o denotes the voltage at which the no-load current J_0 was observed, and E_k the voltage at which the short-circuit current J_k was observed.*

The principle of this exposition of the dispersion-coefficient σ is so framed that (for the purpose of the research) σ can be resolved into a part σ_1 which is dependent only on the square of the number of slots and into a second part which is proportional to the air-gap. This second part is again resolved into a part σ_2, which is dependent on the magnetic resistance of the slot opening, and a part σ_3, which is dependent on the length of the core-body. The problem, then, is to investigate whether such a resolution of the total dispersion-coefficient into three separate functions can be confirmed by the observations, and whether therewith there can be attained an estimation of the total dispersion-coefficient sufficiently permissible and complete for the needs of practical design.

(To be continued.)

A NEW DEVICE FOR PRODUCING ELECTRICAL CURRENTS.†

A demonstration was recently given at Newark, U.S.A., of the "Dynelectron," an apparatus designed by Mr. James H. Reid and his son, Mr. Allen E. Reid, for the direct production of electrical energy from fuel. A gas retort was charged with culm mixed with street sweepings and oil and heated externally, steam being passed through the retort. The gas thus produced was mixed with air in the proportion of one volume of gas to 40 of air, and was then forced through two cells consisting of cast-iron shells containing a molten electrolyte and carbon rods. The two cells were connected in series, and upon open circuit gave 1·8 volts, and upon short-circuit through an ammeter from 50 to 60 amperes flowed. The electrolyte was kept hot by burning gas under the cells.

The construction of the cell will be understood from the following diagram, although the apparatus used in the demonstration differed in certain mechanical details from this. The containing vessel is of iron, with an insulated cover. From this cover are suspended the carbon electrodes C. These are hollow and porous, and their method of formation is such that the inventor believes they will not disintegrate. Certain of these electrodes, he says, have been used for about a month, day and night, and show no change whatever, either upon microscopic or chemical examination. Around these electrodes and projecting up from the containing vessel are perforated iron plates, G. The cell is filled with an electrolyte consisting of an oxide of calcium, sodium and iron, designated as E in the drawing. The vessel is heated by any means to a temperature of about 390° F., which maintains the electrolyte in a molten condition.

Through the hollow carbons is forced the mixture of combustible gas and air, prepared in any manner whatever. This percolates through the pores of the carbon out into the electrolyte, passes up through this and escapes through the pipes KJ. In its passage it causes the electrolyte to foam over into the chamber above the cell, and then runs back through the pipe P. The electrolyte is thus kept constantly in circulation, and it is said that it is not affected

* As remarked previously, it is necessary, in the case of motors with slots that are open at the peripheral surface, to reduce the value of τ in the formula for L by an amount about equal to the total width of all the slot openings within one pole-pitch, corresponding to the increase of no-load current consequent upon the presence of these openings. Or, in formula (7) one must increase the value of δ, the effective air-gap, in corresponding inverse proportion.

* As is known, σ may also be determined on the stationary motor with open secondary circuits, from the transformation ratios of the primary and secondary systems. But for small values of σ this method of determination is obviously very inexact and inconvenient, so that it is not employed in what follows.

† From the *Electrical Review* of New York.

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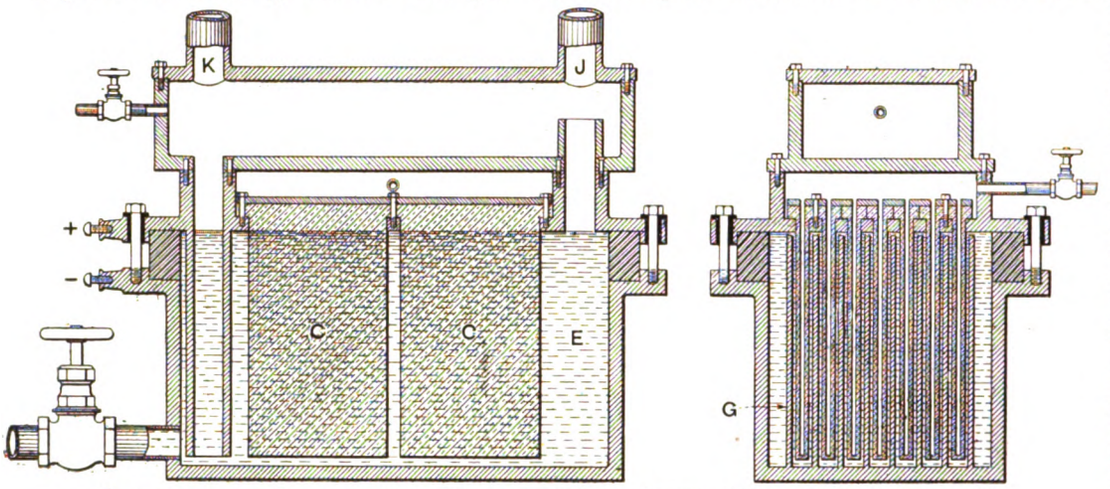
by the reactions in the cell; that which was used in the demonstration had been in constant use for experimental purposes for three years.

The demonstration was not intended to prove the efficiency of this process, but merely to show that considerable current could be drawn from these cells. Mr. Reid, however, says that the efficiency of this process is about 45 per cent. Any fuel can be used, and the flow of gas will be regulated automatically in the completed machines. Mr. Reid is now preparing to build machines for 100 H.P. These will be 8ft. by 8ft. by 10ft. high, and will generate about 10 volts. The cost of a generator of this kind, he says, will not be more than 25 per cent. of that of an equivalent steam plant. One of the experimental types which was constructed was rated at 60 H.P. It contained seven cells and gave 6·3 volts. From tests upon this apparatus Mr. Reid was convinced that he was obtaining as electrical energy 72 per cent. of the energy contained in the gas. This was of poor quality, running about 650 B.Th.U. to the cubic foot, and 5ft. were used per horse-power. This apparatus failed, however, because the carbon electrodes went to pieces quickly, and it required 18 months of hard work to produce an electrode which would not disintegrate.



SIDE-SECTION AND CROSS-SECTION OF NEW APPARATUS FOR PRODUCING ELECTRICAL CURRENTS.

In the completed design it is intended to return the gases given off from the cell under the cell, and use them for heating it and to assist in producing the gas. When a cell is once put into operation it can be worked continuously for an indefinite length of time, as there is not thought to be any corrosion of the iron vessel or disintegration of the carbon, and no change in the electrolyte.

ELECTRICITY IN MINES.

(*Concluded from page 609*).

Stationary Motor.

Though it is not necessary that motor attendants should be skilled mechanics or electricians, they should, at any rate, undergo sufficient instruction to render them competent to detect any irregularity in the working or condition of their machines. As regards the motors themselves, these should be placed in specially-constructed enclosures, accessible only to authorised persons, and ventilated where practicable with intake air. It is far more difficult to maintain a motor in a state of efficiency in a return airway on account of the conditions there prevailing. Where the presence of gas is to be feared, the motor should be enclosed in a flame-tight casing; such a casing, however, is likely to cause a large rise in the temperature of the motor winding, as it renders a free circulation of air difficult. For this reason it is advisable to so place the motor rooms that they can be thoroughly ventilated with a current of intake air, and thus obviate the necessity for the employment of the flame-tight covering. The same points, with respect to the screening of live parts, apply, if possible, in a greater degree below ground than above ground. In mines the motor rooms are generally cramped in size, the lighting is of necessity not so good, and water may often be present. As far as practicable, uninflammable material should be employed in the construction of motor rooms.

Portable Motors for Coal-cutters, Drills, &c.

At the commencement of the past year there were 483 coal-cutters in use, of which 149 were driven by electric power. It has been strongly impressed upon us that many of the thinner seams of coal can only be worked economically with the aid of these machines. The continuous advance as the coal is won does not permit of the same precautions as can be employed in the more permanent parts of the mine; and, moreover, if gas be given off anywhere, it is most likely to be found at the coal face itself. The dangers to be anticipated are four:—(1) Falls at the face. (2) Shock to workmen. (3) Setting fire to inflammable material. (4) Ignition of fire-damp.

Falls at the Face.—Falls may unfortunately be expected to occur whether coal-cutting machines are employed or not, but the noise caused by a machine when working renders it more difficult to hear the signs of movement in the strata. The machines should be stopped from time to time to enable the man in charge to make a careful examination of the state of the roof, and it is advisable that mine managers should specify in writing the intervals of time at which they considor these examinations should be made. Several witnesses stated that the noise arising from an electrically-driven coal-cutter is considerably less than that from a compressed air machine, and this is especially the case if worm gearing, running in a bath of oil, be employed.

Shock to Workmen.—The damp, warm atmosphere, the dirt and dust always present, the continual vibration, and the risk of overloading the motor, all tend to render it difficult to maintain a high standard of insulation, while the confined space in which these machines usually work make it all the more important that this standard should be maintained. To attain this end, the motor should be sufficiently large and of thoroughly good quality in the first instance. Great care should be exercised to exclude dust and dirt from its interior as far as possible, and it should periodically be thoroughly overhauled and cleaned. The method of attachment of the trailing cables to the machines does not always seem to have had sufficient consideration on the part of manufacturers. The terminals on the motor should be enclosed in such a manner as to render it impossible for a man to come in contact with them accidentally. In portable machines the trailing cables should first be attached to the terminals of the machine, and last of all to the terminals in the gate-end switch boxes.

Setting Fire to Inflammable Material.—Apart from the trailing cables, there appears to be little likelihood of a coal-cutting machine originating a fire except when thea rmature is burnt out, and even in this eventuality the machine attendants should be perfectly capable of dealing with it before it reached dangerous proportions.

Ignition of Fire-damp.—Where there is a possibility of igniting fire-damp, the employment of electrically-driven coal-cutting machines assumes an entirely different aspect. It was a somewhat startling fact to learn that out of all the armatures of coal-cutting motors insured by one insurance company rather more than 40 per cent. were annually put out of action, and this has caused us seriously to reflect whether we ought to recommend that electrically-driven machines should be permitted to work in mines where there is a possibility of gas being present. We have come to the conclusion, however, that if reasonable precautions are taken the employment of these machines will not appreciably add to the dangers which it is the lot of those who work in mines to face. One ingenious device which was specially brought to our notice relied on the complete boxing in of the commutator. But the enclosure of the commutator would not afford any security against the ignition of fire-damp if the armature were burnt out or a wire broken. It is evident that the effectual enclosure in flame-tight cases of motors, switches and other sparking electrical appliances will be naturally affected by the form and nature of the joints of the coverings, more especially with coal-cutting and drilling machines, where the whole apparatus is subject to prolonged and violent vibration. A machine over loaded causes continual loss of time and annoyance due to breakdowns, and may even result in a system being abandoned as bad, although it has not had a fair chance. It is to be hoped that owners and managers will bear this in mind when ordering their plant, and will not study an immediate saving in capital cost without at the same time keeping before them the prospect of a long bill for renewals and repairs, which will almost inevitably follow. There appears to be no reason why the continuous-current and alternating-current motors at present available may not be slightly modified so as to make them thoroughly safe and satisfactory tools, which will play an important part in the progress of the industry.

Electric Locomotives.

We intimated when discussing the question of cables, that for special purposes the use of bare conductors below ground was properly admissible. These special circumstances arise when the employment of electric locomotives is contemplated. This method of haulage, so far as we are aware, has not been utilised in this country, but has been successfully employed for some time in America. It is quite conceivable that, where the roads are so tortuous as to render haulage by ropes difficult or impossible, the most feasible method of drawing the coal or mineral to the shaft bottom will be by the aid of electric locomotives. The inevitable sparking at the trolley-wire renders the use of this system impossible in mines where there is danger to be apprehended from the ignition of gas; its employment in mines free from fire-damp need, therefore, only be considered, and it remains to be seen what precautions should be taken to prevent accidents from fire or shock. So far as danger from fire is concerned, the chief precaution necessary is the exclusion of inflammable material from the immediate vicinity of the wires and electrical appliances. The question of shock presents a much more serious difficulty, and this danger, at first sight, appears to render the use of locomotives below ground practically inadmissible. On further consideration, however, it will be seen that by keeping the trolley wires at least 7ft. above the track or by totally prohibiting travelling on foot along the roads during

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the time haulage is taking place along them, the risk of accidental shock is very largely eliminated; special precautions should be taken, by means of conspicuous notices or otherwise, to prevent unauthorised persons from being present on these roads when the current is on. The locomotives, and trams if men travel in them, should be so constructed as to afford reasonable security against accidental shock. A separate generator and system of wiring should be used, and in no case should the voltage exceed the limits of medium pressure.

Electric Lighting.

The very valuable set of rules recently published by the Council of the Institution of Electrical Engineers as a result of three years' labour, practically renders it unnecessary for us to touch on this branch of our subject, except in so far as the ignition of fire-damp is concerned. Where this danger is not present, any installation based on the above-mentioned rules, so far as they apply, ought amply to insure immunity from accident by fire. In a mine the degree of precautions taken must have regard to whether the apparatus is in places frequented by boys and horses, or whether it is only used by a limited number of more skilled operatives. On the other hand, in mines, the possible presence of fire-damp necessitates certain precautions which are not always necessary above ground. None but vacuum lamps are admissible. Experiment have shown that if one of these be broken in an explosive mixture of air and gas, the gas will generally be fired; all electric lamps should, therefore, be enclosed in stout glass covers. But if electric lamps are protected by strong glass globes, there is no reason to apprehend danger from them, even in fiery mines. For if the glass of a safety lamp be broken, the gas will be ignited with even more certainty than in the case of an electric lamp. In fact, the ease with which electric lamps can be extinguished and their freedom from danger should rushes of gas occur, render them in some respects safer than safety lamps, and it is for kindred reasons that they are considered the safest method of lighting in explosive factories. They require to be supplemented, as they have the disadvantage of not being capable of use as gas indicators, and for this reason they are not suitable as portable lamps in gassy mines for officials, although they give an excellent light, thus tending to diminish accidents. The cables should be run in continuous strong metal piping or casing, which should be well earthed; and in no case should the wires be subject to mechanical strain or used to support a lamp. The switches and fuses should be placed in flame-tight cases, as previously mentioned.

Shot Firing.

The tenor of the evidence given before the Committee is in favour of requiring all shots to be fired by electricity in those pits to which the Explosives in Coal Mines Orders apply, and we have reason to believe that in the majority of such pits this system has already been adopted. The orders regulating the use of "permitted" explosives state that the method of firing to be adopted must be by means of an efficient electrical apparatus, or other means equally secure against the ignition of inflammable gas or coal dust. It remains, therefore, to be seen how the various methods of electrical firing fulfil these conditions. Two systems are ordinarily used:—

1. High-tension magneto machines. A small alternating dynamo being employed to generate a current which will pass between the two terminals in the fuse head, and through the priming composition; motion is imparted to the dynamo by means of a handle.

2. Low-tension magneto machines or batteries. This system depends on the fusing of a small metallic bridge soldered to the two terminals in the fuse-head, and, therefore, either a continuous-current magneto machine or a battery of cells can be used. This method presents one great advantage over the high-tension system, in that each fuse can be tested for continuity of circuit before being taken into the mine for use.

There are two dangers to be apprehended from electrical firing:—(1) The ignition of fire-damp from a spark, either in the magneto machine or between the bare leads, when in close proximity. To guard against this danger, high-tension magneto machines should be enclosed in a flame-tight case, and the fuse or detonator leads should be connected up in such a way that there is no possibility of a spark passing from one lead to the other. (2) Premature firing of the shot.

Almost all the accidents due to electric firing have arisen from this latter cause. If the firing cable be first connected to the fuse leads, and not attached to the firing apparatus till the shot-firer is ready to fire, it is difficult to see how an accident of this nature can occur. As an additional precaution, however, all magneto machines and cell batteries should be provided with removable handles, keys or safety plugs, which should always remain in the custody of the shot-firer. The rapid deterioration of primary and secondary batteries, unless carefully looked after, renders their use a doubtful advantage for shot-firing, even though their original cost is but a fraction of that of magneto-generators, as the cost of maintaining them in efficient working order is greater. Two witnesses urged that the Bickford Smith system was as safe as the electrical method of shot-firing. Though this may be the case where every direction in the application of the system is implicitly followed, we feel that there are so many ways in which the system can be misused that the time has come when its employment should be prohibited in those parts of a mine in which permitted explosives can alone be used. The use of electricity partly eliminates the risk of accidents from hang-fires, a danger always present where safety-fuse is employed.

Signalling.

With one exception only, all the witnesses spoke in favour of electric signalling in the shaft. The objection raised was that cases had occurred of signals being prematurely given, but this rather points to faulty design than to inherent defects in the system, as electric signals have been successfully used for a number of years in passenger lifts. It is true that in a mine greater difficulties have to be encountered; for instance, the proximity of power cables and the presence of moisture necessitate additional precautions to prevent leakage of current to the signal wires. As ready communication between motor stations below ground and the power house is often a matter of great importance, we consider it would be advantageous that telephones should be erected in all permanently-installed motor rooms, so that the attendant could at once inform the electrician in charge of the power house of any breakdown of the machinery and speedily obtain assistance if required. Bare wires have been in use many years for transmitting signals in engine planes, as far as we can gather, without causing a single accident; and undoubtedly the ease with which signals can be transmitted by this system has frequently been instrumental in preventing the occurrence of accidents. We think that in those parts of a mine in which gas is to be feared, it is unnecessary to exceed a pressure of 10 volts for this purpose, as by the employment of relays any difficulty that might be entailed by great length of line, or other causes, can be easily overcome.

Electric Re-lighting of Safety Lamps.

One witness raised a very pertinent question during his evidence as to the safety of the indiscriminate re-lighting of safety lamps by means of an electrical apparatus. The great objection to such a practice lies in the danger of a damaged lamp being re-lit and taken back to the coal face. We think, therefore, that if such apparatus is used below ground it should be in charge of a competent person who could examine each lamp, brought for re-lighting, before re-issuing it.

Classification of Mines.

The fact that an electric spark can ignite fire-damp renders it necessary, when framing rules to govern the installation and use of electricity in mines, to divide them into two distinct classes—namely, those in which fire-damp does not exist and those in which its possible presence necessitates addition precautions being taken to prevent the ignition of gas. At present coal mines are placed in two categories. One classification, depending on the necessity for using safety lamps, is governed by General Rule No. 8 of the Coal Mines Regulation Act, 1887. The other, relating to the use of permitted explosives, is regulated by the Explosives in Coal Mines Orders. We have carefully considered the question as to whether we should adopt one of these standards, or whether it would be advisable for us to frame a new classification to meet the conditions of electrical installations. We have, however, come to the conclusion that the first standard is particularly applicable to the use of electricity, and we have therefore indicated in our rules that certain additional precautions should be taken in those parts of a mine which are required to be worked with safety lamps. There may be parts of mines in which so much fire-damp is emitted that the introduction of electricity might be improper, notwithstanding the fact that by law these places may be worked with safety lamps. We wish, therefore, to impress emphatically on both colliery owners and managers that the ultimate responsibility of installing or using electricity in such places should and must rest with them. Such is the case regarding the use of permitted explosives, and there are many mines in which shots are never fired in the coal, and comparatively seldom in the roads. All that rules can do is to provide for general conditions and circumstances. To meet exceptional and special dangers is beyond the scope of any code. But these exceptional dangers have been provided for in the Coal Mines Regulation Act, which contains a section granting special powers to meet exceptional cases. In our opinion, the provisions contained in this section (No. 42) afford sufficient facilities for dealing with any such special dangers as are not expressly guarded against in the rules we have framed. The precautions we have indicated in the rules to guard against the possible ignition of fire-damp may be summarised, generally speaking, as enforcing the covering of all live parts with a flame-tight casing. Coverings for such parts are also necessary to prevent accidents from shock, unauthorised persons having access to the parts, and to exclude dust and dirt. We think, therefore, that just as in many mines, safety lamps are introduced as an extra precaution rather than to guard against the actual ignition of fire damp, owners would be well advised to adopt the analogous course as regards their electric installations, at any rate in the vicinity of the coal face. The extra cost of making a cover flame-tight is trifling, and such covers would undoubtedly afford a better protection from dust and dirt. It may be argued that the flame-tight enclosure of a coal-cutter motor presents disadvantages in respect to undue heating, but it appears questionable to us whether the actual difference as regards this point between a flame-tight and an ordinary cover would be very material.

Existing Installations.

With regard to existing installations, although they may not in all respects conform to the standard and regulations we have suggested, we feel that it would be fair to leave them whenever this can be done without danger to the workmen. We think, therefore, that the case will be best met by giving the inspectors power to require such parts of the existing installations as they think necessary to be brought into conformity with the new rules. In case of differences, which we do not think would often arise, the matter had best be settled in the usual way, by arbitration.

Conclusion.

In order to assist the Department, and also to put our views into a definite shape, we have drawn up a set of rules which we think might, with advantage, be introduced into all mines. They are rather lengthy, and, from their multiplicity, may create alarm, but we do not see our way to deal with the subject effectively except by some code such as we propose. We think, however, that if this code, or one like it, is established, a considerable step will have been made towards securing the safety of miners, and that it will be impossible, under such provisions, that many casualities will occur. Numerically, as the use of electricity grows, the bare number of accidents may be expected even to increase. But, on the other hand, for reasons we have given, we shall hope that accidents from falls at the face will more than correspondingly diminish.

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ELECTRICITY IN MINES.

The report of the Departmental Committee appointed to consider the use of electricity in mines will be read with interest and appreciation by all electrical engineers. We conclude our abstract of the report in this issue, and the draft regulations will be published next week. The proceedings of the Committee have been reported from time to time in *The Electrician*, and an examination of the names of the witnesses reveals the fact that many experts have been consulted; in conjunction with this it must be borne in mind that the Committee included among its members mining and electrical engineers of high standing. The report itself contains very little that will not be found in agreement with modern scientific ideas, and although there is no tendency to recommend the universal or indiscriminate adoption of electricity, yet it is perfectly evident that any attempt to place harmful restrictions upon its greater use is strenously deprecated.

The Committee, while refusing to dictate as to which system of generation, transmission and distribution should be employed, clearly exhibit a leaning towards three-phase working. They recognise that up to the present the most successful system, so far as the motors are concerned, has been continuous current, owing to the ease with which machines worked from such a supply may be started and stopped under all conditions. There is also the fact that continuous current is so very convenient for driving locomotives. On the question of alternating-current motors the report is rather contradictory: under the heading "Use of Electricity" the following passage occurs:—

"... We hope that the progress now being made in the improvement of alternating-current motors will lead to the development of a thoroughly reliable motor without commutator or rubbing contacts, which can be started and run without causing a disturbance on the system, or necessitating elaborate starting gear." Under the same heading, a little further on, the report continues: "On a visit to Messrs. Pope and Pearson's Altofts colliery, near Normanton, we saw a coal-cutter which daily cut 250 tons of coal, holing under the face to a distance of 6ft. The machine is driven by a three-phase induction motor, and has worked well for some years." Surely, if a three-phase motor drives such a piece of apparatus as a coal-cutter satisfactorily for some years there is no reason for doubting that three-phase motors are satisfactory in every respect. Possibly the Committee meant to refer to single-phase motors in the first passage which we have quoted. Coal-cutting is the most arduous work that a motor can be called upon to perform in coal mining. The motor is then constantly in a hot atmosphere laden

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with coal dust; it is started and stopped frequently, and occasionally the cutter gets jammed altogether. It is hardly possible to imagine more onerous conditions; and the very fact of the machine working well for any length of time is proof of its fitness. But looking at the matter from a broader point of view, three-phase working is unquestionably superior to any other system, as far as coal mines are concerned. The ease with which power can be generated and transmitted down the shaft at high tension and then stepped down without moving machinery is greatly in its favour; but the fact that it is possible to employ motors without commutators and, therefore, without sparking, at once places it on a footing far above that of continuous current. Even if slip-rings have to be employed for starting the larger three-phase motors, it is obvious that these may be enclosed more easily than a commutator, not to mention the considerable difference in sparking on the two devices. Everything, in fact, is in favour of the three-phase system, and the Committee have done quite right in recommending it, though not advocating its compulsory adoption.

With regard to the dangers connected with the use of electricity in mines, it would be idle to argue that they do not exist. Unfortunately, they do exist, but not to anything like the extent that is popularly imagined. As the Committee have so faithfully put it: accidents usually arise from faulty installation and careless or unskilled handling. It would not be detrimental to the industry if some form of examination were established which all mining electricians would be compelled to pass before accepting an appointment. At any rate, some system equivalent to that governing the employment of marine engineers might be adopted. But it is not only those directly concerned with the purely electrical work who should be competent; the actual miners themselves should be given careful and strict instructions as to how far they may touch and work with apparatus and wires. The Committee rightly emphasise the fact that, no matter what the system may be, or how high the voltage employed, the whole installation should be considered a source of "potential danger." The conditions obtaining in coal mines are so vastly different from those above ground that this warning cannot be too carefully taken to heart.

The remainder of the report deals with details and suggestions which do not admit of much criticism. Except where electric locomotives are employed, or under other very special conditions, the Committee do not consider an earthed return advisable. A warning is uttered against the overloading of cables by the addition of numerous subsidiary motors, and, owing to the more or less temporary nature of the work at the working face, this warning is a very timely one. No suggestions are made as to the precise form of covering or protection for cables, but it is recommended that this be very robust, and that a spare cable be kept handy for replacing a damaged one in order to minimise the temptation to continue working with a cable so damaged as to be a source of danger. All shots in places to which the Explosives in Coal Mines Orders apply should be fired by electricity, and high-tension magneto-generators should be enclosed in flame-tight cases when used in such mines.

The Committee are to be congratulated on the way in which they have conducted the inquiry, and on the broad-minded report which has been the first result of their deliberations. That it will not be the only result we are assured; for we may confidently hope that the report will give a considerable stimulus to both the electrical and mining industries, by bringing home to mining engineers the immense advantages which are to be gained from the adoption of electricity in mines.

THE NEW TRUNK TELEPHONE EXCHANGE.

(Continued from p. 617.)

Two types of junction circuit are employed—call-wire junctions and signalling junctions. The former are employed in connection with the larger exchanges, the latter for those smaller exchanges from which there are not more than five trunk junction wires. In the case of call-wire junctions, when the call "matures"—*i.e.*, when the trunk wire is available to the subscriber whose demand has previously been transmitted to the record table—the trunk operator presses the call-wire key corresponding to the local exchange from which the demand emanates, asks for the subscriber, and is told by the junction operator at the other end which junction wire to employ. These junction wires are multipled over all the panels of the trunk board on simple three point branching jacks, the bush of the jacks being connected in multiple. This third point is simply earthed through a 250-ohm resistance (Fig. 3) in the case of junction wires to common battery and

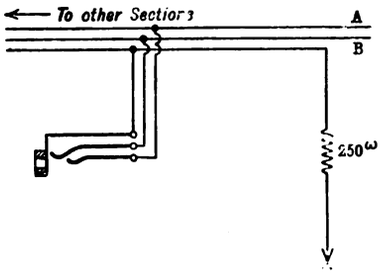

Fig. 3.—Junction Circuit to C.B. and C.B.S. Exchanges when Call Wires are Used.

common battery signalling exchanges (such as Putney, Kingston, &c.), and in the case of magneto exchanges is connected to earth through a 250-ohm relay (Fig. 4). At the local exchanges, on the common battery system,* it will be remembered that a differentially-wound repeating coil with the common battery in the middle is connected across the line. In common battery signalling exchanges,* a relay joined to the A and B lines in multiple takes the place of the repeating coil, and in magneto exchanges a double-wound bridging coil is placed across the line and the middle point of this coil is earthed through an indicator and a battery opposing the battery in Fig. 4.

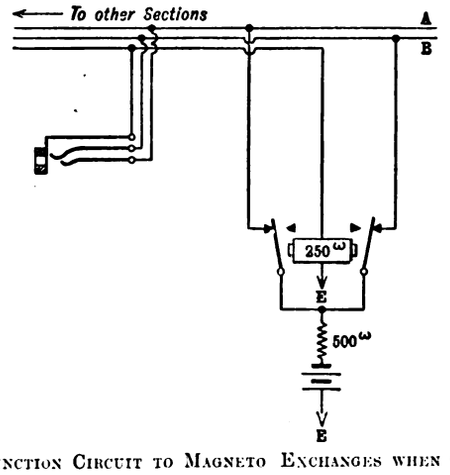

Fig. 4.—Junction Circuit to Magneto Exchanges when Call Wires are Used.

We must now refer to Fig. 5 in connection with Figs. 3 and 4 (Fig. 5 being a repetition of Fig. 2, representing the operator's cord circuits at the trunk exchange). The red plug is inserted in the junction jack, and a circuit is established from the 22-volt battery through the relay R2 (Fig. 5), the barrel of the plug, the bush of the jack and back to earth. (Fig. 3 or 4). The effect of this is first to open the short-

* See, for instance, the descriptions of the Post Office Central and the Putney exchanges, *The Electrician*, Vol. XLVIII., pp. 767, 808, 864, 897, 930, and Vol. XLIX., pp. 544 and 627. These descriptions have also been republished in book form by "The Electrician" Printing and Publishing Co.

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circuit of the condensers (so that while the plugs are disconnected from one another for battery-signalling currents they are still in connection for speaking), and, secondly, to connect R3 directly across the cords on the junction line side of the condensers, R5 being connected between the middle point of R3 and earth.

When the junction line has been cleared at the local exchange, the relay R5 is actuated and the clearing lamp L1 glows until the lines have been cleared on the trunk board. A clearing red lamp common to all these junction lines. In this case, also, the junctions are multipled over several sections. Fig. 6 shows the connections of a signalling junction to a magneto exchange. For central battery signalling exchanges the relay R10 and its battery are dispensed with, R2 becoming a simple relay between the bushes of the jacks and earth. The tongue of this relay is connected to the front springs of the keys; when attracted this makes contact with the connection to the bushes of the jacks, and in its back position it connects the

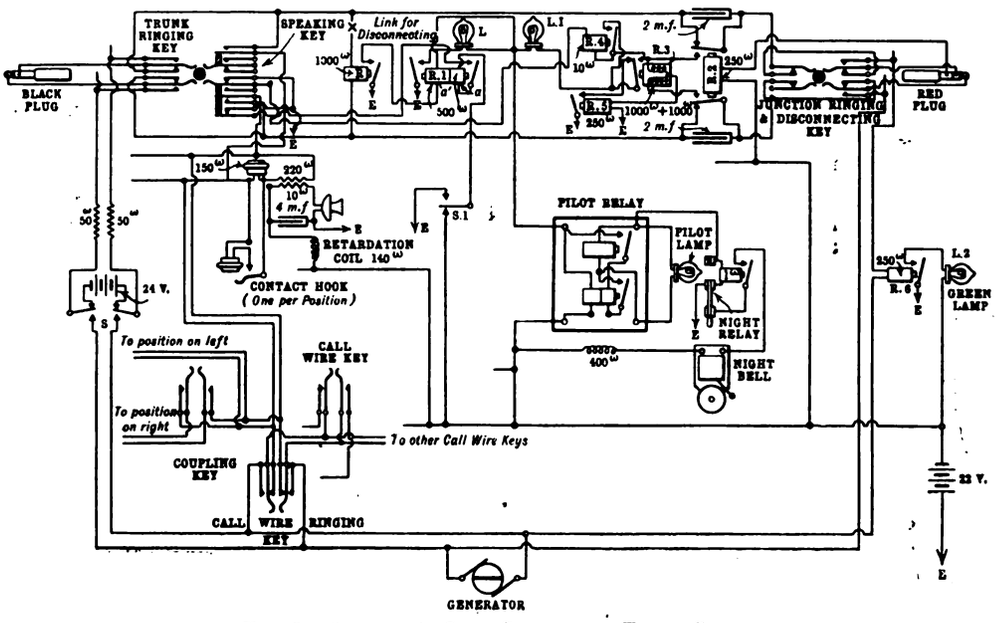


FIG. 5.—OPERATOR'S CORD CIRCUITS ON TRUNK SWITCHBOARD.

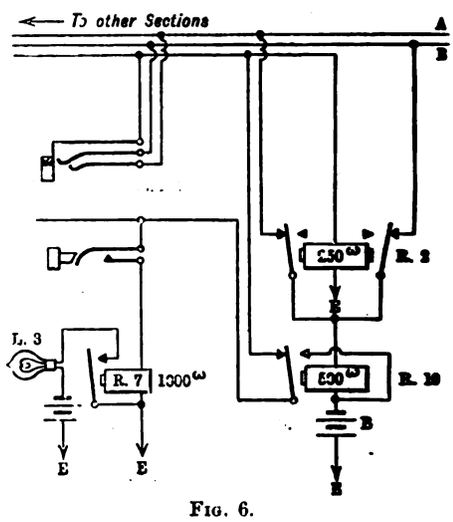
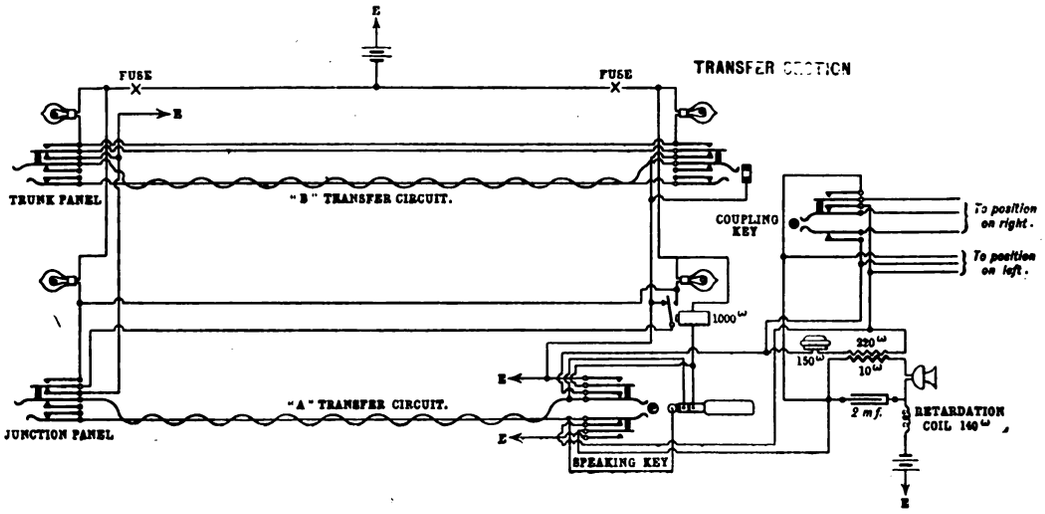


FIG. 6.

JUNCTION CIRCUIT TO MAGNETO EXCHANGES WITH TEST ARRANGEMENT.

signal is similarly received when the London subscriber hangs up his telephone, in the case of central battery and central battery signalling exchanges, or when the subscriber to a magneto exchange rings off.

The local operator rings up the London subscriber in the case of central battery and central battery signalling exchanges, but subscribers connected to magneto exchanges are rung by the trunk operator by means of the combined ringing and common spring of the keys to the A line. For exchanges entirely on the central battery system no relay is required at all, the bush connection to the jacks and the front springs of the keys being all joined together to a common point, which is earthed through a 250-ohm resistance. The trunk operator pushes in the key of each junction in turn. If the line is engaged the lamp will glow. When she finds a free junction she plugs into its jack. This automatically calls the attention



NOTE.—Direct Transfer Circuits between Trunk Sections to be Wired same as "B" Transfer Circuit, but without "Earth" on Socket.

FIG. 7.—CONNECTIONS OF TRANSFER CIRCUITS.

disconnecting key associated with the red plug. A relay, R6, in this ringing circuit causes a green lamp to glow if the circuit is in order; if the lamp does not glow one of the ringing fuses has blown or there is a disconnection from some other cause.

Signalling junctions are connected in virtually the same manner as the call-wire junction, except for the additional provision of a lamp and key for making the "engaged" test. The key is placed above each junction jack, and the lamp is a of the operator at the local exchange by lighting up a lamp, or by actuating some other type of indicator. The clearing signal is automatically sent to the local exchange on the withdrawal of the peg from the junction jack at the trunk exchange.

The "transfer circuits" have next to be described. To explain what these are, let us suppose that a subscriber in East Grinstead wishes to speak to Sheffield. There is no direct

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trunk wire, and communication has to be obtained through the trunk exchange in London. A number of "A transfer circuit" jacks are placed on the middle panel of each trunk switch section for the joint use of two operators, and the operator attending to the East Grinstead trunk plugs into one of these. Although these are eight-point jacks of the standard pattern, the inner springs are not employed. The plug connects the trunk operator's call circuit to the line springs of the "A" transfer circuit—a line leading to the "transfer section" or transfer board in the trunk exchange switch room—and at the same time the auxiliary side springs of the jack close a battery circuit which lights a lamp on that board (see Fig. 7). Forty-six of these A transfer lines from the various trunk sections terminate at each section of the transfer board, and each terminates at a speaking key, associated with which is a calling lamp and three-way plug, the tip and ring of the plug being connected directly to the transfer line. These are all on the keyboard shelf of the transfer board. On the vertical part of the board are a number of jacks in which the "B" transfer circuits terminate, and each of these has a lamp above it. The "B" transfer circuits are, as it were, "outgoing" circuits *from* the transfer board *to* the trunk sections. The transfer operator having ascertained the demand, consults a list which tells her that the Sheffield trunk lines are on section 25 of the trunk switchboard, and she plugs the East Grinstead plug, which is opposite the calling lamp, into the jack of the "B" transfer circuit bearing that number. This lights up a lamp on the Sheffield trunk board, as well as the lamp over jack No. 25 on the transfer board. The lamps cease to glow when the operator at the Sheffield section replies, and glow again when she clears. On receiving the latter signal, the transfer operator removes the plug from the jack. Her duties are thus simple and almost mechanical, and she never comes in on the subscriber's line at all. The connections of the transfer circuits are apparent from Fig. 7.

The connections of the record tables are naturally the simplest of all. There are three record boards, each equipped for 20 lines. For each line there is a self-restoring indicator and a jack. The ends of the record lines at the local exchanges are brought to jacks on the subscribers' sections of the switchboards. When a subscriber desires a trunk line the local operator plugs him through on one of these jacks and gives one ring, which actuates the indicator on the record board at the trunk exchange. The record operator then plugs into the corresponding jack with a single plug connected to her speaking set, and takes particulars of the demand from the subscriber. The indicators of these boards differ from the usual self-restoring type by the fact that the restoring current does not remain on continuously so long as there is a plug in the jack, but it is interrupted when the flap is replaced. Each board for 20 lines is served by one or two operators according to the traffic at the time.

(To be continued.)

COAL CONSUMPTION IN CENTRAL STATIONS.

The following is an abstract of the discussion which took place at the Manchester Local Section of the Institution of Electrical Engineers on Tuesday, January 19th, in connection with Mr. A. S. Giles' Paper on the above subject. The Paper itself was published in our issue of January 22nd.

Mr. COWAN (Chairman) recalled Col. Crompton's prophesy in 1894 of a coal consumption per kilowatt-hour of 0·27d., also Mr. Hammond's in 1898 of 0·2d. per unit. Continuing, he said, that St. Helens now showed 0·18d., Glasgow 0·13d., and that Cadbury's, who had a gas plant for driving their generators, reached the lowest result of 0·125d. per unit. Domestic heating might be profitably done by electricity in the near future, but at the present time only 7 per cent. of the heat was used by existing methods. Referring to Mr. Giles' figure of ½ ton of coal per annum for every square foot of unlogged surface he would quote also Mr. Geipel's figure of 380lb. per annum for logged surfaces. Boiler load-factor was an important economical consideration, and, in his opinion, four Lancashire boilers, worked at 25 per cent., say, with 5lb. to 6lb. of fuel per square foot of grate area, would be more economical than one boiler burning 20lb. per square foot.

Mr. PEARCE said that in Manchester it was the practice to obtain the relative calorific values and analyses and to test the evaporative efficiency by evaporating a given quantity of water with each kind of coal submitted, and, in addition, noting the amount of moisture and the residue of ash, clinker, &c. With regard to the question of hand stoking versus mechanical stoking, he certainly agreed with the author as to the value of mechanical stoking for large plants, but there was one notable exception—namely, the Central London Railway—where mechanical stokers were abandoned for hand firing, and at the same time a better class of coal was adopted, with good results. It would be interesting to know whether the management attributed the better results chiefly to the change from mechanical to hand firing or to the very much better fuel used. In the speaker's opinion it was entirely due to the latter. The coal per unit was reduced from 6lb. to approximately 4lb. on a load-factor of 40 per cent. In most cases mechanical stokers effected considerable economy. He wished to emphasise the author's remarks on cleanliness with regard to heat transmission. The practice in Manchester was to use water from the town supply and 1lb. of soda per boiler per day, and frequent blow-downs, and it was only necessary to thoroughly clean and overhaul the boilers at the city stations once per annum, and the scale then found was never more than $\frac{1}{16}$in. to $\frac{1}{8}$in. thick. With regard to radiation losses, he had, in recent tests, found them to amount to 2lb. of coal per square foot of radiating surface (including boiler losses) in 24 hours. This test was carried out at the Dickinson-street works, and was equal to 16 times Mr. Giles' figure. In tests at the Stuart-street works he got a figure slightly higher. These results gave 5lb. of coal per kilowatt installed. This figure had been borne out by Dr. Kennedy. Of course, it depended on the arrangement of the steam piping employed, but he thought these results were near the mark for plants where the boiler house was end-on to the engine room, and where duplicate ranges were used. Emphasising the author's remarks on superheat, he thought that a great saving was effected by its use, although the author's figures were higher than he thought possible. At the Manchester Bloom-street works tests had been carried out on 3,000 H.P. sets. The Babcock and Wilcox boilers had 5,140 square ft. of heating surface and superheated the steam 90° F. During a three hours' test at full load a result of 2·31lb. of coal per unit was obtained, and, at the price paid for the fuel used, this equalled 0·11d. per unit, a saving of 6 per cent. as compared with the results obtained with saturated steam in otherwise similar conditions. The coal used at all the Manchester stations was Lancashire washed slack and washed peas, having a calorific value of 13,900 B.Th.U. per pound. The coal consumption per unit at Bloom street over a period of the last 12 months was 3·8lb. per unit, at a load-factor of 20 per cent., and the cost in coal amounted to 0·125 per unit. The official test on the 1,800kw. sets at Bloom-street works was with saturated steam, and the result showed a consumption of 19·8lb. of steam per unit. A test was afterwards carried out with superheated steam by way of comparison and with 90°F. of superheat, when the consumption per unit was brought down to 16·75, showing a saving, due to superheat, of some 16 per cent. He (Mr. Pearce) thought there was no economy in having a vacuum of more than 26in. with reciprocating engines where the air-pump discharge was used for boiler feed, as what was gained in this respect was lost in temperature of feed, and in marine practice 24in. was not exceeded. He alluded to Prof Weighton carrying out some tests on a triple expansion engine at Newcastle, with surface condensers returning the air-pump discharge to the boilers (*The Electrician*, Vol. XLIX., p. 747). Although at the Stuart-street works they were running without condensers and no superheat at present, they were able to show a result of 4·1lb. of coal per unit for the last four months' working. This good result showed the value of a high load-factor, which, in this case, was from 50 to 52 per cent. The human element was very important and worthy of careful consideration. He (Mr. Pearce) had introduced in Manchester a bonus system for stokers, and to this he thought the good figures which had been quoted were in some measure due.

Mr. TAITE thought that most cotton mills, taken over the 10 working hours, had a load-factor of 100 per cent. He did not doubt that mechanical stokers were economical in Lanchashire whatever they were in other places. He used coking stokers and found them very satisfactory, but care was necessary to see that the fires were not allowed to get too thin at the back. At Salford they were using a CO_2 recorder and it had enabled them to reduce their coal consumption from 4·3lb. to 4lb. per unit.

Mr. BENNIS said that, regarding Mr. Giles' remarks on combustion, carbonic acid gas taken alone was a most unreliable factor. At a series of careful trials made at the Sheffield electric lighting station by Mr. Fedden on a marine type wet-back boiler, for instance, 13 per cent. of CO_2 was obtained in one test with a boiler efficiency of 80·3 per cent., whereas in another test only 9·9 per cent. of CO_2 was observed, the efficiency being, nevertheless, 85·9 per cent. It was necessary, therefore, to get also the pyrometer readings and the speed of the draught. Carbonic acid gas might mean that air is leaking through the brickwork. The author did not mention the combustion of hydrogen, which was quite as important in Lancashire as proper combustion of carbon, as local coals contained a considerable proportion of the former. Referring to the table the author gave of losses for different volumetric percentages of carbonic acid in the flue gases, the speaker mentioned that this table was only correct for 450deg. above the temperature of the atmosphere, and as this temperature went down the loss also diminished proportionately. In his (Mr. Bennis's) opinion the most important point the author had touched upon was the question of heat transmission, the rate of which varied as the square of the difference of temperature between the hot gases and the water in the boiler. Clean plates were, of course, essential, and he thought the author underrated the care taken of factory boilers in general. His experience was that well-equipped mills take more care than the average lighting station. The rate of heat transmission being dependent upon the temperature, it followed that the best stoker was the one giving the highest furnace temperature, and a stoker without self-cleaning furnaces, like a dirty, clinkered-up fire, could not give the

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best results. Fuel of low quality need not mean low efficiency of boiler. This point was well brought out in the test recorded below:—

Report of Trials of Babcock and Wilcox Boiler fitted with Bennis Stoker and Self-cleaning Compressed Air Furnaces at the County of London and Brush Provincial Electric Lighting Co. (Ltd.), Wandsworth Electric Station, London, S.W.

Boiler heating surface	2,197 sq. ft.	—
Boiler suuperheating surface	251 sq. ft.	-
Date of trial	Sept. 4, 1903 ..	Sept. 8, 1903
Duration of trial	3½ hours	4 hours
Class of fuel used	North Hetton .. Rough small	Riddlings that fall thro' grate of B. & W. chain grates & Vicars stoker.
Calorific value of fuel used ..	12,500 B.Th.U...	8,965 B.Th.U.
Total water evaporated actual	3,537 gallons ..	3,380 gallons.
Av. temp. of feed to boiler ..	143°F.	155°F.
Av. steam pressure by gauge	155lb. per sq. in.	152lb. per square inch.
Av. temp. of gases leav'g boiler	199°F.	217°F.
Gases by econometer	6·67 CO_2	5·8 CO_2
Total fuel consumed	3,976lb.	5,040lb.
Water evaporated per pound of fuel actual	8·89lb.	6·70lb.
Water evaporated per pound of fuel from and at 212°F...	9·97lb.	7·423lb.
Draught	0·3.....	0·33
Efficiency of boiler and stoker	77 per cent.	80 per cent.
Water evaporated per hour from and at 212°F.	1,133 gallons ..	936 gallons.

With reference to Tables A and B in the author's Paper, there were some curious discrepancies; in No. 7 of Table A the pounds of coal used per kilowatt-hour at the author's station equalled 7·79, but in Table B they had gone up to 10lb., an increase of about 28 per cent. In the special test described later on, the corresponding figure was 3·35, hence the average working consumption at the author's station equalled about three times the full-load consumption. With regard to the chairman's remarks that greater economy could be got by working four boilers with a coal consumption of 5lb. per square foot of grate per hour than with one boiler at 20lb., he pointed out the trials made by Mr. Fedden at Sheffield where he got the extremely high boiler efficiency of 80·3 per cent. with water-gauge draught of 2in. and a consumption of 40lb. of coal per square foot of grate per hour. He thought if they had put in sprinkling stokers at the Central London Railway they would not have had to throw them over for hand firing. The sprinkling stoker was much better for varying loads.

Mr. SEATON said that in practice he had never been able to economise by more than 7 to 15 per cent. by superheating the steam, except when converting some prehistoric engine. When people talked to him about lubrication troubles he took them to see their Schmidt engine at Erith. This engine had seven piston valves, and the cylinder temperatures were 800°F., 600°F. and 400°F. respectively. One pound of cylinder oil was used per day of 10 hours, and it cost 6d. He recommended superheaters with straight tubes.

Mr. COOPER spoke highly of the Ellis and Eaves system of induced draught, by which the incoming air was warmed by the outgoing gases, and said he had been able to get evaporations from and at 212°F. of 10·5lb. to 11lb. of water per pound of coal. A point to consider about fuel was the quantity of residue, as this was sometimes costly to get rid of.

Mr. GILES, in reply, referred first to the case of the Central London Railway mentioned by Mr. Pearce, and said he thought the price of coal there was the explanation. He did not agree with Mr. Bennis and his recommendation of high draught. He preferred sprinklers to cokers for his particular conditions. The tendency of cokers to get thin fires at the back, mentioned by Mr. Taite, had also been experienced by him.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Magnetic Orientation during Crystallisation.—T. C. Porter has made a lengthy series of experiments with a view to determine whether crystals in the act of formation and growth could be influenced in their orientation, their system of crystallisation, or their optical properties, by a powerful magnetic field. The spontaneous evaporation of a solution of Marignac's salt gave rise to a semblance of orientation of the small crystals with their axes parallel to the lines of force. But whether this effect is really due to the magnetic field cannot finally be decided without employing magnetic fields of even greater power than those used. After these experiments made at ordinary temperatures, the author turned his attention to the formation of well-known magnetic bodies in the magnetic field. Flowers of sulphur and levigated soft iron particles were taken in the proportion in which they combine to form the magnetic sulphide of iron Fe_3S_4, and were thoroughly mixed together. The mixture was poured into a small paper tube, loosely corked at the lower end, and this tube was placed vertically between the poles of a powerful electromagnet arranged so that the tube stood parallel to the lines of force between the poles, the last being bored, and the little tube standing in the position of the heavy glass in Faraday's celebrated experiment. The current was then switched on, and, at the same time a flame was applied to the mixture where it projected into the air at the top of the tube. As soon as the iron and sulphur began to combine, the flame was withdrawn, and the wave of combination descended right through the mixture. The current through the magnet coils was maintained until the tube had had time to cool; the latter then removed, the paper carefully taken off disclosing a fairly tough rod of sulphide. This was found to be a magnet, weak, but unmistakeable, its poles being disposed as one would naturally expect. Similar experiments were then made with mixtures of iron and sulphur in the proportions necessary to the sulphides FeS, Fe_2S_3, and FeS_2. In each experiment two tubes of the mixture were made, one for the magnet, and one to be fired at a distance from the magnet; this was done to find out whether there were any persistent differences other than magnetic between the two. The mixture for FeS_2 refused to burn in *both* the tubes, as indeed might have been expected. The polarity of the Fe_2S_3 bar was decided, that of the FeS distinct, though very weak.

[T. C. PORTER, *Proc. Roy. Soc.*, November 26, 1903.]

Electrons in Metallic Conduction.—A. Schuster proves that "the number of free electrons in a metal is equal to the number of metallic atoms in the same volume, or exceeds that number not more than three times." This law may be deduced with considerable confidence from optical considerations. With the aid of Drude's equations regulating the transmission of light through metals, and the supposition that the whole of the electromagnetic energy is equal to that taken account of in the usual formulæ with the addition of the total energy of the moving electrons, the author deduces for a number of metals the value of the factor p, indicating the ratio of the number of electrons to the total number of atoms. In nickel, mercury and bismuth the factor closely approaches unity, meaning that the number of free electrons is practically the same as the number of atoms. Though the extreme electric conductivities differ in the ratio 63 to 1, the extremes of p are only in the ratio of 3·5 to 1. The facter p is less than 3 for all metals except aluminium, which in comparison with other metals is very opaque compared with its conductivity. Cobalt, silver, copper and gold have values under 1·6, and in the other metals examined the factor increases in the order—magnesium, platinum, lead, cadmium, antimony, tin, zinc, aluminium. The opacity due to selective molecular absorption is neglected in every case, so that the values of p are upper limits. But it is significant that the list contains no value sensibly less than unity, or, in other words, that in all probability no metal contains less than one free electron for every atom. The simplest explanation of metallic conduction would appear to be that each atom has one or possibly two or three, negative electrons which are easily detached, and follow freely the electric force, even for such rapid oscillations as those of light.

[A. SCHUSTER, *Phil. Mag.*, February, 1904.]

Evolution of Helium from Radium Bromide.—MM. Dewar and Curie announce a remarkable parallel to Ramsay's observation that radium salts dissolved in water produce helium. Some radium bromide weighing 0·4 gramme was left for three months in a glass tube communicating with a small vacuum tube and a mercury manometer. There was a continual slow evolution of gas, but the spectroscope showed nothing but hydrogen and mercury vapour. The same specimen was then taken by Prof. Dewar to the Royal Institution, where it was sealed up in a quartz tube and fused, the gases evolved being drawn off and examined with the spectroscope. Nothing appeared to be present except nitrogen. After thoroughly clearing off all the gas, the tube was sealed up under the oxy-hydrogen flame and sent back to France. About 20 days afterwards, M. Deslandres examined the tube with an induction coil, connecting it up by means of two pieces of tinfoil attached to the ends. He found a spectrum, not of nitrogen,

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but of helium, and that in its entirety. No other lines appeared on the plate even after an exposure of three hours with quartz lenses. The permanent luminosity of the tube only showed a continuous spectrum.

[DEWAR and CURIE, *Comptes Rendus*, January 25, 1904.]

Transmission of N-radiations along Wires.—A. Charpentier has found that some of the effects produced by the N-rays and other radiations emitted by animal bodies may be transmitted along wires. He used a small plate of thin copper, 1cm. or 2cm. in diameter, and called the "transmitter," which was joined to the sensitive screen by a copper wire of any shape, the end of the wire being coiled about the screen. In one experiment the length of the copper wire was 90cm., but it may be much longer. The screen was placed in the corner of a darkened room. The transmitter was first removed out of the neighbourhood of any radiating body, and then was exposed to some active portion of an animal body. The screen then lighted up. The effect was unaffected by any obstacles or screens placed between the transmitter and the screen, so long as the metallic connection was intact. With this apparatus the author repeated all the experiments previously described. The effects remained the same, only their intensity was somewhat reduced, probably owing to the fact that not all the rays are thus transmitted. The transmitter need not be in contact with the radiating body, but the transmission may be interrupted by interposing an electric screen in the shape of a plate of aluminium or copper connected to earth. The transmitter should be parallel to the emitting surface when it is normal to it, the effect is a minimum. The new method has the great advantage that the sensitive screen can be kept at a distance from the human body. It is not necessary that the rays thus transmitted be of physiological origin. The The rays from an Auer burner or a piece of tempered steel can also be transmitted along wires. The author has observed a well marked activity of the nerves governing the act of inspiration.

[A. CHARPENTIER, *Comptes Rendus*, January 24, 1904.]

Effect of Radium Rays on Vegetable Fibres.—Lord Kelvin announces having received from Lord Blythswood a letter with a specimen of cambric rendered thoroughly brittle or rotten by an exposure of about three days to radium bromide. He had put a little circle of cambric in place of the circular sheet of mica, which is commonly used to cover the cavity containing radium bromide in the little receptacle in which it is usually sold. The cambric is quite broken away, leaving an irregularly-shaped hole of about 3mm. greatest diameter in the place which was directly exposed to the radium. Lord Blythswood found the same result in several other trials with exposures of two or three days.

[Lord KELVIN, *Phil. Mag.*, February, 1904.]

THREE-PHASE WORKING, WITH SPECIAL REFERENCE TO THE DUBLIN SYSTEM.*

BY WILLIAM BREW.

(Concluded from page 619.)

Wave-forms.—The four oscillograms A, B, C and D on page 658 are of some interest. A represents the pressure wave of one of the 500kw. generators when running light, and B the same generator coupled to 6·2 miles of 0·15 cable. Curves C and D were taken at the city ends of the feeders, curve C in the early morning, and curve D on a 100kw. load.

Three-phase Distribution.—In considering the relative merits of various classes of distributors we must take into consideration the following points:—

(*a*) As regards the consumer. (1) The maximum safe pressure permissible to earth and between the consumers' terminals and wires. (2) The maximum permissible voltage and variation at the consumers' terminals. (3) The minimum number of consumers affected by an interruption on any one conductor.

(*b*) As regards the supply company. (4) The maxium amount of energy capable of being transmitted for a given cost of cable. (5) The maximum pressure between any two conductors which the insulation of the cable and fittings of the street disconnecting boxes will have to withstand. (6) The maximum pressure to earth tending to break down the cable and disconnecting boxes.

As regards conditions (1) and (2), the Board of Trade regulations confine us within the limits of 250 volts between terminals and 4 per cent. variation either side of the declared pressure It will be evident that conditions (1) and (4) are not the same in the case of three-wire distribution with direct or alternating current, and also, in the case of multiphase distribution with cored cables, where the insulation of street boxes and that between the conductors of the distributing cables may have to withstand much greater pressures than will exist upon the consumer's premises.

As regards condition (3) consideration should be given to the elasticity of any given system of distribution and the minimum number of consumers affected in the case of a temporary interruption of the supply on any one conductor of the distributor, such as would be caused by the blowing of a L.T. fuse or breakdown of a transformer in the case of three-phase distribution with four-core cables, and network supplied from independent transformers star connected. With three-phase distribution we have the choice between three-core or four-core distributors. We are also at liberty to vary the size of the fourth wire of the four-core cable.

Table VI. illustrates the principal points by which distribution by three-core and four-core cables would differ in practice. As regards the size of the fourth or neutral wire to be adopted we might follow the practice of three-wire distribution, and reduce the section of this to some extent. There are, however, reasons which probably justify retaining this conductor of the same size, for instance:—(*a*) One-phase being interrupted the resultant full load current of the other wo phases will combine to form full load current on a neutral of the same section as the other conductors, and one-third only of the consumers will be affected. (*b*) Similarly, two phases being interrupted the neutral will then act as a return for the third phase of equal section, with a slightly increased drop in pressure. (*c*) The increase in the total cost of the cable with the fourth core added of same section as the other three cores only amounts to 20·6 and 17 per cent. respectively in the case of the 0·1 and 0·05 distributors considered for 30 per cent. increase in copper.

The principal points in favour of the four-core cable system which has been adopted in Dublin are:—(1) Greater amount of energy transmitted for given capital cost—the system acting in a manner similar to an ordinary three-wire distribution. (2) Less variations in pressure due to want of balance amongst consumers. (3) Less inconvenience to consumers in the event of any phases being interrupted. Our working experience in Dublin is that considerable weight should be attached to this point. On the other hand against the four-core cable we have:—(1) Greater pressure between conductors tending to break down insulation of the cable

Table VI.—*Comparison of Four-core and Three-core Distributors with 200 volts at Consumer's Terminals and C.R. drop of 4 per cent. per ¼ mile.*

	Description of distributor.			
	Four-core. Consumers connected between each phase and neutral.		Three-core. Consumers connected between each phase.	
Section of each conductor in square inches	0·1	0·05	0·1	0·08
Effective pressure between conductors in volts	346	346	200	200
Max. instantaneous pressure between conductors = P.C.	488	488	283	283
Effective pressure between conductors & neutral or earth	200	200	115·5	115·5
Max. instantaneous pressure between any conductor and earth = *Pe.*	283	283	163	163
Drop in volts per core per ¼ mile = 4% of consumer's pressure	8	8	4·6	4·6
Current density per core in amps. per sq. in. to given 4% drop	726	726	421	421
No. of kw. transmitted with 4% drop per ¼ mile	43·5	21·7	11·6	7·3
Cost of cable in £ per ¼ mile laid & jointed in troughing = C.	£181	£124	£150	£106
Capital outlay in £ per kw. transmitted ¼ mile	£4·17	£5·72	£10·3	£14·5

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers.

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and street boxes. (2) Extra expense as regards fittings in house service boxes, disconnecting boxes, &c.

Drawings of a distribution pillar and a house service box, as employed in Dublin were given in *The Electrician*, Vol. LI., p. 999.

Public Lighting.—With a three-phase system of supply as with other systems special transforming or other generating plant will generally be required to deal with public lighting by means of arc lamps. In those cases where the lamps are coupled to the distributors and switched on in circuits of from four to 10 lamps at a time special generating plant will not be needed, it is true, but this system involves a considerable labour item if a large area containing several hundred lamps has to be dealt with, and, moreover, with single-phase or three-phase systems would necessitate the use of alternate-current lamps, to the exclusion of the more efficient direct-current arcs. Assuming, then, that the area to be dealt with necessitates the use of a number of arc lamps in series, we have then to decide at what pressure the current should be supplied. It is to be noticed in connection with this point that the cost per mile of arc lighting as regards cables and lamps will be more or less independent of the pressure adopted if the circuits radiate from one central point. In other cases arc feeders are necessary—the number of these feeders being greater with lower pressures and fewer lamps in series. On general lines, it would appear, therefore, most economical to have as great a number of arc lamps in series as possible. There are, however, considerations of safety and freedom from breakdown which usually prevent these pressures exceeding 1,000–2,000 volts. The pressure of supply having been fixed, the best type of transforming plant, alternating or direct current, to be adopted will depend largely upon local conditions. We have the choice of—(*a*) Static transformers, chokers, &c.; (*b*) rectifiers; (*c*) motor-generators. If we are dealing with a large area the cost of a spherical candle-power at the street lamps will usually be least with (*c*)—viz., direct-current open-type arcs—under normal working conditions.

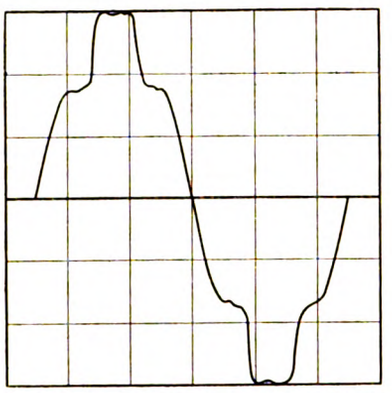
In Dublin the circuits are arranged with 21 lamps in series with a terminal pressure of 1,100 volts. The circuits are supplied by two direct-current generators in series, with their middle point earthed through an indicating device, the two generators being driven from an asynchronous motor on the same shaft. The maximum pressure to earth at any one lamp will, therefore, never exceed 550 volts, and will only reach this figure at two lamps on each circuit. The curves, Figs. 13 and 14, refer to one of these three-phase motor generators of 210 B.H.P., of which there are three installed, supplying 500 double-carbon open-type arc lamps.

Three-phase Motor-generators.—The impedance curve for one of these machines is shown in Fig. 14. In making the observations, the motor was held stationary and the slip rings short-circuited. Observations were then made of the current in each phase of the stator for various applied voltages. It is important to notice that the short-circuit current at 5,000 volts will amount to about five times the full load current of 16 amperes. With a machine of this class, if copper fuses in oil baths of the Ferranti type be employed on the E.H.T. side, it will be necessary to examine them at frequent intervals, as the copper will have to be run hot at full load if the fuse is really to be of service, in the event of a short-circuit on one of the generators. A curious effect has been observed with these machines. With one of the 500kw. generators coupled to two trunk mains supplying a motor-generator at full load during the daytime, with practically no other load on, a slight surge has been observed having a period of about twice that of the engine speed. The same load divided amongst two motor-generators had no effect. Again, with two motor-generators fully loaded, the same conditions did not produce any noticeable effect.

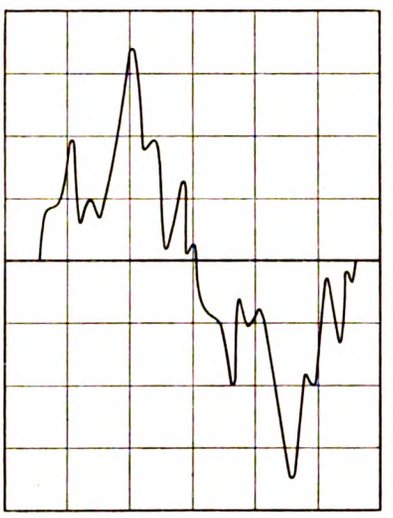
It would appear, therefore, that the motor-generator must be working at a certain power-factor to produce this result. The writer is further investigating this matter.

These machines were found of considerable value as regards their balancing effect on the pressures on the Dublin network, when, on starting the new system of supply, the three phases were unavoidably somewhat out of balance for some days.

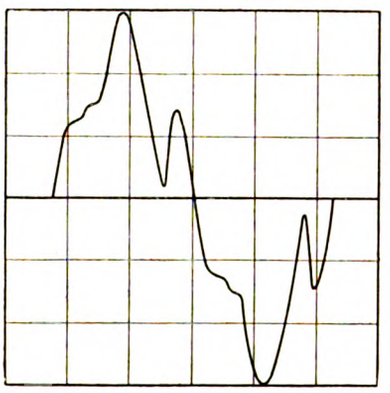
In concluding these short notes, the writer desires to express his thanks to Mr. Robert Hammond for permission to bring the subject before you.



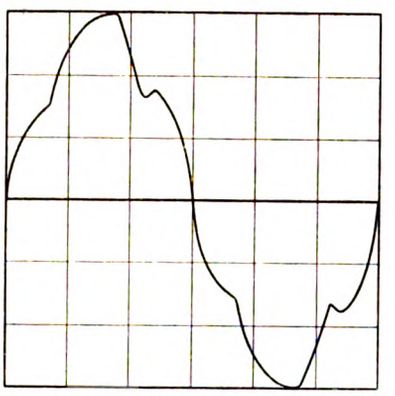
A.—500KW. GENERATOR PRESSURE WAVE, PIGEON HOUSE.



B.—500KW. GENERATOR COUPLED TO 6·2 MILES OF 0·15 CABLE.



C.—PRESSURE WAVE (EARLY MORNING), DUBLIN.



D.—PRESSURE WAVE (LOAD = 1000KW.), DUBLIN.

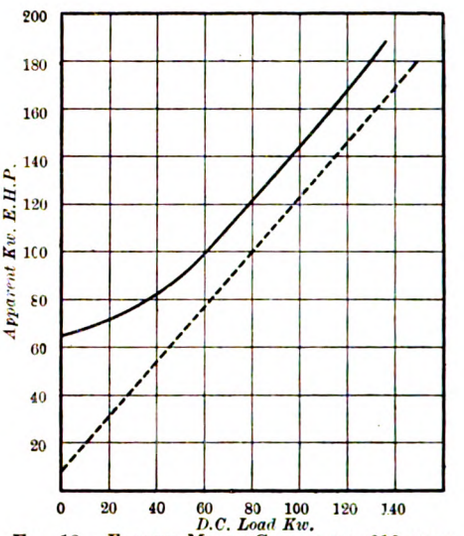


FIG. 13.—KOLBEN MOTOR-GENERATOR, 210 B.H.P.

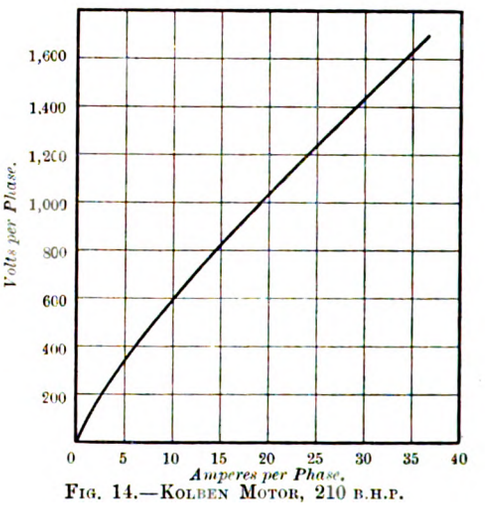


FIG. 14.—KOLBEN MOTOR, 210 B.H.P.

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The following is an abstract of the discussion which took place in connection with Mr. W. Brew's Paper :—

Prof. THRIFT (chairman) said that, among the points of special interest to him was the question of the circulation of idle currents in the windings of mesh-wound generators, and he thought that a note to be brought before the Section by Mr. Tatlow would afford a probable explanation for their existence. With regard to the measurement of capacity currents referred to by Mr. Brew, he thought there was an unaccountable discrepancy between the calculated and observed values, and he asked whether the actual leakage had been determined or not. In the course of some remarks on resonance, he noticed that the conditions seemed to favour resonance—*e.g.*, with the seventh harmonic. The banking of transformers was also a matter of great interest and the successful banking of different sizes was a thing, in his opinion, not to be expected. Regarding Mr. Brew's valuable remarks on the fourth core of the distributing cables, he considered that continuous-current practice might be followed, and a saving in cost effected by reducing the area of the fourth core.

Mr. SHEARDOWN thought the reduction in exciting current of the 500kw. generators at the Pigeon House station on the insertion of 9 miles of 0·15 sq. in. three-core cable (Fig. 4 of Mr. Brew's Paper)* to be rather large. The exciting current necessary to keep 5,000 volts at the terminals had to be reduced, in fact, from 89 to 78 amperes, a reduction of over 12 per cent. He (Mr. Sheardown) had had a test made on a 500kw. B.T.-H. three-phase 2,500-volt alternator at the Ringsend station, the exciting current, taken from the 500-volt 'bus bars, necessary to produce 2,600 volts on open circuit without any cable connected to the 'bus bars being 14·5 amperes. On connecting up in parallel to the generator two triple-concentric cables each 0·05 sq. in. in section and connected in series with a three-core cable of 0·1 sq. in. section, making in all 9·2 miles of cable, the exciting current required to keep the pressure at 2,600 volts was reduced to 14 amperes, a difference of 3·4 per cent. The experiment was not, of course, on all fours with Mr. Brew's, as he was not quite certain of the capacity of the cables when connected up, but the triple-concentric cables in parallel would probably have a higher capacity than the Pigeon House three-core cable, and it appeared to him, in any case, that the capacity would not account for the great difference between 3·4 and 12·2 per cent. Continuing, he questioned the correctness of the terms rotor and stator applied to a generator.

Mr. M. RUDDLE said that he, in most cases, preferred three-phase transformers to single-phase ones, on account of their tendency to balance, which outweighed the advantages of the single-phase type named in the Paper. No difficulty was ever experienced in getting banked transformers to share load equally, provided that they were suitably designed, but a very small thing, such—for instance, as a bad connection—might throw them out. As a matter of fact they did not share quite perfectly at all loads, and as proof of this he quoted the figures below, relating to two banked sets of three transformers, of 250kw. and 50kw. output respectively at various loads :—

50kw. transformers	12 ..	10 ..	15 ..	22 ..	21 ..	26 amps.
250kw. transformers	50 ..	42 ..	45 ..	96 ..	92 ..	104 „

He mentioned that the slow pulsation or surging referred to in the Paper caused very little trouble when the load was considerable, but with light loads, say after 11:30 p.m., it was quite in evidence. It had been got over by inserting choking coils in the primary circuit.

Mr. TATLOW mentioned that Mr. Brew used the short circuit currents to measure impedance, but that the impedance so obtained was not the same as the working impedance. He agreed with Mr. Brew, that the short-circuit current must lag and had a large armature reaction. But for this reason the short-circuit current might be reduced, and the deduced impedance would be too high. He thought the great advantage of four-core distribution to lie in the fact that it enabled a distribution at a higher pressure than the lighting pressure. But he objected to the fussing about balance which was sometimes evidenced by station engineers and the complications involved in splitting up small installations into different circuits.

Mr. BREW, in reply, said that the idle currents in mesh-wound generators were apparently due not only to certain harmonics set up by the stator slots, and referred to in his Paper, but also to irregularities in the winding, eccentricity of the rotor, and mechanical matters of that nature. Regarding leakage, he mentioned that apparatus which, when measured in the ordinary way, gave an infinite insulation resistance, was capable of passing a measurable leakage current at high-pressures due to brush discharge at numerous points in sub-station switch-gear, &c. As to resonance, it might be dangerous, but the oscillograph enabled them to recognise the harmonics, and to avoid the combinations of circuits likely to cause trouble. Banking of transformers in three-phase working was perfectly easy and merely a matter of design, but, just as in single-phase working, differences in the design of the banked transformers might cause the load to be shared unequally, a very slight cause would sometimes affect the proportion in which the load was shared in the case of large transformers banked across the same 'bus bars. A few spirals formed in the secondary leads of a transformer taking more than its share of the load under these conditions would sometimes remedy the trouble, the turns in the cable having a slight choking effect with large secondary currents. He though the difference between the magnetising currents with various capacities found by Mr. Sheardown and those in the Paper was probably due to a considerable difference in the design of the generators—*i.e.*, Oerlikon and Thomson-Houston machines.

* *The Electrician* of Jan. 22, p. 533.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, February 4.

Mr. C. S. MEIK said he had devised a scheme for facilitating the traffic of London in conjunction with Mr. Walter Beer. This consisted of the construction of two broad avenues, one running from north to south and the other from east to west of London. The former he proposed should commence at Enfield and terminate between Croydon and Wallington, crossing the Thames between Blackfriars and Waterloo Bridges, and the latter commencing near Hounslow and terminating in Essex to the east of Barking. Each of these avenues would be 24 miles in length, 160ft. in width, and consist of two storeys or decks, one at the ordinary level of the existing roadways and the other an elevated road. Above this latter he suggested the construction of a suspended railway after the design of the Elberfeld-Barmen Railway. By such a method of construction he maintained that the fast traffic could be kept quite distinct from the slow traffic. On the upper deck trolley tramways could be constructed, and from the fact that there would be practically no obstruction to their progress the rate of travelling would be much greater than was now possible. There would be footways for passengers on both decks and subways for pipes below the lower deck. A special fast motor road could be provided. Cross roads intersecting the main avenues were also proposed with double-deck construction, but without the railway communication above the upper deck. The two main avenues would cross each other between King's Cross and Rosebery-avenue. Further, a new embankment should be constructed between Blackfriars and Waterloo Bridges, on the south side of the river, with double decks, the lower being for wharves and the upper for road traffic, and also providing a terminus for the tramways along the Blackfriars and Waterloo Bridge Roads. With regard to the railway communication along the main avenues, witness discussed the possibilities of the suspended railway, a shallow subway tramway beneath the lower deck and tube railway at a still lower level. The cost of construction of these three methods of communication he put at the following figures per mile : Suspended railway, £75,000 ; shallow subway tramway, £230,000 ; tubes, £350,000. From the point of view of safety, he considered the suspended railway was superior to either of the other methods ; as to carrying capacity all three were about the same ; and with regard to appearance, this he admitted was the only questionable point. But the other advantages possessed by the suspended railway outweighed this disadvantage. Careful valuations had been made of the cost of the land required to construct these main avenues, and from these it appeared that the cost of this, after deducting recoupment from the sale of the surplus land, would be very small. His estimates of the cost of the railway and tramway communication (exclusive of equipment) along the avenues were as follows :—48 miles of suspended railway and 48 miles of trolley tramways, £3,888,000. If a shallow subway tramway were used instead of the suspended railway, this figure would be increased to £12,000,000, or if tube railways were used the figure would be £16,000,000. The equipment for any of the three systems he put at the same—viz., £4,752,000—so that the totals for construction and equipment would be as follows :—Suspended railways and trolley tramways on the upper deck, £8,640,000 ; subway tramways and tramways £17,040,000 ; tube railways and tramways, £21,552,000. The gross revenue he put as follows :—Railway : 96,000,000 passengers at 2d., £800,000 ; 155,000,000 passengers at 3d., £1,937,500. Tramways : 192,000,000 passengers at 0·8d , £640,000 ; a total of £3,377,000. Working expenses were put at 50 per cent. for the railways and 40 per cent. for the tramways, and upon this assumption the net revenue would be £1,624,750. The capital required for the complete construction of the two main avenues he put as follows :—With suspended railways, £36,107,000 ; with tramways in subways, £44,507,000 ; with tube railways, £49,307,000. After 15 years' working, he estimated the following financial results under the three different circumstances :—Suspended railways, £365,544 profit ; subway tramways, £130,000 deficit ; tube railways, £1,900,000 deficit. None of these estimates took into account the rent from the pipe subways, which would be constructed on both sides of the proposed avenues.

Friday, February 5.

Sir RALPH LITTLER, Chairman of the Middlesex County Council, said he objected to the establishment of any tribunal which would take away from Parliament any of the powers it at present possessed. The best thing to do was to leave matters as they were, as he considered that the locomotion problem of London was now in such a chaotic state that it would be impossible to deal with it in a comprehensive manner.

Mr. J. E. WALLER, of Messrs. Kincaid, Waller, Manville and Dawson, said that his opinion was that tramways would play a considerable part in solving the traffic problem of London, although he did not advocate that tramways should be permitted in streets where there was not sufficient space for at least one line of traffic alongside the curb. This meant that a double line of tramway could only be laid in a street having a minimum width of 30ft., or a single line in a street not less than 22ft. wide. Under these conditions he failed to see that the tramways would cause any obstruction to the traffic. In fact, he rather held the opposite view. Underground railways could not serve the travelling population in the same way as tramways, especially for short distances, whilst the enormous capital involved in their construction was against their extensive development. On this point, and the general utility of a comprehensive system of tramways throughout London, he largely agreed with the evidence given by Mr. Sellon (see *The Electrician*, January 15, 1904, p. 485), but was very emphatic that in such crowded thoroughfares as Lombard-street, the tramways would be best carried in subways. Such a comprehensive scheme, however, would be too large to be promoted by one company or one authority, and he

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thought it would be better to allow anybody to promote lines, but regard should be paid as to their suitability as forming part of the general scheme. He did not consider it was a practical suggestion that a board of locomotion should draw up a scheme of tramways for London. If the general principles upon which tramways were to be authorised were made known, a number of matured schemes would be placed before a traffic tribunal (if one were established), and it would not then be a difficult matter to come to a conclusion as to which schemes should or should not be adopted. Witness then discussed the advantages and disadvantages of the three methods of procedure in order to promote tramways in the United Kingdom. To summarise his opinions, they were as follows:—Relief should be given to both company and municipal promoters, there should be no frontagers veto, there should be no ratepayers veto against municipal schemes, and no local veto against company schemes. The right to promote tramway undertakings and to be the tramway authority should be extended to all county councils. He believed that the only satisfactory way to deal with the tramway legislative problem, whether applied to London or the whole of the country, was by the creation of a special tramway or street traffic board, probably forming a Government department. The Commission adjourned.

THE LATE MR. McMILLAN.

Mr. McMillan was such a favourite among all classes of members of the Institution of Electrical Engineers, that it is but natural they should desire their appreciation of his services and their sympathy with his widow and children to take practical shape. It has thus occurred to many that a fund might be established which should be placed at the disposal of Mrs. McMillan, and the Council of the Institution intend to establish such a fund, and to invite subscriptions from the membership generally as a tribute to the memory of their late Secretary. We do not doubt that there will be a generous response to this appeal, and that there will not be a single member, associate or student who does not contribute commensurately with his means. Mr. Henry Edmunds, acting on a generous impulse, has already issued a circular letter to some members of the Institution inviting their subscriptions, to which many have already responded, but we are given to understand that the Council will in the course of a few days issue a direct appeal.

At the meeting of the Institution of Electrical Engineers last night, the president (Mr. R. Kaye Gray) referred in the following terms to the loss which the Institution had sustained.

Before we commence our business this evening I have, in the name of the Council, to tell you that Mr. McMillan has died. You all have, of course, heard of it through the Press. I have no intention of saying to you, who knew Mr. McMillan so well, what his qualities were. We all miss him very, very much. There is only one thing I would like to say. He has left a widow and two children. Unfortunately, we cannot—not as a Institution—deal with the matter from a financial point of view as we would like to, and therefore the Council has decided to invite the members of the Institution to do what they can for those Mr. McMillan has left behind. The Council has done everything it can in other directions. You would like to express to Mrs. McMillan the sympathy you feel for her in her great loss, which I am sorry to say has been made more acute by the loss of her mother since Mr. McMillan's death.

Sir HENRY MANCE (Past-president), in submitting a resolution of condolence, said that if Mr. McMillan had one fault, it was that of extreme devotion to duty and to the care of the interests which were entrusted to him. It was a pleasure to work with him. He could only simply say that, whilst the Institution had lost a most valuable official, all of them had lost a personal friend. The resolution which he had to submit was the following:

"That the members of the Institution of Electrical Engineers, in full meeting, desire to express their profound sorrow at the death of their late secretary, Mr. Walter George McMillan, and to put on record their high appreciation of his personal character and those qualities which, as a scientific man and as an administrator, had contributed so much to the prosperity of the Institution; and also to express to Mrs. McMillan and the other members of the family their heartfelt sympathy under this sudden calamity."

Prof. JOHN PERRY, also a past-president, referred in feeling terms to the Christian life which Mr. McMillan had always led. Further, his capability to clear away difficulties was astonishing. The zeal with which he worked had been the subject of some remarks of his (Prof. Perry's) at the end of his year of office, and these remarks now bore a significance which did not then belong to them. He had said "I get the credit, but Mr. Mcmillan was the man who did the work. But there is a serious side to this power of Mr. McMillan to take up all sorts of work and pull it through. We are taking too much out of Mr. McMillan. There is a great deal too much output, and I am sorry to say it is an output with a large load-factor." Since making those remarks he had noticed the extreme "fag" which Mr. McMillan had shown. It was a great blow to Mr. McMillan's wife, but the blow would be lessened by the knowledge that her husband had earned the respect and gratitude of the Institution. Their mourning was nothing compared to Mrs. McMillan's. He had the honour to second the resolution.

The PRESIDENT said it was absolutely unnecessary to put the resolution to the meeting. With regard to the fund it was hoped to obtain £2,000. A fund, which had already been started had been handed to the Institution for management.

CORRESPONDENCE.

EDDY CURRENTS IN DYNAMO MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you allow me to reply as briefly as I can to the remarks made by Mr. M. B. Field in your issue of February 5th upon my Paper on eddy currents. (*The Electrician*, January 1st, p. 419, and January 8th, p. 449.)

Towards the end of the first column one finds the following:—"It appears that it is the latter [experiments on solid rings] the author has based his deductions upon, with the result that his conclusions are certainly misleading." In the last paragraph of § 2 of my Paper it is said that, "To show that the greater part of the eddy-current loss does not take place in the armature an alternating current was passed *through the armature* by means of the slip rings [this was done later through the commutator. See Appendix to Paper.] and the losses separated by the method given in the Appendix."

The greater part, therefore, of Mr. Field's remarks, based on this misreading of the whole meaning of the Paper, does not bear on the main point at issue. The ring experiments* were undertaken to find what kind of loss is obtained at higher frequencies than those used by Profs. Hopkinson and Wilson, and they in no way affect my final argument, which relies entirely upon the experiments on laminated cores. This argument is, shortly, as follows: The hysteresis loss in armature cores is known to a very fair degree of accuracy. If one can find the ratio of the hysteresis to the eddy-current loss the latter is also determined. I have done this, and find that the eddy-current loss is always less than the hysteresis. It is so even in rotating fields, a point not mentioned in the Paper, but brought out in reply to Mr. Stoney, who raised it in the discussion which followed the Paper. Under the conditions of practical working the ratio of hysteresis to eddy-current loss in the armature is, in the case of the machine tested, 0·85 of the ratio obtained with alternating fields, and is always of this order. The total eddy-current loss being about 30 per cent. of the total losses in a good modern machine, and the hysteresis loss about 10 per cent., it follows that there is a very large percentage of the eddy-current loss unlocalised, especially when the machine is on load. This can only occur in the solid masses of iron which form the magnet cores and yoke.

The coefficient 0·85 is derived as follows: Prof. Baily's experiments showed that the hysteresis loss is increased by 54 per cent. when a flux density of 8,000 lines per square centimetre is reached in a rotating field, as compared with a simple alternating flux. He also calculated that the eddy-current loss increases by 80 per cent., so that the resultant effect on the ratio of hyteresis to eddy loss is to reduce it in the proportion $1{\cdot}54/1{\cdot}8 = 0{\cdot}85$.

With regard to the straight-line law connecting torque and speed in motors running light, Mr. Field states that "the loss in the solid portion is proportional to $\sqrt{n}$."

I have always taken Heaviside's articles on "The Induction of Currents in Cores" as the most complete theoretical investigation of the subject known to me. The expression given there† for the watts lost by eddy currents in a solid core surrounded by an alternating current is

$$w = \frac{4\pi l}{\rho}(\pi^2 c^2 \mu n)^2 (\mathrm{NI})^2 \mathrm{Y}.$$

* The theories of Heaviside, Thomson and Ewing all assume constant permeability, which is never true in alternating-current practice.

† "Electrical Papers," Vol. I., p. 364 (36).

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From this follows the statement in the Paper that the loss is proportional to μ^2/ρ and to n^2. Where Mr. Field has obtained his $\sqrt{n}$ law from I do not know. My point with regard to the greater loss in iron than copper should, I think, be clear. It is that for a given variation in the resultant ampere-turns of excitation, the eddy-current loss is 500,000 times greater in iron than copper cores of the same dimensions.

No one has yet theoretically investigated the case where, instead of the ampere-turns, the reluctance varies. The boundary conditions are no longer the same.

Figs 4 and 6 are, as stated in the Paper, graphs of $\mathbf{B}/\mathbf{H}$, and $\mathbf{H}$, for the complete hysteresis loop. If μ were defined as $d\mathbf{B}/d\mathbf{H}$ they would, of course, be different, but it is not.

I do not gather from the article whether he has realised that, in the motor method of separating losses, eddies in the field magnet cores exert a retarding torque on the armature. It is for this reason, chiefly, that exact localisation of the loss has been hitherto unattempted, although makers have so far realised solid-core-loss that laminated poles and yokes are now common. The eddies are mostly caused, I believe, by unsymmetrical armature core construction.

With regard to the converter tests in Table VII., the facts, as stated, are correct, for in order that the speed and excitation should be the same the voltage on the first machine had to be controlled by a regulating resistance. The wattmeter readings are quite reliable and the curves have been plotted from them. The ammeter and voltmeter readings have been given as taken, to show under what general conditions the machines were working.

Finally, Mr. Field says that "dynamo makers calculate the hysteresis and eddy-current losses in armatures by well-established formulæ, of the approximate correctness of which there can be no doubt." This is perfectly true if for "armatures" one reads *machines*. It is a pity that the discussion at Newcastle was not fully reported, or Mr. Field would have learnt this from the makers themselves.

I thank you, Sir, for this opportunity to correct misunderstanding. To me it is a matter of regret that we now live so rapidly that criticism must often be hasty. No doubt, in this case of eddy-current distribution evidence will accumulate by which, in time, manufacturers and users of dynamo-electric machines will generally accept or reject my conclusions.—Yours, &c., W. M. THORNTON.

Newcastle-on-Tyne, Feb. 8.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I note that Count Arco, in his letter published in the last issue of your paper, says:—

In a lecture before the Queen and King of Italy he (Marconi) agreed that the employment of the closed exciter circuit for transmitters is due to Braun, and that these patents possessed priority over his own. He maintained his priority only in connection with the tuning of both oscillating systems.

This is not a correct statement of what Mr. Marconi said on the occasion referred to, and conveys a wrong impression. The exact words used by Mr. Marconi, which appear on p. 15 of the official publication of the Associazione Elettrotecnica Italiana, and edited by the Unione Cooperativa Editrice of Rome, were as follows:—

Il Prof. Braun ha suggerito anche egli l'uso di un condensatore associato al filo aereo; ma non mi consta ohe prima della data dei miei brevetti egli abbia riconosciuto l'assoluta necessità dell'accordo dei due circuiti, condizione senza la quale non é possibile trasmettere a considerevoli distanze.

Which may be translated:

Prof. Braun also has suggested the employment of a condenser associated with the aerial wire; but I am not aware that he recognised, before the date of my patents, the absolute necessity of the two circuits being in tune, without which condition it is impossible to transmit over considerable distances.

Mr. Marconi was describing in his lecture a certain arrangement of advantage which he had patented. He mentioned incidentally that a certain part of his arrangement—viz., the use of a condenser associated with the aerial wire—had been suggested also by Prof. Braun, but that this part of Marconi's general arrangement was of no utility by itself, that there was no value in using the condenser unless certain further arrangements were made—viz., the attuning of the transmitting circuit to the receiving circuit—the complete arrangement, the tuning of the circuits and the use of the condenser in one of them being the subject of Marconi's patent. The essential part of the arrangement Marconi describes in his patent is the tuning of the two circuits; the condenser circuit is a means to this end. There is no value in the employment of a closed oscillatory circuit for the production of oscillations in the aerial wire, unless that closed oscillatory circuit is tuned to the same period as the aerial wire.—Yours, &c.,

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.).
London, E.C., Feb. 10. H. Cuthbert Hall.

PARLIAMENTARY INTELLIGENCE.

FIRE RISK IN TUBE RAILWAYS.

Mr. GERALD BALFOUR, in the House of Commons on Monday, replying to Sir T. Dewar, said that the precautions which are, or might be, taken against the risk of fire on tube railways were discussed last autumn by the officers of the Board of Trade and those of the several tube railways open for traffic or in course of construction. The Board's chief inspecting officer of railways and their electrical adviser subsequently drew up a list of recommendations on which the observations of the companies were invited. When finally settled, these recommendations would be imposed as requirements so far as the powers of the Board allowed.

POST OFFICE TELEPHONE SYSTEM.

In reply to Sir T. Dewar in the House of Commons on Monday, Lord STANLEY said that nine Post Office telephone exchanges have been opened in London and three others were being constructed. On February 4, 15,020 telephones were working in connection with these exchanges. The expenditure for the working lines, and for a large amount of general construction available for the further development of the system and the establishment of additional exchanges amounted, on November 30, to £1,441,775. Parliament, when providing money for telephone capital expenditure, did not allot a defined portion of expenditure in London. The sums provided for general expenditure would be exhausted by the end of the present financial year, and he proposed at the earliest opportunity to ask leave to introduce a bill to provide further moneys for the extension of the telephone system.

UNDERGROUND TELEGRAPH CABLES.

In the House of Commons on Tuesday, Lord STANLEY stated that underground telegraph cables were now laid continuously from London to Carlisle, and a section of 19 miles was being laid over the Beattock summit in Scotland. By the end of the financial year a double line would also be laid between Manchester and Leeds.

ELECTRICITY IN MINES.

Mr. AKERS-DOUGLAS, in the House of Commons on Wednesday, stated that he was now considering the best steps to take with the view of establishing special rules in accordance with the regulations attached to the report of the Departmental Committee on Electricity in Mines.

The following are amongst the petitions which have been entered against bills of an electrical interest:—Barking Urban District Council against the East London and Lower Thames Electric Power Bill; Willesden Urban District Council against Harrow-road and Paddington Tramways Bill and the London County Council Tramways Bill.

The Torquay Tramways Bill has been passed as having complied with Standing Orders, as also have the South-Western and Isle of Wight Junction Railway (Extension of Time) and the Harrow-road and Paddington Tramways Bills. When the North Yorkshire Dales Railway Bill came before the Examiners of Private Bills for notification of compliance with Standing Orders no appearance had been entered, and the measure was accordingly marked "dead." The bill took powers to incorporate a company with a capital of £960,000 for the construction of surface electric railways between Hellifield and Scorton in the West Riding of Yorkshire, a distance of about 51 miles, and to acquire land for three generating stations. The borrowing powers amounted to £450,000.

Lincolnshire and Yorkshire Electric Power Bill.—A conference of delegates representing the local authorities affected by this bill was held at York last week. The towns represented were York, Hull, Scarborough, Beverley, Ripon, Harrogate, Bridlington, Filey and Hessle. It was unanimously resolved that the bill be opposed by all local authorities affected, each authority depositing a separate petition, as their interests were not identical.

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LEGAL INTELLIGENCE.

Colwell and Others v. St. Pancras Borough Council.

This case came before Mr. Justice Joyce on Wednesday, Thursday and Friday last week.

Mr. HUGHES, K.C., for the plaintiffs, said the action was brought to restrain a nuisance caused, or alleged to be caused, to plaintiffs by defendants in the working and use of an electricity generating station and dust destructor at King's-road, Camden Town, London.

His LORDSHIP asked if defendants had statutory power for the nuisance.

Mr. HUGHES said they had not. The defendants were undertakers under the Electric Lighting Acts. The plaintiffs were leaseholders and occupiers of five houses in Great College-street, defendants being the freeholders.

His LORDSHIP: I suppose you are asking too much all this time?

Mr. HUGHES said defendants had bought up the various interests of the other houses running along Great College-street. Defendants' scheme was not as it sometimes was where an electrical generating station was worked in conjunction with a dust destructor, the heat generated in the destructor being used to generate electricity; but there was one shaft between the two and common to both. He did not think that the two undertakings were worked together except to that extent. The electrical generating station had been in operation for some years. In May, 1902, having found it necessary to increase their power defendants determined to put in a very greatly increased plant, including three large engines of 750 I.H.P. The engines driving the continuous-current dynamo did not run in step, and they got a certain periodic increase and decrease in the vibration. In May, 1902, defendants began working, but not at full load. At this time persons occupying plaintiffs' houses began to find at various times a very great increase in the vibration, and complaints began, which ultimately culminated in this action. The defendants in their defence said that the engines were at present defective in balance and consequently did not run smoothly, but that this defect could be remedied if time was given for that purpose.

Evidence was given on behalf of plaintiffs by Col. R. E. CROMPTON, C.B., who said he was instructed last October in connection with this case and made an examination and inspection of the premises for the purpose of this action in January, which was, he supposed, the time of maximum load. He noticed distinct vibration, which undoubtedly was caused by reciprocating machinery. He afterwards went to the generating station, and asked that the engine might be shut down. This was done, and this reduced the amount of vibration to an extent that nobody could possibly doubt or deny. There was no trace of vibration set up by the passing of tramcars or waggons.

Mr. J. J. BOURNE, A.M.Inst.C.E., corroborated, and other evidence was tendered.

At the close of the plaintiff's evidence,

Mr. BEAUMONT (also for plaintiffs) said with regard to vibration and the time which elapsed before the action was commenced, the nuisance caused before defendants put in their heavy machinery was very slight. The real nuisance occurred when the heavy machinery was put in. He did not suggest that defendants had not tried to minimise the nuisance, but they had not succeeded at the time the action was commenced, though it was now less than formerly. He (counsel) without binding himself, said he felt that if defendants removed the new engines plaintiffs would not have much cause to complain. The nuisance from noise and dust was also considerable, and the smell from the destructor was highly objectionable. The injunction he sought was to restrain defendants from working their electric generating station and dust destructor so as to cause a nuisance or injury to occupiers of plaintiffs' houses by vibration, noise, dust and offensive smells, or so as to injure the structure of the said houses.

His LORDSHIP said he did not see what right the reversioners had to sue at all except for damage to the fabric.

Mr. BEAUMONT said vibration would cause injury to the structure.

Mr. BOUSFIELD, K.C., for defendants, said that there were two or three separate causes or alleged causes of action. As to the minor matter of the dust destructor, defendants had no wish to annoy the inhabitants of the district. Ever since 1895 they had been improving their arrangements. There was really nothing which any reasonable person could complain of Then as to the electric lighting plant, it must be of importance to him to establish that, as regarded the old plant, there was nothing of which any reasonable person could complain. They had got the fact that the old plant was at work in 1895, and had been working ever since. It was an extremely strong observation to make with regard to the old plant to-day that nobody ever really complained about it. He would now come to the new engines. At no time had the vibration been of anything more than a temporary character. He should submit that a public body doing its best to discharge its statutory duty with reasonable skill was entitled to a certain amount of grace, and if, notwithstanding the amount of skill and experience the body could bring to bear upon it, there was a temporary nuisance it was not a case for an injunction. That was the state of things before the writ was issued. He submitted that on and from Jan. 8 there was nothing which any reasonable person could complain of. The great authority on the question of the balancing of engines was Prof. Dalby, and defendants had put themselves in that gentleman's hands. Defendants thought their engineers should have time to complete their experiments. Defendants were under a statutory duty to supply the district with electricity.

His LORDSHIP: You say the limit of your duty is to use all reasonable precautions against causing a nuisance.

Mr. BOUSFIELD: Yes.

Major PHILIP CARDEW (called for defendants) said he had attended at defendants' station at various times when the electric lighting plant was running. In January he found two alternators and some of the older plant, which were synchronised while he was there. There was no difficulty in synchronising the engines so that they ran to balance one another. From what he saw there was very little vibration. The engines were running quietly, but there was a slight noise from the escape of steam. He went to Great College-street, and found a certain amount of vibration. He could not feel anything while sitting in a chair. In some of the rooms of the houses he could not detect any vibration. On Jan. 11 defendants had more plant running—two alternators and six small sets. The load was not very large at that time, but the machinery was running at full speed. He went again to Great College-street, and the vibration seemed less distinct. At these tests practically everybody was present. The houses were not of very solid structure, and the floors shook a little as you moved over them. Witness spoke as to other experiments he had made, and said that such vibration as there was proceeded from the new machinery. He had been informed of what had been done by defendants up to the present, and, in his view, those who were responsible for the undertaking had done, and were doing, all that reasonable skill could do to remedy the vibration. He had no doubt that the engines would ultimately be brought into perfect balance. He quite agreed with what Prof. Dalby was doing in the matter, and thought the vibration would be perfectly cured. He thought the vibration was caused through defective balancing of the engines, and mathematical balancing of the engines would be a perfect cure.

Prof. DALBY said he had devoted particular attention to the subject of the balancing of engines. He had seen defendants' engines. They were of the type usually employed in electricity generating station work. Experiment proved that such engines showed no vibration in certain conditions. He had experimented in the past for this sort of thing and he had not the slightest doubt that he would cure the vibration in this case. The necessary work would take some months. He was not aware that at Manchester electricity works they had to give up reciprocating engines and have turbines.

Mr. BLAIR, defendants' engineer, also gave evidence as to the alleged nuisance from the dust destructor.

On Monday morning Mr. Justice JOYCE delivered judgment. He said this action was instituted on Nov. 30, 1903, and it was virtually admitted that by reason of the vibration caused by defendants' works at various times plaintiffs had a right to complain of the annoyance to which they had been subjected, or, rather, a right to complain unless it were merely a temporary annoyance. It was such an annoyance as it continued defendants could not deny to be a nuisance in law. That was virtually admitted, but, if necessary, he decided the facts that that was so. It appeared to him that by the vibration so much nuisance had been occasioned as to justify the action unless the defendants could show that they were entitled to cause a nuisance by reason of its being, as they alleged, a temporary nuisance, or by reason of something in the nature of the annoyances referred to. He was of opinion that the amount of the annoyance caused had been a material interference with the comfort of the plaintiffs. In this particular case the annoyance caused had not been temporary and occasional personal inconvenience, but, in his opinion, was such as was calculated to work material injury to the property of the plaintiffs, and, beyond all question, was most serious, and likely to depreciate the value of plaintiffs' property. In this particular case there was a clause in the order which authorised the work that nothing in the order should exonerate the undertakers from any indictment or proceeding for nuisance in the event of any nuisance being occasioned by them. What it really came to was that, notwithstanding that order, it was suggested that for months, or it might be for years, after the first erection or construction of the works the defendants were entitled to make the neighbourhood uninhabitable or to cause annoyance and vibration until the time might have arrived when they should have contrived or managed in some way or other to carry on their works without creating a nuisance. What was to happen if they never succeeded in doing that no one was told. However, that proposition, to him, was entirely wrong, and was one to which he was quite unable to accede. He would rather say that after the construction of their works, if not before, the owners of these works, particularly under an order like this, were not entitled to carry them on at all, unless and until they could do so without occasioning a nuisance to the neighbouring owners of property. In his opinion there must be an injunction, not distinguishing in any way between the old machinery and the new, restraining defendants from carrying on these works in such a way as by vibration, noise or otherwise, to occasion a nuisance or injury to plaintiffs during the continuance of their lease, and there must be an inquiry as to damages. This order would be without prejudice to any question in reference to any nuisance or annoyance that might be caused by the working of the dust destructor after March 30 next, and the defendants must pay the costs of the action.

His lordship suspended the operation of the injunction for six months, saying there was to be no nuisance and vibration between 12 p.m. and 7 a.m., and after May 1 between 11 p.m. and 7 a.m. The inquiry as to damages would be directed to the separate interests of the plaintiffs.

Corporation of Swansea v. the Swansea Improvement and Tramway Co.

In the Chancery Division on Tuesday Mr. Justice Buckley heard an action in which plaintiffs claimed a declaration that upon the true construction of the Tramway Act, 1870, and Swansea Tramway Act, 1882, plaintiffs were entitled to require the defendant company to sell, and the defendant company were thereupon bound to sell to plaintiffs the whole of the tramway undertaking within the borough of Swansea. They also

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asked for a declaration that upon such purchase being made defendant company were not entitled to have any lease granted to them by plaintiffs for the purchased property or any part thereof. The defence was that the Board of Trade had properly refused to sanction the purchase, as the time was not yet ripe, and defendants claimed the right to oppose sanction being given by the Board of Trade.

Mr. WARMINGTON, K.C., for plaintiffs, said it was a question of law as to the true construction of certain Acts of Parliament, more especially Acts of Parliament passed in 1882, having regard to the statutory powers given by the general Tramways Act of 1870 to local authorities to buy tramways. There were four special acts including provisional orders—the Acts of 1870, 1874, 1878 and 1882. Under the Act of 1874 the company were empowered to work the tramways. By the Act of 1878 other tramways were authorised to be constructed by defendants. In that year also parts of the Act of 1870 were incorporated. The important point under the Act of 1870 was that a corporation might purchase within six months after the expiration of a period of 21 years, and within six months after the expiration of every subsequent period of seven years, with the approval of the Board of Trade. The question was as to plaintiffs' position with regard to the Act of 1882 and the part of the act requiring a notice of sale to be given. The first time they could purchase was thus within 21 years of the passing of the act mentioned. The Act of 1882 thus raised a different set of circumstances to that which had existed under the other acts, and the question was the construction of that act. The Corporation might at any time within six months of the passing of the 1882 Act give notice, and at any time within one year might purchase, upon such terms approved by the arbitrators in a manner provided by the Board of Trade under the Act of 1870, so much of the tramways as should be then constructed. It was also provided that the company should do nothing to increase their system unless the Corporation should give notice that they would not construct tramways. That section never came into force, for there was no election on the part of the Corporation to construct tramways, nor did they then elect to purchase. The Corporation did subsequently give notice of purchase.

The JUDGE: Within six months?

Mr. WARMINGTON said the method was to frame a notice, to submit it to the Board of Trade, and if the Board of Trade approved they sent it to the company. The plaintiffs had framed a notice and submitted it to the Board of Trade. The Board of Trade sent the notice to the Tramway Company and asked whether they had any objections. In this case objection was made that it was impossible because sec. 35 of the Act of 1882 prohibited any purchase within a period of 21 years, and that period would not expire until 1906. Plaintiffs contended that under this section the law gave them a new period for the purchase of the tramways.

The JUDGE: What is 1906?

Mr. WARMINGTON: The period when the 21 years will expire. Plaintiffs desired to know what their position was and asked that sec. 35 of the Act of 1882 consolidated the various dates at which the tramways were constructed and, instead of allowing them to have different dates, to make one new date—viz., Feb. 28, 1906. All the Corporation wanted to know at the present stage was whether they could give an effective notice, and if so, when?

Mr. HALDANE, in reply to his Lordship, said his clients would be glad if the point was decided.

Mr. WARMINGTON, continuing, argued that sec. 35 of the Act of 1882 gave a new right to purchase all the amalgamated tramway undertaking. The right of purchase under sec. 35 was a somewhat different right to that under the Act of 1870. They had to buy other things under sec. 43 of the 1870 Act. Sec. 35 contemplated the sale as a going concern. His clients' point was that, if they elected to exercise their rights under the Act of 1870, they would not be able to bring into operation sec. 34 of the Act of 1882..

Mr. HALDANE said sec. 36 conferred a new power to purchase. It was a negative clause; they were not to purchase any of the tramways otherwise than by agreement until an expiration of 21 years. He submitted that, taking sec. 35, they had nothing there but a restriction which owed its origin to the Act of 1870 alone.

Mr. BUCKMASTER submitted that the Acts of Parliament contemplated the purchase of the four tramways at different times.

JUDGMENT.

On Wednesday judgment was delivered.

His LORDSHIP said plaintiffs asked the Court to declare what were the rights as between plaintiffs and defendants in an uncertain future—namely, in the event of the plaintiffs availing themselves of a statutory option to purchase defendants' tramways. The defendants concurred in asking the Court to say what those rights were. The question depended upon the construction of a certain Act of Parliament. But for the request on the part of the defendants he should have felt considerable doubt as to whether he could thus prematurely declare what the rights would be in a future event, but it seemed the defendants also wanted to know his view. He left the question open as to whether the declaration he now made would be binding in certain circumstances. The facts were that, in 1882, defendants held three statutory rights of making tramways, and had made, in whole or in part, tramways under those several authorities. They were respectively dated 1874, 1878 and 1879. In each case Part III. of the Tramways Act, 1870, in which sec. 43 was included, applied, and the result was that at certain intervals (the first of which was 21 years) from each of the three dates, and subsequently at intervals of seven years, plaintiffs had statutory rights, if they were so minded, to buy those three respective tramways. The earliest dates at which those several options would arise were 1895, 1899 and 1900. In that state of facts, in 1882 was passed the act which I have to construe. The Act of 1882 contained sec. 35 upon which the question to be determined arose. The act incorporated Parts II. and III. of the Tramways Act, 1870, and thus included sec. 43 of the Act of 1870, and by sec. 3 it defined the tramways as meaning the tramways of 1882. He therefore had to read the Act of 1882 as if it contained sec. 43 of the Act of 1870, and contained also sec. 35 of the Act of 1882. Sec. 35 created in the plaintiffs a new right of purchase altogether in the tramways. The plaintiffs sought to say that a new statutory option to purchase all four sets of tramways, as forming one amalgamated undertaking, had become vested in them. He was unable to arrive at any such conclusion. He did not think the section had any such effect. Sec. 35 of 1882 was not affirmative but negative. It proceeded on the footing that there being already, by virtue of sec. 43 of the Act of 1870, a right to purchase at various dates, to be ascertained in the way he had mentioned, the Corporation should not purchase except in the way mentioned in sec. 35. It was addressed to two sets of facts—the first where the lease of the tramways or some part of them had been granted by the Corporation to the company, in which case, during the existence of the lease, the Corporation were not to buy the company out unless the company agreed; and, in the second case, where no lease had been granted, they were not to buy until the expiration of the 21 years from the completion of the tramways. Originally the time was 21 years, not from completion, but from authorisation. As a matter of fact, the tramways were completed in 1885. The effect of sec. 35 was that until 1906 the Corporation were not to exercise the statutory power to purchase conferred by sec. 43 of the Act of 1870. There was no new right of purchase at all. It was a pro-prohibition, restriction or limitation imposed upon the existing right of purchase. The plaintiffs had said that if that was so the result would be very extraordinary—that if a lease was granted it might postpone the right of purchase for several periods of 21 years. So far as his lordship saw, that was so. He did not see anything irrational in that state of things which would lead him to come to a contrary conclusion. The object might have been to keep the whole undertaking in the hands of either the company or the Corporation. He agreed that that would have the effect of preventing the Corporation from becoming masters of the situation for a much longer time, but that was perfectly sensible and perfectly intelligible. He thought, therefore, he ought to declare on the first point, that upon the true construction of sec. 35 of the Act of 1882 the effect was not to create any new right in the plaintiffs to purchase the tramways or any of them but only to restrict or limit the right of purchase existing by virtue of sec. 43 of the Act of 1870. On the second, or subsidiary, point he must declare, according to the true construction of sec. 34 of the Act of 1882, the purchase there mentioned was not, as regarded the tramways of 1882, confined to a purchase under sec. 32 of the Act of 1882, but included purchase under sec. 43 of the Act of 1870.

He accordingly made those two declarations.

Ferranti Limited.

In the Chancery Division on Tuesday, Mr. Justice Byrne had before him the petition of Estler Bros., creditors, for the compulsory winding-up of Ferranti Limited on the ground that the company was insolvent. A large body of debenture-holders opposed the petition.

Mr. BUCKMASTER, K.C., for petitioners, said they were creditors for £827, partly for goods sold and delivered and partly in respect of dishonoured acceptances. In December, 1901, the company issued £100,000 first mortgage debentures, and on the terms of that issue hung a great deal. Since December last receivers and managers carried on the business for the debenture-holders. They prepared a circular and balance-sheet, which showed £413,597 assets and secured creditors £100,000. In these circumstances the petitioners could not get paid. The Company had not filed any affidavit in answer to the petition, but the debenture-holders, through Messrs. Tate and Whittaker, the receivers and managers, had put in an affidavit in answer. The matter stood over from time to time pending the settlement of a scheme, but nothing had come of it, and now it seemed that the directors had determined to effect a voluntary liquidation of the company. Counsel said he objected to a voluntary liquidation because, under the terms of the trust deed, if there were a voluntary liquidation, the holders got a bonus of 10 per cent. on their debentures. If it were compulsory they would only get 5 per cent.

Mr. GEO. HENDERSON, representing creditors for £14,000, supported the petition.

After hearing counsel for the company, the petition was ordered to stand over.

Electric Tramways Construction and Maintenance Co. (Ltd.)

The petition of Alldays Limited, for the winding-up of this company was in the list on Tuesday, but counsel for petitioners asked leave to withdraw. His clients had arranged with the company. Other counsel appeared for creditors who supported the petition and had not been settled with and desired to be substituted as petitioners.

Mr. Justice BYRNE made an order for substitution, and gave leave for the necessary amendments of petition.

Re Geipel's Steam Trap Patent.

In the Court of Appeal (Lords Justices Vaughan Williams, Stirling and Cozens-Hardy) on Monday, judgment was delivered on the appeal of William Geipel from an order of Mr. Justice Buckley directing a patent, No. 7,860, granted to him in 1893, to be revoked unless disclaimer of two figures in the complete specification were made.

Lord Justice STIRLING read the judgment of the Court. He said the present appeal related to only so much of Mr. Justice Buckley's order as referred to one of the figures in Mr. Geipel's specification (No. 7,860, 1893), the patentee admitting that as regarded the other figure the decision of the Court below was well founded. The ground upon which it was sought to revoke the patent was that there was disconformity between the provisional and complete specifications.

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Their lordships, in the result, held that there was no disconformity between the provisional and complete specifications, the figure in the complete specification being merely a development of a figure found in the provisional specification. The appeal was accordingly allowed.

Workmen's Compensation Act.

At Salford County Court on Monday, before Judge Parry, a moulder named John Alfred Hill sought to recover £200 from the British Westinghouse Electric and Mfg. Co. (Ltd), Trafford Park, for personal injuries. Plaintiff was a moulder earning 37s. 2d. per week, and alleged that while carrying some molten metal by the "shanks" the latter broke, and he received injuries which had affected him seriously. Defendants admitted the apparatus in question had not been tested. The medical evidence was conflicting A consulting surgeon called in by defendants said that by an electrical test he was satisfied plaintiff had power to grip. The judge suggested a reference to a medical expert in nervous diseases, but counsel for defendants urged that the case was a surgical one.

Plaintiff was awarded £75 damages. £25 had been paid into court.

MUNICIPAL, FOREIGN, & GENERAL NOTES

APPOINTMENTS VACANT AND FILLED.

An engineer is wanted to take charge of a power house, also a superintendent for mains and sub-stations. Applications to Midland Electric Corporation for Power Distribution (Ltd.), 73, Lichfield-street, Wolverhampton. See advertisement.

Bradford Corporation require an assistant electrical engineer. Salary £250 per annum. Applications to the town clerk (Mr. Frederick Stevens) by 18th inst. See also advertisement.

The Technical Education Board of the London County Council require a principal for their new Poplar Technical Institute. Commencing salary, £500. Applications by 13th inst.

A London engineering firm advertise for a representative with a connection among shipbuilders, engineers, &c. Office accommodation in Glasgow will be provided.

Mr. J. Telfer, superintendent on the Rotherham Corporation tramways has been appointed manager of the Warrington Corporation tramways. Mr. Telfer takes up his duties on March 1.

EDUCATIONAL NOTICE.

Electrical Standardising, Testing and Training Institution.—Prof. C. A. Carus-Wilson, M.A., M.I.E E., will commence a special course of lectures to the senior students of this Institution upon "Direct-current Motor Construction," on Feb. 18. Mr. J. B. C. Kershaw, F.I.C., will deliver a lecture on "Fuel Economy" on Feb 20.

Acton.—The Council have received offers for the supply of electricity in bulk from Hammersmith Borough Council and from the North Metropolitan Electric Power Supply Co., but have decided to adhere to their decision to accept the offer of the Metropolitan Electric Supply Company.

Aerial Bridge over the Weir.—The Bridge and Ferries committee of Sunderland Corporation have rejected an offer for the construction of an aerial bridge over the River Weir on the cantilever principle, the motive power being electricity. The estimated cost was £20,000.

Airdrie and Coatbridge Tramways—The official inspection of these tramways took place on Thursday last, and the lines were opened for traffic on Monday.

Barnet.—A draft agreement between the Council and the North Metropolitan Electrical Power Distribution Co. for the supply of electricity under the Council's electric lighting order (1900) has been approved by the Council.

Batley.—The report of Major Druitt, Board of Trade inspector, as to the accident to an electric tramcar on Jan. 16 has been issued. The report attributes the blame to the driver Bowers, who (according to the report) drove the car at an excessive speed on approaching a curve. Bowers alleged that when he applied the Westinghouse brake it had not the slightest effect, but Major Druitt says the brake was found to be in good order after the accident. There is an appreciable interval of time between the moment of applying the Westinghouse slipper brake and the braking effect being felt, and Major Druitt thinks it most probable that Bowers, feeling no immediate effect on the car, jumped to the conclusion that the brake had failed, and at once took it off, intending to stop the car by another method. In his hurry he performed the wrong motions.

Battersea (London).—The Borough Council on Wednesday decided to carry out mains extensions, &c., at an estimated cost of £770. £60 is to be spent in connection with experiments in the conversion of gas-lamp columns for electric lighting.

Belgian Labour Conditions.—In view of the discussion which ranged round the recent placing by the London County Council of an order for tramrails in Belgium, a report upon the labour conditions in that country, recently made by Sir Brooke Boothby, is interesting.

The report states that there is no fixed price for Belgian tramrails, which is governed mainly by the size of the order. Basic steel is used in their manufacture, as this is considered by Belgian manufacturers cheaper and more suitable than Bessemer steel. In the works where these rails are made the hours of work are longer, wages smaller, and holidays fewer than in the United Kingdom. Skilled workmen receive 3·8d. per hour, ordinary workmen 2·37d. to 3·32d, and youths 0·76d. to 1·42d. The hours of work are 59 per week, and overtime is paid one-fourth extra.

Berlin–Hamburg Express Electric Railway.—Definite schemes have been elaborated for the construction of the above lines. Two projects have been placed before the German Government, and it is said to be probable that an early decision will be arrived at in respect of one of the schemes. Both schemes propose the erection of a central generating station at Wittenberg, and one contemplates the use of the existing railway stations along the route, The traffic between Berlin and Hamburg has become so heavy that the laying of a third track has become necessary for the steam trains. The journey between Berlin and Hamburg now takes three hours by express, and both the electric schemes provide for this being reduced to 1½ hours.

Brussels–Antwerp High-speed Railway.—It is announced that the electric high-speed railway from Brussels to Antwerp, which has been in contemplation for more than three years, is about to be constructed. It is to reduce the period of the journey from 60 minutes, as at present, to 20 minutes.

Burnley.—Another tramway route has been opened for traffic. The expenditure on electric tramways to date is about £170,000.

Camberwell (London).—The Council have decided to petition against the London and Lower Thames Electric Power Bill, in order to obtain a clause to prevent the company from supplying any railway or other company having running powers in the borough.

Charity.—We have received from the hon. sec. (Mr. W. W. Jiggens) a copy of the first annual report and accounts of Callender's Hospital and Distress Fund, which was initiated at the Belvedere Works and the fund started with a portion of the balance over from the late Reservists' Fund. The distress fund has met with the almost unanimous support of the employés at the works, of whom no less than 1,376 are subscribers. During the year nearly £290 has been paid in, and this has been supplemented by donations to the amount of over £80, enabling the committee to distribute grants to hospitals, convalescent homes, &c., to the extent of £210. This excellent fund starts its second year of existence with a balance in hand of £153. The management is entirely voluntary.

Chepstow.—An inquiry was held here last week into the complaints as to the manner in which the Chepstow Electric Light and Power Co. had laid their mains. After taking evidence Major Cardew laid the mains bare at certain points. His report will be presented in due course to the Board of Trade.

Cheshire Electricity and Power Gas Scheme.—In the bill of the Cheshire Electricity and Power Gas Co. power is sought to enable the company to supply electricity in bulk and to manufacture and distribute power gas for power and heating, but not for illumination :—

The price to be charged for power gas is not to exceed 3d. per 1,000 if over 4,000,000ft. are consumed per quarter, or 4d. per 1,000 if less than that quantity is taken. The price for electricity will range from ¾d. to 3d. per unit. The promoters are Messrs. H. Brunner, E. B. Lupton, W. M'D. Mackey, A. Mond and W. E. Rowcliffe. The first directors will comprise Messrs. A. Lupton, W. M'D. Mackey, A. Mond and six others. The capital is to be £1,000,000 in £1 shares, but with power to divide these shares into preferred half and deferred half shares. It is proposed to issue debenture stock to the extent of £333,000.

Dartmouth—At the Council meeting last week Mr. Medway congratulated the members upon the considerable improvement in the lighting of the town by electricity. For the last quarter the Council paid £94, against £99 previously paid for gas. For the smaller sum they had 11 extra lamps and 19 all-night lamps, against nine gas lamps, and five times the candle-power.

Derby.—A long discussion took place at the last Council meeting on the recommendation of the Parliamentary committee to grant the National Telephone Co. permission to place their cables underground. Some members favoured the erection and equipment of a municipal telephone exchange, but eventually the report was carried by 32 votes to 19.

On the minutes of the Tramways committee Councillor Newbold called attention to the fact that Messrs. Thomas Nash & Sons, who had been appointed to test the Belgian rails for the electric tramways, had reported that certain rails submitted to them were not in strict accordance with the specification. The committee being of the opinion that the defects were not of a serious nature, had decided to accept 400 tons of the rails, which had already been rolled, on the distinct understanding that no further rails would be taken by the committee which were not absolutely within the terms of the specification. The committee's report

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was adopted, and an undertaking was given that the contractors should be requested to employ as many local men as possible on the work, having regard to the large numbers of unemployed in the town.

Property has been purchased in Full-street for extending the lighting station.

Ealing.—An inquiry was held last week into the application of the Council to borrow £25,000 for electric lighting extensions. The business manager, Mr. Lewis, said they now had 1,700 consumers connected, with the equivalent of about 57,000 8 c.p. lamps; also 160 prepayment meters.

Electric Haulage on Canals.—Nottingham Chamber of Commerce has received a communication from the Trent Navigation Co. stating that the Government intend to introduce this session a bill extending the powers conferred under the Railways (Electrical Powers) Bill to inland navigation.

Electro-Thermic Process in Steel Manufacture.—A correspondent from New York writes as follows:—

The Canadian Government has established a commission to investigate European methods of manufacturing steel by the electro-thermic process. The members of the commission are Dr. Eugene Haanel, superintendent of mines in Canada; Mr. C. E. Brown, electrical engineer; Mr. Nystrom, draughtsman; Mr. Thomas Cota, secretary; an English steel expert, and a photographer, who will be added to the party in Europe. Plants in Sweden, France and Italy will be examined, and the Dominion Government believe that the work will do much to encourage the development of iron mining and steel manufacturing in Canada, electrical energy being generated by water power.

Exhibition.—It has been decided to postpone the opening of the exhibition at Milan, Italy, until April, 1906.

Farnham.—The Council have decided to take no further action in connection with the electric lighting order (1900).

Glasgow.—The Electricity committee's report presented to the Corporation last week (which was approved) recommended the ordering of three steam turbines for the electricity power stations.

The annual meeting of the Corporation Friendly Society was held recently. The total revenue for 1903 was £5,166. 3s., expenditure £4,264. 8s. 8d., balance £901. 14s. 4d, bringing the total amount to credit of the society to £1,448. 15s. 7d. The superannuation fund was increased to £9,591. 13s. 6d. The membership of the society is now 2,759.

Halifax.—Application has been made for sanction to a further loan of £10,000 for providing additional generating plant for the tramways.

Hull.—The salary of the tramway manager, Mr. W. J. McCombe, has been increased from £350 to £400 per annum with an ultimate increase to £450 in two annual increments.

Ilford.—The clauses of the District Council's bill, which were defeated at the special meeting in January, were rejected by the ratepayers at the poll on Saturday.

Ilkeston.—The tramways engineer and manager (Mr. O. A. Pilcher) has resigned.

Islington (London).—It has been decided to transfer from the electricity account to the general rate for the next half year £12,000, to provide for carbons and labour in connection with street arc lighting.

The chairman of the committee (Ald. Mills) explained that the recommendation was to enable the committee to properly discharge the obligations placed upon them with regard to arc lighting, irrespective of the cost of current, so that the borough itself, as a consumer, should be treated in the same way as outside consumers. At present the borough was charged 3½d., but that did not include cost of carbons and labour; while outsiders were charged 4d., 5d. and 7d.

Jamaica.—The Wireless Telegraph Law, 1903, enacted by the Governor and Legislative Council of Jamaica, provides that no person shall erect, maintain, or use within the island of Jamaica, or any of its dependencies, any apparatus or machine whereby communication by wireless telegraphy can be held between the said island, or its dependencies, and any place outside the same without having first obtained the sanction of and a licence from the Governor in Privy Council. Any person offending against this provision is liable to a penalty not exceeding £1,000, and to an additional penalty not exceeding £50 for every day or part of a day during which he continues so to offend. The Governor may authorise any machinery or apparatus so erected to be seized and destroyed.

Light Railway.—Objections to the confirmation of the Rugby and District Light Railway Order were considered by Sir Herbert Jekyll last week.

It was stated that the cost per mile, including equipment, would be about £13,000, the total estimate of cost being £62,340, plus £17,650 for expenses of widening, &c. A ratepayers' petition, objecting to the extension of the period of purchase from 21 to 35 years, was presented, but Sir Herbert doubted whether the Board of Trade would be disposed to go behind the agreement entered into between the local authorities and the arbitrators in that matter.

London County Council.—At Tuesday's meeting the Fire Brigade committee reported on the question of the maintenance of electric bells and negotiations with the Post Office.

The Post Office offered, in consideration of an annual payment at the rate of 5s. per bell, not only to maintain all bells (of which there are between 1,600 and 1,700) and the wiring, the switchboards, testing boards, time switches and door pulls in permanent stations and street stations, but to provide and fix free of cost to the Council the electric bell apparatus required in new stations. The committee advised the termination of the present arrangement with Messrs. F. J. Coleby & Co. and the acceptance of the offer of the Post Office.—Agreed to.

Car Ploughs.—The Highways committee were authorised to expend a further £1,500 for spare car ploughs in connection with the electrical working of the tramways.

Site for Electricity Sub-station.—It was resolved to expend £5,000 in the acquisition of property in Bloomfield-street, Burdett-road for a sub-station for the eastern portion of the Council's northern tramways.

Inspection of Theatres.—The Theatres and Music Halls committee recommend that a sum not exceeding £100 be granted for expert assistance in the work of inspecting the electrical arrangements in places of public entertainment under the Council's jurisdiction.

Marylebone (London).—The polling of the ratepayers on the question as to whether the Borough should proceed with the promotion of the Council's bill "for conferring further powers upon the Council with regard to the supply of electricity" was duly taken on Monday last, with the result following:—

For the promotion	3,779
Against	2,603
Majority in favour of promotion of the Bill	1,176

The numbers represent less than one-third of the parochial electors.

A special meeting of the Council was held last evening, in accordance with the provisions of the Borough Funds Act, for the purpose of confirming or otherwise the promotion of the bill and to resume the discussion on the clauses.

Mr. E. R. Debenham (chairman of the Electric Supply Committee) said it was necessary, as advised by the Council's parliamentary agents, that the Council should confirm or otherwise the promotion of the bill as it stood. The consideration of the clauses was a subsequent matter. Any of the clauses might be amended by the Council so long as such amenments did not interfere with the spirit of the measure. In reply to questions by Councillors Ed. White, Strauss and Little, he said the maximum demand system which they proposed to adopt had in other districts resulted in an average charge of about 2¾d. per unit. With regard to the taking of current in bulk from Willesden, this was an essential part of the scheme to enable them to supply current without waiting for the completion of their own generating station. On the question of the suspension of the sinking fund contribution for three years, there was nothing unusual in this, as a certain period was invariably allowed to cover the time of the installation of the system. On the point of the provision in the bill of £15,000 for public lighting, which was stated to be an insignificant amount, this was sufficient for the main thoroughfares where the light was proposed to be installed, the further extension of the public lighting from time to time being a point for settlement subsequently. With regard to the clause giving power to the Council to supply lamps and fittings, this power was only sought to place the Council in a position to make arrangements with contractors or other persons for the wiring of small householders' premises. This class were good customers, inasmuch as they were regular consumers, but it was unreasonable to expect them to go to the initial expense of wiring their premises and supplying fittings. There was no intention on the part of the Council to trade and deal in lamps and fittings in the ordinary sense.

The formal motion confirming the promotion of the bill was then put to the meeting and carried by 41 votes to four.

Middlesbrough.—The Council will apply for sanction for a loan of £20,000 for electric lighting extensions.

Municipal Telephony.—At Tuesday's meeting of Portsmouth Town Council, the report from the Telephone committee was presented and its adoption moved by Councillor W. T. Dittman. The minutes contained a report of the refusal of the Local Government Board to sanction the borrowing of the whole of the money (£12,000) asked for for the extensions to the telephone service.

Councillor Dittman said that before presenting their report the committee first considered the advisability of approaching the Local Government Board with a view to inducing them to alter their decision, but ultimately they thought it best to come to the Council for instructions.

Ald. T. Scott Foster said the decision of the Local Government Board opened up a very wide question. The Council had not been treated quite fairly in the matter. Throughout the history of the telephone undertaking they had been hampered, and efforts had been made to smash up the enterprise. The decision of the Board, if carried further, might lead to refusals to grant loans for future extensions of the electric light and tramways undertakings, on the ground that the inspectors did not think the extensions would be profitable. Personally he believed there was some little suspicion attaching to the decision of the Board; perhaps some undue influence had been at work to bring about the decision.

The minutes of Brighton Telephone committee, presented to the Corporation last week, stated that the manager had reported that by March 1st 750 subscribers would be connected to the Corporation's system. The committee have resolved to charge rentals from that date.

Bournemouth Corporation have decided to approve the scheme prepared by the International Electric Co. for the erection and

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equipment of a telephone exchange in the Bournemouth area in opposition to the existing system of the National Telephone Co., and the local authorities in the area affected will, it is stated, support the company's application to the Postmaster-General for a licence to establish a telephone system in the area.

National Telephone Co.'s Statistics.—At Dec. 31, 1903, the number of exchanges on the National Telephone Co.'s system was 1,072, call office stations 3,571, exchange stations 247,471, private stations 30,118.

Newport (Mon.).—An inquiry into the Council's application for permission to borrow £60,000 for extensions of the electricity supply undertaking was held recently.

After details as to population, &c., had been given by the town clerk,

The Borough Electrical Engineer (Mr. H. Collings Bishop) gave details of the progress of the undertaking. The revenue last year was £12,485, and in the present year was estimated to reach close upon £20,000. In the first four years there was a deficit, in the fifth year a profit of about £403. Since 1901 there had been a profit every year, and the result for the present year, including the power station and the old station, would be on the right side.

Mr. Parry, assistant to Mr. H. F. Parshall, consulting tramway engineer, also gave evidence.

In reply to an opposing ratepayer, Mr. Bishop said nothing was allowed for depreciation, because he did not think there was any necessity to make such an allowance.

The Inspector (Mr. North) said the Local Government Board would disallow items of plant which were superseded and upon which there was a debt.

Mr. Bishop said the view he and the Corporation took was where the plant was kept up to the mark out of revenue no depreciation was necessary. The sinking fund was a depreciation fund.

Mr. T. H. Hazell, secretary to the local gas company, said his company had made an offer to light certain streets with incandescent gas, and this would have effected a great saving over the scheme presented by Mr. Collings Bishop.

Mr. Collings Bishop said the estimated saving by gas was not correct.

Mr. W. A. Baker, a member of the Electricity committee, said the whole question was very fully gone into by the committee, who found important omissions in the gas company's offer.

North Metropolitan Tramways Co.—At the meeting on Wednesday, the chairman (Mr. G. Richardson) said that the attitude taken up by the London County Council with regard to the electrification of the lines leased to the company was a matter of grave importance. The company had not at any time raised any obstacles beyond those they had been advised were perfectly legitimate and came within the terms of their lease. They had made serious representations to the Council with reference to the adoption of the conduit system of traction, and asked that they should be furnished with the fullest possible information as to the capital cost and cost of working, and until they received such information they were not prepared to offer any suggestion as to the manner in which the work of re-construction should be carried out. They had only demurred to the introduction of the conduit system. In January last the secretary wrote to the London County Council, stating that the directors were of opinion that the overhead system of traction could be much more rapidly and economically established than was possible with the conduit system, with the minimum disturbance and inconvenience to the public.

Outrage.—The lad Schutz was yesterday found guilty of committing a brutal outrage upon Mr. W. E. Lane, secretary of the Electric Lighting and Traction Co. of Australia. Prisoner was ordered to be detained during His Majesty's pleasure, on the ground of insanity. We are pleased to learn that Mr. Lane has completely recovered from the effects of the murderous assault.

Plymouth.—On Monday the Electricity committee submitted for approval a report by the borough electrical engineer (Mr. E. G. Okell), recommending the provision of additional plant at the electricity works, and that application be made for sanction to a loan of £20,000 for carrying out the work.

The chairman of the committee (Mr. Radford) suggested that the question of these extensions might be deferred until the next meeting. The monthly and quarterly returns were exceedingly satisfactory and showed a rate of progress much greater than anything shown before. In view, however, of the serious prospective increase in their plant, he asked the borough treasurer to present a return for the past nine months' working of the undertaking. That return showed a net profit of £1,634. With the present rate of increase the margin of 5,000 lamps now left would soon be absorbed. They anticipated from the extensions a profit of £3,000 per annum. Owing to pressure of works the Finance committee had not had time to fully investigate the figures, and although a month's delay might be serious, the Electricity committee did not wish to rush the matter.

The minutes were confirmed with the modification proposed by Mr. Radford.

Pietermaritzburg (Natal).—This city has a population of about 20,000 persons, and the Corporation electricity works supply current to about 800 consumers. The total connections in December last were equivalent to 24,700 8 c.p. lamps, including 236 H.P. for motors. No motors are allowed to be used between 5 p.m. and 9 p.m.

Municipal tramways are under construction about 6½ miles in length to 4ft. 8½in. gauge on the overhead trolley system.

Presentation.—On Monday, the employés of the Warrington tramways and electrical departments made a presentation, consisting of a pair of prismatic binoculars and an illuminated address, to Mr. W. H. Grimsdale, who will shortly vacate his position as chief electrical engineer to the Corporation to return to the office of the consulting engineers (Messrs. Preece and Cardew) for the purpose of carrying out a large Government contract at Portsmouth. The presentation was made by the new borough electrical engineer, Mr. P. Vincent L. Mathias.

Side-street Lighting.—Fulham (London) Council has under consideration the question of lighting the side streets by gas or electric light. On Wednesday a report by Mr. Arthur J. Fuller, the borough electrical engineer, was issued.

Mr. Fuller states that he took considerable trouble to ascertain the exact cost of ordinary gas lighting (using flat burners), incandescent gas lighting, incandescent electric lighting and electric "Nernst" lamp lighting, so that the committee might judge the respective merits of each system. Taking the year ending March 31, 1903, he found that the total amount paid to the gas company for street lighting was £5,058. This covered the cost of supply, attendance and cleaning for an average of about 1,650 lamps. The average cost per lamp, including all charges, was £3. 12s. for an ordinary 5ft. burner, giving about 12 c.p. when new. The gas company suggested that the Council should enter into agreement with them for incandescent gas lighting, and to provide against the capital cost for this work the company offer to loan the Council £3,360, spread over 20 quarterly payments or £168 each. Under this arrangement the annual charge for 1,600 lamps would be £5,520, of which £4,848 would be for gas supply, &c., and £672 for repayments of loan. The charge per post fitted with one mantle under this arrangement would be:—Gas, £2. 0s. 6d. per annum, plus 7s. 6d. for repairs, 4s. for mantles at 6d. each, 2s. for rods and 15s. for attendance; total for lamp £3. 9s. The candle-power per lamp is stated to be about 80 c.p.

Up to the present no attempt had been made to introduce electric lighting for side streets. Of late years incandescent electric lighting had received considerable attention from the makers of incandescent electric lamps, with the result that they were now all able to turn out lamps which had very high efficiency combined with long life. He (Mr. Fuller) had given the matter careful attention and believed, if the present posts were converted, the result would give great satisfaction. It would only be necessary to attach a suitable fitting in the existing lanterns and to connect this by a main cable. The cost would work out as follows:—Connection from main cable to switchboard at top of post £1, including making good; fuse and switch-box, altering lamp, &c., 15s.; total for post, £1. 15s. If an effective special bracket were used, the total per post would be increased to £2. 10s. The cost of renewing these per annum, taking current at 1½d. per unit, for a 32 c.p. lamp, would be £2. 6s. 10d., renewals 3s. 6d., repairs and maintenance 5s., attendance 15s., total £3. 10s. 4d. per post.

The Nernst lamp was of a different type to the ordinary incandescent lamp, inasmuch as its efficiency was extremely high, taking only 1·5 watts per candle-power per hour, against 3 to 4 watts per candle-power per hour of an ordinary electric lamp. If this system were adopted it would be possible to give a steady light continuously, equal to about 80 c.p., at a low cost. Assuming 1½d. per unit for current, one ½-ampere Nernst lamp, giving from 70 c.p. to 80 c.p., would consume 393 units per annum. Allowing for renewals would cost 16s. 3d., attendance 15s., which works out at £4. 0s. 4d. The total cost for fixing would be £2. 15s., as the cables did not as yet extend into every street.

Mr. Fuller found that at present they could only convert 250 of the gas posts for electric lighting. The price under each system for these 250 worked out as follows:—Gas as at present, annual cost £754. 3s. 4d.; incandescent gas, annual cost £862. 10s., capital outlay, £555; incandescent electric, annual cost £879. 3s. 4d., capital outlay, £437. 10s.; Nernst, annual cost £1,004. 3s. 4d., capital outlay £687.

In comparing the above figures he wished it to be borne in mind that under the gas company's suggested arrangement only 4s. for mantles, at 6d. each, is included, or eight mantles per annum. He thought this figure was an under-estimate, and advised the Council, should it decide to go in for incandescent gas, to get the company to take all risks as to mantles.

The report concludes:—"In arriving at a decision it would be well if you considered that whatever gas might cost, for the electric lighting the money is being paid to one of your own departments, and, therefore, has a better result for the ratepayers than if the same amount were paid for the same lighting to the gas company."

Southwark (London).—An inquiry, ordered by the Privy Council, will be held on 18th inst. at Southwark Town Hall, into the application of the Borough Council to prepare a scheme providing that the expenses of the Newington electric lighting undertaking should become chargeable on the whole borough of Southwark.

Sunderland.—The expenditure of the electricity supply and street lighting department for the half-year ended Sept. 30 was £8,613, income £12,988 2s. 7d., net profit £840. The estimated expenditure for the half-year ending Sept. 30 next is £10,751 and the revenue £15,379.

It is anticipated that the profit on the Corporation tramways for the financial year drawing to a close will be about £5,000.

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Tariff Changes.—Under the new British Indian customs regulations electrical and galvanic instruments, apparatus and appliances, including telegraphic and telephonic apparatus (except telegraph instruments and apparatus and parts thereof imported by or under the orders of a railway company or by a passenger as part of personal baggage and in actual use by him in the exercise of his profession, in which case they are admitted free) is subject to an ad val. duty of 5 per cent.

Telephony in Canada.—It is reported that a company has recently obtained a Dominion charter and is about to erect exchanges and to construct long-distance telephone lines throughout Canada in competition with the Bell Company. The "Canadian Engineer" is responsible for this announcement, and states, further, that 1904 promises an active development of telephone competition in Canada.

Theft of Telegraph Wire.—At Worship-street (London) Police Court on Saturday a dealer, named James Hibbard, and two labourers, named Joyce and Waker, were committed for trial on a charge of being concerned together in stealing and receiving a large quantity of copper wire, the property of the Postmaster-General.

Torquay.—The Council have referred back a recommendation of the Electric Lighting committee to apply for a loan of £42,500 for erecting new electricity works.

Tunstall.—Burslem Town Council have offered to supply electricity to Tunstall Council on the following terms:—

(1) Tunstall Council to agree to take not less than 50,000 units per annum for seven years at 2d. per unit up to 100,000 units, 1½d. up to 200,000, and 1d. over 200,000 units. (2) If the Tunstall switchboard is fixed at the station in Burslem extra charge for switchboard attendance at Burslem £75 per annum. (3) Mr. Bremner to act as electrical adviser to Tunstall Council and to supervise the laying down of electric mains in Tunstall on terms to be arranged by him with the approval of Burslem committee. (4) The question of Mr. Bremner, or the electrical engineer for the time being, acting as electrical engineer for Tunstall to be considered by Burslem Council if above terms are satisfactory to Tunstall. Should Burslem be in a legal position to give a supply of current Tunstall Electric Lighting committee will then recommend the Council to enter into an agreement with Burslem Corporation for supplying Tunstall with electricity in bulk on the terms contained in para (1).

Walsall.—The Electricity committee report a profit on the past year's working of £313, against a deficit of £244 in the previous year.

Wallsend.—The Council have authorised proceedings being taken against the Newcastle-upon-Tyne Electric Supply Co. for nuisance alleged to be caused by their Neptune Bank electricity works.

War in the Far East.—The Great Northern Telegraph Co. notify that their Vladivostock-Nagasaki cable is temporarily closed, and that traffic via Vladivostock for China and Japan cannot be accepted until further notice.

West Ham.—On Tuesday the Finance committee reported that, as the works actually commenced or about to be taken in hand amounted to £600,000, they regretted being unable to recommend that the "electrification" of the lines acquired from the North Metropolitan Tramways Co. be at present proceeded with.

The East London and Lower Thames Electric Power Bill is to be opposed.

West Hartlepool.—The Electric Lighting committee have decided that, in cases where the services of the electrical engineer are requested by customers for preparing plans and specifications for electric light, a charge be made in accordance with the following scale:—

5 per cent. on value of work done. If the work is not carried out, the following fees be charged: £1. 1s. for 25 lights or 10 H.P. in motors; £2. 2s. for 50 lights or 20 H.P. in motors; £3. 3s. for 100 lights or 30 H.P. in motors; £4. 4s. for 150 lights or 40 H.P. in motors; £5. 5s. above 200 lights or above 80 H.P. in motors. When the engineer is requested to make a test of the installation, subsequent to the first test, a fee of 10s. 6d. is to be paid by the consumer to the Corporation.

Westminster.—The City Council have appointed a sub-committee to arrange with representatives of the various electric light companies supplying current in the district a scheme with respect to the hours during which the companies shall have access to their distributing boxes. (An inquiry was recently held into the question and the proceedings were fully reported in *The Electrician*.)

Will.—The will of the late Mr. Ernest Thompson (Messrs. Nalder Bros. and Thompson), who died recently at the early age of 36, has been proved at £11,694.

Willesden (London).—The Works and General Purposes committee of the Council reported on Tuesday having inquired into charges made by a weekly paper against Mr. E. T. Ruthven-Murray, the electrical engineer.

The committee state that they have come to the conclusion that Mr. Murray acted throughout the entire course of the negotiations with the North Metropolitan Electric Power Supply Co. in the best interests of the ratepayers, but are of opinion that the consent of the Electricity committee should have been obtained before Mr Murray had an interview with the consulting electrical engineer to Tottenham Council.

A motion was passed placing on record the unabated confidence of the Council in Mr. Murray.

Subsequently a letter was read from the North Metropolitan Electric Power Supply Co. asking whether a temporary arrangement could be made with the Council whereby the electrical engineer should continue in charge of the station, they paying to the Council such proportion of the engineer's remuneration as may be considered reasonable.

It was resolved that, pending further consideration of the matter, the electrical engineer be asked to take charge of the station as requested.

The Electricity committee reported having discussed with the solicitor the opinion obtained from counsel as to the powers of the Metropolitan Electric Supply Co. to enter into arrangements for the supply of electricity outside the area defined in their acts and orders. It was decided to request the company to give an undertaking to discontinue, on being required to do so, the supply of electrical energy to any person or company in the parish of Willesden.

It was resolved to apply to the Local Government Board to sanction a loan of £20,000 to be expended as follows:—Extensions of mains, services and provision of consumers' meters, £15,000; motors for hiring, £2,000; hire-purchase wiring, £3,000.

Wolverhampton.—Sanction to a loan of £16,514 for electric tramways has been received by the Corporation.

Women in the German Government Telegraph and Telephone Service.—Female labour was first employed in this service in Germany in 1874, mainly owing to the difficulty of obtaining men for the work. On the amalgamation of the postal and telegraph services under Von Stephan, the women employed in the telegraph service were discharged. Podbielski, Von Stephan's successor, was more favourably disposed to female labour, and women's share in the work of the department has been re-established, and women can now attain to any position in the telegraph service in Germany. 4,000 females are employed in the German Government telephone department, and this service is popular. The wages are very low compared with the rates in England. A pension follows automatically upon good service, the requirements of which, as to health, character, education, &c., are even more exacting than in the same service in Great Britain.

Worcester.—The electric tramways were officially inspected on Saturday, and the public service inaugurated.

Workhouse Lighting.—Walsall Board of Guardians have decided ts adopt electric lighting for their workhouse.

Yarmouth.—The profit on the current year's working of the electricity undertaking, after paying all charges, including interest and sinking fund, it is reported, will be over £1,000. Last year £500 was voted in relief of rates, after which there was a profit of £378. The Council are recommended to vote £800 in relief of rates this year.

TRADE NOTES AND NOTICES.

[*Notices for insertion under this heading must reach us first post Thursday; New Catalogues, Price Lists and similar matter early in the week.*]

TENDERS INVITED.

Ealing Corporation invite tenders for the supply and erection of one 750kw. steam alternator, central service condenser, &c. Specifications, &c., from the borough electrical engineer (Mr. J. Douglas Knight), electricity works, South Ealing, London, W. Tenders (addressed chairman Electricity committee, Town Hall, Ealing, W.), to the town clerk (Mr. George E. Brydges), by 4 p.m. Feb. 25. See also advertisement.

Kilmarnock Corporation invite tenders for the supply and erection of pipe-work, feed-pump, economiser, jet-condensing plant, &c.; arc and incandescent lamps, posts and gear; lighting and traction feeders, mains, switch pillars and road-work, and electricity meters. Specifications from the town clerk (Mr. W. Middlemas), and may also be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to the town clerk by March 14. See advertisement.

Preston Corporation invite tenders for laying a complete system of feeder mains on the drawn-in system. Specifications, &c., from the consulting and resident engineer (Mr. Walter H. Tittensor), 25, Burrow-road, to whom tenders by Feb. 15. See advertisement.

Fulham (London) Borough Council invite tenders for the supply of electrical stores for year ending March 31, 1905. Tenders to the Town Hall, Fulham, by 4 p.m. March 2. See advertisement.

Hornsey Town Council invite tenders for stores for electricity works and cable and cable stores, &c. Specifications, &c., from the borough electrical engineer (Mr. Norman Staniland), electricity works, Tottenham-lane, Hornsey, between 10 and 12 a.m. An advertisement contains further particulars. Tenders to the town clerk by 4 p.m. Feb. 29.

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Blackburn Electricity and Tramways committee invite tenders for the supply of stores for the Electricity and Tramways departments for the year ended March 25, 1905. Further particulars are set out in an advertisement. Specifications, &c., from the engineer and manager (Mr. A. S. Giles) after Tuesday. Tenders (addressed to the chairman of the committee, Town Hall, Blackburn), by noon Feb. 29.

The *New General Traction Co.* invite tenders for the construction of about 3 miles of new tramways and the reconstruction of 5½ miles of tramways at Coventry. Specifications, &c., from the engineer (Mr. I. E. Winslow), 20, Bishopsgate-street Within, L ndon, E.C., to whom tenders by 1 p.m. March 5. See also advertisement.

St. Anne's-on-the-Sea District Council invite tenders for the supply and erection of a steam dynamo. Specification from the chief engineer (Mr. James H. Clothier). Tenders to the clerk, Council Offices, St. Anne's-on-the-Sea, by noon Feb. 27. See also advertisement.

Tenders are invited for the supply of electricity meters, house service boxes and fuse boxes, to be supplied during the ensuing 12 months to the Metropolitan Borough of *Hammersmith*. Specifications from the borough electrical engineer (Mr. Gilbert G. Bell), 57, Fulham Palace-road, London, W. Tenders to the town clerk, Town Hall, Hammersmith, by 6 p.m. Feb. 24. See also advertisement.

Greenock Corporation invite tenders for one 400kw. steam-driven traction and lighting generator. Specification, &c., from the burgh electrical engineer (Mr. J. A. Robertson), Hunter-place, Greenock. Tenders addressed to town clerk (Mr. Colin MacCulloch), Municipal-buildings, Greenock, by 10 a.m. Feb. 25. See also advertisement.

The Scottish office of *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring installations for direct connection with the fire brigades at Glasgow and Sheffield. Tenders by 17th inst. Further information from the managing director, 49, Queen-street, Glasgow. See advertisement.

The municipality of *Port Elizabeth* (South Africa) invite tenders for the supply of telephone material for the Sand, Palmiet and Bulk River water scheme. Specifications, &c., from the agents of the municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C., to whom tenders by 10 a.m. Feb. 22. See advertisement.

The Metropolitan Borough Council of *Islington* will meet on Feb. 26 to consider tenders for various electrical stores. Forms of tender, &c., at the Town Hall, Upper-street, London, N., after 15th inst. Tenders by noon Feb. 25.

Islington (London) Lighting committee also invite proposals from contractors for carrying out of wiring for and the supply of motors to the Council's consumers on a system of simple hire or hire-purchase. Proposals to the electrical engineer (Mr. Albert Gay), 56, Eden-grove, Holloway, N., by Feb. 17.

Islington (London) Borough Council also invite tenders for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple core, high-tension feeders and low-tension distributors, and pilot cable, with feeding junction and service boxes. Tenders to the town clerk (Mr. Wm. F. Dewey) by noon Feb. 24.

Bermondsey Metropolitan Borough Council invite tenders for electrical stores for one year from March 31. Tenders to Mr. Fre.lk. Ryall, Town Hall, Spa-road, London, S.E., by noon Feb. 16.

The Baths sub-committee of the Borough of *Camberwell* invite tenders for the supply and erection at Camberwell Baths of new engine and dynamo, &c. Tenders by 6 p.m. Feb. 16.

Sunderland Corporation invite tenders for a travelling crane and a storage battery. Tenders to chairman of Electric Lighting committee, Town Hall, Sunderland, by noon Feb. 26.

Birmingham, Tame and Rea District Drainage Board and Birmingham Corporation require tenders, by 9 a.m. March 7, for erection of electric power station, destructor house, &c., at Nechells

Salford Corporation require tenders by 3 p.m. 26th inst. for 12 months' supply of stores, including electrical and mechanical car accessories, wire, &c.

London County Council Asylums committee invite tenders by Feb. 17 for 12 months' supply of stores, including electric lighting sundries.

London County Council invite tenders by Feb. 16 for five tubular fuel economisers, &c., for Greenwich electricity generating station.

Walthamstow District Council invite tenders by 5 p.m. 23rd inst. for one year's supply of stores, including electricians' materials.

Halifax Corporation require tenders by noon 29th inst. for one year's supply of stores for electricity and tramways departments.

Hanley Corporation invite tenders by 22nd inst. for steam or turbo-alternator, with condensing plant, superheaters, &c.

Battersea (London) Borough Council invite tenders by noon 22nd inst. for a year's supply of electricity meters, carbons, &c.

Rathmines and *Rathgar* (co. Dublin) District Council invite tenders by 20th inst. for meters, arc lamp carbons, &c., for 12 months.

Lanark County Council invite tenders by 10 a.m. 29th inst. for engines, dynamos, cables, &c., for electric lighting of *Cambuslang*.

Radcliffe District Council invite tenders by 20th inst. for station lighting and wiring to motors, testing instruments, &c.

TENDERS RECEIVED AND ACCEPTED.

The tender of the British Thomson-Houston Co. has been accepted for the motors to be used on the trains of the Underground Electric Railways Co. of London (Metropolitan District Railway, &c.). It will be remembered that the Sprague Thomson-Houston system of multiple-unit control was a short time since decided upon for the trains of the Metropolitan District, the contract being awarded to the British Thomson-Houston Co. after extended competitive trial. The same system is employed by the Central London, Great Northern and City, and North-Eastern Railways and the Metropolitan Railway of Paris.

The British Westinghouse Electric and Mfg. Co. have recently supplied direct-current motors (of the new Westinghouse "SB" type and aggregate 540 H.P.) to the Great Northern Railway. Messrs. Babcock and Wilcox, Newcastle and District Electric Lighting Co., South Durham Steel and Iron Co., E. Newell & Co., Mills, English & Co., Monks, Hall & Co., Baldwins (Ltd.), Markham & Co, Dorman, Long & Co, and Heenan, Froude & Co.

Dewsbury Council have accepted the following tenders:—
Callender's Company, 440yds. of cable.
Green and Boulding, automatic injector.
Sir Hiram Maxim Electrical and Engineering Co., steam piping.

Swindon Council have accepted the tender of Mr. L. Howell for Reason arc lamps, and that of Steel Bros. for carbons for arc lamps.

The following tenders have been accepted by Bradford Corporation Tramways and Electricity committees:—
J. Russell & Sons, steel tramway poles, £662.
Bolckow, Vaughan & Co., 700 tons steel girder rails at £5. 13s. 11d. per ton, and 35 tons of steel fishplates at £7. 3s. 11d. per ton.
British Westinghouse Co., 1,000kw. generator, £3,272.
J. Musgrave & Co., steam engine, £7,870

Croydon Corporation have accepted the tender of Dorman, Long & Co. for extensions of the electricity station buildings at £2,905. 11s. 1d. and that of the Alphons Custodis Chimney Construction Co. for the erection of a 200ft. chimney shaft at £3,873.

Battersea (London) Borough Council have accepted the tender of the Simplified Conductor Co. (Ltd.) for three switch pillars at £71. 10s.

Hammersmith (London) Borough Council have accepted the tender of the British Electric Transformer Co. for six 100kw. transformers at £120 each.

A further repeat order (for 80 additional cars) has been placed by Newcastle-on-Tyne Corporation with the British Westinghouse Co. for Westinghouse magnetic brake equipments.

Westminster City Council have accepted the tender of Thomas Potter & Sons for extending the electric light installation at Marshall-street baths at £178.

London County Council have accepted the offer of the Electrical Power Storage Co. for repairs to the electric battery at Crossness at £241. 5s.

Kirkcaldy Corporation have accepted the tender of the British Thomson-Houston Co. for additional electric tramcars at £3,80 4. 16s.

BUSINESS NOTICES.

The Edison and Swan United Electric Light Co. (Ltd.) will open on Monday a wholesale West End warehouse and showrooms at 60, Great Marlborough-street, Regent-street, W., where large stocks of "Royal Ediswan" lamps and of the company's well-known manufactures generally will be held.

The Chloride Electrical Storage Co. (Ltd.), Clifton Junction, near Manchester, have opened an office at 78, King-street, Manchester, to deal with business in the North. The office will be under the charge of Mr. Davenport, who has been for many years the Chloride Company's Northern representative.

Messrs. Sybry, Searls & Co. (Ltd.), tool and mining steel manufacturers, Cannon Steel Works, Sheffield, have opened a London office at 46, Queen Victoria-street, E.C.

Messrs. R. and F. Wilson and G. Langley (trading as Wilson Bros., electrical engineers and manufacturers, 5, St. Peter-street and 49, Bromham-road, Bedford), have dissolved partnership. Debts by R. and F. Wilson, who continue.

The Paterson Engineering Co. (Ltd.) notify that they have opened a London office at Amberley House, Norfolk-street, W.C., where business in the south of England will be handled.

Mr. H. Holt has resigned his position as manager of the plant and motor department of Messrs. Veritys Limited, London, and has taken up a similar position with the Rhodes Electrical Mfg. Co.

Wimbledon District Council have accepted the tender of the Paterson Engineering Co. for a water softener and filter, softened water storage tank, &c., for the electricity works.

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LIQUIDATIONS, BANKRUPTCIES, &c.

F. Moore, formerly electrical engineer, 12, St. Paul's-street, Leeds, has been adjudicated bankrupt. First meeting of creditors 17th inst., at 22, Park-row, and public examination, 23rd inst., at County Court House, Albion-place, Leeds.

G. Jackson and D. Smith, electrical engineers, 6, Annetwell-street, Carlisle, have been adjudicated bankrupt. The first meeting of creditors takes place on 22nd inst. at 34, Fisher-street, and the public examination on same date at 29, Lowther-street, Carlisle.

A meeting of the creditors of Gardner Bros. & Co, electrical engineers, Burton-on-Trent, was to have been held at Derby County Court on Wednesday, but in the absence of a quorum the affairs were left in the hands of the Official Receiver (Mr. F. Stone). The liabilities were returned at £2,811. 19s. 2d., available assets £43. 14s. 5d.

The trustee in the bankruptcy of Wm. Scholes (trading as Scholes & Son), electrical engineers, at Failsworth, Manchester, and Middleton, has been released.

Charles Wallis, electrical engineer, 121, Cleethorpe-road, Great Grimsby, has been adjudicated bankrupt.

Claims against the Electric Traction Co. (Ltd.) must be sent by March 11 to Mr. W. B. Peat, 3, Lothbury, London, E C.

Sale by Auction —Messrs. Wheatley Kirk, Price & Co. have received instructions from the liquidator (Mr. J. P. Garnett) of Heaton and Smith (Ltd.) to sell by auction at an early date on the premises, Salford Switch Works, Frederick-road, Salford, Lancs., the entire stock-in-trade, work in progress, loose tools and utensils, office furniture and other effects. The catalogue will comprise a large number of enclosed motors, switchboards, distribution boards, electroliers, wall and other brackets, pendants and a variety of fittings, switches, &c. Further particulars are given in an advertisement. Catalogues shortly from Messrs. David Smith, Garnett & Co., C.A., 22, Booth-street, Manchester; Messrs. Parkinson, Slack and Needham, solicitors, 10, York-street, Manchester; or from the auctioneers, Albert-chambers, Albert-square, Manchester, and 46, Watling-street, London, London, E.C.

The Corporation of Launceston (Tasmania) have for sale alternate-current plant and direct-current arc lighting plant. Some particulars are given in an advertisement. Further information from the city electrical engineer, Town Hall, Launceston, Tasmania.

Premises to Let —A wharf with good river frontage at Battersea is to be let. Applications to Mr. Harold Griffin, 54, High-street, Battersea, London, S.W. See also advertisement.

An exceptionally well-built, fireproof factory warehouse (over 14,000 superficial feet), in close proximity to Liverpool-street Station, London, E.C., is to be let or sold. Further particulars from Messrs. W. J. Bush & Co. (Ltd.), Ash-grove, Hackney, London. See advertisement.

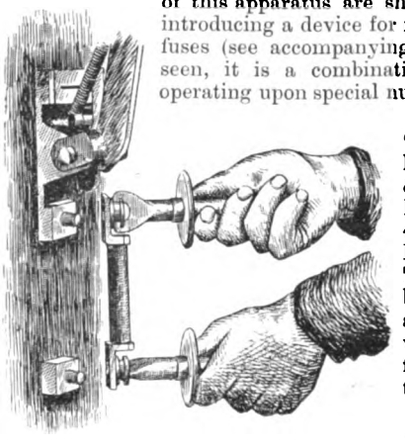
Schuler-Lahmeyer Motor.—The Lahmeyer Electrical Co. inform us that they have completed arrangements for the purchase of the Schuler single-phase alternating-current motor, the rights of which were, until recently, held by Messrs. Ferranti Limited. The Lahmeyer Company are now in a position to supply these machines.

The "Talking Sign."—A new form of apparatus for advertising by electrical means is being placed on the market by the British Electric Signs Co. (Ltd.). Each letter of a word or words it may be desired to flash out is produced by means of a "monogram," which consists of 21 electric lamps, each sunk in a reflecting cell of an appropriate shape. Any letter or figure can be represented by illuminating simultaneously a certain number of these 21 lights. Words or sentences are produced by placing the corresponding number of "monograms" side by side. In order to vary the inscriptions, an apparatus resembling very much in its arrangement and function a musical box, is used, which, through rotating, varies at short intervals the combination of simultaneously glowing lamps in each of the monograms. The inscriptions therefore continually change. Each monogram possesses one of these devices, which is made to receive 40 metal bars, each of which possesses projections corresponding to a letter or figure. All these rotating devices are rigidly connected together and slowly turned by a small electro-motor. Copper tongues, just clearing the drum, then make electrical contact with the projecting parts of the nearest metal bar of the commutator. Each metal bar in turn comes into contact with the copper tongues. After each monogram has produced 40 characters, the series is repeated.

Weights and Measures.—Mr. Alfred J. Martin, F.S.I., has compiled a number of tables of Imperial, Metric, Indian and Colonial weights and measures, which are published by Mr. T. Fisher Unwin, price, 2s. 6d The book has been specially compiled with a view to meeting the early adoption of the metric system of weights and measures for use within the British Empire. Of this change the author is a warm advocate. Numerous reasons are given by the author why the metric system should be promptly adopted in this country, and amongst these the following note on p. 114 may be quoted:—"If we delay the change many more years, all other countries will eventually adopt French denominations, and we shall be more insulated than ever."

Catalogues, &c.—A new illustrated price list of the latest improvements in oil cans is issued by Messrs. Joseph Kaye & Sons (Ltd.), Lock Works, Leeds, and 93, High Holborn, London, W.C. This firm are specialists in oil can construction and supply, and the most useful types of these goods are to be found in the new list.

Messrs. W. F. Jones & Co., 50, Cannon-street, London, E.C., have ready a new catalogue of main switches in which a number of examples of this apparatus are shown. The same firm are introducing a device for mounting and dismounting fuses (see accompanying illustration). As will be seen, it is a combination of insulated spanner operating upon special nuts and screws.

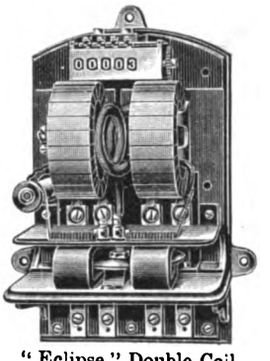


Safety Mounting and Dismounting Device.

A 4th edition of the "Fredennis" trade price list of wires, telephones, &c., stocked in London by Messrs. W. F. Dennis & Co., 49, Queen Victoria-street, London, E.C., is ready. The goods listed include bright drawn rods, copper and bronze wires, covered wires of various kinds, flexible cords for arc lamps, telephone instruments, &c.

Messrs. Monté Callow & Co., 6, Ludgate-broadway, London, E.C., issue a sheet of testimonials as to the merits of D. M. (Disincrustant Marseilles) for preventing and removing scale in boilers, &c.

Mr. G. Braulik, 217-218, Upper Thames-street, London, E.C., has ready a new list of "Eclipse" electricity meters. Copies of the pamphlet can be obtained on application. The accompanying illustration shows an example of the double-coil type of "Eclipse" meter for 2-wire or 3-wire currents. It is claimed that these are true wattmeters, and therefore suitable for constant and alternating currents. The overall dimensions are 12in. by 9in., weight 16½lbs.



"Eclipse" Double-Coil Electricity Meter.

Mr. G. Braulik has ready a new circular price list of "Eclipse" miniature arc lamps.

Under the title of "Steam and Electric Locomotives," the Brush Company have issued their Bulletin No. 5.

A list of improved electrical apparatus, for use in hospitals and by surgeons and scientific experimenters, is issued by Messrs. Marshall and Woods, 2, Gray's Inn-road, London, W.C.

Export Merchant Shippers' List.—The 1904 edition of the "Export Merchant Shippers of Great Britain and Ireland," published by Messrs. Dean & Son, 160A, Fleet-street, London, is just published. The book shows an enlargement of 50 pages over last year, and a number of new towns have been added to the export section.

Directories.—Among the useful directories which reach us at the beginning of February is the "Paper Trade Directory of Great Britain, India and the Colonies," published at 22, St. Andrew-street, London, E.C., price 1s. We have to acknowledge the receipt of the issue for 1904, which contains a list of paper-making factories, &c., which will be found of service not only to those who require paper, but also to those who wish to come in direct communication with paper-mill owners, &c. In these mills there is a large amount of electrical installation work constantly going on.

Imports.—The following are the values of imports to this country during January last:—

Electrical machinery, £33,726 (a decrease of £8,303 compared with Jan., 1903); telegraph cables and apparatus, £117,150 (increase £86,073); other electrical goods and apparatus, £74,674 (increase £21,897).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Feb. 3 to 9 with the ports of destination:—

Africa—Alexandria, £119; Cape Town, £1,281 (including £60 telegraph material); Durban, £1,243 (including £325 telegraph material)

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East London, £420; Mossel Bay, £23; Port Elizabeth, £131. *Argentina*—Buenos Ayres, £31; Rosario £406. *Australasia*—Adelaide, £1,130 (including £1,080 telegraph material); Auckland, £294; Hobart, £345; Launceston, £64; Lyttelton, £24; Melbourne, £88; Otago, £95; Perth, £397; Sydney, £1,866; Wellington, £1,032 (including £684 telegraph material). *Brazil*—Rio Janeiro, £9,550 (telegraph cable). *Ceylon*—Colombo, £379 (including £26 telegraph material). *China*—Shanghai, £36. *Germany*—Hamburg, £184 (including £150 telegraph material). *Gibraltar*, £126. *Holland*—Amsterdam, £60; Rotterdam, £9 and 57 tons telegraph wire. *Hong Kong*, £1,237 *India*—Bombay, £166; Calcutta, £737. *Italy*—Leghorn, £50. *Japan*—Kobe, £90; Yokohama, £360. *Portugal*—Oporto, £97. *Straits Settlements*—Singapore, £44 (including £16 telegraph material). Total £22,114, against £14,005 in the corresponding week last year (Feb. 4 to 10).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December 14, 1903.

27,298 J. T. DAWES. Liverpool. Magnetic separators.
27,316 F. J. WARDEN-STEVENS. Automatic supply of electricity.
27,330 W. FAIRWEATHER (Stromberg Carlson Telephone Mfg. Co., U.S.). Multi-party line systems.*
27,350 F. W. DE TALL (Henry Noel Potter, U.S.). Electric or vapour lamps.
27,373 J. L. DAVIES. Arc lamps.
27,392 I. O. REVILLIOD. Electricity meter. (Date applied for Dec. 15, 1902, date of application in Switzerland.)*
27,399 H. LEITNER. Byfleet. Means for separating accumulator plates.

December 15, 1903.

27,410 H. W. CLOTHIER. Manchester. Automatic circuit-breakers and measuring instruments.
27,416 F. REA and E. J. REINDORP. Mechanical ear for overhead wires.
27,456 F. H. DE VEULLE. Coventry. Electric ignition for internal combustion engines.
27,497 A. MCDUCKHAM. Lighting gas burners by electricity.
27,505 C. A. CARUS-WILSON. Testing for grounds and stroke or short-circuits in electric cars or trains.
27,506 A. P. WRIGHT and H. H. MIDGLEY. Dynamo-electric machinery.
27,522 R. TRESKOW. Electric ignition for explosion motors.*

December 16, 1903.

27,574 A. LE N. FOSTER. Brush and commutator for internal combustion engines.*
27,576 W. ROOS. Magneto-electric ignition for internal combustion engines.*
27,585 H. J. WALKER. Casing and holder for electric wires.*
27,628 E. M. FOX. Means for resisting fire and electricity.

December 17, 1903.

27,654 VERITYS LIMITED and G. O. DONOVAN. Birmingham. Starter and automatic cutout for electric motors.
27,662 A. F. GUY, F. H. WHEELER and J. A. DAVENPORT. Liverpool. Attaching circuit wires to terminals of electrical apparatus.
27,677 F. J. HOWITT and P. R. JACKSON & CO. Manchester. Dynamo-electric machinery.
27,696 W. STRICKLAND. Galvanic cell.
27,712 C. D. ABEL. (Siemens and Halske A.G., Germany). Glow lamps with metallic filaments.*
27,722 L. J. HUNT and the SANDYCROFT FOUNDRY CO. Liverpool. Alternating-current induction motors.
27,733 T. A. HEARSON (Adolf Bleichert & Co., Germany). Electrically-driven suspended railways.*
27,734 T. A. HEARSON (Adolf Bleichert & Co., Germany). Safety device for switches of electrically-driven suspended railways.*
27,736 J. Y. JOHNSON (Elektrizitäts A.G. vorm. W. Lahmeyer & Co., Germany). Electrical means for starting prime movers.*

December 18, 1903.

27,765 F. O. J. ROOSE. Bournemouth. Trolley heads.
27,783 ROMANOFF (LONDON) SYNDICATE, LTD. (Hippolyte de Romanoff, France). Storage batteries.
27,814 J. B. DE ALZAGARY. Carbons for arc lamps.
27,818 T. HAMILTON-ADAMS. Arc lamps.
27,825 LA SOCIÉTÉ DES ACCUMULATEURS CHELIN. Electric lamp particulaly for miners' use. (Date applied for, Aug. 3, 1903, date of application in Belgium.)*
27,830 F. C. RENTSCH and R. SCHUBERT. Electric bell.*

December 19, 1903.

27,865 D. WELLS. Edinburgh. Electrical indicator.
27,891 B.T.-H. Co. (G.E. Co., U.S.). Bearings for measuring instruments.
27,892 B.T.-H. Co. (G.E. Co., U.S.). Brush-holders for dynamo-electric machines.
27,893 B.T.-H. Co. (G.E. Co., U.S.). Controllers for electric motors.
27,894 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current dynamo-electric [illegible] machines.
27,895 B.T.-H. Co. (G.E. Co., U.S.). Electric synchronising devices.
27,896 B.T.-H. Co. (G.E. Co., U.S.). Systems for controlling fluid-pressure.
27,897 B.T.-H. Co. (G.E. Co., U.S.). Sanding systems.
27,898 B.T.-H. Co. (G.E. Co., U.S.). Means for actuating shafts.
27,900 P. HARDEGEN. Selective telephone systems.*
27,921 OTIS ELEVATOR CO. (Otis Elevator Co. (Inc.), U.S.). Automatic control of electric motors.*
27,924 G. GIBBS. Safety devices for electric railway systems.*

December 21, 1903.

27,956 W. T. MUNRO and W. W. LUMSDEN. Glasgow. Automatic temperature alarm.
27,969 H. DE GARRS. Sheffield. An automatic pump for regulating the water beneath the transformation chamber in underground electricity supply works.
28,003 W. FAIRWEATHER. (Kellogg Switchboard and Supply Co., U.S.) Telephone transmitters.*
28,021 E. N. HENWOOD. Applying resilience in the hubs of wheels.
28,030 E. C. RIMINGTON. Electricity meters.
28,051 P. M. LINCOLN. Synchronising apparatus for electrical machines. (Date applied for, Dec. 29, 1902, date of application in U.S.)*
28,055 SOCIÉTÉ FRANÇAISE D'INCANDESCENCE PAR LE GAZ (Système Auer). Arc Lamps. (Date applied for, Dec. 22, 1902, date of application in France.)*
28,057 W. H. WHEATLEY. (Atwood Electric Co., U.S.) Composition for cells of batteries*
28,059 B.T.-H. Co. and A. S. CURITT. Trolley earth indicating apparatus.
28,060 E. E. F. CREIGHTON. U.S. Compensating systems for alternating current generators. (Date applied for, Dec. 20, 1902, date of application in U.S.)*

December 22, 1903.

28,071 W. H. MACKENZIE. Bournemouth. Guide to facilitate attachment of trolley head to wire.
28,073 VERITYS LIMITED and P. G. EBBUTT. Birmingham. Electric light fittings.
28,076 C. LILLICRAP. Swansea. Electrical milk separator and preservative.
23,079 A. W. TURNER. Birmingham. Electric chemico printing process.
28,093 J. VAUGHAN. Gateshead-on-Tyne. Universal turn electric crane.
28,115 P. HOFFMANN. Pocket induction coils.*
28,147 W. H. HILLYER. Electrically-operated switches.*
28,177 W. QUASCHNING. Liverpool. Pocket electric lamps.
28,183 W. K. L. DICKSON. Electrically-actuated musical instruments.

December 23, 1903.

28,192 T. HAYNES and W. H. GOWING. Birmingham. Ball bearing for motors, dynamos, &c.
28,215 VERITYS LIMITED and G. O. DONOVAN. Birmingham. Resistance coils.
28,232 A. SABAT. Coin-freed apparatus for electric light supply.*
28,234 R. W. PAUL. Moving-coil galvanometers and the like.
28,241 J. F. HOYNE. Window cleaner driven by electromotor.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

25,023 KOHLER. Controller for electric motors.
27,284 SPENCER. Retarding back running of electric tramcars.
27,497 DE GRAVE. Watertight cases for electric bells and telephones.
27,768 CAROLAN (G.E. Co., U.S.). Pneumatic train-control systems.
27,773 CAROLAN (G.E. Co., U.S.). Regulating supply of electricity.
27,785 FAIRBRASS. Scoring in games and electrically transmitting the scores to distant places.
27,849 ELECTRIC AND ORDNANCE ACCESSORIES CO., ASTINGTON and HALL. Electric lighting of vehicles and for electric lighting generally.
27,861 GROSS. Arc lamps.
28,006 HOOKHAM. Electricity meters.
28,303 BARTON. Electric lamp support and flexible cord protector.

1903.

1,054 CALLENDER'S CABLE AND CONSTRUCTION CO. and WARD. Electric fuse pillar boxes.
2,152 HERZ. Electric spark-plug for explosion motors.
3,042 ASPINALL and DALLAS. Electrical conduit system.
3,204 TYERMAN. Trolley and trolley poles.
3,226 RICHARDSON and ALLEN. Hangers or ears for trolley wires.
3,635 EVERSHED and EVERSHED AND VIGNOLES. Electric soldering irons.
3,700 MATHER. Apparatus for cleaning the grooves and thread of electrical tramway rails.
3,704 BRAGSTAD and LA COUR. Alternating current-machine applicable as converter motor and generator. (Date applied for April 29, 1902.)
3,709 BURTON and LEACH. Points for overhead conductors on electric tramways.
3,983 MIES. Safety electric fuses.
6,540 PARSONS. Switches.
7,384 EVANS (A.E.G.). Dynamo-electric machines.
7,385 EVANS (A.E.G.). Electricity meters, with means for measuring maximum consumption.
8,507, 8,508 and 8,509 THOMPSON (Stone). Space or wireless telegraphy.
12,083 ASHCROFT. Method and apparatus for agitating contents of electrolytic cells or effecting systematic transference of portions of contents from one cell to another.
16,348 WHITNEY. Electrical stop-motion mechanism for textile machinery.
23,490 IMRAY (Potter). Storage battery plates.

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BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Dynamo-Electric Machinery." By Prof. Silvanus P. Thompson, F.R.S. Vol. I.: Continuous-current Machines. 7th edition. (London: E. and F. N. Spon.) 30s.

"Electrical Engineers' Pocket-Book." By Horatio A. Foster. 3rd edition. (London: E. and F. N. Spon). 21s.

"The Phase Rule and its Applications." By Alex. Findlay, with introduction by Sir William Ramsay, F.R.S (London: Longmans, Green & Co.) 5s.

"A Manual on the Care and Handling of Electric Plants." By Norman H Schneider. (London: E. and F N. Spon.) 3s. 6d.

"Elements of Electromagnetic Theory." By S. J. Barnett. London: Macmillan & Co.) 12s. 6d.

"Introduction to the Study of Physical Chemistry." By Sir William Ramsay, F.R.S. (London: Longmans, Green & Co.) 1s

"Journal of the Institution of Electrical Engineers." Edited by W. G. McMillan. Vol. XXXIII., Part I., January, 1904. (London: E. and F. N. Spon) 2s.

"Transactions of the American Institute of Electrical Engineers." Vol. XX., No. 9, November, 1903. (New York: The Institute.) 50cts.

"Proceedings of the Royal Society." No. 487, Vol. LXXII. (London: Harrison & Sons.) 6d.

"Lecons Électrotechnique Générale." 2nd edition. Vol. I. By P. Janet. (Paris: Gauthier-Villars.) 11fr.

"Transactions of the North-East Coast Institution of Engineers and Shipbuilders." Vol. XX., Part I. (London: Andrew Reid & Co.)

"Phénomènes Fondamentaux et Principales Applications du Courant Alternatif." By R. Swyngedauw. (Paris: Vve. Ch. Dunod.) 5fr.

COMPANIES' MEETINGS AND REPORTS.

St. James' and Pall Mall Electric Light Co. (Ltd.).

The ordinary general meeting was held on Tuesday, Col. EUSTACE J. A. BALFOUR presiding.

The GENERAL MANAGER and SECRETARY (Mr. Frederic J. Walker) read the notice calling the meeting and also the auditors' report.

The CHAIRMAN said: Gentlemen, you have now the statement of accounts before you with the report of the Directors recommending that the usual dividend be paid, making for the seventh year a distribution of 14½ per cent. on the ordinary shares, but, before asking you to adopt these, I should like to place before you certain details, so that you may be fully cognisant of the position of the Company, and satisfied that there is nothing whatever to fear from what might at first sight appear to be a set-back in the steady progress which has been made hitherto. During the past year the equivalent of 21,783 8 c.p. lamps has been added, making a total at the end of the year of 254,468. The output for the year amounted to 7,140,205 units, representing an increased sale of 255,992 units over that of the preceding year. On the other hand, a small decrease in the price obtained per unit has caused the revenue to remain practically stationary. In estimating the meaning of this fact we must not forget that we are making comparison with 1902, a year of quite exceptional prosperity. Not only was the Coronation year one of unusual activity and display, but it was also favoured with more than its share of the foggy weather which does so much for our returns. 1903 has undoubtedly witnessed a want of elasticity in West End trade, together with a remarkable absence of fogs; and these two facts combined, have caused our returns, for the first time in our history, to mark time instead of advancing. The best proof, however, that this is a purely temporary pause is found in the fact that the six weeks of 1904 which have already elapsed have brought about a most satisfactory advance in our sales, and give every prospect of a largely-increased business in the coming months. You will note from the engineer's figures at the end of the report that 6,662,228 units were generated at the Company's stations within the district of supply, and that 1,118,082 units were purchased from the Central Electric Supply Co. (Ltd.). The cost of the former was normal, the very excellent economies to which I referred last year having been maintained throughout, but the average cost of the electricity sold by us has been increased by 0·4d. per unit. This is directly due to the charge of 3d. per unit which has had to be paid for the supply drawn from the Central Company. The existence of this external source of supply has been of the utmost value in enabling us to use our own plant with a proper regard to wear and tear, and to maintain a sufficient reserve to give us that margin of safety in our supply to which we have always attached the greatest importance. Our stations are in first-class order, and the whole detail of the business has been organised so that it runs as well as the fine pieces of machinery in our engine room. Our capital does not increase; no further issue is contemplated. All requirements for the extension of our business can be drawn from the Central Company. I have put these points before you, as I am desirious that you should be fully acquainted with the facts, so that you may be in a position to appreciate, as we do, that this Company is in a sound and stable position, and that the apparent set back in the accounts, due to our connection with the Central Company, is temporary only, and in no wise differs from the position which we should have been in if we, as the St. James' Company, had directly undertaken our own extensions, even if such could be made, which is more than doubtful, making provision, as we should have had to do, for some years to come. I now move the adoption of the report and accounts.

Mr. WALTER LEAF (Vice-Chairman) seconded.

The motion was carried unanimously. The retiring directors, Col. E. J. A. Balfour and Mr. Walter Leaf, were re-elected, as were the auditors, Messrs. Deloitte, Dever, Griffiths & Co.

The CHAIRMAN: That concludes our business, but before closing the meeting I wish to express, as I have happily been able to do in previous years, our sense of gratitude to the permanent staff. I may say that, with one or two exceptions, they have been with the Company from the first, and have formed one of the principal levers by which its prosperity has been built up. A man may be highly paid, but you cannot get from him his best services unless his heart is in the work. I am glad to say that in the case of this Company we have a permanent staff whose heart is in their work. I should also like to mention in this connection that, for the last two years—and I hope that in future years we shall do the same—we have sent the leading members of our staff abroad to study what is being done in the very best central stations on the Continent, for it is essential that we should be kept thoroughly up to date in modern methods, and the small sum of money which such visits cost is, I am sure, well spent. I beg to propose a hearty vote of thanks to the staff, and I hope you will join with me in that.

This was carried unanimously, and a vote of thanks to the Chairman terminated the proceedings.

BRITISH ELECTRIC TRANSFORMER CO. LTD.—The directors state in the report for the year ended Dec. 31 that, as the result of the first year's working, after placing £500 to credit of reserve to provide for depreciation, there remains a net profit of £9,714. 12s. 2d. The directors are placing £548. 15s. 3d. to capital suspense account, and propose, after payment of the 6 per cent. preference dividend, to pay a dividend at the rate of 7 per cent. per annum on the ordinary shares, £2,000 is to be put to reserve (exclusive of depreciation reserve), £1,000 to be written off preliminary expenses, and the balance (£1,569. 17s. 8d.) to be carried forward.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO. (LTD.)—At the meeting on Friday last, Mr. George Westinghouse attributed the delay in holding the meeting to the great demands upon his time by the American Westinghouse Companies, whose developments and operations were of great value to the British company's interests. With regard to their own company, under the direction of those connected with their American company, and with the authority and support of their directors, there had been created in four years a vast manufacturing plant, and, at the same time, there had been developed a management and business which would have been otherwise impossible, or would have required, as in the case of the American company, at least 15 years. The most potent factor in delaying the completion of the plant, singular as it might seem, was the phenomenal activity in business which began in America the year their company was registered. This activity absorbed, in a large measure, those most skilled in building and in managing manufacturing plants, and caused great delay in delivery of material and machinery required to complete the plant. The American Westinghouse Companies had, in consequence of the delay, furnished a large amount of apparatus, and had made a special allowance, or deduction, of £60,000 as an offset to the manufacturing profit which should have resulted from an earlier completion of their works. This allowance had contributed to the profit required to pay the interim and preference dividends for the year ended July 31 last. The dividend for the present year depended on final results, and it was not, therefore, contemplated to pay an interim dividend. With regard to the issues of further capital, the directors had considered it of the highest importance to secure a large amount of business so as to fully utilise the manufacturing facilities at the company's disposal, and to that end a large selling staff had been created and local offices established in important centres. Success had attended these efforts to secure new business. The orders in hand not executed on Jan. 31, 1904, amounted to £1,608,256. He was satisfied, considering all things, that the results achieved justified the expenses so far incurred. Their factory was practically in full working order, and he looked forward to results comparable to those obtained by the great companies in America, where the electric industry had a stability and prosperity excelling that of older-established businesses. As to the great size and extent of their works he was of opinion that no less an enterprise was required to carry on their business. The works at present gave employment to about 7,000 hands, and the buildings had been so planned that extensions could be made at comparatively small expenditure. At present, it was true, the works had a surplus capacity, but in the near future there seemed reason to believe that they would not be large enough. They not only manufactured for the home trade and the colonies, but they had supplied apparatus to other Westinghouse Companies. Of the railways in this country which he referred to last year as having taken steps to use electricity for the operation of some of their trains, only one—the Mersey—had so far put the new service into operation. In view of the development of a cheaper, safer and better system of electrical distribution for railway operations, the passing last session of the Railways (Electrical Power) Act was of great importance, as the act would enable the railways of any district, by conjoint action, without necessity for further parliamentary power, to economically utilise electricity for the operation of numerous urban and suburban services and this enlarged field of operation would undoubtedly receive renewed attention from railway mana

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gers. In connection with the development of the electrical industry, he wished to again state his conviction that the gas engine would prove the most important instrument for the cheap production of power. As to the general prospects of the company, the output from the works at Manchester for the first three months of the year would show a loss, as it had only just been started; but since then the returns, month by month, had been increasing satisfactorily. There might be a period of waiting and delay, but he considered the business a sound one in every respect.

CHILIAN EXPLORATION AND DEVELOPMENT SYNDICATE (LTD.)—At the statutory meeting last week, the chairman (Mr. John Hurst) said that the scope of the syndicate's transactions was divided into engineering, mining, trading and financial departments. The engineering department was intended to deal with all classes of engineering, electrical, architectural and industrial business. It would prepare plans, specifications, estimates and details for all kinds of public and private work in the towns of Chili, including the construction of tramways, electrical works, &c. Chili presented an ideal field for the operations of the electrician. A fine opportunity existed for the electrification of railways already built and the making of new electrical lines. The water power of Chili was almost boundless, having their origin chiefly in the majestic range of the Andes. By the co-operation of the electrical engineer and the water-power engineer, unlimited motive energy could be provided for important factories and industries of all kinds.

CRYSTAL PALACE DISTRICT GAS CO.—In the report for the half-year ended December it is stated that the company has deposited a bill for (inter alia) powers to compel Beckenham Urban District Council to prepare accounts of its electric lighting undertaking once in every year, and thereupon fix the charges for electricity supply at such rates that the revenue shall not be less than the expenditure for any year.

LIVERPOOL OVERHEAD RAILWAY CO.—At the meeting on Tuesday, the chairman (Sir William Forwood) said the report showed a gratifying increase in their traffic compared with the corresponding period last year, the number of passengers having gone up from 5,440,400 to 5,896,000, an increase of about 8 per cent. This resulted in an addition to revenue of £2,951. He regretted to say their expenses had considerably increased, for they had to spend £2,092 extra to earn £2,951. A part of the extra expense was for exceptional outlay. They had been running an accelerated service during the past half-year. The increase in mileage had been 8,000 miles on the railway and 12,500 miles on the tramways. They had put aside £2,000 for renewals and £500 of that sum as sinking fund for the tramways. Their renewal fund was now £26,559, after deducting £1,000 for new rails. They had carried £100 to contingent fund, making it £1,150. The receipts per passenger had been 1·93d. The revenue per tram-mile had been 24·47d., and had been the highest ever reached during the past year. The expenditure had been 18·82d. per tram mile, which also marked the highest point reached. In 1900 it was only 15d. As a result of the half-year's working they had earned £44,145, and the working expenses were £33,210, leaving a balance of £10,934. Deducting interest (£3,800) there was available for dividend £10,882. 5 per cent. on the preference shares would absorb £3,000, and 1½ per cent. on the ordinary shares required £3,750, against 1¼ per cent. in the preceding half-year. The balance (£4,132. 1s. 11d.) would be carried forward. The agreement with the Lancashire and Yorkshire Railway had been signed, and they were going on with the connection between Seaforth Sands station and the Seaforth station of the L. and Y. Co.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (LTD.)—The directors' report presented at the meeting on Friday last stated that the installations connected to the company's mains during the year were equal to 15,361 8 c.p. lamps, bringing the total up to about 101,824. 2,649,841 units of electrical energy were supplied, against 2,107,104 in 1902. During the past year, 9,936yds. of main and branch piping and troughing had been laid, and 47,780yds. of main and branch cable. The gross earnings for the year amounted to £16,330. 10s. 1d., and, after paying interim dividend and interest, the usual dividend of 5 per cent. was recommended for the half-year ended Dec. 31 (less tax), making 8½ per cent. for the year, and carrying forward £633.

The chairman (Mr. J. D. Milburn) said that since the establishment of the company they had paid 96 per cent. on the capital. Their first dividend (in 1890) was 2 per cent., and each successive year it had been increased. In 1898 they paid 8½ per cent. and this had since been maintained. They had made a great concession to consumers by reducing their price 25 per cent., but what they had lost in one way they had gained by an additional demand for current. The directors proposed forming a depreciation account, with a view to meeting any possible loss they might have upon the termination of their provisional order. The report was adopted.

POOLE AND DISTRICT ELECTRIC TRACTION CO. (LTD.)—The report states that the additional capital outlay during 1903 amounted to £3,115, and the total capital expenditure was £67,787. The receipts were £15,661, and the expenses (including £351 for interest) £9,993, leaving a profit of £5,668, to which should be added £959 from last account, making £6,628 available for distribution, which the directors recommend should be applied by placing to credit of depreciation and reserve £1,000, by paying a dividend at the rate of 10 per cent. per annum £5,000, carrying forward £628.

TYNESIDE TRAMWAYS CO.—At the half-yearly meeting at Newcastle on Monday, the chairman (Lord Armstrong) recorded substantial progress. During the past six months the company had carried a quarter of a million more passengers than during the previous six months, and that brought the total revenue for the year up to £16,882. The receipts per car-mile had increased. Their expenses per car mile were lower than Liverpool and Newcastle and the same as Sunderland. Extra cars were on order. It had that day been decided to let the contract for the extension of the lines to Gosforth Park. A dividend was agreed to for the half-year at rate of 2½ per cent. per annum.

WATERLOO AND CITY RAILWAY CO.—At the meeting yesterday the chairman (Lieut.-Col. the Hon. H. W. Campbell) said that, though some of the shareholders might be disappointed at the result of the past half-year's working, there was no really no cause for anxiety. The revenue showed steady progress up to August, but on the 10th of that month the deplorable accident on the Metropolitan Railway of Paris occurred, and there was no doubt that disaster was the cause of the gradual falling off in the traffic of their railway. The decrease continued up to November, but now the traffic again showed steady, if small progress. On the Waterloo and City Railway the lighting of the stations and of the tunnel was absolutely independent of the motive power, so that in case of accident to a train the lighting of the stations and of the tunnel would not be interfered with in the slightest degree. This was not the case on the Paris line, and this accounted in great measure for the loss of life. There was also a gas installation, and, in addition, there was an oil lamp in every carriage. In case of accident on the line, means were provided by which passengers could get out at each end of the carriage, and they could then walk on a pathway to the station at either end. There would be no risk in so doing of coming into contact with the electricity on the third rail, as means were provided by which every driver on the railway could in a few seconds cut off the electricity from the centre rail without communicating with the generating station at the Waterloo end. Moreover, every train would stop at once on the driver of the motor cutting off the electricity from the third rail. The railway was also thoroughly well ventilated. The line had been opened 5¼ years, and had (including season ticket holders) carried 30,000,000 passengers without an accident of any kind. That fact spoke volumes for the way in which the traffic had been worked, and as an old railway man, he might say that the regularity of the service was remarkable. There had been a falling off in revenue of £300, and a slight increase in expenses, which included £160 paid as compensation to one of their workmen. But for that the directors would have been able to pay the same dividend as last year, 3½ per cent. The traffic for the current half-year was growing steadily, and there was no reason why they should not go on increasing the dividend by small additions.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

MORTGAGES AND CHARGES.

EVERSHED AND VIGNOLES (LTD.)—Trust deed dated Jan. 18, 1904, supplemental to trust deed of Feb. 11, 1903, securing £15,000 debentures created by resolution of even date), has been registered. Property charged, £2,500 capital uncalled on shares issued since date of principal trust deed. Trustees, Law Guarantee and Trust Society.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26⅞d. per oz. (Feb. 11). Consols 86⅞—86⅞ for money, 86½—86⅝ for account; 2½ per cent. annuities 86¼—86½ (Feb. 11). Consols Pay Day, Mar. 1; Stocks and Shares Continuation Days, Feb. 23 and Mar. 8; Ticket Days, Feb. 24 and Mar. 9; Pay Day, Feb. 25; Mining Share Carry-over Days, Feb. 22 and Mar. 7.

BAKER STREET AND WATERLOO RAILWAY CO.—The directors' report states that the capital expenditure during the past half-year amounted to £204,175, and the estimated expenditure for the current half-year is £300,000.

LANCASHIRE AND YORKSHIRE RAILWAY CO.—At the meeting this week the chairman (Sir Geo. J. Armytage) said excellent progress had been made in the electrification of the Liverpool, Crosby and Southport Railway and they hoped to commence the new service within the next two months.

LONDON PLATINO-BRAZILIAN TELEGRAPH CO. (LTD.)—Notice is given that the 6 per cent. debenture (bearer) bonds, due for payment March 1, will be paid off at par on and after that date by the London Joint Stock Bank, Finsbury Pavement, London, E.C. The half-yearly interest coupons of the debentures will be paid at the same time.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.).—This company has offered its shareholders at par 5,000 £5 5 per cent. cumulative preference shares (the balance of £50,000). The capital is required for the extension of the supply mains to Hythe and Sandgate, for extensions in Folkestone and to pay off a banker's overdraft of about £10,000.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered £200,000 5 per cent. first mortgage debenture stock of the *Auckland Electric Tramways (Ltd.)* to be quoted in the official list. The committee have also been asked to allow the further issue of £12,500 4 per cent. perpetual first mortgage debenture stock of the *Electric Construction Co. (Ltd.)* to be quoted.

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BRISTOL TRAMWAYS AND CARRIAGE CO. (LTD.)—The report for 1903 states that the gross receipts were £253,150. 5s. 6d., working, general expenses and renewals £164,762. 17s. 8d., leaving £88,387. 7s. 10d. Of this interest absorbed £11,301. 11s. 9d., 4 per cent. preference dividend £19,000, and interim dividend at the rate of 8½ per cent. per annum (less tax) for half-year ended June £20,098. 19s. 2d. It is proposed to pay a final dividend at rate of 9½ per cent. (less tax) £22,661. 9s. 2d., and to add the balance (£15,325. 7s. 9d.) to reserve for contingencies. The interest on investments has been carried to credit of contingencies fund. The receipts from the tramways department show the substantial increase of £14,771, equivalent to about 7½ per cent., although the system of tramways operated compares exactly with the mileage open during preceding year.

GREAT CENTRAL RAILWAY CO.—Between Grimsby and Cleethorpes the company's traffic was so seriously affected by the electric trams, that weekly season tickets were instituted at 6d. per head, equal to a fare of ½d. for the single journey of 4 miles, if the passenger travelled twice a day, and less than this if he travelled more frequently. The tramway company have not brought down their fares lower than 1d. for the single journey, with the result that the bulk of the residential traffic has returned to the railway.

GREAT NORTHERN, PICCADILLY AND BROMPTON RAILWAY CO.—The report for half-year to Dec. 31, presented at the meeting last week, stated that the capital expenditure was £1,175,504. The estimate for the current half-year was £900,000. Under their 1903 Act further capital powers to the extent of £250,000 in shares, with £83,000 borrowing powers, were authorised. The rent due from the Underground Electric Railways Co. of London (under the terms of the agreement for lease dated Jan. 13, 1903) to Dec. 31, 1903, permitted of the payment of a dividend at the rate of 4 per cent. per annum. The Chairman (Sir H. Fowler, M.P.), said that the company had acquired all the station sites, from which the tunnels were being bored. Up to the present £175,504 had been spent, and it was estimated that £900,000 would be spent during the current year. Work was making satisfactory progress.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—The report of the directors for the year 1903 states that the number of houses and shops connected with the system during the year increased from 2,889 to 3,210, and the number of equivalent 8 c.p. lamps from 249,870 to 280,133. The renewal account stands at £50,430. 1s. 8d., an increase of £6,285. 5s. 7d. for the year. After providing for this, writing £3,000 off cost of purchase of Kensington Court Co. (Ltd.), and paying the preference dividends and an interim dividend at the rate of 10 per per cent. per annum on the ordinary shares, the balance standing to credit of net revenue is £17,773. 5s. 11d. £2,125 has been appropriated to preference dividends, and it is proposed to pay a further dividend on the ordinary shares at the rate of 10 per cent. per annum and a bonus of 2 per cent. for the year, making 12 per cent. for the year. £8,298. 5s. 11d. will be carried forward. The seats on the board vacant by the death of Sir F. J. Bramwell and Sir C. Grant have been filled by the election of Mr. C. C. Wyllie, jun., and Sir H. Bliss.

LONDON, TILBURY AND SOUTHEND RAILWAY CO.—At the meeting last week the chairman said that he hardly dared lay much stress on the estimates of experts as to the traffic which the company would obtain when a portion of the system was electrified, but if those estimates were realised they would all be compelled to admit that it was a good thing to have widened the line in the metropolitan district and to have adopted electricity as the motive power.

NATIONAL TELEPHONE CO. (LTD.)—The report of the directors for the half-year ended Dec. 31 states that the income of the half-year was £941,259. 14s. 11d., compared with £868,462. 11s. 10d. for the corresponding period of 1902, an increase of £72,797. 3s. 1d. The working expenses were £527,284. 5s., compared with £473,267. 12s. 1d., an increase of £54,016. 12s. 11d., the net result (after deducting Post Office royalties, £86,236. 7s. 11d.) being a profit of £327,739. 2s., compared with £316,553. 6s. 5d., an increase of £11,185. 15s. 7d. Rentals carried forward for unexpired terms of running contracts amounted to £827,163. 19s. 10d., compared with £771,102. 14s., an increase of £56,061. 5s. 10d. Out of the available balance of £269,421. 15s. 11d., the directors recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference and 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock and 5 per cent. per annum on the deferred stock (less tax in all cases). £110,000 is transferred to reserve, £10,505. 2s. 7d. carried forward. £413,288. 1s. 7d. has been expended on capital account during the half-year in the erection of 16,891 additional exchange and private stations and in the construction of underground works.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)—The report states that the past year has been a prosperous one. The income was temporarily affected by the reduction in price of current from 6½d. and 3½d. to 6d. and 3d. per unit. The lamps and motors fixed during the year were: Lamps 3,403, motors 4,485 (equivalent 8 c.p. lamps), compared with lamps 2,916, motors 930, in the preceding year, making a total of 33,310 lamps and (the equivalent of) 7,545 in motors, together 40,855. The separate consumers in 1901 were 502, in 1902 580, and in 1903 704. The annual increase in motive power, measured in horse-power, was: 1901, 20 H.P.; 1902, 31 H.P.; 1903, 149½ H.P.; total installed, 251½ H.P. Of these a large proportion (133½ H.P.) are the property of the company, and let out on hire. The units sold for driving motors during the past two years were 40,397 and 103,110 respectively. The mains have been increased by 4 miles 78yds., making 13 miles 313yds. Steps have been taken to obtain a provisional order for extending the company's area of supply. A proposal to increase the company's capital will be submitted at the annual meeting. The directors have been invited by the Finance committee of the Town Council to re-open negotiations for the purchase of the company's undertaking. It is proposed to pay the preference dividends and a dividend on the ordinary shares at 4½ per cent.

RAND CENTRAL ELECTRIC WORKS (LTD.)—A cable from Johannesburg states that for January the units generated were 776,940, yielding a gross revenue of about £7,000, compared with 677,860 units and £5,078 in the corresponding month of 1903.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.).—Subject to audit, the directors propose to pay a dividend of 10 per cent., together with a bonus of 5 per cent., in addition to the 5 per cent. already paid, making 20 per cent. for 1903.

YORKSHIRE ELECTRIC POWER CO.—The directors' report states that since the first meeting in September last, the erection of the station at Thornhill has made progress. A scale of charges for current has been settled, and negotiations with various local authorities, colliery proprietors and others, for the supply of power are proceeding.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Feb. 6	1,073	+ 300	36	44,122	+ 8,568
Ayr Corporation	,, 6	164	+ 9	38	11,198	+ 176
Barnsley	Jan. 29	144	- 12	4	592	- 42
Bexley District Council	Feb. 5	113	...	18	2,735	...
Birkenhead	,, 7	1,046	+ 126	...	...	...
*Birmingham Tramways Co.	,, 6	5,099	+ 273	5	25,335	+ 1,938
*Blackburn Corporation	,, 5	771	+ 109	§45	38,049	+ 1,767
Blackpool Corporation	,, 4	296	- 8	§14	39,343	- 211
Blackpool and Fleetwood	,, 6	219	+ 30	6	1,100	- 14
Blackp'l, St. Anne's & Lytham	,, 4	155	+ 155	†14	2,030	+ 1,451
Bolton Corporation	,, 7	1,615	+ 81	45	81,998	+ 8,874
Bournemouth Corporation	,, 3	848	...	5	4,209	...
*Bradford Corporation	,, 7	3,453	+ 301	43	168,230	+ 22,110
Brighton Corporation	,, 7	763	+ 36	44	40,636	+ 2,677
Brisbane Tramways	Dec. 23	2,643	- 305	25	59,550	+ 779
*Bristol Trams & Carriage	Feb. 5	4,395	+ 116	11	49,763	+ 2,357
*Buenos Ayres & Belgrano	Jan. 10	3,339	+ 357	12	41,583	+ 2,125
Burnley Corporation	Feb. 6	836	+ 182	45	41,288	+ 7,795
Burton Corporation	,, 7	297	...	27	9,424	...
Calcutta Tramways Co.	,, 6	R36,342	+ R7,440	6	R222,901	+ R43,138
Camborne-Redruth	,, 8	98	...	14	7,675	...
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 6	6,994	- 44	6	41,788	+ 74
Chatham & Dist. Lt. Rys.	,, 4	517	+ 123	5	2,492	+ 550
City & South London Rly.	,, 7	3,239	- 26	6	19,288	- 917
Cork Electric Trams Co.	,, 4	396	+ 24	5	1,991	+ 53
Darwen Corporation	,, 6	212	+ 12	45	10,170	- 231
Devonport & Dist. Trams.	Jan. 29	441	+ 84	4	1,909	+ 317
Dover Corporation	Feb. 6	164	- 4	†45	10,009	+ 51
Dublin & Lucan Railway	,, 7	103	+ 9	6	508	+ 33
Dublin Southern District	,, 5	677	- 4	¶5	3,5.3	+ 858
Dublin United	,, 5	3,705	+ 104	¶5	78	
Dudley—Stourbridge	Jan. 29	718	+ 33	4	2,910	+ 135
Dundee Corporation	Feb. 3	803	+ 42	37	31,766	+ 2,047
East Ham Council	,, 6	578	+ 68	†45	29,689	+ 8,107
Gateshead & Dist. Trams.	Jan. 29	852	+ 36	4	3,544	+ 165
Glasgow Corporation	Feb. 6	13,140	+ 1,119	36	491,896	+ 52,050
Gravesend—Northfleet	Jan. 29	193	+ 24	4	830	+ 127
Greenock & Port Glasgow	,, 29	458	+ 98	4	1,944	+ 270
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 29	238	+ 29	4	1,011	+ 137
Hudder-field	Feb. 6	1,074	+ 105	...	...	...
Hull Corporation	,, 6	2,004	+ 342	†45	85,660	+ 6,439
Ilkeston Corporation	,, 3	120	...	12	1,426	...
Ipswich Corporation	,, 6	311	...	5	8,224	...
Isle of Thanet Co.	,, 7	215	- 5	...	...	...
Kidderminster & District	Jan. 29	87	- 13	4	339	- 40
Kirkcaldy Corporation	Feb. 3	189	...	49	8,855	...
Lanarkshire Trams Co.	,, 9	567	...	5	3,008	...
Leeds Corporation	,, 6	4,798	...	45	245,196	...
Liverpool Corporation	Jan. 30	9,334	+ 166	5	47,740	+ 2,164
*Liverpool Overhead Rly.	Feb. 7	1,532	- 68	6	9,264	- 3.5
*London County Council	Jan. 30	8,578	+ 782	†44	229,983	+ 76,527
Lowestoft	...	...	...	...	...	...
Manchester Corporation	Feb. 6	10,692	+ 2,703	34	393,626	+ 181,961
Mersey Railway	,, 6	1,431	+ 339	5	7,213	+ 1,865
Merthyr	Jan. 29	186	+ 23	4	753	+ 81
Middleton	,, 29	233	+ 13	4	979	+ 20
Newcastle-on-Tyne Corp.	Feb. 6	3,580	+ 555	5	17,437	+ 2,695
Newport (Mon.)	,, 6	442	+ 239	19	8,532	+ 4,337
Oldham, Ashton & Hyde	Jan. 29	486	- 29	4	1,997	- 160
Perth (W. A.) Elec. Trams.	Feb. 5	1,429	+ 184	5	7,391	+ 1,030
Peterborough	Jan. 29	104	- 72	4	443	- 72
Poole and District	,, 29	206	- 15	4	895	- 16
Portsmouth Corporation	Feb. 6	1,391	+ 161	†45	77,987	+ 5,167
*Potteries	Jan. 29	1,575	+ 92	4	6,438	+ 225
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 29	37	+ 5	4	193	+ 14
Salford Corporation	Feb. 8	3,638	+ 805	45	171,608	+ 48,144
Sheerness	Jan. 27	40	...	4	176	...
Sheffield Corporation	Feb. 7	4,201	+ 273	†46	206,063	+ 17,425
*Southampton Corporat'n	,, 4	848	+ 41	5	4,204	+ 154
Southend Corporation	,, 3	190	+ 9	44	13,976	+ 2,164
Southport Tramways	Jan. 29	229	+ 25	4	965	+ 92
S. Staffordshire Trams.	,, 29	784	+ 122	4	2,947	+ 245
Sunderland Corporation	Feb. 7	1,074	+ 101	45	54,366	+ 2,541
*Swansea Trams	Jan. 29	476	+ 53	4	1,872	+ 39
Taunton Trams	,, 29	44	- 3	4	190	- 9
Tynemouth and District	,, 29	204	- 10	4	840	+ 12
Tyneside Trams Co.	Feb. 3	283	+ 60	5	1,321	+ 318
Wallasey District Council	,, 6	583	+ 61	†45	30,726	+ 3,742
Weston-super-Mare	Jan. 27	28	+ 2	4	81	- 6
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 29	336	- 19	4	1,310	- 42
Wrexham	,, 29	103	...	4	397	...
Yorkshire Woollen District	,, 29	485	...	4	2,035	...

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Feb. 9.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS, WEEK TO FEB. 9		SHARE.	LAST DIVIDEND	NAME.	Price Wed., Feb. 9	RATE PER CENT. YIELDED.	DIVIDEND DUE	BUSINESS WEEK TO FEB. 9.	
						Highest.	Lowest.							highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.						**TELEPHONES.**		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅞—5	5 0 0	April, Oct	4⅛	4⅜	5	3/0	Chili Telephone (fully paid)	4⅜—5⅛	5 14 3	August	..	..
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..	St.	6%	National Co. Pref. Stock	102 —104	5 18 0	..	103¾	102
10	10/0	Barcelona Tramways Ord.	7⅞—8⅛	5 17 8	..	..	..	St.	5%	Do. Def. Stock	78 —81	6 1 2	..	79	78
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..	10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12½—14½	4 2 9	Feb, Aug	..	..
St	4½%	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..	10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	14 —15	4 0 0	Feb, Aug	14⅜	..
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	..	..	5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5⅝	4 13 0	Feb, Aug	5⅝	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..	St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 —97	3 12 2	June, Dec	95½	95½
5	2 6	Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	..	..	St.	4%	Do 4 per Cent. Deb. Stock (red.)	100 —102	3 18 5	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	97	..	1	0/7½	Oriental	⅞—1	6 13 4	April, Oct	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 —21	3 10 10	Feb, Aug	..	..	1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10⅝	3 15 11	..	..	..	5	3/0	United River Plate	5½—6	5 16 8	July	5⅝	..
St.	4%	Do. 4 per Cent. Debs.	108 —108	3 14 0	Feb, Aug	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5⅛	4 15 3	June, Dec	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	79 —82	3 12 9	..	81⅛	81⅜	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 - 105	4 15 3	June, Dec	..	..
St.	5%	Do. Pref. Ord. Stock	91 —94	5 6 2	..	93⅛	92⅜			**ELECTRICITY SUPPLY.**					
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	..	..	1	..	Blackheath & Greenwich, Dist. Ord. (f.p.)	¾—1	..	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅞	4 7 0	..	104	103⅝	1	..	Do. 7 Cum. Pref.	1⅛—1⅜	..	..	..	..
100	4½	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..	St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	114 —117	3 17 7	..	..	..
10	6/0	British Elec. Tr. Traction Ord.	10½—11½	7 12 5	..	12⅛	10⅞	10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11½	5 4 3	Feb, Aug	11⅞	11⅝	10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	120½	..	10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	..
5	..	Buenos Ayres and Belgrano Ord.	3 —3½	..	..	3⅝	3⅜	St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
5	3 0	Do 6 per Cent. "A" Cum Pref.	5½—5⅝	5 4 0	..	..	..	St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	3/0	Do. "B"	4¾—5⅛	5 14 3	..	5⅞	5	5	4 6	Brompton & Kensington Elec. Sup. Ord.	10½—10⅞	4 13 0	..	1⅛	..
St	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	105⅞	105⅛	5	3/6	Do. 7 per Cent. Pref.	9⅞—10⅛	3 8 4	Mar, Sept	..	..
St	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	100	..	5	3 0	Calcutta Electric Supply Ord. ex rights	6 —7	4 12 10	..	..	..
5	2 6	Calcutta Tramways	6½—7	4 12 10	..	6⅞	6⅞	St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 8	..	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 —107	4 4 2	..	106⅛	104	5	4/0	Charing Cross & Strand Electric Sup.	8¼—8⅝	5 14 3	Feb, Aug	8½	..
1	1/0	Cape Electric Tramways Shares	1⅝—2	8 10 0	..	..	..	5	2/3	Do. 4½ per Cent. Pref.	5⅜—5⅝	4 0 0	Feb, Aug	..	..
St	4%	Central London Ordinary Stock	94 —97	4 4 3	June, Dec	96⅛	94⅛	5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅞ 5	4 10 0	..	4⅞	..
St.	4%	Do. 4 per Cent. Pref Stock	98 —101	4 0 4	..	101⅛	101	St	4%	Do. 4% Deb. Stock (red.)	103 105	3 16 3	..	..	..
St	4%	Do. Deferred Stock	91 —94	4 8 11	..	..	..	5	2 0	Chelsea Electric Supply Ord.	5⅜—6	4 8 0	March	6	5⅞
100	4%	Do. 4 per Cent. Debs.	110 —115	3 9 9	..	110½	..	St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	166 —169	4 3 1	Jn, Dec	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾ - 5¼	4 15 3	..	..	..	10	5/0	City of London Electric Lighting Ord.	10¼—10⅝	6 19 6	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..	10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St	2¾%	City and South London Rly. Con Ord	50 —53	4 9 7	Feb, Aug	52	50⅛	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Ju, Dec	..	..
St	5%	Do. 5 per Cent. Perp. Pref. (1891)	125 —128	3 19 8	Feb, Aug	..	..	St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St	5%	Do. (1896)	122 —125	4 0 4	..	..	..	10	4/0	County of London & Brush Prov. Ord.	8 —9	4 8 11	..	..	..
St	5%	Do. (1901)	120 —125	4 1 1	..	..	..	10	6 0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	11⅞	..
St	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..	St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 — 110	4 1 10	..	..	..
St	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	102 —105	4 16 5	..	..	..	St.	27 6⅞	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	100⅛	100
10	5 0	Dublin United Trams. (1896) Ltd., Ord	12½—13½	4 1 6	..	..	..	5	2 0	Folkestone Electricity Supply Co. Ord	5¾—6¼	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..	St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 3	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf	3 —4	7 10 0	..	..	..	10	..	Havana Electricity Co. Shares	9½—10⅛	..	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..	5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 —8	3 15 0	..	7⅛	7⅛	1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm. Prf	⅞—1⅛	..	..	..	..
10	..	Gt. Northern, Piccadilly & Brompton Ord., 8 per Bros. Scrip Certs.	9 —10	..	..	..	..	5	6%	Kensington & Knightsbridge Ord.	11 —12	4 3 4	..	..	..
10	10%	Imperial Tramways Ord	20 —21	4 13 0	Mar, Sept	..	..	St.	4%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14½—14¾	4 2 10	Mar, Sept	..	..			Kensington. & Kngtbg. Co. & Notting Hill Co. (Joint Station; 4% Deb. Stck. (red.)	103 —106	3 16 2	..	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..	5	..	London Electric Supply Ord.	1⅞—2⅛	..	..	2⅛	1⅞
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..	5	3/0	Do. 6 per Cent Pref.	5⅛—6	5 0 0	..	..	..
St	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	91⅛	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 1	Mr, Jn, S, D	97	..
10	1½%	Liverpool Overhead Railway Ord.	4⅞—5	2 10 0	Feb, Aug	..	..	10	8 0	Metropolitan Electric Sup. Ord.	18 —19	4 1 7	April, Oct	18⅞	18½
1	5%	Do. 5 per Cent. Pref.	10 —10½	4 15 3	Feb, Aug	..	..	5	..	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	..	..	5⅜	5⅛
St	4%	† Do. 4 per Cent. Deb.	98½ —100⅞	3 19 10	Jan, July	..	..	St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11¼—11⅞	4 5 1	..	11⅞	11⅝	St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 4	..	96⅛	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 —105	3 16 4	..	103⅞	..	100	4/	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
St.	..	Mersey Con. Ord. Stock	8 —11	..	..	..	..	1	6/0	Notting Hill Electric Ord.	13 —14	4 5 9	March	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12—15	..	..	..	..	100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..	5	2 6	Oxford Electric Ord.	5½—6	4 11 8	March	5⅞	..
1	..	Metropolitan Electric Trams Def	⅝—¾	..	..	..	..	St.	4%	Do. 4% Deb. Stock	97 —100	4 0 3	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1⅛	4 8 11	..	..	..	1	..	Rand Electric	1⅜—1⅝	..	..	..	..
100	5%	Montreal St. Rly. St'k 5% Mrt. Dbs. (1908)	103 —105	4 17 1	..	..	..	100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	104 —106	4 4 11	..	..	..	5	5 0	St. James's and Pall Mall Electric Ord.	14½—15½	4 13 9	Feb, Aug	..	..
5	..	New General Traction Ord.	⅛	..	..	..	..	5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8⅜	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	..	May	..	..	St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	..	..	5	2/6	Smithfield Markets Electric Sup. Ord.	3¼—3⅜	3 6 8	..	..	..
10	10/0	Potteries Electric Traction Ord.	8¾—9½	5 5 3	..	..	..	St.	4%	† Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..	5	1/9	South London Electric Supply Ord.	3⅜—4⅛	4 2 4	..	4	3⅞
St.	4½%	Do. 4½ per Cent. Deb. Stock	102 —105	4 5 9	..	..	..	5	2/6	Urban Electric Supply Ord.	4⅜ 5	5 0 0	..	4⅜	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..	5	2/6	Do. 5% Cum. Pref.	4⅞—5⅛	4 17 7	..	4⅞	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..	5	6/6	Westminster Electric Supply Ord.	12½—13½	4 16 4	Mar, Sept	13⅜	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6	..
St.	3½%	Waterloo and City Ord.	91 —94	3 9 8	June, Dec	..	..			**ELECTRIC MANUFACTURING &c.**					
								1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—½	6 13 4	..	..	..
		TELEGRAPHS.						1	..	Aron Electric Meter 6% Cum. Pref.	⅝—¾	..	Mar, Sept	..	..
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..	5	4/0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	6⅜	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..	5	3 0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..	St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	105½	..
St.	15/0	Anglo-American	50 —53	6 0 9	F, My, Ag, N	51	..	St.	4½%	British Thomson-Houst'n 4½% 1st Mt. Db.	103 —105	4 5 8	..	..	..
St.	30/0	Do. Preferred	94 —96	6 7 7	F, My, Ag, N	95⅜	95	5	3/0	British Westinghouse 6% Pref.	3½—4	7 10 0	..	4⅛	3⅞
St.	1/0	Do. Deferred	7⅛—8	0 12 8	F, My Ag, N	7⅞	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 3 4	..	95⅛	94
100	8 2	Commercial Cable Capital Stock	180 —190	4 4 5	Ju, Ap, Jy, O	..	..	2	..	Brush Electrical Engineering	¾—1⅛	..	March	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 —91	4 8 3	Jn Ap, Jy, O	90⅜	..	2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 —1½	8 0 0	Mar, Sept	..	..
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	7⅞	7½	St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	98 —101	4 11 2	Mar, Sept	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..	St.	4½%	Do. Perpetual 2nd Deb. Stock	75 — 80	5 12 8	Jan, July	..	..
5	2/0	Direct Spanish Ord.	2⅛—3⅛	5 14 4	April, Oct	..	..	5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	10⅝	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7⅛—8⅛	5 17 8	April Oct	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5⅝	4 6 11	Jan, July	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅞—101⅞	4 9 1	Jan, July	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	..	..
20	3/0	Direct United States Cable	10 —10½	6 3 10	Ja, Ap, Jy, O	10⅜	10⅛	1	7/d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —101	4 9 1	Jn, Dec ..	..	..	St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88—93	4 14 9	..	..	..
St.	26/0	Eastern Ordinary	119 —124	5 12 11	Ja, Ap, Jy, O	122	120½	1	1/6	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March	..	..
St.	17/6	Do. 3½ per Cent. Pref. Stock	88 —91	3 16 11	Ja Ap, Jy, O	88½	88	100	5%	Crompton and Co. (Nos. 1 to 54,000)	1½—2	7 10 0	Jan, July	1½	..
St	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	106	105¾	*		Do. 5 per Cent. 1st Mort. Debs. (red.)	97⅝—100⅝	5 0 0	Jan, July	..	..
10	2/6	Eastern Extension	10¾—11½	6 4 5	Ja, Ap, Jy, O	11	..	5	..	Dick, Kerr & Co. Ord.	8½—8¾	..	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	104 —107	3 14 9	Feb, Aug	..	..	5	..	Do 6% Cum. Pref.	5¼—5⅜	..	..	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	98 —101	4 0 0	Feb, Aug	..	..	St.	4½%	Do. 4½% Deb. Stock	103—105	4 5 9	..	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	90⅝—102⅞	3 18 11	May, Nov	101⅛	..	5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	⅛	..	Feb, Aug	..	..
10	5/0	Great Northern of Copenhagen	22 —23	5 8 8	Jan, July	..	..			Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
25	12 6	Indo-European	38 —41	6 1 11	May, Nov	..	..	St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
100	6%	London Platino-Brazil. 6% Debs., 1904	100 - 103	5 19 5	Mar, Sept	..	..	5	2/6	Edmundson's Elec. Corp. Ord.	5¾—6⅛	5 12 0	H'lf-yearly	6⅛	6
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..	5	3/0	Do. 6 per Cent. Cum. Pref.	5⅞—6⅛	4 16 0	..	..	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 4 11	..	104½	..
2½	..	West Coast of America	½—1	..	..	..	..	2	1/2½	Electric Construction Co.	1½—1⅝	6 71 2	Jan, July	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..	2	2 9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —8½	9 4 8	May, Nov	6¾	6⅛	1	..	Electrolytic Alkali Ord.	½—¾	..	..	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..			Do. 7 per Cent. Cum. Pref.	½—1	..	..	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..	St.	7%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	3/0	Western Telegraph	11¾—12¼	5 14 3	Mr, Jn, O, D	12⅛	11⅞	10	5/0	General Electric (1900) 5% Cum. Pref.	9½—9¾	5 2 7	..	9½	9¼
100	5%	* Do. 5% Debs. (2nd Series, 1906)	99 —102	4 18 0	June, Dec	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 —98	4 2 6	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 3	..	..	..	5	6/0	Henley's Telegraph Works Ord.	12 —13	7 13 10	Feb, Aug	12¾	11½
								St.	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
		FINANCIAL, INVESTMENT, &c.						St.	4½%	Do. 4½ per Cent. Mort Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
								10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	18⅝	..
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..	100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 4	Mar, Sept	..	..
10	2/0	Globe Telegraph and Trust	8½—8¾	4 11 5	Ja Ap Jy O	8⅝	8½	10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11½	4 8 11	Mar, Sept	..	..
10	8/0	Do. 6 per Cent. Pref.	12½—12¾	4 14 1	Ja Ap, Jy, O	12⅝	12½	12	12/0	Telegraph Construction & Mainten'ce.	33 —36	6 13 4	Mar, July	35	33½
8	4/0	Reuter's	6½—7½	5 6 8	April, Oct	6⅞	..	100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	5 0 0	April, Oct	118	..	5	3/0	Willans and Robinson Ord.	4 —5	6 10 0	Apr, Oct	..	..
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* In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

ON Wednesday afternoon a deputation from the University Colleges of London, Manchester, Liverpool, Leeds, Birmingham, Nottingham, Bristol, Newcastle, Dundee and Sheffield waited upon the Chancellor of the Exchequer with the object of asking for an increase in the present annual Treasury grant of £27,000 to university colleges. The various colleges, together with their respective grants, were given on p. 593 of *The Electrician* of February 5th. Sir OLIVER LODGE introduced the deputation, and pointed out that the present amount set aside for the purpose by the Treasury was quite inadequate if the work was to be carried on as originally intended. It seems that it is comparatively easy to secure endowments for chairs, and even large sums for buildings, from private donors, but that great difficulty is experienced in obtaining money for annual maintenance from similar sources. In these circumstances it is pleasing to learn that Mr. AUSTEN CHAMBERLAIN will recommend that the vote be doubled for the present year, and that he hopes it will be increased to £100,000 next year. No college will participate, however, whose work is not of university standard.

IN his Paper on "The Distribution of Electricity in Shipyards and Engine Works," which covers similar ground as did Mr. A. D. WILLIAMSON'S Paper before the Institution of Electrical Engineers last year, Mr. J. A. ANDERSON advocates a three-phase current distribution for power and continuous-current for lighting and those few motors which require a fine and frequent speed regulation. He deals specifically with the case in which the current is not generated at the works themselves, but is supplied in the form of three-phase current from outside, and suggests that the continuous current should be produced by rotary converters. Double distribution of this nature seems hardly necessary in ordinary circumstances, however, in which the range of speed variation required of the motor itself is not beyond what can be provided by means of three-phase motors. Two ordinary sets of three-phase circuits, one for motors and the other for lighting, should meet all requirements in most cases; but as continuous-current motors are preferable for cranes and a few similar purposes, if they can be had without introducing too much complication in the system, it would be better to employ continuous current for all motors if this class of load predominates. Some of the figures which Mr. ANDERSON gives for the power consumption of various machines are valuable, but in other cases it is to be regretted that he has supplied us with such scanty data regarding the work done by the machine tools, the power consumption of which he has determined. Taken as a whole, however, the Paper possesses considerable merit and is likely to be of value to manufacturers and engineers interested in the subject.

MR. CARNEGIE'S offer of a common building for all the American engineering societies has not met with the unanimous approval that might have been expected. The Society of Civil Engineers has not yet decided whether to accept the offer, and the arguments, pro and con, in the shape of a printed circular, are to be submitted at the annual general meeting. Certain members of the Society are under the impression that it is beneath the dignity of a professional body to accept such a gift, and that intimacy with societies devoted to other branches of engineering might prove derogatory. They are further doubtful as to whether the architectural features of the proposed ten-storey building will "suitably impress the general public." Other objections relating to the site of the building and the cost of maintenance have also been advanced, but these are evidently of small importance compared with the loss of dignity which it is thought the Society would sustain by associating with its sister societies.

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It is rather startling to read of such ideas emanating from America, where conservatism is at a discount; and although the wish to preserve prestige is always praiseworthy in individuals or societies, yet it is hard to see how the good reputation of the American Society of Civil Engineers would lose one whit by the acceptance of Mr. CARNEGIE'S offer. A home in the "Temple of Engineering," on the other hand, would doubtless tend to raise the status of the younger branches of the profession, and the whole industry would ultimately be benefited. This is evidently Mr. CARNEGIE'S intention, and it is interesting to learn that he has now increased his gift to $1,500,000.

The present methods for determining the hysteresis and eddy-current losses in iron sheets from which armature and transformer stampings are made, are rather cumbersome and exacting, and engineers whose duty it is to examine the iron with regard to its magnetic properties will, doubtless, read with interest the description of the method devised by Herr R. RICHTER and described in another column of this issue. The great advantage of the method is that whole sheets can be tested by its means without the necessity of previous preparation and fitting.

An abstract of the Paper read by Dr. MULLINEUX WALMSLEY before the Institution of Electrical Engineers will be found on another page of this issue. Although the author had some very interesting pictures of American and Canadian colleges to show, it seems regrettable that so much time was occupied in reading an abstract of the Paper, as every member desirous of joining in the discussion could have obtained a copy of the Paper many days before the meeting.

Dr. WALMSLEY'S contribution to a well-worn subject contains much that is interesting and also much that everyone has known for a long time. He endeavours to show that candidates for entrance to transatlantic engineering colleges are better fitted to receive the training than those in England, but it seems that this superiority is largely due to their greater age. Whether he receive his preliminary education in England or America, a youth of 18 will most certainly be more fitted to take advantage of scientific and technical training than one of 15 or 16. There can be no doubt that English engineering students are often allowed to commence their professional training at too early an age. But everything does not rest with the students, and we most heartily concur with Dr. WALMSLEY when he says that the teachers should be engineers who have had wide and successful practical experience. Mere academical training, no matter how sound, is not sufficient for teachers of engineering.

While CHARPENTIER and MEYER are pursuing their researches into the biological and physiological effects of N-rays, apparently quite unmoved by the scepticism which still prevails in many quarters concerning the very existence of the rays they work with, M. C. GUTTON, in a note presented to the Academy of Sciences by Prof. POINCARÉ, announces the discovery of a new magnetic effect of great interest, which shows the most characteristic N-ray effect in a new connection. It appears that N-rays are not the only agent capable of imitating the effect of heat in increasing the luminosity of a faintly luminous screen. A magnetic field does it also, but with the important provision that it must not be uniform. This fact has apparently stood in the way of the effect being discovered long ago. The experimenter would naturally be inclined to place the object under investigation in the centre of the most intense magnetic field at his command. But the effect described by M. GUTTON disappears in a uniform magnetic field however strong, whereas it is observed in an extremely feeble field which has the merit of not being uniform. The criticism which will no doubt be immediately advanced is that the new effect is contrary to the law of the conservation of energy. A permanent magnet requires no supply of energy to keep up its magnetism. Yet it increases the amplitude of oscillation, and hence also the expenditure of energy of luminous particles. This contradiction will be removed if it is shown either that there is a loss of magnetism of the magnet as a result of the process, or that the energy of the screen is more rapidly exhausted. In any case, if the author is right in supposing that the increase of luminosity is a direct effect of the presence of the field, we shall have at our disposal another valuable and sensitive test for the divergence of lines of magetic force.

According to two of our halfpenny contemporaries, a petition is being signed by some inhabitants of Cornwall, for presentation to Parliament or to the Government, asking for the removal of the Marconi wireless telegraph station situated at Poldhu. The idea underlying this movement was suggested some months ago in the lay Press—viz., that the working of the station is responsible for the long spell of bad weather, which seems to be especially marked in the south-west of England. It is now only fitting that the Marconi Company should put forward the converse proposition, and suggest that, owing to the abnormal amount of rain which has fallen, they have been unable to maintain communication with America by wireless telegraphy.

Electrochemical Lectures.—Mr. B. Blount will deliver a series of three Cantor lectures at the Society of Arts, on March 7, 14 and 21, on "Recent Advances in Electro-Chemistry."

Personal.—It is stated in the *Physikalische Zeitschrift* that Prof. Curie of Paris has declined the Cross of the Legion of Honour awarded to him, as he does not wish to be alone distinguished for the discovery of radium, in which his wife has had an equal share.

Great Northern and City Railway.—The Great Northern and City Railway was opened to the public on Sunday last. The date of the opening was originally fixed for February 1st, but at the last moment the inspecting officers of the Board of Trade ordered a few small details to be altered. These have now been put right. A detailed illustrated description of the line and its equipment appeared in *The Electrician* for January 15th and 29th.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903
Tarifa—Tangier	Jan. 18, 1904
Oran—Tangier	Feb. 3, 1904

Telegraphic communication with Jersey (via Guernsey) is interrupted, and messages can only be forwarded direct via France.

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Engineering Standards Committee.—A letter has been received by the Engineering Standards Committee from the Board of Trade informing them that His Majesty's Treasury will make a grant-in-aid to the Committee equal in amount to that subscribed by the supporting institutions and firms interested.

Wireless Telegraph Notes.—According to a Russian report, the Japanese have established wireless telegraphic communication between Chemulpho and Chifu by means of ships stationed between those ports.

During a violent south-westerly gale on Saturday, the topmast of the Admiralty telegraph station at Dover was blown down. It was quickly put into position again, however, and communication continued.

Electrification of the North-Eastern Railway.—We announced in our issue of January 22nd that in about a fortnight from then the North-Eastern Railway Co. proposed to run some trains to schedule time for the education of their motormen preparatory to carrying the regular passenger traffic a few weeks later. This is now being done, and trains now run regularly between Newcastle-on-Tyne and Tynemouth, a distance of about 8 miles. Before the end of next month it may be expected that the electrically-equipped trains will be employed for the ordinary passenger traffic.

Ice Damage at the Niagara Power House.—The *Electrical World* of New York states that a mass of ice in the form of a huge icicle which recently collected on the side of the bluff overhanging the power house of the Niagara Falls Hydraulic Power and Mfg. Co. at Niagara Falls, became detached from its support and crashed through the roof of the power house. Two roof girders were broken and a hole 60ft. wide made in the roof. The ice and débris fell upon the machinery in the generating room, temporarily disabling some of the machines. The station was shut down for a short time to avoid short-circuits from the ice and water, but afterwards resumed operations.

Electric Welding.—An interesting table is given in the *Zeitschrift für Elektrotechnik* with regard to the energy required for welding metals with an apparatus based on the heating effect of the current at the contact between the two pieces which are to be joined.

Size of apparatus.	I.	II.	III.	IV.	V.	VI.	VII.
Max. section, iron sq. in.	0·0465	0·155	0·465	1·55	2·32	3·87	6·2
,, ,, copper ,,	0·0155	0·0542	0·155	0·504	0·736	0·946	1·32
Time in seconds	10	15	25	40	60	90	120
Kw.-hour per 100 pieces	0·5	2·1	8·4	47·5	92	210	450
Max. H.P. required	3·5	8·5	21	70	100	135	200

The figures at the head of the columns relate to the various sizes of apparatus made by the Munich firm of H. Hellberger.

High-speed Trials in America.—The American technical journals state that, since the recent official announcement of the decision of the New York Central Railway to equip its New York terminals and suburban service with electric power, the company has arranged for a series of tests in which an attempt will be made to equal, if not surpass, the Marienfelde–Zossen record of 130 miles an hour. For this purpose a stretch of track about 9 miles long between Schenectady and Amsterdam, New York, is to be especially prepared. When the contract for electrical equipment was let to the General Electric Company it was not stipulated, apparently, that a high rate of speed was desired. At a recent conference, however, between officials of the New York Central and the General Electric Company, definite plans are said to have been outlined for the speed tests.

"Elektrische Bahnen."—This is the title of a new German publication devoted almost exclusively to matters concerning electric traction in general and electric railways in particular. It is edited by Prof. W. Kübler and published in Munich and Berlin by R. Oldenbourg. Four issues appeared at irregular intervals during the second half of last year, but we understand that it is to appear henceforth fortnightly. In glancing through the four issues alluded to, forming the first volume, the clear print and the good quality of the illustrations are noteworthy. The contents, consisting largely of original contributions, are on the whole of a descriptive nature, bearing not only on technical, but also on commercial matters. Continental electric railway enterprises, of which so much has been heard lately, are described at length and illustrated, but similar undertakings in England and America seem to have been neglected. A considerable part of the paper is devoted to patents, reviews, legal matters, general notes, &c.

Curative Powers of Radium.—The daily papers contain brief reports of a Paper read before the Paris Academy of Medicine on Tuesday by Dr. Darier. He dealt with the therapeutic action of radium applied in infinitesimal quantities, especially in connection with the suppression of neuralgic pain. Two cases of convulsive nervousness which had come under his observation had been completely cured after three days' application of radium on the temples. A patient suffering from neurasthenia had been restored in three days, while another affected by acute facial paralysis recovered in one day, According to the *Daily Chronicle* correspondent, the activity of the radio-active preparation employed varied from 10 to 7,000, compared with an estimated radio-activity of 1,800,000 for pure radium measured in the same units. The preparation which had given the best results had an activity of from 1,000 to 7,000 units, and this had been applied during two to six hours a day. The lecturer pointed out that preparations of radium of this strength could be made at a very reasonable cost.

Physical Society.—The Annual General Meeting of the Physical Society was held on Friday last at the Royal College of Science, South Kensington. The report of the Council and the report of the treasurer having been read, the following officers and council were elected for the ensuing year:—*President.*—R. T. Glazebrook, D.Sc., F.R.S. *Vice-Presidents.*—Those who have filled the office of President, together with T. H. Blakesley, M.A.; C. Chree, D.Sc, F.R.S.; Prof. J. D. Everett, D.C.L., F.R.S., and J. Swinburne. *Secretaries.*—W. Watson, D.Sc., F.R.S., and W. R. Cooper, M.A. *Foreign Secretary.*—Prof. S. P. Thompson, D.Sc., F.R.S. *Treasurer.*—Prof. H. L. Callendar, M.A., F.R.S. *Librarian.*—W. Watson, D.Sc. F.R.S. *Other Members of Council.*—C. V. Boys, F.R.S.; W. Cassie, M.A.; W. B. Croft, M.A.; H. M. Elder, M.A.; Prof. J. Perry, D.Sc., F.R.S.; A. W. Porter, B.Sc.; W. A. Price, M.A.; Prof. F. T. Trouton, Sc.D., F.R.S.; W. C. D. Whetham, M.A., F.R.S.; S. A. F. White, M.A. Dr. R. T. Glazebrook, F.R.S., then delivered his Presidential Address, which consisted of a survey of the modern theory of the microscope, dealing chiefly with the work of Abbé and Rayleigh.

Mercury Vapour Lamps.—The *Electrical World* of New York states that in a U.S. patent issued on January 19th Mr. Peter Cooper Hewitt describes an important application of the mercury vapour lamp for reproducing variations of current in an electric circuit, the latter being either wholly independent or a branch of a divided circuit. The striking feature of the principle is that it enables the production in the secondary circuit of electrical variations of greater magnitude than the original electrical variations in the primary or transmitting circuit. In other words, it offers a solution to the problem of the telephone repeater. As illustrated and described, a magnet in the telephone transmitting circuit is in close proximity with a vapour tube, and the telephone receiving device is in series in the vapour tube circuit. In one form shown the core of the magnet in the transmitting circuit embraces the vapour tube. It is stated that the amplification of the electrical variations in the secondary circuit is due to the fact that a given magnetic variation may cause a wider fluctuation of effective resistance in the gas or vapour than the fluctuations of electrical energy producing the variation of the magnetic field. Accordingly, by employing the vapour tube the vibrations of the circuit are magnified, not by induction effects, but by varying the ohmic resistance of the circuit in which the apparatus is placed.

Turbines most Suitable for Low Falls.—Mr. Alphonse Steiger, in a Paper read before the Institution of Civil Engineers on Tuesday, drew attention to the prejudice which exists against the utilisation of water-power with low falls, which constitute the majority of water-powers of the British Isles; this, he said, arises principally out of the disregard of their peculiarities and the want of knowledge of the results which

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may be obtained from a specially-adapted turbine under varying conditions, and is traceable to many unsatisfactory installations of absolutely unsuitable turbines. The demands of the generation of electricity by water-power, such as high speed, rapid regulation and concentration of large power in one unit, have influenced very considerably the art of building turbines. In the first place, the desire for high speeds has led to a more general adoption of radial-flow turbines, of which the inward-flow type is preferable, being the more efficient. An example of radial outward-flow turbines was cited, giving the special reasons which had led to their adoption in one case of a relatively low fall, and the manner in which a quite satisfactory efficiency had been obtained from this otherwise less efficient type. One new type, the cone turbine, was referred to as taking the place of the so-called "mixed-flow turbines," with a view to obtain a high speed under low falls, even for large units. With special regard to electrical requirements, reference was made to the arrangement of several wheels on one common turbine shaft, vertical or horizontal, giving a few instances of the vertical arrangement which, in certain cirumstances, was particularly advantageous, as the weight revolving on the footstep could be entirely balanced, and so the loss of power by friction was reduced almost to nil. The necessity of placing the footstep of a turbine in an accessible position was alluded to, and the two kinds of overhead footsteps most commonly used were illustrated. The Paper concluded by drawing attention to the necessity of studying more closely the conditions of water-powers with low falls, and of paying greater attention to more careful adaptation of turbines to such falls, which would probably lead to a better appreciation of the water powers of this country.

The Bengal-Nagpur Railway's Workshops.—This railway company has recently built extensive locomotive and carriage workshops at Kharagpur, India, situated about 70 miles from Calcutta. Formerly repairs were carried out in Nagpur, but work having become too much for the shops there, it was decided to build new shops at a more convenient place. In 1901, Mr. E. S. Franklin was appointed by Sir John Wolfe Barry, the consulting engineer to the line, to draw up a scheme for the electrical equipment of the shops, and it is owing to the courtesy of Mr. Franklin that we are enabled to give the following particulars of the plant, which was completed and started in November, 1903. Three 200kw. Siemens-Belliss steam dynamos generate continuous current at 220 volts and three-phase current at 140 volts when running at 380 revs. per min. A small 60kw. set is also provided. Steam is supplied at a pressure of 160lb. by three Lancashire boilers (30ft. by 8ft. 6in.) built by D. Adamson & Co. All pipes and boilers are lagged with mica and covered with planished steel. The switchboards, supplied by Kelvin and J. White, are provided with automatic minimum cut-outs for the continuous-current side of the dynamos and automatic maximum cut-outs for each continuous-current feeder. Continuous current for power purposes is distributed by means of lead-sheathed cables, laid in stone troughs filled in with bitumen. The lighting wires, on the other hand, are carried overhead on porcelain insulators supported on iron poles. 110 continuous-current motors, ranging in power from 1 H.P. to 50 H.P., are employed for driving the machine tools, cranes, &c. Many of the larger motors may be regulated in speed in the ratio of 2 to 1 by means of field rheostats. Small tools are driven in groups from short lengths of shafting. Lighting is carried out by means of incandescent and arc lamps, and a number of electric fans have been installed. Besides two 40-ton, one 20-ton and three 5-ton travelling cranes, the transport of materials is facilitated by two 10-ton crane locomotives, one cupola hoist and two jib cranes, all operated electrically. The electric locomotives collect their current, by means of two shoes, from two channel rails, laid along the centre of the track on ambroin insulators. All the cranes were built by Messrs. Stothert and Pitt. Three-phase current at 2,200 volts is transmitted by two independent overhead lines to the pump house (3 miles distant), where two pumps, each capable of delivering 30,000 gallons per hour against a total head of 165ft., are driven by two 45 H.P. three-phase induction motors manufactured by the Electric Construction Co. Either pump may be started and stopped from the power-house switchboard.

Losses in Porcelain Insulators.—In an article on the above subject by Herr R. M. Triese in the *Elektrotechnische Zeitschrift*, it is stated that porcelain insulators may be regarded as small capacities, the two sides of which are formed by the holder (earth) and the wire respectively, the dielectric being the porcelain. In certain tests, a large number of insulators connected in parallel were suspended head downwards in a bath of water connected to one terminal of the testing transformer, the surface of the water being level with the neck of the insulator. The holes in the insulators, provided for the iron supports, were filled with water, and electrical contact with the other pole of the transformer was made by means of metallic chains dropping into the holes. In Tables I. and II. are recorded the results of the tests. Table I. refers to an insulator of an older type, possessing a double petticoat and weighing 3·44lb., while Table II. concerns a modern type of insulator with four petticoats and weighing 2lb. Both types withstood approximately the same disruptive tension. The frequency of the testing current was 50 ∾ per sec.

Table I.

Impress'd voltage.	Amps. taken by insulator.	Power-current. Amps.	Wattless-current. Amps.	Watts lost.	Apparentloss Volt-amps.	Power-factor.	Capacity. Mfd.
5,000	0·0000474	0·0000059	0·0000465	0·0295	0·237	0·124	
10,000	0·0000948	0·0000131	0·0000930	0·131	0·948	0·138	
15,000	0·0001422	0·0000214	0·0001395	0·321	2·13	0·151	
20,000	0·0001896	0·0000303	0·000186	0·606	3·79	0·160	
25,000	0·000237	0·0000401	0·0002325	1·002	5·925	0·169	0·0000296
30,000	0·000284	0·0000510	0·000279	1·530	8·53	0·180	
35,000	0·000332	0·0000625	0·0003255	2·190	11·61	0·188	
40,000	0·000379	0·0000747	0·000372	2·990	15·17	0·197	
45,000	0·000427	0·0000870	0·0004185	3·915	19·20	0·204	
50,000	0·000474	0·0000995	0·000465	4·975	23·70	0·210	

Table II.

Impress'd voltage.	Amps taken by insulator.	Power-current. Amps.	Wattless-current. Amps.	Watts lost.	Apparentloss Volt-amps.	Power-factor.	Capacity. Mfd.
5,000	0·0000418	0·0000049	0·0000415	0·025	0·209		
10,000	0·0000836	0·0000098	0·0000830	0·098	0·836		
15,000	0·0001254	0·0000147	0·0001245	0·220	1·881		
20,000	0·0001672	0·0000196	0·0001660	0·392	3·344		
25,000	0·0002089	0·0000245	0·0002075	0·612	5·225	0·1172	0·0000264
30,000	0·0002508	0·0000294	0·0002490	0·882	7·524		
35,000	0·0002926	0·0000343	0·0002905	1·200	10·24		
40,000	0·0003344	0·0000392	0·0003320	1·568	13·38		
45,000	0·0003762	0·0000441	0·0003735	1·985	16·93		
50,000	0·0004179	0·0000490	0·000415	2·450	20·89		

High-tension Tranmission in America.— According to the *Electrical World* of New York the longest transmission line in the north-western states is that of the Washington Water Power Co. of Spokane. The line is about 110 miles long between generator and consumer. A portion of it runs through swampy country, where considerable trouble was experienced last winter on account of ice forming around the pole butt and finally lifting the pole out of the hole. This difficulty was overcome by putting horizontal cross-pieces on the butts underground. The line consists of three No. 2 solid copper wires, with 60,000-volt Locke insulators and pins, made of about 3in. wrought iron with cast-iron shanks. At the generating station, two 2,250kw. 4,000-volt revolving-field alternators, each directly connected to a Victor turbine, operating under a head of 70ft., have been installed. The electrical apparatus, including generators, transformers, switches, lightning arresters, &c., was built by the General Electric Co. The switchboards are installed on a gallery overlooking the whole power house, and all main 'bus bars are in separate pottery cells under the gallery. Two sets of bars permit of the city service and the transmission system being separated when necessary. The generator switches are of the motor-operated remote-control type, and the exciter is directly connected to a separate water wheel without governor. A Lombard governor is installed to operate each of the larger generators; only one of these governors, however, will be used at a time, as a practically constant gate opening on one wheel will be used, allowing the governor on

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another wheel to regulate for the whole station. Three water cooled transformers (with one spare) raise the voltage from 4,000 to either 45,000 or 60,000 volts, the latter having been in experimental use successfully on the line for some time. There are no high-tension switches, other than disconnecting switches, installed between the line and the transformer primaries. Lightning arresters are installed, each single pole arrester being in a separate brick compartment extending from the lower floor of the building to the high-tension wires. Current is delivered to six sub-stations, each equipped with three-phase step-down water-cooled transformers, varying from 100kw. to 750kw., with primary taps for 60,000 or 40,000 volts. Each sub-station is equipped with an automatic high-tension oil switch mounted in a separate brick cell above the panel and connected between the transformer primary and line. The current will be used almost exclusively for mining purposes. At the Standard and Hecla mines, four General Electric 300 H.P. induction motors will be used to drive compressors, hoists, &c. One of these motors will be geared directly to a hoist. There is upwards of 800 H.P. in synchronous motors, and the remainder is in induction motors. The synchronous motors are started direct from the line through low-voltage taps on the transformers.

Electric Power in Workshops.—A Paper on this subject was read by Mr. J. T. Irwin before the Rugby Engineering Society last night. The author said that there seems to be only one case in which rope or belt driving of shops can be at all justified, and that is where a small engine is installed to drive small compact works, and where the lighting is other than electric. The following points should be taken into consideration in planning an electrical equipment:—It should be possible to switch off individual lamps, either arc or incandescent, if they are not in use. Arc lighting should be carried out with continuous-current lamps no matter whether the main supply is continuous or alternating. It should be possible to run the lighting load in parallel with the power load, so as to keep the generators as near full load as possible, and therefore it is necessary for the motors to start under load without excessive current. The motors, starting switches, &c., should be as simple as is consistent with proper operation. It should be possible, if necessary, to vary the speed of motors without much extra cost. If a great amount of arc welding is done, a supply of continuous current at or near 100 volts will be necessary. If the Thomson system of welding is to be used a general supply of alternating current will save the cost of a converter. A continuous current supply at 110 volts (with a battery and booster if the load is a very varying one) would fulfil nearly all these conditions, and for works where the shops are small and the distance of distribution is limited, this will probably be the best system to adopt, as it permits of burning single enclosed arc lamps off the mains; the arc lamps can then be run according to the lighting required and not to the number of lamps that must be run in series. This system is of more general application than is generally supposed, but if the works are very large or scattered, a higher voltage must be adopted, and a polyphase system of supply considered. When the Niclausse boiler works of Messrs. Willans and Robinson were being planned, the question of the adoption of alternating or continuous current came up. In some respects the alternating current could claim superiority for works of this kind. The load was principally made up of motors driving shafting, pneumatic hammers, hot and cold saws, rolling mills, and machines which ran at constant speed and therefore suitable for driving by means of induction motors. But, although a consideration of the motor driving alone might lead to the installation of alternating current, other considerations, and among them that of cost, weighed in favour of a continuous-current supply. The main supply is at 410 volts from three shunt-wound generators, two of which are 220kw. machines, and one a 90kw. machine. Working in parallel with the generators, and in conjunction with a Highfield automatic reversible booster, is a battery of 197 E.P.S. cells. The cells are able to give a discharge of 125 amperes for three hours. Instead of the ordinary three-wire system, with equal voltage on each side of the middle wire, a balancer is provided which has two windings and two commutators on the same armature core, and gives 308 volts on one side and about 102 volts on the other. As there is very little load on the 300-volt circuit, the function of the machine is not to balance so much as to give a supply at 100 volts, and it is referred to as a rotary transformer. The reason for this division is, in the first place, to supply current at 100 volts for arc welding; secondly, to allow of single arc lamps being run where two lamps would not be necessary; and thirdly, to allow, where required, of a large range of speed, as, for instance, on coring machines. Thus, by keeping the field of the motor across the 400-volt circuit, and by putting the armature successively across the 100, 300 and 400-volt circuit, the speed will vary in the ratio of 1 : 3 : 4. Intermediate speeds can be obtained by field regulation if necessary. The main arc lighting is carried out from the 400-volt circuit, partly by enclosed lamps and partly by open type lamps. The enclosed lamps are run four in series and the open type lamps eight in series. All these lamps are provided with external automatic cut-outs and substitutional resistances. One of the problems to be solved was that of driving the rolling mill and the tube draw benches by means of a motor, without disturbing the arc lamps running off the same set of mains. The motor is of 275 B.H.P., the armature being interchangeable with those of the generators in the power station. The speed is also the same as the generators—viz., 360 revs. per min. The motor is compound wound and drives, by means of ropes, an 8in. diameter shaft, to which the mill and draw benches are coupled. The rope pulley on the shafting is about 15 tons in weight, and therefore acts as a flywheel governor.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 19th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. Annual General Meeting at Storey's Gate. The Council's report will be presented, after which the conclusion of the discussion will take place upon "The Heat Treatment of Steel." Time permitting, the following Paper will also be discussed: "The Motion of Gases in Pipes, and the Use of Gauges to determine the Delivery," by Prof. R. Threlfall, F.R.S.

SATURDAY, February 20th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

2:30 p.m. Visit to the Works of the Central Electric Supply Co., Grove-road, Marylebone.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture I. by the Right Hon. Lord Rayleigh, F.R.S., on "The Life and Work of Stokes."

WEDNESDAY, February 24th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, Westminster. Paper to be read: "Automatic Railway Signalling," by E. Fisher.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. Meeting in the Royal Institution, Liverpool. Paper to be read: "Conduit and Surface-Contact Tramway Systems," by G. Balfour.

THURSDAY, February 25th.

ROYAL INSTITUTION.

5 p.m. Afternoon Lecture I. on "Electrical Methods of Measuring Temperature," by Prof. H. L. Callendar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting, when the adjourned discussion on Dr. R. Mullineux Walmesley's Paper, "Transatlantic Engineering Schools and Engineering," will be taken.

FRIDAY, February 26th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, South Kensington, Agenda: (1) "A New Dilatometer," by Mr. Bornikson. (2) "A Quartz Thread Vertical Force Magnetograph," by Dr. W. Watson. (3) "On Stresses in a Magneto-static Field," by G. W. Walker. (4) "Some Hints on the Preparation of Diagrams," by Dr. W. Watson.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Ordinary Meeting at 25, Great George-street, Westminster. Paper to be read: "Boiler House Design," by L. G. Crawford.

ELECTRO HARMONIC SOCIETY.

8 p.m. Concert (Ladies' night) in the King's Hall Rooms of the Holborn Restaurant.

ROYAL INSTITUTION.

9 p.m. Evening discourse on "New Developments in Electric Railways," by Alexander Siemens.

SATURDAY, February 27th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture II. on "The Life and Work of Stokes," by the Right Hon. Lord Rayleigh, F.R.S.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(Continued from page 646.)

The evidence already discussed will probably be considered to establish beyond reasonable doubt the theory of atomic disintegration, as the explanation of the property of radio-activity. There is, however, another aspect of the theory to be considered which has already received a large measure of experimental confirmation. Radio-activity is the property of but a few atoms only of the total mass in any given instant. A certain fraction, represented by λ, contributes the activity in any given second, while the vast preponderance $1 - \lambda$ is, strictly speaking, not radio-active at all. It is for the time being ordinary matter which must possess a normal chemical and physical nature in addition to and independent of the radio-active properties contributed by the fraction undergoing disintegration. This accounts for the dual character of the properties of radio-active matter which was pointed out (p. 44) in the case of radium, which exhibits the completely normal character of a heavy element of the alkaline-earth family in addition to all its radio-active properties. This should hold true equally for the numerous transition-forms now known,

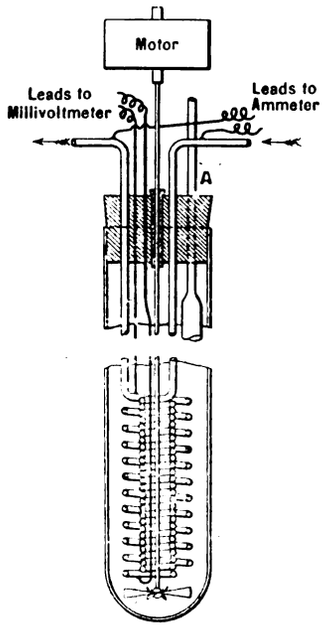

Fig. 30.

and of these the emanations of radium and thorium on account of their gaseous nature and their property of being condensed at low temperatures, have been the most closely examined. In this and similar work the gaseous properties of the matter is the real object of study, the radio-activity merely furnishing the means of detection and measurement. If the volatility or vapour pressure of a gas were investigated by direct methods, the limit of detection would be reached with pressures of $\frac{1}{100}$mm. of mercury. In the case of the emanations we can study accurately the effect of changing temperature on the volatility of quantities a million million times less, and the results, therefore, are of great general interest from a purely physical point of view.

The apparatus used in this investigation (Rutherford and Soddy, *Phil. Mag.*, 1903, VI., 5, p. 561) is shown in Fig. 30. The emanation was carried by means of a steady stream of some suitable gas through the doubly-wound copper spiral, which was immersed in a bath of liquid, kept well stirred, at the temperature required. The liquid employed was ethylene, which boils at -103°C. and freezes at -169°C. The outside tube was cooled with liquid air, and ethylene gas passed in through A until the level of the liquefied ethylene was well above the top of the spiral. The emanation was passed through the spiral after the bath had been cooled by means of liquid air slightly below the temperature of condensation. The apparatus was wrapped round with felt and allowed to warm up slowly and the temperature noted at which the emanation volatilised and was swept out of the spiral by the gas stream.

The general arrangement of the apparatus for the case of the radium emanation is shown in Fig. 31. The emanation was stored in the gas holder B, and small quantities could be

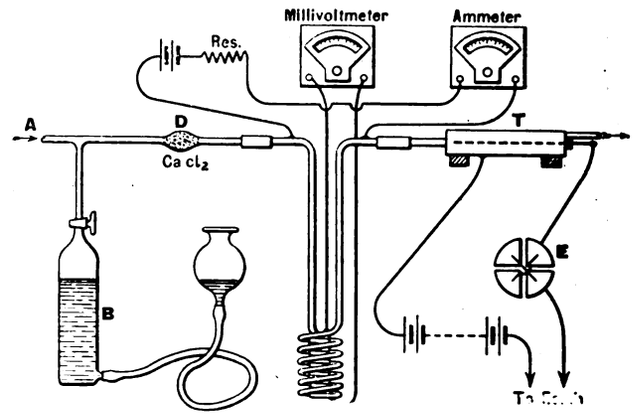

Fig. 31.

sent into the gas stream passing into the spiral from A, as required. The temperature of the bath was measured by the resistance of the copper spiral, and this was determined by keeping a constant current of about an ampere flowing through it, and measuring the difference of potential between two points at the top and bottom of the spiral by means of a millivoltmeter. In Fig. 32 the resistance of the copper spiral is plotted on the vertical axis, and the temperatures in degrees centigrade on the horizontal axis. The fixed points chosen in the calibration of the spiral were the boiling and freezing points of water, the boiling and freezing points of ethylene and the boiling point of liquid air of known oxygen content. The temperatures of the condensation of the thorium emanation

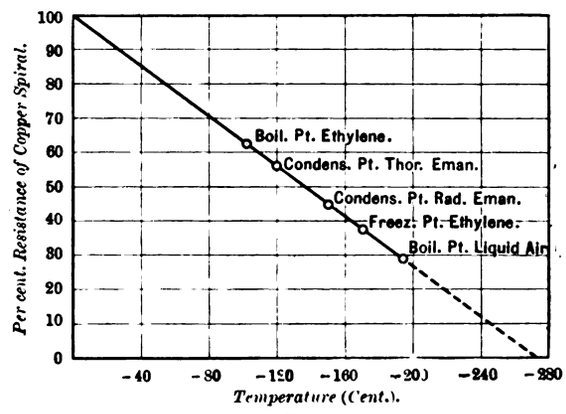

Fig. 32.

(-120°C.) and of the radium emanation (-150°C.) were found by interpolation. With the radium emanation the point of volatilisation and condensation is very sharp. In one experiment at -154°C. no emanation was observed in the gas stream, although less than $\frac{1}{10000}$th part could have been detected, while at -150°C. the greater part had volatilised. The decay of the activity of the thorium emanation is so rapid that the emanating compound has to be retained continuously in the gas stream. It is then found that some emanation escapes condensation when the temperature is as low as -150°C., but the greater part is condensed at much higher temperatures. The point given above, 120°C., represents the temperature at which condensation commences to take place. In the case of the radium emanation, no great

* These articles are based on a series of 12 lectures which Mr. Soddy has delivered at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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difference is observed between the temperature of initial volatilisation and complete condensation, provided sufficiently slow streams of gas are employed.

This difference between the two emanations was further investigated by means of the apparatus shown in Fig. 33, which is arranged for the case of the thorium emanation. The gasholder B and T piece of Fig. 31 replaces the thorium oxide tube A for experiments with the radium emanation. Instead of the emanation being carried by a steady current of gas it is transferred to the spiral, and thence to the testing vessel, by means of the mercury pump P. In this way the experiments could be performed in an atmosphere of any gas at any pressure below atmospheric, and the emanation allowed to remain in the condensing spiral any definite time before being removed. It was found that the temperature of condensation in the case of the radium emanation was substantially the same however the experiment was performed. But for the thorium emanation the proportion of the total condensing at any temperature varied—(1) with the nature of the gas used, a greater proportion condensing in an atmosphere of hydrogen than of oxygen; (2) with the time allowed, a greater proportion condensing the longer the emanation was allowed to remain in the spiral. The proportion escaping condensation was always greater when a current of air was kept passing than when the experiments were performed by means of the pump in a stationary atmosphere. The temperature of initial condensation – 120°C. was, however, always substantially the same whatever the conditions.

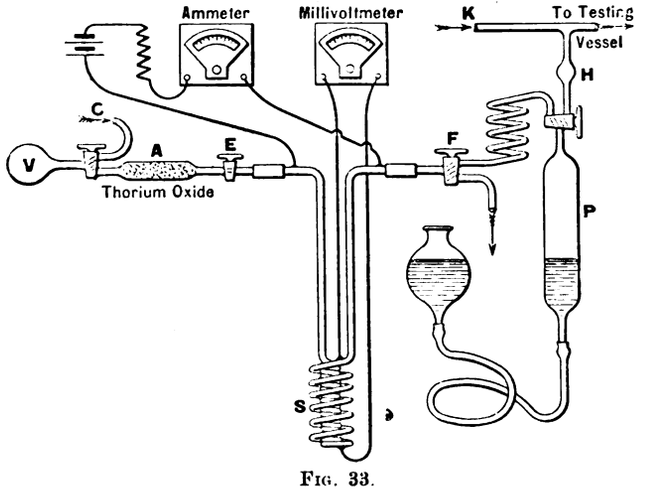

FIG. 33.

The difference between the behaviour of the thorium and the radium emanation is capable of a simple explanation on the disintegration theory. Consider quantities of the two emanations possessing similar radio-activity—*i.e.*, giving a similar number of α-rays per second. The radio-activity is proportional to the number of atoms disintegrating per second—*i.e.*, to λN, where N is the total number present and λ the radio-active constant. Since λ for the radium emanation is 6,000 times smaller than for the thorium emanation, it follows that when λN is equal for the two cases, N, the number of atoms of emanation present, must be 6,000 times greater in the case of the radium emanation than in the case of the thorium emanation. Condensation can only take place by the approach of two or more of the condensing molecules into each other's sphere of influence, and it is to be expected, when the quantities present are extremely small, that the amount condensing will depend on the concentration of the particles, the time allowed for the process to take place, and the nature of the atmosphere in which the experiments are performed. The concentration of the particles would be less when the emanation was carried by a steady stream of gas than in a stationary atmosphere. The particles would diffuse more rapidly in hydrogen than in oxygen, and the rate of condensation would be accelerated. This effect of time on the progress of condensation would rapidly diminish as the number of condensing particles were increased. It would probably diminish as the square of the number present, and, hence, would be negligible for the case of the radium emanation. If, however, the methods of detection were made so sensitive that an effect $\frac{1}{6000}$th of that obtained in the experiments on the thorium emanation could be detected for the radium emanation, the phenomena in the two cases should be strictly comparable. The ionisation current in the experiments on the thorium emanation was probably about 10^{-10} amperes. An ionisation current of 10^{-14} amperes is quite within the experimental range, and a method is therefore indicated of putting this view to further experimental test. From the ionisation current, and the probable number of ions produced by each α-ray in its passage through the gas, it can be deduced that the thorium emanation obtainable from 10 grammes of thorium oxide if confined in 1 cubic cm. volume would only exert a pressure of between 10^{-16} and 10^{-17} atmosphere, so that the emanation obtainable from a million tons of thorium oxide, if concentrated in this volume, would only just produce a pressure that could be directly measured. It is, therefore, a matter of remark that the emanation can be made to condense completely at any temperature, and the question remains unsettled as to whether the phenomenon is really one of simple gaseous condensation at all. It is conceivable that a surface film of the gas used to carry the emanation condenses on the walls of the spiral by the action of capillary forces, and carries with it the particles of emanation by attraction, possibly of a chemical nature. Such a surface condensation would presumably only occur in a gas below its critical temperature, and should, therefore, be absent in perfectly pure hydrogen or helium. It would be interesting to repeat the experiments in a stream of hydrogen of the highest possible purity. It is possible that condensation in these circumstances might not occur. In this connection may be mentioned the work of Miss Gates (American Physical Society Meeting, Washington, December, 1902), who found that the matter causing the imparted activity of thorium could be volatilised at temperatures above a red heat and deposited on neighbouring cold surfaces. This indicates that phenomena similar to the condensation and volatilisation of the emanations take place with the imparted activity matter at high temperatures.

Another property of the emanation of radium which has been investigated is its density as shown by its coefficient of diffusion into air. The first experiments were performed by Rutherford and Miss Brooks. They determined the rate at which the emanation confined in one half of a long cylinder diffused into the other half when a partition between the two halves was withdrawn. They found a value for the coefficient of diffusion of about 0·08, which is comparable with that of ethyl ether, and indicates a density in the neighbourhood of 80 (H = 1). If the molecule of the emanation is assumed to be monatomic like argon, the atomic weight is, therefore, in the neighbourhood of 160.

The great difficulty in the experiments is to eliminate the effect of the imparted activity produced from the emanation from that of the latter by itself, and the rate of diffusion tends to appear lower than the tone value in consequence. Owing to the very rapid initial changes in the radio activity of the matter causing the imparted activity it is difficult to correct accurately for this error. The value given above, 0·08, is 20 per cent. greater than the uncorrected value. A determination of the coefficient has also been made by Curie and Daune (*Comptes Rendus*, 1903, 136, p. 1,314), who obtained the value 0·1, which indicates a density nearer to that of alcohol (46) than of ether. Most recently Bumstead and Wheeler (*Am. Journ of Science*, February, 1904, p. 97) obtained a value indicating a density of 180, so that the evidence is conflicting, probably for the reason already given. The latter have definitely proved that the radio-active gas obtained from the tap-water at New Haven, U.S.A., and from the soil in the same neighbourhood, is the radium emanation, for the rate of decay of its activity and its rate of diffusion are similar to the latter. The existence of the radio-active gas in tap-water was first shown by J. J. Thomson in the Cambridge water, and experiments by H. S. Allen on the rate of decay of its activity indicated that it was the same as the radium emanation. The existence of this emanation in the soil was first noticed by Elster and Geitel. It appears therefore that radium is very

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widely diffused in the earth's crust although in otherwise quite unrecognisable quantity.

The Production of Helium from Radium.—(Ramsay and Soddy, *Proc.* Roy. Soc., Vol. LXXII, 1903, p. 204.) The emanation and the occluded hydrogen and oxygen produced in the decomposition of the water present are liberated from a radium salt when it is dissolved, and it seemed probable that if helium were being produced as already suggested (p. 521) it would be also occluded in the solid and be released on solution. In two experiments 20mgs. and 30mgs. of radium bromide which had been kept some months in the solid state, were dissolved in water and the gases freed from hydrogen and oxygen by means of a red-hot spiral of partially oxidised copper wire. The residual gases were compressed into a spectrum tube of a few cubic millimetres volume, passing en route through a U tube cooled in liquid air to condense the emanation and any carbon dioxide present. The gas showed in one case the complete spectrum of helium, and in the other the most characteristic yellow line D_3. This experiment has since been repeatedly confirmed.

In another experiment the emanation from 50mgs. of radium bromide was sealed up in a spectrum tube. After three days the D_3 line of helium became visible, and in a few days the tube showed the complete spectrum of helium. This conclusively proves that the radium emanation gives helium during its disintegration, but of course helium may be produced from the radium atom in its initial disintegration also. Rutherford has suggested that the α particle is an atom of helium. The mass of the particle, according to his preliminary determinations, is 1·6 times that of the hydrogen atom, whereas the mass of the helium atom in terms of hydrogen is 4. It seems likely that this discrepancy may be accounted for, and that the α particle will ultimately be shown to be a helium atom. It seems certain that the α particles of all the radio-active bodies are likely to be of the same mass, and that the comparatively narrow limits in which they differ in penetrating power, &c., result from their possessing different velocities. This hypothesis would therefore lead to the belief that helium is a common product in the disintegration of all the radio-elements.

It may be pointed out that the quantity of helium produced from radium is, as theory requires, excessively minute, and most refined methods must be employed for its detection.

(To be concluded.)

THE NEW TRUNK TELEPHONE EXCHANGE.

(Continued from p. 655.)

Having now described fully the methods in which the various connections are carried out, we come to the apparatus itself and its arrangement. Fig. 8 is a general view of the switch-room and Fig. 10 a plan showing the position of the various sections of the switchboard. The latter figure is to scale, so that a good idea of the large size of the room is obtainable. As seen, the room is L-shaped, but at present part of it is divided off by a temporary partition, and the part of the switchboard which has been erected so far is shown by the full lines. The extensions indicated by the dotted lines will be added as occasion demands. The whole length of the room on one side is taken up with ordinary trunk sections, and on the opposite side are seven "concentration" sections grouped together. At the end of the room the three transfer sections are placed and two local sections for subscribers with special lines for trunk service, and there are also separate sections for the foreign trunk lines (to France and Belgium) and a "learner's" section. In the middle of the room are the record tables, an "enquiry section" and the monitors' and supervisors' desks, &c. The test-board (which will be described more fully presently), the intermediate distributing frame and the relay and condenser rack are together in a separate room; and the power plant is in the basement, together with the power plant for the "Central" local exchange, which occupies the fourth floor of the same building, the trunk exchange being on the third floor. A separate battery and charging plant, following the standard lines for common battery telephone work, is employed for signalling purposes, but current for speaking purposes is taken from the "Central" local exchange battery.

FIG. 8.—GENERAL VIEW OF SWITCHROOM.

Fig. 9 shows the trunk switchboard in section. So far as possible the framework is of iron, and as a further precaution against fire all the wires carrying heavier currents for "power" purposes are in an iron trough along the top of the board at the back. Another trough on floor level carries all the trunk cables and transfer wires, and this one has a sheet iron bottom, sides of the fire-proof material "uralite," and engine room floor-plates as a cover. The board is faced with mahogany panels, and the cabinet work presents a well-finished and elegant appearance. These panels are backed with "uralite," a material of which considerable use is made in the exchange. The doors at the back of the board are of wood, covered front and back with thin sheet iron. A horizontal keyboard shelf is employed, and the lighting is, as usual, from the top of the switchboard with lamps hidden from view by reflectors which project the light on to the board.

Fig. 11 is a photographic view of one of the trunk sections, a "concentration section" having been chosen for the purpose. As seen, there are two operators' positions—one on either side of the central panel, on which are the junction line jacks for those junction lines which are worked with call-wires. These are in 12 rows, each containing 20 three-point jacks. The

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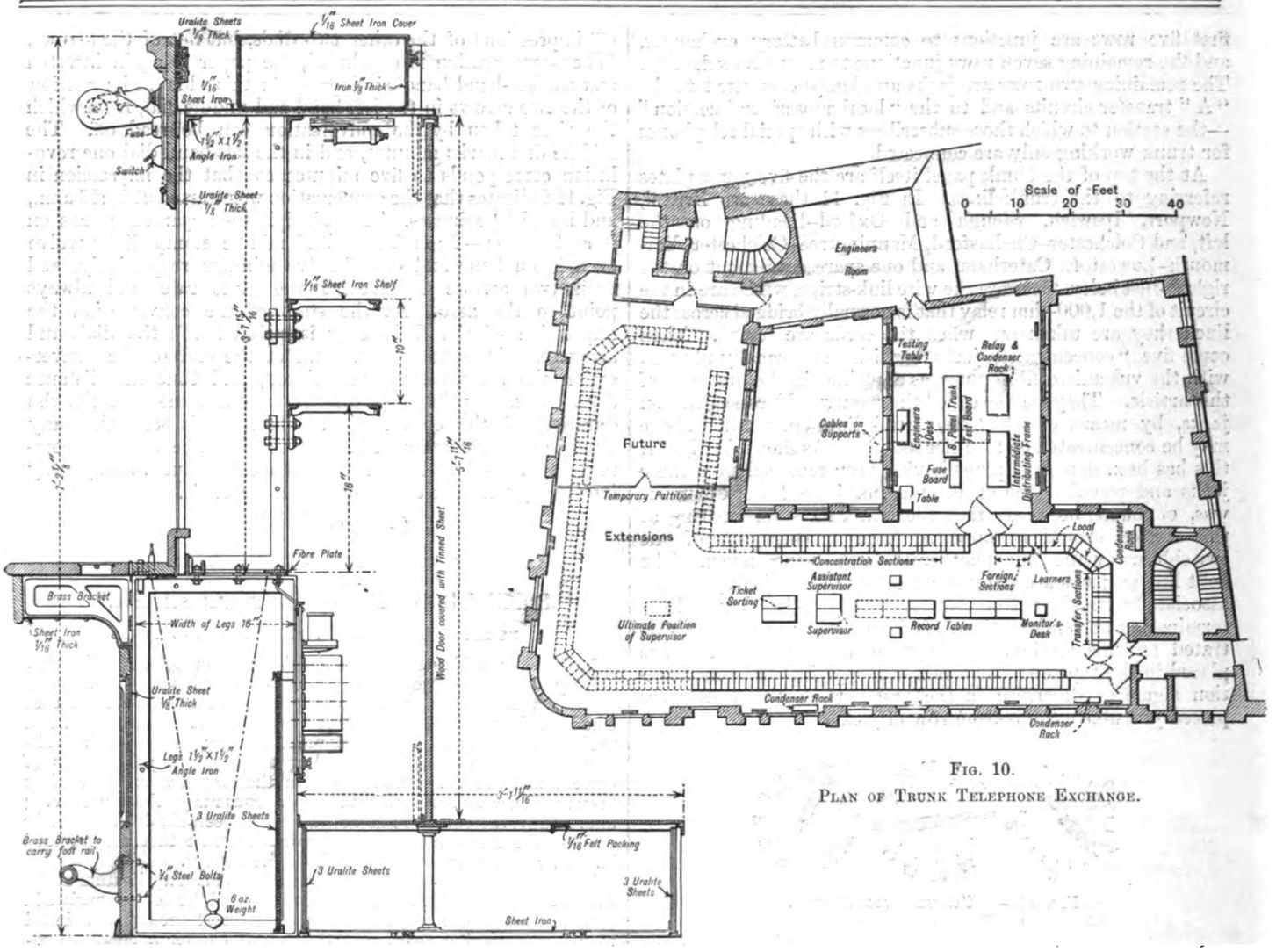

FIG. 10.
PLAN OF TRUNK TELEPHONE EXCHANGE.

FIG. 9.—CROSS SECTION OF SWITCHBOARD ON TRUNK JUNCTION SECTION. Scale 1:16.

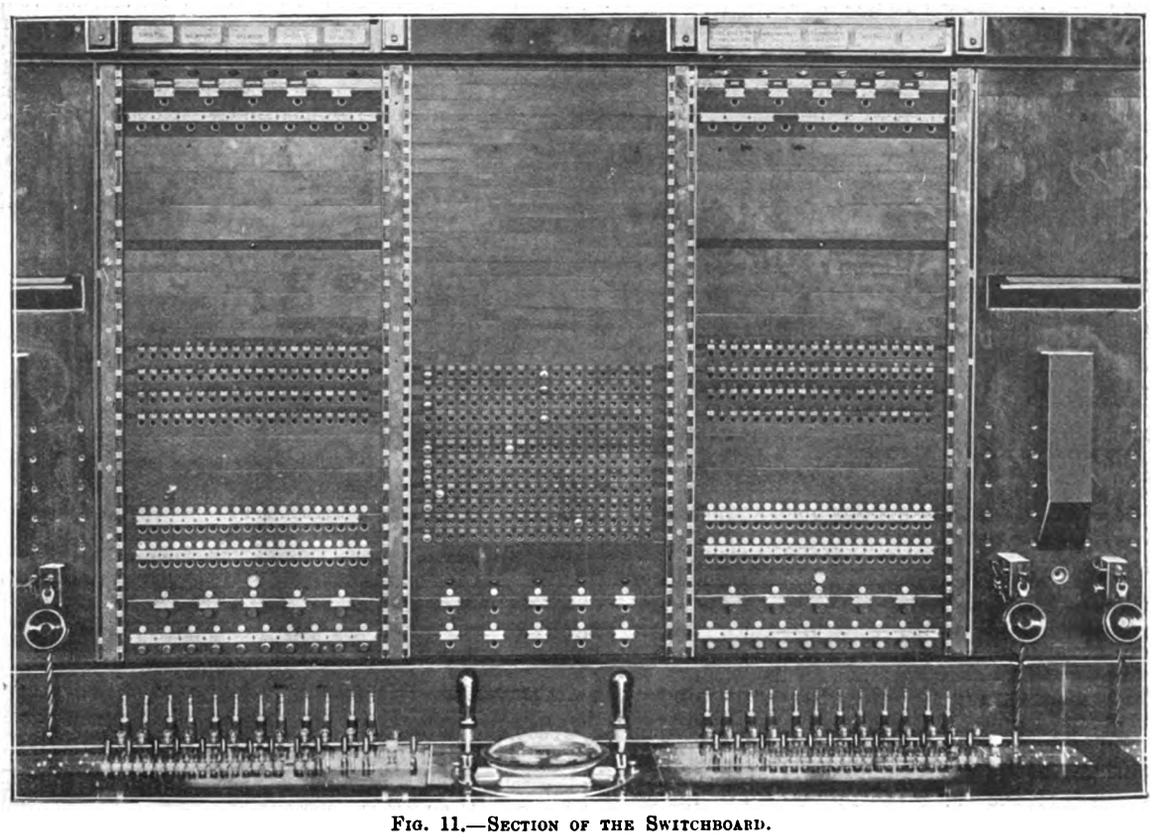

FIG. 11.—SECTION OF THE SWITCHBOARD.

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first five rows are junctions to common battery exchanges, and the remaining seven rows junctions to magneto exchanges. The remaining two rows are jacks and lamps connected to the "A" transfer circuits and to the "local subscribers' section" —the section to which those subscribers with special telephones for trunk working only are connected.

At the top of the trunk panel itself are the five name-plates referring to the trunk lines. In Fig. 11 these are Bristol, Newport, Ipswich, Slough and Oxford–Reading on the left, and Colchester–Chelmsford, Manningtree–Colchester, Yarmouth–Lowestoft, Caterham, and one spare equipment on the right. Just below these are the wire link-strips, which are in the circuit of the 1,000-ohm relay that is normally bridged across the line; they are taken out when the cords are tested. Then come five "concentration jacks," which are normally plugged with the vulcanised fibre plugs, as explained in the first part of this article. They may be called the "outward" concentration jacks, by means of which the trunk lines enumerated above may be concentrated on to other sections. As shown in Fig. 11, this has been done, the plugs having been removed from these jacks and placed in the ordinary trunk jacks lower down; it was, of course, necessary that the trunk lines terminating at this section should be operated from another part of the switchboard while our photograph was being taken. The next line of jacks are the inward concentration jacks, and are associated with the bottom row of jacks. When trunk lines terminating at other sections of the board are to be concentrated on this section, the plugs from the bottom row are placed in the top row. The lamps for giving the concentration signal as described in the first part of this article are placed just above the bottom row of jacks.

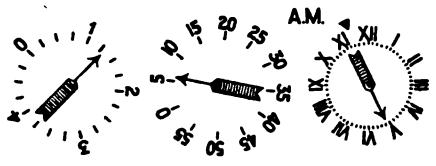

Fig. 12.—A Calculagraph Record.

In the centre of each trunk panel are four rows of 20 jacks each for the signalling junctions—*i.e.*, those for which call wires are not employed. Above each jack is the small press button for making the "engaged" test, and a red lamp which glows if the line is engaged is placed in the centre of the dark strip in the middle of the blank space above. One lamp serves for all these junctions. The next two rows of jacks and lamps are used for the "B" transfer circuits. Below these, in a strip by itself, is the pilot lamp, and then the five main trunk jacks with their calling lamps and the 10 concentration jacks as already explained. The keyboard of each position comprises six pairs of plugs and cords, associated with each of which is a pair of keys, one a combined trunk ringing and speaking key (coloured black to correspond with the black trunk plug), the other a combined junction ringing and disconnecting key (coloured red to correspond with the red junction plug), and there is a clearing lamp in front of each plug. In front of these keys there are 20 call-wire keys to the local exchanges for use in connection with the call-wire junctions, an inter-connecting key on the extreme right for grouping up the operator's positions, and next to this a key coloured white for ringing on the call-wires at night-time. Each operator is provided with an extra receiver for use when speaking on the longer trunk lines is faint.

Timing conversations is effected by means of a "calculagraph" placed on the shelf between each two operator's positions. This ingenious appliance consists to outward appearance of a clock and two handles. Inside there are three revolving discs with indices, to which are attached metal stamps, in front of which is a rubber pad. When the conversation is started, one end of the ticket upon which the particulars of the demand have been entered is placed in a slot in the calculagraph, and the right hand handle is pressed back. This marks on the paper the impression of the right-hand dial and indices (Fig. 12), showing the time the conversation starts. A forward movement of the same handle prints off impressions of the other two dials, but not of the arrows. When conversation is concluded, the paper is again inserted and the left-hand handle is depressed; this adds the impression of the two arrows in the left-hand and middle dial, from which the time taken by the conversation can be read off. The middle dial marks minutes, and in the left-hand dial one revolution corresponds to five minutes, so that the impression in Fig. 12 indicates that the conversation was started at 11:26 a.m., and lasted 6¼ minutes. The principle the apparatus works on is as follows:—The left-hand and middle stamp dial revolve once in an hour and once in five minutes respectively, and their two arrows revolve at the same rate and always point to the zero. At the start of the conversation the impression of the dials only is printed off; the dials and arrows continue to revolve, and at the end of the conversation the arrows only are printed, and thus the distance from the zero printed off at the commencement marks the duration of the conversation. Thus it is seen that any number of conversations can start and finish between the commencement and end of the first one without in any way interfering with the correctness of the records.

(To be concluded.)

SOME USES OF THE OSCILLOGRAPH.*

BY D. K. MORRIS AND J. K. CATTERSON-SMITH.

1. *The Recording of Magnetisation Curves of Transformers during Working.*—The registration of the behaviour of the magnetic cores of transformers when working on the mains is a matter of considerable practical interest, but has hitherto proved a difficult problem from the experimental point of view. There is the well-known method of obtaining the loop by comparing the waves of current and E.M.F. at no load; then the Braun vacuum tube has been applied so as to record the instantaneous magnetisation curves; and, finally, the curve of magnetisation has been obtained by slowly varying the magnetising current at such a rate that the induced E.M.F. was kept constant throughout the change.

The method described in the following note is an application of the double oscillograph of the Duddell pattern; and the device consists in passing through one of the oscillograph strips a current proportional to the magnetising force, and through the other a current proportional to the induction density. A parallel beam of light from an electric arc is reflected from the mirror attached to the one strip, so that the reflected beam is subject to an angular vibration in a horizontal plane proportional to the magnetising force. This reflected beam is received on one of the smaller faces of a right-angle prism placed so that its large surface is inclined at 45deg. The vibrations of the beam are thus transformed into movements in a vertical plane. The light is then received on a silvered lens (acting as a concave mirror of about 18in. radius) and focussed back on the second oscillograph mirror, so that the final reflected ray partakes of both vibrations as co-ordinates in the usual manner of **B-H** curves.

The no-load current of a transformer is a measure of the magnetising force applied to the core, and except for the demagnetising action of the eddy currents it measures the value of **H** for the iron in the core. The principle of the method employed in obtaining a current which shall be proportional to the induction density **B** is extremely simple. A large coil having no iron core, and of inductance and resistance as nearly as may be comparable with that of the transformer at no load is placed in parallel with the transformer winding.† Assuming r_1 and r_2 to represent the resistance of the two circuits respectively, and L_2 the inductance of the coil, then the following equation must hold at every instant

$$r_1c_1+\frac{ns}{10^8}\cdot\frac{d\mathbf{B}}{dt}=r_2c_2+L_2\frac{dc_2}{dt},$$

where n is the number of turns and s the sectional area of the iron in the transformer core.

The first term of each side of this equation is a vector approximately at right angles in phase to the vector representing the second term, so that if $r_1c_1=r_2c_2$ then c_2 is proportional to **B**. Owing, however, to the irregular form of c_1 it is necessary not only to have the ohmic drops equal, but that both should be small relative to the second terms; otherwise, the curve obtained requires an irregular correction, which, though not impossible to estimate, is very troublesome. The condition, therefore, for successful **B-H** curves is that the ohmic drop in both circuits shall be equal and also small in amount. Fig. 1 represents diagrammatically the arrangement

* Paper read at the Birmingham Local Section of the Institution of Electrical Engineers on January 27th.

† Should this voltage be excessive, it is practicable without sensible error to transform it down, and so allow the use of a smaller coil.

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of test, whilst in Fig. 2 is reproduced a loop curve obtained in the manner described. The method is applicable to the determination of eddy currents, for without altering the apparatus the same values can be obtained (taking account of the ratio of the impedance of the

Fig. 8 shows a greater alternating-current load than in Fig. 7, the direct current having increased to 28 amperes.

Fig. 9 shows a still greater alternating-current load, with the direct current increased to 33 amperes.

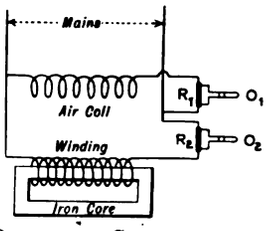


Fig. 1.—Diagram of Connections for obtaining B-H Loop Curves.

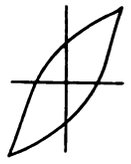


Fig. 2.—B-H Loop Curve.

Fig. 3.—Current under Normal Conditions.

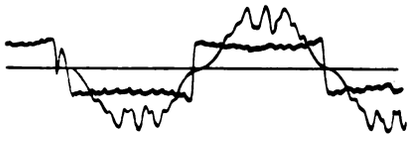


Fig. 4.—E.M.F. and Current under Normal Conditions.

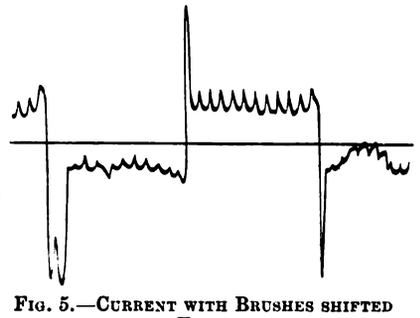


Fig. 5.—Current with Brushes shifted Forward.

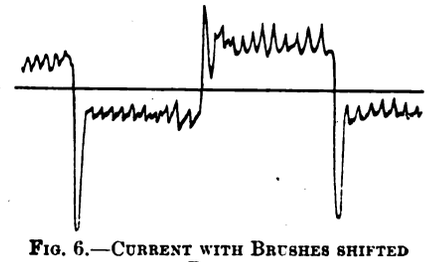


Fig. 6.—Current with Brushes shifted Backward.

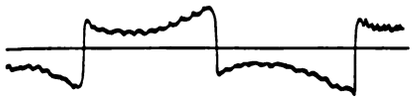


Fig. 7.—Current in Armature with Small Output on A.C. Side.

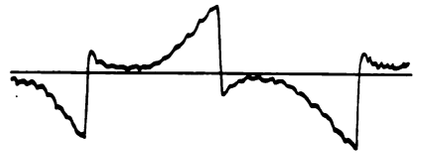


Fig. 8.—Current in Armature with Larger Output on A.C. Side.

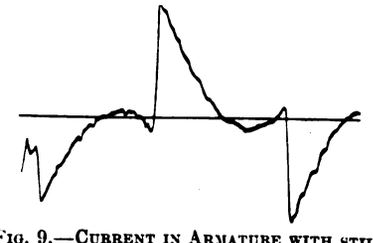


Fig. 9.—Current in Armature with still Larger Output on A.C. Side.

two circuits) from a direct-current supply, and can be varied cyclically. The reduced values of H will then give at once the demagnetising action of the eddy currents. The method of superposing the vibrations of two oscillograph strips in planes at angles is also applicable to the estimation of small power-factors, since a straight line can only be obtained as the resultant vibration when the two waves in these strips are exactly in phase. Any departure from this condition results in an ellipse more or less elongated.

2. *Note on the Currents in a Direct-current Shunt-wound Motor and in a Rotary Converter under Varying Conditions of Load.*—The experiments of which the following are illustrations were made with a 110-volt Westinghouse 7½kw. converter, used first as a shunt motor and then loaded on the alternating-current side. A special attachment, consisting of three heavy copper slip-rings, suitably insulated, was supported on a frame bolted on to the revolving part. The armature winding, which was of the ordinary four-pole series type, with only two paths for the current to flow from positive to negative brushes, was cut at one place on the side furthest from the commutator and the exposed ends led by stout short connections to two of the slip-rings. From one of these slip-rings a No. 26 silk-covered wire was led along the coil, which had been cut as closely as possible, threading it under the binding wire and returning in a similar way to a third slip-ring. Thus, when the brushes on slip-rings 1 and 2 were short-circuited by a suitable low-resistance shunt, the potential across this shunt was a measure of the current flowing in one half of the armature, and the potential between the second and third slip-rings was directly proportional to the voltage in the armature coil. A Duddell oscillograph of the double high-frequency pattern was arranged to measure these two potentials.

It should be mentioned that the results are, so far, subject to error, in that the current in the first two slip-rings was less than half the external current by an amount which was probably about 5 per cent. This arose from the resistance of the measuring shunt.

The peaked form in Fig. 4 arises from the presence of copper damping pole-pieces.

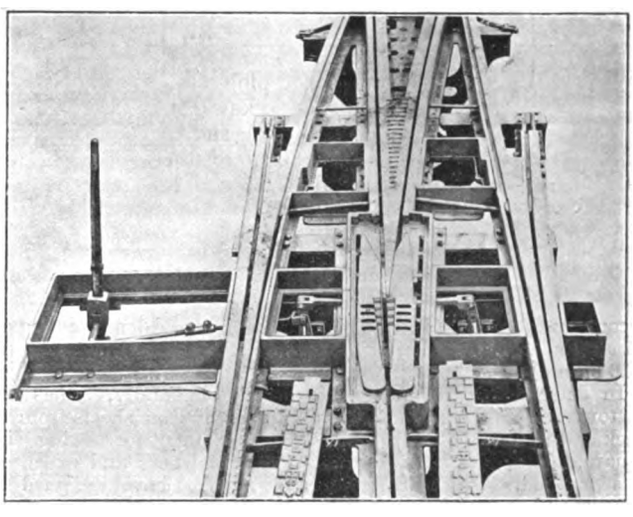
Both Figs. 5 and 6 show the heavy short-circuit which occurs when the brushes are in a false position, and they show that heavy irregularity sets in at the same time.

Fig. 7 represents an alternating current, having a frequency of about 40 ∿ per sec., and sufficient to raise the main direct current supply from 16 to 24 amperes.

In conclusion, we would like to express our indebtedness to Messrs. F. B. Carmichael, A. W. Lambourne and the departmental assistant (Mr. Bird) for their able and energetic assistance.

A NEW SLOT POINT.

We are now able to describe the new slot point made by Hadfield's Steel Foundry Co. for the new lines of the London County Council tramways, and briefly referred to in our recent article. In conduit



tramways the divergence of the two slots at junctions has always been a source of trouble, due to the fact that the merging of the slots one into the other creates an objectionable width of opening (with ¾in. slots this sometimes amounts to 2in.). The narrow rubber tyres now so commonly used on light vehicles drop into

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these openings, causing a very uncomfortable wrench when the wheel leaves the slot The slot tongues which are used to divert the plough are made in the form of flat steel plates sliding backwards and forwards in recesses in the side castings. These work at a distance of 1⅝in. from the top surface of the slot rail. On these plates a number of projections are arranged so as to come within ⅜in. of the road surface at the fixed slot point, thereby reducing the depth at the opening by 1¼in. The nose of the fixed slot point is tapered off to the level of the projections, so that any wheel riding on the slot tongue is easily carried on to the point. The projections are divided by radial slots, in order to clear the strengthening ribs on the long cast-steel cover. The whole apparatus is exceedingly simple, and can be readily removed for inspection in a few seconds without interfering with the traffic. In the illustration above the lids of the slot points and the covers of the road boxes have been removed to show the arrangement of the slot tongues.

APPARATUS FOR DETERMINING THE IRON LOSSES IN WHOLE SHEETS.

According to Steinmetz, the total iron loss in sheets, not exceeding 1mm. (0·0393in.) in thickness,

$$=\left[\eta B^{1.6} p 10^{-7} + \left(\frac{0{\cdot}1645}{w_0} d^2\right) p^2 B^2 10^{-13}\right] \text{ watts per cubic centimetre,}$$

where η = hysteresis coefficient, varying, for iron, between 0·001 and 0·005, B = maximum flux per square centimetre, p = cycles per second and w_0 = resistance in ohms of an iron rod 1 metre long and possessing a cross-section of 1 sq. mm. The average value for w is 0·10 ohm.

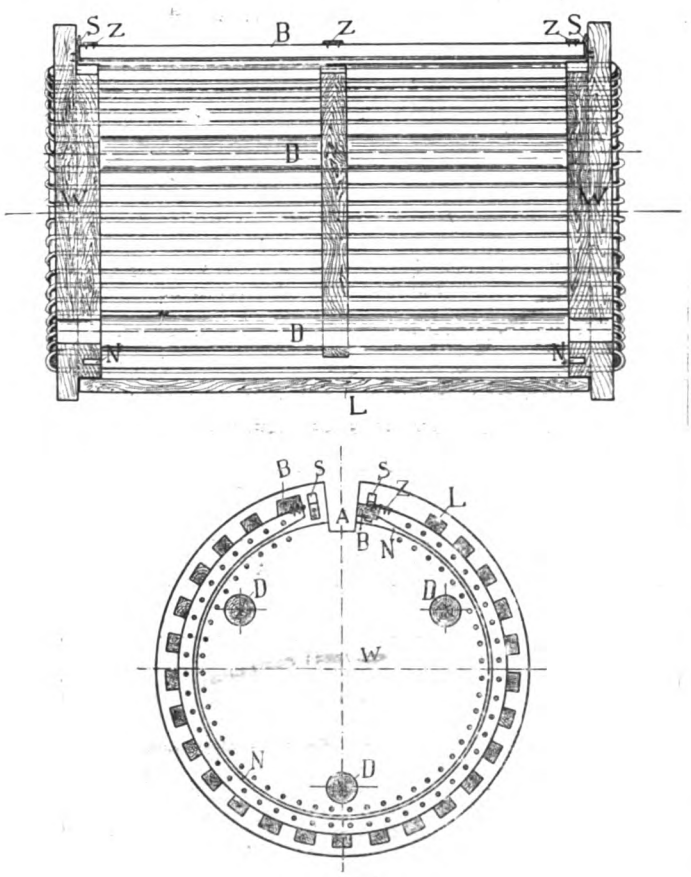

Fig. 1.

In determining these iron losses experimentally, it has been customary to take at random a number of iron sheets from the pack and to machine them into forms convenient for testing (ring, square, strips, &c.). On account of the slowness and expense of this method, Messrs. Siemens and Halske have designed the apparatus described below.

The new method is characterised chiefly by the fact that the whole sheet, as it is manufactured, is subjected to the test. Referring to Figs. 1 and 5, it will be seen that the apparatus is in form of a drum, into which the iron sheets are pushed through a slot, A, when they assume the form of a cylinder with slightly overlapping ends. Stout wooden poles, D, rigidly connect the two ends of the drum, into which grooves are worked to serve as guides to the inserted sheets. The beams B may be moved up and down by means of hinges Z in order to facilitate, on the one hand, the introduction of the sheets, and, on the other, the pressing down of the overlapping ends after insertion. The windings of the magnetising coils consist of bare copper wires, stretched between the sides of the drum, as indicated in Fig. 1. If required, the winding is divided into two parts, which may be connected either in parallel or series, thus allowing measurements to be carried out over a comparatively long range with a restricted supply voltage. As a rule, between four and six sheets are measured at the same time, and the necessary corrections are then comparatively small. Figs. 2 and 3

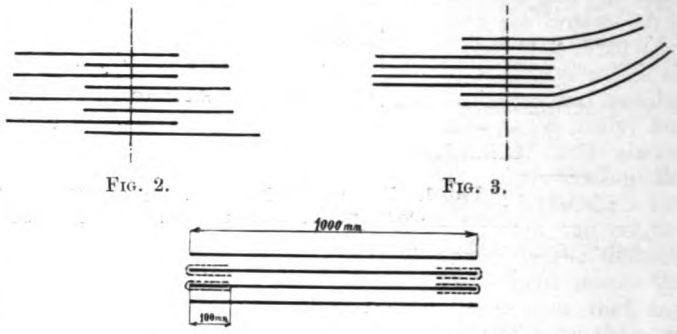

Fig. 2. Fig. 3.

Fig. 4.

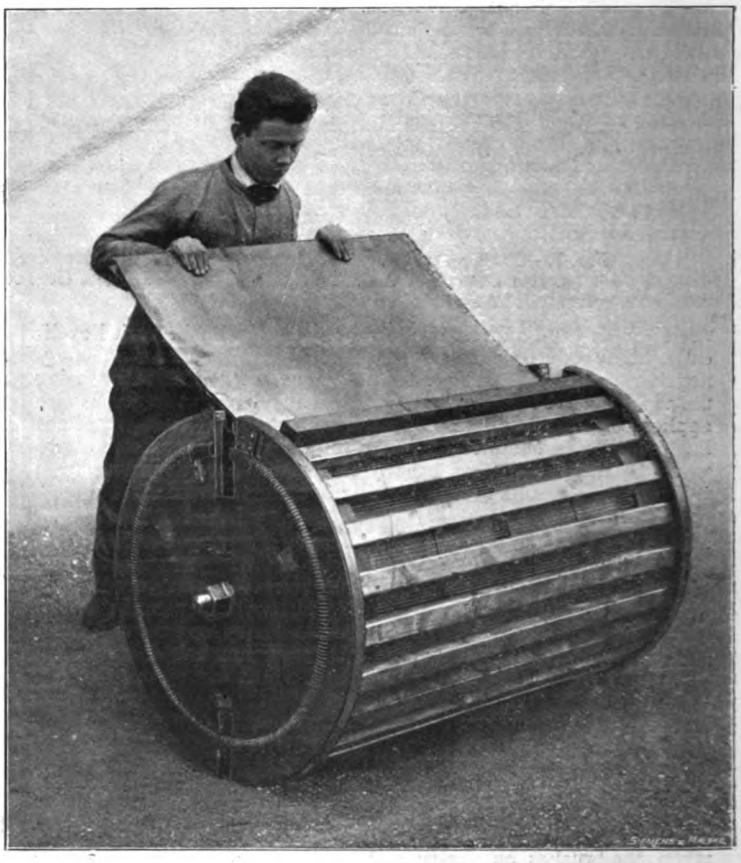

Fig. 5.

show the usual methods of overlapping, the former giving the more accurate results. In order to avoid the generation of heavy currents, owing to the iron sheets forming the secondary circuit of a transformer, the sheets are insulated by means of paper strips in such a manner that neither the overlapping ends of one and the same plate nor the sheets amongst themselves come into electrical contact. Figs. 4 and 6, relating to sheets 1,000mm. wide, show how this may be accomplished. For ordinary purposes the overlapping ends need not be insulated from one another, the result obtained in this case differing, it is stated, from that obtained with completely insulated sheets (Fig. 6) by not more than 3·5 per cent. (B=10,000).

The *modus operandi* is as follows:—A flux-density for the test being decided upon, the alternating voltage necessary to produce this flux is calculated from the formula $e = 4{\cdot}44\, B q p n 10^{-8}$, wherein q = section through the iron sheets in a direction perpen-

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dicular to the magnetic flux, $p = \sim$ per sec. and n = number of turns of the winding of the apparatus. As seen from the vector diagram (Fig. 7), this theoretical voltage e is smaller than the voltage E actually required at the terminals of the apparatus on account of the self-induction and resistance of the magnetising winding. We have, in fact, $E - e = KJ$, where K very nearly $= R\cos(\varphi - \psi)$. Further, $R = \sqrt{w^2 + (2\pi pl)^2}$ and $\tan \psi = \frac{2\pi pl}{w}$, wherein w = resistance of the magnetising coil and l = self-induction of this coil (without any iron sheets being inserted into the apparatus). J denotes the current.

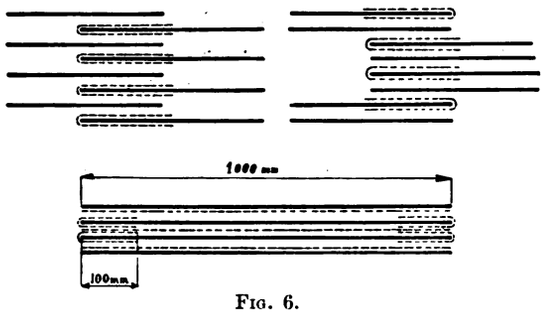

Fig. 6.

Cos φ is obtained in the customary manner by means of a voltmeter, ammeter and wattmeter. Since w and l are known for every apparatus, it is possible to calculate first the constant K and then (by assuming, in the first place, a current J, which, after a test has been made, may have to be corrected) the required voltage E. The cross-section q is most easily obtained from the formula connecting it with the weight, length and specific gravity of the sheets. In

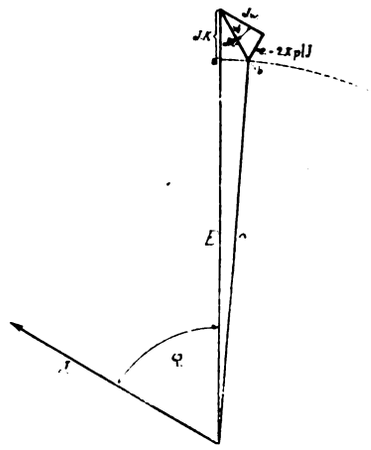

Fig. 7.

order to obtain the iron losses, it now only remains to deduct from the wattmeter readings the copper loss in the magnetising coil of the apparatus. The iron loss, again, is divided into its hysteresis and eddy-current components by the Steinmetz equation given at the beginning of this article.

TRANSATLANTIC ENGINEERING SCHOOLS AND ENGINEERING.

A Paper on "Transatlantic Engineering Schools and Engineering" was read by Dr. R. Mullineux Walmsley, before the Institution of Electrical Engineers, on Thursday of last week. The author commenced by referring to the large amount of attention which is now being given to technical education in this country and he also quoted recent Papers on the subject. In March of last year he commenced a three months' tour in the United States with the object of inquiring into the methods of American technical education; this tour was undertaken at the instigation of the governors of the Northampton Institute and the information obtained was embodied in the Paper. After interviewing several leading engineers and representatives of large manufacturing firms in New York, Dr. Walmsley visited, among others, the following places:—Philadelphia, Baltimore, Washington, Pittsburgh, Madison, Chicago, Buffalo, Niagara, Toronto, Ithaca, Montreal, Schenectady, and the New England States of Massachusetts, Rhode Island and Connecticut. Altogether, about 34 universities, colleges and schools, and 48 factories were visited, in addition to which numerous interviews were held with business men at their offices not situated at the works.

The author divided the American and Canadian schools for higher engineering education into three classes:—Those attached to universities which are not supported by the State, but derive their funds from endowments, from private contributors and from students' fees; those attached to the State universities and almost, if not entirely, supported by the State in which they are situated and from federal funds—in these the fees charged to the students are small, and there are many free places; and those which are not attached to any university, but are frankly technological schools and nothing else. The latter are, as a rule, of private foundation, independent of State control and derive a large proportion of their income from students' fees.

The institutions of the first class are found chiefly in the eastern or Atlantic states, those of the second are in the central and western states, whilst in the third class the institutions are scattered all over the country and are very numerous. The State aid of higher technical education in the United States dates from 1862 and the passing of the Morrill Act, by which a grant of public land was made to each state proportional to the number of senators and members of Congress which it returned to the Federal Legislature. The funds derived from this source, which in process of time have become large, are to be entirely spent upon the maintenance of the work and the payment of the instructors, and are not to be used for buildings or capital expenditure. A more recent act, passed in 1890, authorises the contribution of a further sum not exceeding £5,000 per annum to each state from the Federal treasury, the amount contributed under this head in 1901 being £240,000.

Many of the universities visited consisted of a series of fine buildings, situated in extensive grounds, and the engineering department was usually prominent. The workshops, as a rule, are lavishly equipped, and the laboratories even more so. Manufacturers are very generous in their gifts to the colleges, one firm building a special full-sized locomotive, which was presented to a college for testing purposes. The electrical laboratories cannot be extended fast enough to accommodate the increase in the number of students, but they are equipped throughout with modern and efficient apparatus and machinery. For electric traction work the University of Illinois at Urbana has, in conjunction with the Illinois Central Railway Co., built and equipped an experimental car which can be attached to any train so as to furnish data obtained under actual working conditions. The car was provided by the railway company, and equipped with its instruments and fittings by the university. The Brooklyn Polytechnic is allowed from time to time by the local street railway company to use part of its track for experimental work, the company supplying the necessary current and an operating staff.

The general absence of specially equipped and separate electrochemical laboratories was somewhat surprising. As an exception may be mentioned the electrochemical laboratories at the University of Pennsylvania in Philadelphia and the University of Wisconsin at Madison. Some other places have made a start, however, and it is fairly certain that well-equipped laboratories for electrochemistry, electro-metallurgy and cognate subjects will soon be the rule rather than the exception. With regard to the applications of electricity in signalling, especially in telegraphy and telephony, the equipment did not appear commensurate with the importance of the subject. For the first of these subjects, beyond a few laboratory experiments for testing capacity, insulation, &c., little seemed to be provided. In telephony things were somewhat better, chiefly owing to the enterprise of companies manufacturing telephone apparatus. At the Worcester (Mass.) Polytechnic a large oil transformer, approximately 6ft. by 5ft. by 4ft., has been constructed and housed in a special building on the campus, to give facilities for high voltage research. With this transformer pressures up to 450,000 volts have been obtained, and experiments made on an overhead line specially erected for the purpose in the campus. At Cornell University a special battery of 30 small dynamos, each giving 500 volts, has been installed, so that continuous-current experiments up to 15,000 volts can be made.

Referring to the question of the teaching staffs, Dr. Walmsley said it is recognised in the United States and Canada that, in addition to sound academical training, the teachers should also be possessed of considerable experience as engineers. It is not the men who have been in practical life and have failed that are wanted, but men who have had practical engineering experience and have been successful in it. Even with the large resources at the disposal of the colleges, however, their present financial position is not strong enough to enable them to offer the salaries for heads of departments which the necessities of the case require. It is the universal custom to *require* teachers to engage in outside consulting work. The plan of arranging for short courses of lectures, to be given by representative and well-known engineers directly connected in actual practice with the subject of the course, is very frequently adopted. Not only do the professors settle the curricula, and teach the subjects included therein, but the whole question of the award

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ing of the honours and of the graduating diplomas is placed in their hands without restriction.

From a financial point of view the transatlantic engineering colleges appear to be on a better footing than those in England. Although a considerable amount of money is given in large sums by millionaires, the extent of the smaller contributions from a great number of individuals does not seem to be realised. In the year ended August 31, 1902, a sum not far short of £100,000 was received by the University of Pennsylvania from private donors. These donors numbered about 400 separate individuals, and although there are one or two large amounts, including one of £10,000 and another of £5,000, the bulk of the money came from the large number of much smaller contributions. There was also a single donation of £100,000.

By means of extensive tables, the author proceeds to discuss the financial details of various institutions, both individually and collectively, and shows that the percentage amount of the ordinary income received from State, or municipal and federal sources (all of which is public money) is 22·2 per cent. for the universities, but reaches the high figures of 62·2 per cent. for the schools of technology. The total amount contributed in the year 1900-1901 by the Federal Government for education of university rank reaches the large total of £1,133,600, whilst the individual States and the municipalities together contributed £1,011,900 for similar purposes. The older institutions, which have practically no State aid towards their income, receive large contributions from private benefactors, whereas the western universities, with their large drafts upon the State, are left severely alone by private benefactors.

Under the heading "The Students Available and the Conditions of Entrance," Dr. Walmsley makes some very pertinent remarks. He says that the basis of the American and Canadian educational system is the common or public school which the child enters at the age of six. At 10 he is transferred to the grammar school, which forms the intermediate stage between the primary and the secondary school. Here he remains for four years, and learns very little beyond elementary English and arithmetic. Such students as can then afford to pursue their education to a higher level enter either the high school, with its classical and modern side, or the manual training high school or manual training school, in which workshop instruction forms a large part of the curriculum. At this stage the usual courses extend over another four years, but in some of the manual training schools they cover only three years; generally, therefore, by the time the student has gone through the whole course he is 18 years of age. These schools take charge of the stage of education which is immediately preparatory to the entrance to the universities and technical colleges, but the majority of the pupils do not carry their education further, but pass direct from them into ordinary life. Taking first the manual training high schools and the manual training schools, a large proportion of the time, often approximating to one-third of the whole, is spent in the workshops, the remaining time being given to mathematics, drawing, science, literature and modern languages. In the high schools, on the other hand, there is a classical course, and often, in addition, what we should call in this country a modern side, in which modern languages and science take the place of Latin and Greek. Mathematics is, of course, taught in all sections of the school. Under certain conditions, the student is permitted to choose for himself the subjects which he intends to study, and the author does not consider this advisable. Students for the classical sides of the high schools frequently make better engineers than those who have gone through the manual training schools. Owing to later age of entrance and to their general education having, as a rule, been carried to a higher point, the candidates for technical courses in America are more able to take advantage of the training than their English cousins. The American navy, army and civil service do not prove such formidable competitors as the corresponding British services in the demand for men who would otherwise take up engineering. Many students in America are men who have had to support themselves from a comparatively early age, and who, after saving up sufficient money, often go through a four years' course when well on in life. Entrance of students under 18 years of age to technical institutions is strongly discouraged. In nearly all cases an entrance examination is set, which is more difficult than the matriculation examination of the University of London. English is a compulsory subject in every instance, but there is a certain amount of variation regarding other subjects in the different schools. There is a tendency, in institutions of good reputation, to still further raise the conditions of entrance, this being due to the fact that the increasing number of candidates is severely taxing their resources and accommodation.

Fees for tuition range from nothing up to £52 per annum, according to the locality and status of the school. The highest fees are charged at the eastern universities, but tuition is practically free to residents in the middle west states, as these latter derive a considerable part of their income from the State. There are a great number of free scholarships in connection with several universities. The cost of living is comparatively low at Canadian institutions.

It seems to be a common opinion that four years is insufficient for the work to be done, and there is a movement on foot either to give a longer preliminary training, or to lengthen the time spent in the professional school. Although the age of entrance is late, the preparation is not so good as it might be, and an attempt is made to remedy this state of affairs by devoting a large amount of time to teaching non-professional subjects during the first two years, thus crowding much highly technical work into the remaining two years.

Tables are given in the Paper which show the total number of hours devoted to different subjects in several institutions Mathematics is usually carried through the various stages of the infinitesimal calculus. The amount of time given varies between somewhat wide limits, many of the schools only taking the subject during the first two years. Physics and chemistry are taught in the earlier years, but owing to the exigencies of time-tables the laboratory work does not always run synchronously with the lecture and exercise work in these subjects. There are, Dr. Walmsley says, for English ideas, too many instances of the laboratory work being postponed until the lecture work has been almost, if not quite, completed. In fact, though there are some exceptions, the laboratory work in these subjects is not given so prominent a place as it is in the best English technical schools; chemistry claims the greater share, and physics is sometimes left very much in the cold, notwithstanding the splendid equipment at the disposal of the various institutions. The teaching of mathematics and physics to engineers is a subject into which Dr. Walmsley inquired somewhat closely, and particularly as to whether the teaching of these subjects should be placed in the hands of the pure mathematician and of the pure physicist, or in the hands of men who, whilst being necessarily well trained in the subject matter, are primarily engineers. The question does not arise so much in the polytechnics and technical institutes as in the universities where these subjects are also taught to large bodies of students who are not taking the engineering courses. Most of the authorities consulted were strongly of opinion that this teaching, where engineering students are concerned, should be placed in the hands of men who have been thoroughly trained as engineers, and that it should be differentiated very markedly from the teaching of the same subjects to the other classes of university students. It was pointed out that there need be no sacrifice of real mathematical or real physical training, and even little change of syllabus in arranging such courses, that the teaching by an engineer to engineers could be made as thorough a groundwork for sound mental training as if the more academical practice were followed, and that the gain to the students would be very great indeed. It is quite true, the author continued, that in some of the universities exigencies of staff or finance do not allow the suggested plan to be followed, but in the majority, even of these cases, the engineering classes are so large that special courses of lectures, exercises and laboratory work in mathematics and physics are given to them apart from the arts or science students, and then the special nature of the audience is borne in mind by the instructors, even though the latter may be nominally attached to the other faculties of the university. The difficulty of following what was usually considered the better course was often accentuated by the fact that, owing to financial reasons, the junior staff in these subjects had frequently only an academical training, the salaries offered being too low to attract trained engineers.

The amount of time allocated to mechanical drawing and workshop practice varies between very wide limits. Many schools require their students to design and execute elaborate pieces of constructive work, such as a triple-expansion engine. The Massachusetts Institute, on the other hand, has gone so far as to change recently the title of its workshops to "laboratories," thus emphasising the fundamental idea of the collegiate position of such shops, and clearly differentiating them and their purposes from commercial workshops. An important point is the way in which the attention of the senior students is directed towards the current literature of the various subjects. In more than one institution each member of the senior class has a particular technical journal assigned to him, and he is required to enter up upon index cards particulars of all the important Papers in a form in which they can be filed for ready reference. The cards, after being inspected by the instructors, are typed in duplicate, the indexing student keeping one copy and the other going into the general index of the department. Summer courses are arranged at some of the institutions, but these are usually attended by students who are not taking the regular winter courses. The best of the latter employ their time during the summer either in visiting workshops or in taking actual work with some manufacturing firm. Each student has to prepare a graduation thesis in the fourth year, but there is, as a rule, very little original work done. The theses are sometimes printed, but in most cases, whether printed or not, are bound and placed among the records of the Institution's work.

In most of the colleges post-graduate courses of a very elaborate nature are organised, the student is allowed to select his particular line of work and the full resources of the laboratory together with

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the help of the professorial and artisan staff, are placed at his disposal. Much very valuable work has emanated from these courses. In the 16 institutions which Dr. Walmsley discusses there were as many as 1,134 students doing fourth-year work, and 237 post-graduate students. For purposes of comparison, the following figures, published two years ago by the Association of Technical Institutions, give for Great Britain the number of day students, *15 years old and upwards*, taking complete technological engineering courses in university colleges and technical institutions :—

Courses.	First-year students.	Second-year students.	Third-year students.	Students who have attended more than three years.	Totals.
Engineering ..	1,141	724	347	52	2,264
Mining	118	29	15	4	166
	1,259	753	362	56	2,430

The contrast between the 56 students in engineering and mining who were attending courses beyond the third year in Great Britain and the 1,371 fourth-year and post-graduate students in the United States and Canada is almost startling in its vividness.

Enquiries among principals and employers revealed the fact that there is never the slightest difficulty in finding remunerative employment for graduates, indeed many of the latter secure appointments before their course is completed. The premium system is practically non-existent and the large firms start graduates at a living wage, at the same time giving them every opportunity to improve their position. Another direction in which the employers help the colleges is in practically throwing open their workshops during the summer vacation for the undergraduates to obtain workshop practice under commercial conditions. No undergraduate who is willing to work need be at a loss in America to find a shop in which he will be welcomed and given every reasonable facility. The firms giving such facilities say that they are amply repaid by becoming acquainted in advance with the real value of the men who are graduating, and in the data they acquire for making their selections when the time comes. This fact is worthy of note in connection with recent proposals in this country for the adoption of the so-called "sandwich" system of training engineers.

A criticism was made by more than one well-known official connected with telegraph and telephone work. It was that the colleges are too much concerned in turning out what may be called "kilowatt" men, and do not pay sufficient attention to the "milliwatt" men, the consequence being that it is very difficult indeed for telephone and telegraph companies to obtain the trained assistants which they require for the development and carrying on of their business. Referring to the position of technical education in England, the author comes to the conclusion that modern trade developments are moving so rapidly that, for the moment and until the reforms of secondary education now so strongly advocated have been accomplished, it would be disastrous to stand still, and we must press forward our technological education and make the best of the materials which are available. At any rate, a proportion of the secondary education which is being given is good, and we shall obtain at least some students who are well fitted to take advantage of more than all that we can put before them.

In order that the conditions may be bettered, he advocates the abolition of the premium system, the better equipping and staffing of the technical schools, more encouragement at home for graduates and wider knowledge that college training is absolutely essential. In short, the employers and manufacturers hold the key of the position. Some form of the sandwich system should be adopted. The state of affairs is not so bad that it cannot be remedied, and the local authorities would do well to rise to a sense of the very great importance to the country of education of a university standard. They should raise funds for the promotion of technical education.

The discussion was opened by Prof. H. E. ARMSTRONG, F.R.S., who said that he experienced considerable difficulty in deciding what was advisable with regard to the use to be made in England of the experience gained in America. He hoped that at the next meeting Prof. Ayrton would be able to state his views on the subject of electrical engineering education and the facilities afforded in America for the extension of the industry. Unfortunately, Prof. Ayrton had been seriously ill and was still unwell. But he knew that he had formed an extraordinarily high opinion of what was being done in America, especially with regard to the very intimate connection that had been established between colleges and employers. Personally, he (Prof. Armstrong) was not able to give an expert opinion on the technical questions concerning engineering education, but he was not at all inclined to think that American experience was going to be of very much use except in teaching us what not to do. He had come home from his American tour with the Moseley Commission extremely well satisfied with what was being done here, and there was not, in his opinion, such an enormous amount of leeway to make up. But he did agree with the author that the employers had not yet been tapped. He thought the American colleges were behind us from the practical point of view; they had scarcely emerged from the academic stage at present, and the ideas of technical education which had been developed in this country by many electrical men had not yet established themselves in America. There was a lack of depth in a large part of the American training. He doubted whether the average boy going up to the colleges in America was in the least degree superior to the average boy in England. On the other hand, our students did not put their backs into the work as the Americans did. In considering this question they must be very careful to distinguish between the education which the world gives and the education which the school gives. He could not help thinking that the characteristics of the American were developed out of school rather than in the school. The extraordinary alertness shown by the American was in no way bred in the schools. In fact, less was done in American schools to develop individuality than was done here. The American was over-taught throughout his college course. How the student could emerge from the college course with any individuality left in him he could not understand. In England the aim was to throw the student more and more upon his own resources. The author had mentioned the ample provision made for research. There might be a good deal of provision, but there was not much research work being done. What the American colleges were suffering from was great over-provision. If they could "scrap" the greater part of the provision and get men in who would develop greater individuality there would be a considerable improvement in the output. We should have to watch very carefully the growth of public opinion in America with regard to the output from the schools. He knew of instances in which manufacturers had been dissatisfied with the output and had abandoned scientific assistance. With regard to the enormous provision of buildings and laboratories, he pointed out that it must be borne in mind that a building was a monument, and he thought a great many of the American schools and colleges were erected as monuments. In America, of course, there was something to be made out of a building. A professor was not a monument and there was nothing to be made out of him and he was not held in the same esteem. Therefore there was not the same reason for councillors to advocate the advancement of the one as the other. He hoped that before long in England the whole question of engineering college equipment would be seriously discussed. His opinion was that we should altogether modify the present system of technical education and throw a larger proportion of the training on to the works, and to train men far more from the research point of view than had hitherto been the case. He had long thought that the engineer was not nearly sufficiently developed on the practical side. The tendency was to follow precedent too much. Therefore, instead of spending large sums on new buildings, we should first make up our minds whether it was not necessary to modify the course of instruction in a very serious way.

The discussion was then adjourned until Thursday next, February 25th.

RULES FOR THE INSTALLATION AND USE OF ELECTRICITY IN MINES.*

Definitions.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and earth as read by a hot wire or electrostatic voltmeter, and

(*a*) *Low Pressure.*—Where the conditions of the supply are such that the pressure at the terminals where the electricity is used cannot exceed 250 volts, the supply shall be deemed a low-pressure supply.

(*b*) *Medium Pressure.*—Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 250 volts, but cannot exceed 650 volts, the supply shall be deemed a medium pressure supply.

(*c*) *High Pressure.*—Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 650 volts but cannot exceed 3,000 volts, the supply shall be deemed a high-pressure supply.

(*d*) *Extra High Pressure.*—Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 3,000 volts, the supply shall be deemed an extra high-pressure supply.

Section I.—General.

1. *Quality of Installation.*—The whole of the machinery, material and workmanship in connection with the supply and use of electricity shall be the best of its respective class, and sufficient in size and power for the work it may be called upon to do.

2. *Installation of Machinery.*—All electric machinery shall be installed as far as is practicable in dry, well-lighted and well-ventilated places.

3. *Apparatus to Work without Undue Heating.*—All electrical apparatus shall be so worked that the rise in temperature will not injure its insulating materials.

4. *Protection of Live Metal Work; Complete Enclosure of same where Gas is liable to be Present; Earthing of Metallic Coverings.*—All live metal work, such as commutators, slip rings, resistances, switches, starters, cut-outs, shall be substantially made and effectively covered or guarded

* Drawn up by the Departmental Committee on the Use of Electricity in Mines.

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so as to avoid danger through accidental shock or risk of fire. In any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the covering shall be constructed so that there is no danger of firing gas by any sparking or flashing which may occur during the normal or abnormal working of the apparatus. All metallic coverings shall as far as practicable be effectively earthed where the pressure exceeds the limits of low pressure.

5. *Conditions as to use of Medium Pressures.*—The pressure of a supply delivered to the motor or other terminals shall not exceed the limits of a low-pressure supply, unless the following conditions are complied with:—

(*a*) Where a medium pressure supply is used for power purposes, or for arc lamps in series:

(1) The frame of every electric motor or transformer shall be efficiently connected with earth.

(2) The wires or conductors forming the connections to the motors, transformers, arc lamps or otherwise in connection with the supply, shall be, as far as practicable, completely enclosed in strong armouring or metal casing efficiently connected with earth, or they shall be fixed at such a distance apart, or in such a manner, that there shall be no danger from fire or shock.

(3) The supply to every motor, transformer or arc lamp shall be controlled by an efficient switch, placed in such a position as to be easily handled by the person in charge of the motor transformer or arc lamp, and connected so that by its means all pressure can be cut off from the motor, transformer or lamp itself, and from any regulating switch, resistance or other device in connection therewith.

(4) Switches, efficient fuses or automatic cut-outs shall also be provided, so as to protect the circuits from excess of current, and these switches, fuses and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(*b*) Where a medium pressure supply is used for incandescent lamps in series:

(1) The wires or conductors forming connections to the incandescent lamps, or otherwise in connection with the supply, shall be completely enclosed in strong armouring or metal casing, and this armouring or casing, together with the switches and lamp holders (if metallic), shall be efficiently connected with earth.

(2) Switches, efficient fuses or automatic cut-outs shall also be provided, so as to protect the circuits from excess of current, and these switches, fuses and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

6. *Prohibition of Pressure exceeding Medium beyond the Main Airway.*—No higher pressure than a medium pressure supply shall be taken beyond the in-bye ends of the main airways.

7. *Conditions as to use of High and Extra High Pressures.*—No higher pressure than a medium pressure supply shall be used other than for transmission or for motors, and then the following conditions shall be complied with:—

(1) No motor or transformer shall be of less normal rating than 75 B.H.P.

(2) The frame of every electric motor or transformer shall be efficiently connected with earth.

(3) The wires or conductors other than overhead lines above ground forming the connections to the motors or transformers or otherwise in connection with the supply shall be completely enclosed in a strong armouring or metal casing efficiently connected with earth.

(4) The machines, apparatus and lines shall be so marked as to clearly indicate that they are high pressure, either by the use of the word "Danger" at frequent intervals, or by vermilion paint properly renewed when necessary.

(5) The motors, machinery coupled thereto, and transformers shall be fixed in proper rooms or enclosures set apart solely for the purpose, and a notice shall be fixed in a conspicuous position at the door of every such room forbidding unauthorised persons to enter.

8. *Test to Detect Injury to Line during Installation.*—Every fixed electric line shall be tested for insulation after having been placed in position and before it is used for the purpose of supply, the testing pressure being at least 200 volts. The results of such tests of each line or section of line shall be duly recorded.

9. *Insulation of Circuits.*—The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus and devices forming part of or in connection with such circuit, shall be so maintained that the leakage current shall not under any conditions exceed $\frac{1}{1000}$ of the maximum supply current, and suitable means shall be provided for the immediate localisation of leakage.

10. *Special Test for Circuits above Medium Pressure before Use.*—A high-pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood a continuous applicat on during half an hour of a pressure exceeding the maximum pressure to which it is intended to be subjected in use—that is to say, in the case of every electric line a pressure twice the said maximum pressure, and in the case of every machine device or apparatus a pressure 50 per cent. greater than the said maximum pressure. The results of such tests shall be duly recorded.

11. *Earth Detectors in Generating and Transforming Stations.*—Earth or fault detectors shall be kept connected up in every generating and transforming station to show immediately any defect in the insulation of the system. The readings of these instruments shall be recorded at least twice daily in a book kept at the generating or transforming station or switch house, and immediate steps shall be taken to rectify any defects.

12. *Construction and Arrangement of Main and Distribution Switch and Fuse Boards.*—Main and distribution switch and fuse boards must be made of incombustible insulating material, such as marble or slate free from metallic veins, and be fixed in as dry a situation as practicable, and be so placed that a fire thereon cannot spread to combustible material. Live metal must be fixed at such a distance from all metal not at the same potential, or be so separated by insulating partitions that an arc cannot be formed between the metal surfaces. All circuits, switches and instruments shall be clearly labelled for identification.

13. *Distributing Centres and Sub-centres.*—Conductors must radiate from distributing centres and in large systems from those centres to sub-centres At these centres suitable switchboards shall be fixed, by which the pressure can be cut off from any circuit.

14. *Bunching of Conductors.*—No conductor shall be bunched in the same duct, pipe or groove with one at another pressure of supply unless they are each separately protected by a strong continuous metallic sheathing efficiently earthed.

15. *Provision of Switches, and Cut-out or Fuse.*—Every circuit carrying not more than 3 amperes must be protected on each pole by a fuse. Every circuit carrying more than 3 amperes must be controlled by a switch on each pole and cut-out or fuse on each pole. The switch shall be on the live side of the fuse.

16. *Construction and Ventilation of Machine Rooms.*—No portion of the internal surface of any room in which electrical machinery is installed shall be formed of substances easily ignited, and the use of inflammable materials in such rooms shall be reduced to the minimum. Such rooms when underground shall where possible be ventilated by intake air.

17. *Fire Extinguishing in Machine Rooms.*—Fire buckets, filled with clean dry sand, shall be kept in electrical machine rooms ready for immediate use in extinguishing fires.

18. *No Repairs to be carried out when Current is on.*—No repair or cleaning of any electrical apparatus except mere wiping or oiling shall be done when the current is on.

19. *Use of Rubber Gloves and Mats during Adjustment of Live Parts of Switches or Machines.*—Gloves and mats of indiarubber or other non-conducting material shall be supplied and used where the live parts of switches or machines, working at a pressure exceeding the limits of low pressure, have to be handled for the purpose of adjustment.

20. *Competent Person to make Daily Inspection.*—The manager shall appoint a competent person or persons to inspect daily all electrical machinery and apparatus, who shall make a true report in writing of the result of such examination before leaving the mine.

21. *Competent Persons to be on Duty.*—A competent person shall be on duty at the mine when the electrical apparatus or machinery is in use; and at such time as the amount of electricity delivered down the mine exceeds 200 B.H.P. a competent person shall be on duty at the mine above ground and another below ground.

22. *Appointment and Instruction of Machine Attendants.*—No person shall be allowed to work any electrically-driven apparatus unless he has been previously instructed in his duty, and has been duly authorised by the manager or under-manager.

23. *Immediate Report to Management of Abnormal Working of Plant.*—All persons engaged in or about the mine shall at once report to the management anything unusual observed in the working of the plant.

24. *Prohibition of Unauthorised Persons interfering with Installation.*—No person shall wilfully damage, interfere with or, without proper authority, remove or render useless any electric line or any machine, apparatus or part thereof used in connection with the supply or use of electricity.

25. *Posting of Instructions as to Treatment of Persons suffering from Electric Shock.*—Instructions shall be posted up in every generating and motor house containing directions as to the restoration of persons suffering from electric shock.

26. *Provision of Telephonic Communication.*—Direct telephonic communication shall be provided

(*a*) Between the generating station and the pit bottom or main distributing centre in the pit.

(*b*) Between the generating station and the pit head.

(*c*) Between the pit head and the pit bottom or main distributing centre in the pit.

27. *Notice of Existing and New Installation to be sent to Inspector.*—Before any electric installation is erected at any mine, notice in writing must be sent to H.M. Inspector of Mines for the district. Notice must also be sent of any existing electric installation at any mine within three months after the coming into force of these rules.

28. *Plan Showing Installation to be Kept.*—A plan shall be kept at the mine showing the position of all electrical machinery, apparatus and lines at or in the mine, and shall be corrected as often as may be necessary to keep it up to a date not more than three months previously.

29. *Storage Batteries.*—If fixed storage batteries are used underground they must be placed in well-ventilated rooms or enclosures.

Section II.—Generating Stations and Machine Rooms.

1. *Generating Sets.*—Generating sets shall be spaced so that there is ample passage all round them, not less than 4ft. between separate sets or less than 3ft. between any set and the wall. For installations of over 200 B.H.P. an enclosure in which the electrical energy is generated shall be fenced off and set apart for that purpose only. It shall contain the engines, dynamos, switchboards and any other mechanical or electrical apparatus belonging thereto, but shall not contain boilers, feed-pumps, haulage engines or other machinery, or be used as a store room or workshop, except for repairing the machines therein.

2. *Provision of Switch House where Generating Station is over 400yds. from Pit Mouth.*—Where the generating station under the control of the owner

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or manager of the mine is not within 400yds. of the pit mouth, a switch house shall be provided near the pit mouth containing switches for cutting off the supply of electricity to the mine. This house shall only be entered by duly authorised persons, and a notice to that effect shall be posted at the door, and the same regulations as to switchboards and their enclosures in generating stations shall apply thereto.

3. *Main Switchboard.*—The main switchboard shall be separated from the engine room by a hard wood rail not less than 3ft. from the front of the board. The space in front of the board shall be a platform raised not less than 6in. above the floor level, and preferably constructed of wood blocks.

4. *Provision to be made for Clear Space at Back of Main Switchboards.*—If there are any connections at the back of the switchboard, there shall be a clear space behind the board of not less than 3ft. This space shall not be utilised as a store room or a lumber room, or obstructed in any manner by resistance frames, meters or otherwise. If space is required for resistance frames or other electrical apparatus behind the board, the passage way must be widened accordingly. No cable shall cross the passage way at the back of the board except below the floor or at a height of not less than 7ft. above the floor. The space at the back of the switchboards shall be properly floored, accessible from each end, and, except in the case of low-pressure switchboards, must be kept locked up, but the lock must allow of the door being opened from the inside without the use of a key. The floor at the back shall be firm and even, and shall be of hard wood, or be covered with good insulating material.

5. *Provision of Automatic Cut-out and Meters for Generators.*—Every generator shall be provided with an automatic maximum cut-out or switch and fuse on each pole between the generator and the 'bus bars. Where generators are paralleled reverse current cut-outs shall also be provided. Suitable instruments shall be provided for measuring the current and pressure of each generator.

6. *Automatic Cut-out and Ammeter for Feeder Circuit.*—Every feeder circuit shall be provided with an automatic maximum cut-out or switch and fuse on each pole and an ammeter.

7. *Arrangement of Switchboard where Continuous Supply is maintained.*—Where the supply is maintained continuously the switchboards shall be arranged in sections, so that all pressure can be cut off from any section for the purpose of cleaning or repairing it. No work or cleaning shall be carried out on any portion of a switchboard, above the limits of low pressure, while the pressure is on the board.

8. *Lightning Arresters for Overhead Lines.*—If the transmission lines from the generating station to the pit are overhead there shall be lightning arresters in connection with the feeder circuits.

9. *Protection from Short Circuits with Low-pressure Installations.*—Where the supply is at low pressure the 'bus bars and any live metal work on the front of the boards must be so spaced or separated by fillets of non-conducting material that there shall be no danger of accidental short-circuits, and switches must be provided which will open even on a short-circuit without danger to the attendant. Automatic cut-outs must be arranged so that when opening outwards the contact lever does not fall within 6ft. 6in. of the floor. If unenclosed fuses are used they must be placed within 2ft. of the floor.

10. *Live Metal on Front of Switchboards at Medium Pressure and upwards.*—Where the supply is at a pressure exceeding the limits of low pressure, there shall be no live metal work on the front of the switchboard within 8ft. of the platform, and the space provided under Rule 4 shall be not less than 4ft. in the clear.

11. *High-pressure Meters to be connected through Transformers where practicable. Metal Casings, &c, to be Earthed.*—Where the supply is at a pressure exceeding the limits of medium pressure the instruments should, where practicable, be connected through transformers and worked at low pressure. Where such transformers are not used the metal cases of all instruments shall be either earthed and guarded by efficient earthed metal cages out of reach of the attendant, or be completely protected with insulating covers. All metal work not in connection with the circuits shall be connected to earth, and all switches shall be operated by long and well insulated levers.

12. *Earthing of Machine Frames.*—The frames and bed-plates of all generating machines and transformers at a pressure exceeding the limits of low pressure, shall be efficiently connected to earth.

13. *Protection of Live Metal.*—All terminals and live metal work, where practicable, shall be protected with insulating covers, or with metal covers connected to earth.

Brush Rockers.—The brush rockers of machines working at a pressure exceeding the limits of low pressure shall be worked by hand wheels at a safe distance from the brushes.

14. *Rubber Mats.*—Insulating stands or rubber mats must be placed at the commutator or collector side of all open-type machines working at a pressure exceeding the limits of low pressure.

15. *Fencing of Generators.*—The fencing of generators having collector rings or commutators must be of teak or hard wood or metal. If of metal, that part of the metal which might be touched by a person when wiping commutator or collector rings shall be covered with insulating material.

16. *Unauthorised Persons not to enter Motor Rooms or interfere with Apparatus.*—No person other than an authorised person shall enter a machine or motor room or interfere with the working of any machine, motor or apparatus connected therewith.

Section III.—Cables.

1. *Prohibition of Earthed Circuits.*—Except as is hereinafter provided, metallic circuits shall in every case be maintained completely insulated from earth. The neutral point of polyphase systems shall not be earthed without notification in writing to the inspector of mines of the district.

2. *Insulation of Continuously-insulated Cables.*—All continuously-insulated cables and wires shall be highly insulated, and the insulating material must be protected from mechanical injury. The insulating material must be so so protected or, as far as is practicable, be of itself of such a nature that it will not deteriorate under the action of water or alternate periods of wet and dry, or at the highest temperature to which it will be subjected. Rubber must not be allowed to exceed 130°F., or paper—or fibre—insulation 170°F. In specially hot places the conductors shall be so large that the electric heating is almost nil.

3. *Tests of Continuously-insulated Cables.*—A continuously-insulated cable must be so constructed that when a test piece of it has been immersed in water for 24 hours it will, while still immersed, in the case of cables intended for low or medium pressures, withstand 2,000 volts for 10 minutes between the conductor and the water and between cores if there are more than one in the cable. If the cable is intended for high or extra high pressure, twice the working pressure shall be taken for this test. Prior to the immersion, the test piece must have been bent six times (three times in one direction and three times in the opposite direction) round a cylindrical surface not more than 12 times the diameter of the finished cable.

4. *Certificate of Maker's Tests.*—Continuously-insulated cables and wires which are to be used at low and medium pressures must be subjected at the maker's works to a test under water of 2,000 volts for one hour between the conductor and the water, and between cores if there are more than one in the cable, after 24 hours' immersion in water, and each drum and coil must be certified to have been so tested. Where high or extra high working pressures are intended, the tests must be made at twice the working pressure. A written certificate, signed by a cable manufacturer or competent engineer of the United Kingdom shall be sufficient evidence that the requirements of this rule have been complied with.

5. *Protection of Conductors.*—Unless fixed in sight and out of reach of injury, all conductors other than lead-covered armoured cables must further be protected by a strong covering, and this in damp situations must consist of water-tight metal tubes, which shall be electrically continuous throughout, and efficiently connected to earth. Means must be provided to prevent the accumulation within the tubing of water arising from condensation or other sources. Short bends or elbows must be avoided, corners being turned by smooth-bore round bends or suitable boxes.

6. *Protection of Exposed Ends of Conductors entering Terminals of Switches, &c.*—The exposed ends of cables where they enter the terminals of switches, fuses and other appliances must be properly protected and finished off, so that moisture cannot creep along the insulating material within the waterproof sheath, nor can the insulating material, if of an oily nature, leak out of the cable.

7. *Limits of Sections.*—The sectional area of a copper conductor must not be less than that of a No. 18 S.W.G. wire, with the exception of the case of flexible cord conductors and wires for fittings, when the sectional area must not be less than that of a No. 20 S.W.G. wire. All insulated copper conductors having a greater area than that of a No. 14 S.W.G. wire must be stranded.

8. *Sectional Area of Conductors.*—The section of all conductors along which the current is to pass shall be such that if double the normal current were flowing the temperature would not rise to the point at which the insulating material would be damaged or deteriorated.

9. *Current Densities.*—If the conductors are of copper, they shall be of high conductivity, and when the area does not exceed 0·2 sq. in. the current density must not exceed 1,000 amperes per square inch; when the area exceeds 0·2 sq. in, but does not exceed 0·7 sq. in., the current density must not exceed 800 amperes per square inch; and when the area exceeds 0·7 sq. in., but does not exceed 1 sq. in., the current density must not exceed 750 amperes per square inch.

10. *Joints not to take Strain.*—In every case wires and cables must be so clamped and secured at their joints as to ensure that the contact is relieved, not only from the weight of the cables, but from any strain that may be put upon them.

11. *Joints.*—All joints must be, as far as practicable, mechanically and electrically perfect to prevent heat being generated. All joints where possible must be soldered. Soldering fluids containing acids or other corrosive substances must not be used. The insulation of all joints in insulated conductors must be most carefully attended to. In any place of part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, suitables joint boxes must be used.

12. *Joint Boxes.*—Joint boxes must be used to connect lengths of cables or conductors equivalent to or larger than 7-16 S.W.G., and must be so constructed that (1) the conductors cannot be readily short-circuited, (2) the insulation between opposite poles will not readily break or chip, (3) the connections do not heat.

If used in damp places, special precautions must be adopted to exclude moisture. Joints constitute a source of weakness, and they must therefore be accessible, and their positions should be indicated by a conspicuous mark.

13. *Joining of Cables in Certain Places.*—Soldering of joints is prohibited in any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies. In such places conductors must be connected by means of metal screw clamps, connectors or their equivalent. These connectors must consist of separate clamps on each cable end, with a gap between, which must be bridged across by a link making contact under oil, or in a gas-tight box. The links should be easily removable

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for dividing the cables when required for testing purposes. The connectors must be constructed with ample contact suface to prevent any perceptible rise of temperature when carrying twice the full load. When the separate conductors of cables, at different potentials, such as twin, triple or concentric cables, are connected in the same box, ample insulation and mechanical protection must be provided between the conductors. On no account may wires, other than signalling wires, or cables be joined by merely twisting them together.

14. *Overhead Lines on Surface.*—It shall be permissible to use on the suface bare overhead wires under the following conditions:—

(*a*) Every overhead line shall be attached to supports at intervals not exceeding 200ft. where the direction of the line is straight, or 150ft. where the line makes an angle at the point of support.

(*b*) Every support for an overhead line shall be of durable material, and properly stayed to withstand forces due to wind pressure, change of direction or unequal lengths of span, and have a factor of safety of at least 10, calculated from the weight of the wires only. The wires must have a factor of safety of at least five at 30°F.

(*c*) All overhead lines shall be attached to insulators, and shall be so guarded that they cannot fall away from the supports.

(*d*) The overhead lines shall at every part be absolutely clear of any traffic going under them.

(*e*) Whenever overhead lines are used they must be protected by efficient lightning arresters.

(*f*) Service lines from overhead lines shall be connected as directly as possible to suitable insulators firmly attached to some portion of the premises which is not accessible to any person without the use of a ladder, and from this point they shall be efficiently enclosed and protected.

15. *Buried Lines on Surface.*—Cables buried on the surface shall be continuously insulated. Unarmoured cables must be mechanically protected by suitable material. High-tension cables must not be placed in the same trough or conduit with low or medium-tension cables, unless they are each separately protected by earthed metallic shields.

16. *Shaft Cables.*—All cables used in shafts must be highly insulated and substantially fixed. Shaft cables shall be properly supported at intervals, varying according to the weight of the cable. Where the cables are not completely boxed in and protected from falling material, space should be left between them and the side of the shaft that they may yield, and so lessen a blow given by falling material. They shall, if reasonably practicable, be taken down the down-cast shaft and along the main intake airways.

17. *Underground Cables.*—(*a*) As the condition of underground roads is very variable, the manager shall be responsible for placing the cables in positions where they will be least liable to be damaged by falls of roofs or sides, or by tubs or trams passing or getting off the road.

(*b*) Where the cables in main haulage roads cannot be kept at least 1ft. from any part of the tub or tram, they shall be specially protected. When single cables are used they shall, if practicable, be fixed on opposite sides of the road.

(*c*) The fixing with metallic fastenings of cables and wires not provided with metallic covering to walls or timbers is prohibited.

(*d*) Cables when suspended shall be suspended by leather or other flexible material in such a manner as to allow of their readily breaking away when struck, before the cables themselves can be seriously damaged.

(*e*) Trailing cables for portable machines shall be specially flexible, heavily insulated, and protected with either galvanised steel wire armouring, extra stout braiding, hose pipe, or other effective covering. Trailing cables shall be regularly inspected, and any defects in them promptly repaired.

(*f*) At points where the flexible conductors are joined to the main cables, a fixed terminal box must be provided, and be of such design that the lugs can be securely clamped without risk of undue heating, and that no live metal can be exposed when the lid is closed. A switch shall be fixed close to or in the terminal box capable of entirely cutting off the supply from the terminal box and motor.

18. *Cables to be Protected during Repair of Roads or Blasting.*—Where main or other roads are being repaired, or blasting is being carried out, suitable temporary protection must be used so that the cables cannot be damaged.

Section IV.—Switches, Fuses and Cut-outs.

1. *Switches to be of Suitable Design.*—Every switch must be of such a type and size that it will not overheat when the full current flows continuously; when it is switched off under full load it must not be possible to form an arc, and it must be incapable of remaining in partial contact, and its handle must be insulated and so arranged that the hand cannot touch live metal.

2. *Fuses to be of Suitable Design.*—Fuses must be so proportioned that no overheating can take place in any part when the full current flows continuously. They shall effectually interrupt the current when a short-circuit occurs, and also when the current through them exceeds the working current by 100 per cent. Their covers must be of incombustible material, and either non-conducting or of rigid metal lined with insulating incombustible material, and kept clear of all internal mechanism. Fuses must not be placed in wall sockets, ceiling roses, or switch covers.

3. *Material, Marking and Replacing of Fuses.*—Hard metal or soft metal soldered to hard-metal lugs must be used for fuses. They shall be stamped or marked with the current for which they are intended to be used, and shall only be changed or replaced by an authorised person. In the event of a fuse melting, its circuit must be switched off before the fuse is replaced.

4. *Enclosure of Switches, Fuses, &c, not in Machine Rooms.*—All live parts of switches, fuses and cut-outs not in machine rooms or in compartments specially arranged for the purpose must be covered. These covers must be of incombustible material, and must be either non-conducting or of rigid metal, and, as far as practicable, clear of all internal mechanism.

5. *Makeshift Switches not Permissible.*—All points at which the circuit has to be made or broken shall be fitted with proper switches. The use of hooks or other makeshifts is prohibited.

6. *Prohibition of Open Type Switches and Fuses in certain places.*—In any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the use of open type switches, fuses and cut-outs is prohibited; they must either be enclosed in gas-tight boxes, or break under oil.

Section V.—Motors.

1. *Switches to be placed near Motors.*—All motors, together with their starting resistances, shall be protected by switches capable of entirely cutting off the pressure and fixed in a convenient position near the motor.

2. *Ammeter for each Motor.*—Every motor in a machine room shall be provided with a suitable ammeter to indicate the load put upon the machine.

3. *Motors to be worked without Undue Heating.*—Motors must not be worked at a heavier load than they can carry for a six hours' run, with a maximum rise of temperature attained by any accessible part of the motor of 80°F. as measured by a thermometer.

4. *Protection for Cables passing through Metal Casings, &c.*—Special care must be taken to ensure that the holes, where unarmoured cables or wires pass through metal frames or into boxes or motor casings, are substantially bushed with insulating bushes, and, where necessary, with gas-tight bushings, which cannot readily become displaced. All the internal machine connections shall be efficiently protected against damage by accident or rough usage.

5. *Provision of Flame-tight Enclosure of Motors, &c., in certain places, which are only to be opened by Authorised Persons.*—In any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, all motors, unless placed in such rooms as are separately ventilated with intake air, shall have all their current-carrying parts, also their starters, terminals, and connections, completely enclosed in flame-tight enclosures, made of uninflammable material, and of sufficient strength as not to be liable to be damaged should an explosion of fire-damp occur in the interior, and such enclosure shall not be opened except by an authorised person, and then only when the current is switched off. The pressure shall not be switched on while the enclosures are open.

6. *Current to be Switched on gradually.*—When starting a motor the switch block shall not be moved across the contacts with one rapid movement, but with a slow movement until the armature has attained its proper speed, and care must be taken that the strain is put on the machine gradually.

7. *Enclosure of Portable Motors.*—Portable motors which are fed by flexible cables must be provided with strong terminal boxes for making secure mechanical and electrical contact with the cable lugs, as provided in sec. III., rule 17 (*f*); the boxes must entirely enclose all live metal, and the lids must be firmly screwed down. These boxes must be securely attached to the machines, or be designed to form a part thereof.

8. *Motors to Cease Working if Fire-damp is present.*—In any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, a safety lamp or other suitable apparatus for the detection of fire-damp shall be provided for use with each machine when working, and, should any indication of fire-damp appear on the flame of the safety lamp or other apparatus used for the detection of fire-damp, the person in charge shall immediately stop the machine, cut off the current at the gate end or nearest switch, and report the matter to an official of the mine.

9. *Current to be cut off at Motor if Machine is jammed.*—In cases where the cutter of a coal-cutting machine becomes jammed, the current shall be immediately cut off from the motor, and the tension holding the machine up to the face shall be released. The machine shall not be re-started until the increased load upon the cutter has been removed.

10. *Manager to specify Length of Period of Continuous Work of Coal-cutter.*—A coal-cutter motor shall not be kept continuously at work for a period of time exceeding a maximum period, which shall be specified in writing by the manager.

11. *Casing of Portable Motors to be opened once a Week.*—The casing of all portable motors shall at least once a week be opened by a competent person appointed by the manager, and the parts of the motor so enclosed shall be cleaned, and all dust and dirt be removed before the casing is replaced.

12. *Daily Examination of Portable Machinery and Accessories.*—All portable machines, when in use, and their trailing cables, with switches, fuses, and other appliances, shall once in every 24 hours be examined by a competent person or persons appointed by the manager.

13. *Authorised Person to be in Charge of Portable Machines. Current to be cut off at Close of Work.*—The person in charge of a coal-cutter or drilling-machine shall be a thoroughly competent man duly authorised by the manager; he shall not leave the machine while it is working, and shall, before leaving the working place, see that the current is cut off from the trailing cables. He must not allow the cables to be dragged along by the machine.

14. *No Repairs to Portable Machines while Current is on.*—No repairs shall be made to any portable machine until the pressure has been cut off from the trailing cables.

15. *Portable Machines to Cease Working when Out of Order.*—Should any sparking or arc be produced outside a coal-cutting or other portable machine, or by the cables or rails, the machine shall be stopped and

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the occurrence reported to an official of the mine, and the machine shall not be worked again until the defect is repaired.

16. *Manager to Fix Interval between Wedges in Holing.*—Wedges or blocks shall be systematically inserted into the holing cut as the cutter progresses, and at a distance apart to be fixed by the manager. Where the holings left by the machine are found to be sufficient to act in place of wedges, wedges need not be inserted.

SECTION VI.—ELECTRIC LOCOMOTIVES.

1. *Electric Locomotives only permissible in certain places, and then with Medium and Low Pressures only.*—Electric haulage by locomotives by the trolley system is not permissible in any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies. On this system no pressure exceeding the limits of medium pressure may be employed.

2. *Protection from Danger of Shock.*—The cab of the locomotive and all trucks used to convey persons shall be so roofed that persons riding are efficiently screened from contact either with the trolley wires or the roof of the road.

3. *Position of Trolley Wires and Conditions of Working.*—In drifts and underground roads the trolley wires must be placed so that they are at least 7ft. above the level of the road or track, or the pressure must be cut off from the wires during such hours as the roads are used for travelling on foot. The hours during which travelling on foot is permitted shall be clearly indicated by notices and signals placed in a conspicuous position at the ends of the roads. At other times no one other than a duly authorised person shall be permitted to travel on foot along the road.

4. *System of Returns.*—On this system either insulated returns or uninsulated metallic returns of low resistance may be employed.

5. *Separate Generator to be Employed for Locomotives.*—In order to prevent any other part of the system being earthed, the current supplied for use on the trolley wires with an uninsulated return shall be generated by a separate machine, and shall not be taken from or be in connection with electric lines used for any other purpose.

6. *Protection of Storage Battery Locomotives in certain Mines.*—If storage battery locomotives are used in any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the rules applying to motors in such places shall also be deemed to apply to the boxes containing the cells.

SECTION VII.—ELECTRIC LIGHTING.

1. *Lampholders, Switches, &c., not to be directly fixed to Metal or Timbering.*—Lampholders, switches or other fittings must not be directly fixed to the timbering or metal work, but to hard wood or incombustible non-hygroscopic insulating base blocks.

2. *Use of Arc Lamps.*—All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger from the presence of coal dust. They shall be so screened as to prevent risk of contact with persons.

3. *Pressure for Lighting.*—For lighting purposes only low-pressure electricity shall be used, unless the conditions set out in rule 5, sec. I., are complied with.

4. *System of Wiring.*—Small wires for lighting circuits must be either conveyed in pipes or casings, which, if underground, shall be non-inflammable, or suspended from porcelain insulators, or tied to them with some non-conducting material which will not cut the covering, and so that they do not touch any timbering or metal work. On no account must staples be used. If metallic pipes are used they must be electrically continuous and earthed. If separate uncased wires are used they must be kept at least 2in. apart, and not brought together except at lamps or switches or fittings.

5. *Wires not to be Subjected to Mechanical Strain.*—No wire carrying a current shall be used underground to support a lamp, or be otherwise subjected to mechanical strain.

6. *Vacuum Lamps only Permissible in certain places.*—In any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, vacuum lamps must alone be used; they shall be enclosed in gas-tight fittings of strong glass, and have no flexible cord connections. The wires must be protected by a strong continuous metallic sheathing efficiently earthed.

7. *Lamps to be Changed only by Authorised Persons and when Current is on in certain places.*—Lamps underground shall only be changed by a duly authorised competent person. While lamps are being changed on any circuit in any place or part of a mine, as mentioned in Rule 6, the supply must be switched off from that circuit.

8. *Other Lights to be provided at certain places in case of Failure of Electric Light.*—At every entrance between the top and bottom of the shaft and at the shaft bottom, and in all machine rooms and at other places where the failure of electric light is likely to cause danger, a sufficient supply of safety lamps or other suitable lights shall be maintained for use in the event of a failure of the electric light.

SECTION VIII.—SHOT FIRING.

1. *Shots to be Fired Electrically in places to which the Explosives in Coal Mines Orders apply.*—All shots in places to which the Explosives in Coal Mines Orders apply shall be fired by electricity, and only by such persons as are duly authorised in writing, High-tension magneto-generators shall be enclosed in flame-tight cases when used in such mines.

2. *Firing Cable to be not less than 25yds. in length.*—The shot-firing cable shall be of such length as to enable the shot-firer to be out of danger from projected material, and shall in no case be of less length than 25yds.

3. *Method of Connecting up for Firing.*—The shot-firing cable shall be first connected to the detonator or fuse wire by the shot-firer, and not connected to the electric-firing apparatus until all persons in the vicinity have taken cover.

4. *Detachable Key or Plug of Magneto-generators to be in Custody of Shot-firer.*—The handle or key of a magneto shot-firing apparatus shall be detached when not required for firing, and shall under no conditions pass from the personal custody of the shot-firer whilst on duty. Magneto machines must be frequently tested to ensure that they give the necessary pressure and current.

5. *Detachable Plug of Cell Batteries to be in Custody of Shot-firer. Batteries to be Tested for Efficiency.*—Primary or secondary batteries when used for shot-firing shall be provided with a removable connecting plug or key, without which the circuit cannot be closed, and this plug or key shall be detached when not required for firing, and shall under no conditions pass from the personal custody of the shot-firer whilst on duty. Such batteries must be frequently tested to ensure that they give the necessary pressure and current.

6. *Electricity from Light or Power Mains not to be used except under certain conditions and then only in Sinking Shafts, &c.*—Electricity from lighting or power cables shall not be used for firing shots, except in sinking shafts or stone drifts, and then only when a special firing plug, button or switch is provided, which plug, button or switch shall be placed in a fixed locked box, and shall only be accessible to the authorised shot-firer. The firing cable or wires shall not be connected to this box until immediately before it is required for the firing of shots, and shall be disconnected immediately after the shots are fired.

7. *Cable to be disconnected before any Person approaches Missed Shot.*—No person shall approach a shot which has been attempted to be fired by electricity and failed to explode until the firing cable or wires have been disconnected from the apparatus.

8. *Firing Cable not to be in Contact with other Cables.*—When shot-firing cables or wires are used in the vicinity of power or lighting cables, sufficient precautions shall be taken to prevent the shot-firing cables or wires from coming into contact with the lighting or power cables.

SECTION IX.—SIGNALLING.

1. *Signal Wires not to come into Contact with other Wires.*—All proper precautions must be taken to prevent electric signal and telephone wires from coming into contact with other electric conductors, whether insulated or not.

2. *Prevention of Circuit being Accidentally Closed.*—Contact makers or push buttons of electric signalling circuits shall be so constructed and placed as to prevent the circuit being accidentally closed.

3. *Limit of Pressure where Bare Wires are used in certain places.*—In any place or part of a mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, bare wires shall not be used for signalling circuits except in haulage roads, and the pressure shall not exceed 10 volts in any one circuit. If the length of line would otherwise necessitate a higher pressure, suitable relays must be provided.

SECTION X.—ELECTRIC RE-LIGHTING OF SAFETY LAMPS.

1. *Authorised Person to be in Charge of Re-lighting Apparatus, and to Examine Lamps before Re-issue in certain mines.*—In mines to any place or part of which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, when safety lamps are re-lighted underground by electricity, the manager shall select a suitable station or stations, which are not in the return air-way, and in which there is not likely to be any accumulation of inflammable gas; and no electric re-lighting apparatus shall be used in any other place. The re-lighting apparatus shall be securely locked so as not to be available for use except by persons authorised by the manager to re-light safety lamps, and who shall examine all safety lamps brought for re-lighting before they are re-issued.

2. *Apparatus to be Enclosed in Flame-tight Case.*—All such apparatus shall be enclosed in a flame-tight casing, and shall be provided with a suitable switch or safety plug, so that no sparking can occur except between the terminals provided for the purpose inside the safety lamp.

SECTION XI.—EXEMPTIONS AND MISCELLANEOUS.

1. *Exemption for Existing Installations with Inspector's Leave.*—Notwithstanding anything contained in these rules, any electrical works or apparatus installed or in use before the coming into force of these rules may be continued in use unless an inspector shall otherwise direct or subject to any conditions that he may prescribe.

2. *Exemption from Rules in Special Cases.*—An inspector may by writing, signed by him, dispense with any of the above rules in any case in which the special circumstances appear to him to render such exemption necessary or desirable.

3. *Sec. 42 of Coal Mines Regulation Act and Sec. 18 of Metalliferous Mines Regulation Act.*—In case any difference of opinion shall arise between an inspector and an owner as to any requirement or exception under this section, the same shall be settled as provided in sec. 42 of the Coal Mines Regulation Act, 1887, or in sec. 18 of the Metalliferous Mines Regulation Act, 1872.

Royal Society.—Among the Papers down for reading yesterday was one by Prof. J. Walker, F.R.S., on "Theory of Amphoteric Electrolytes," and another by G. C. Simpson on "Atmospherical Radio-activity in High Latitudes," communicated by Prof. A. Schuster, F.R.S.

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AUTOMATIC DEVICES.

We have on former occasions deplored the fact that fashion should often play too prominent a part in engineering. That there must be some effect of this nature is unavoidable. Younger engineers and the profession generally will naturally look to eminent men and leaders in the industry for guidance, and their own ideas, whether consciously or unconsciously, will be moulded to some considerable extent by the views and public pronouncements of these leaders. Moreover, certain habits of thought have also been imported from abroad together with machinery and plant, and the former must of necessity have their influence upon the men who are accustoming themselves to make use of the latter. The result of this should on the whole be beneficial, and it would, in fact, always be so if the correct amount of importance were always attached to each of the ideas which act as impulses from without, and if the proper correcting coefficients are applied in order to assimilate to prevailing conditions that which has been newly acquired. Unfortunately, however, this does not always happen, and there is a danger that a fashion which has initially resulted from particular circumstances may invade territory in which its adoption is not altogether suitable. Of late we have been importing many electrical engineers and much machinery from America, and we have been charmed by several of the ingenious automatic devices that have been evolved in that country, where the saving of unskilled and what may, perhaps, be termed low-skilled labour has always been regarded as a question of first importance. It has been the custom in that country to consider the saving of working expenses in the immediate future to be worth a large increase in initial capital outlay, and the question of ultimate life and renewal of plant has been relegated to the background in the land of "wholesale scrapping." In consequence, there has been in the United States a development of automatic devices far in excess of the requirements of other countries, and this development has been even in some respects in excess of the country's own requirements, for it has been fostered by the natural inventive talents of the Americans.

Every branch of electrical engineering has now been attacked by the craze for automatics, and the fashion has reached a point where a word of warning may not be out of place. In nearly every case we are willing to admit that the principle is right—as right "as rain," we might say, for the analogy conveys much

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in view of the present weather conditions. It is possible, in fact, to have too much of a good thing, whether it be rain, or those automatic devices which are dependent on human agency for their conception. Take, for instance, the application of automatic devices in electrical engineering that has come most to the front lately, viz., the multiple unit traction system. The advantages of distributing the motor cars in the train, instead of employing one single locomotive or motor car to draw it, have long been realised—we believe, even before the name "multiple unit system" was invented. The next step was obviously to devise a means to control the motors on the various cars from one controller in the front car. This, however, in its crude form, would necessitate the employment of several cables conveying heavy currents along the whole length of the train, and, therefore, the equivalent of controllers were placed on all the motor cars, and these were actuated by relays termed "contactors." For working the contactors, a supplementary set of low-power circuits connected to a small master controller had to be added; and in some systems of multiple unit control the method is removed a step further from direct control, by the employment of pneumatic devices for working the controllers, the valves of the pneumatic appliances being opened and shut by means of the supplementary low-power electric circuit. The systems which are already in use apparently work well, but a step further in this long chain of inter-dependent automatic devices—even if it be not so final as the replacement of the motorman in the front car by an automaton or by gear worked automatically from the track—would as likely as not so weaken the whole connection as to cause electric railway engineers to return in a panic to a more primitive system.

Another automatic device, the use of which has recently extended in the United States, is the "remote control" switchboard. In view of the one or two disastrous fires that have occurred in generating stations, the general idea of placing each switch in a separate fire-proof chamber, and working them all electrically or pneumatically from a single keyboard, has much to commend it, especially in view of the large currents or high voltages which are dealt with at the main switches. But here again there is danger if the principle is carried too far. In breaking, on the occurrence of a short circuit, the reading of the ammeter is not so impressive as the appearance of the arc at the circuit-breaker, and many of our tramway engineers would not willingly accept the idea of a circuit-breaker being replaced by the pressure of a button on a keyboard remote from the circuit-breaker itself. Trouble from such a cause could, doubtless, be prevented by the addition of another automatic device as a safeguard, and this points to one of the dangers of automatics, namely that the inventor can never stop, but, in order to render his system perfect, has to devise automatic upon automatic to provide for every contingency. This has, in fact, happened in the case of the telephone switchboard, the latest development of which, although bewildering in its ingenuity, is also bewildering in its complexity. In the new trunk telephone exchange to which we refer, a successful attempt has been made to produce a common-battery luminous signal board, the operating of which is as simple as possible although it has to work in connection with a number of other exchanges with calling and clearing arrangements of various degrees of automatism. The result is the most intricate combination of relays and other devices that we have ever seen in a telephone exchange. So far is the principle carried out, in fact, that we should not have been surprised to find on the switchboard a blue lamp associated with an automatic cut-off device to put a subscriber out of circuit should his language exceed the bounds of parliamentary usage in the event of the failure of one of the existing automatic devices.

To return to traction and lighting switchboards, however, we will not pass too hasty judgment on the "remote-control" board, for we hope soon to hear more of the one which it is proposed to instal at the new generating station of the London County Council tramways. Although, as we have said, several boards of this nature have been employed in the United States, there has been little record of the experience which has accompanied their use over an extended time. The latter part of a Paper by Mr. H. S. MEYER commenced in this issue, describes a new system of voltage regulation by means of an automatic device, but, however excellent this device may be, most engineers in this country will agree that it is unnecessary. A certain amount of automatism is necessary in electricity works and, indeed, in the operation and control of electrical machinery generally, but it is dangerous to follow the dictates of fashion in this direction too far. We will remind our readers of an old saying attributed to Mr. EDISON: "The best automatic device is a nigger."

OBITUARY.

WILLIAM THOMAS ANSELL.

We regret to record the death of Mr. William Thomas Ansell, which took place at Southsea on the 12th inst., in his 82nd year. He was the son of Dr. Ansell, a noted London physician, and was educated at Bruce Castle, Tottenham, and in Paris. Through his mother he inherited extensive sugar estates in Berbice, and the first five years of his business life were devoted to their management.

Mr. Ansell returned to England in 1845, and joined the service of the Electric Telegraph Co. in November of that year, prior to its incorporation in March, 1846, under the auspices of the late John Lewis Ricardo. Mr. Ansell successively held the position of assistant superintendent of the Midland district, manager of the Liverpool office (1849) and of Glasgow for a short time, returning to take the superintendence of the Manchester District (including Liverpool), but left in a few months to organise the Great Western district, then in course of formation. He remained in Bristol till late in 1857, when he was appointed general superintendent of the company. In consequence, however, of impaired health, through the severity of his duties as general superintendent, he obtained leave of absence from 1858 to 1861; but the energy which had characterised his official career was ill-suited to an idle life, and, quickly utilising the opportunity thus afforded him, he accepted temporary service in cable work in the Levant and in Turkey under Messrs. Newall & Co. On his return to England Mr. Ansell was appointed general superintendent and engineer in Ireland for the Electric and International Telegraph Co. with his headquarters at Cork. During the eight years of his stay in Cork he threw himself with characteristic energy into the municipal life of the city, and on retirement from Ireland consequent on the transfer of the telegraphs to the State in 1869 he received illuminated addresses with a service of plate, both from his brother councillors and from the leading inhabitants, headed by Lord Fermoy. Similar testimonials had previously been received by him from the Liverpool and Great Western districts. He entered the service of the Eastern Telegraph Co. in 1870, and remained with them as traffic superintendent until his retirement in January, 1897, when he retired from active service with a pension. It had been his good fortune during his career to be in the vanguard of those employed in extending and organising the telegraphic system, and he was consequently known and esteemed throughout the telegraph world.

In November, 1895, Mr. Ansell completed his 50 years of service in telegraphy, an event which was celebrated by a

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dinner and a presentation in London. He was a Fellow of the Royal Geographical Society, and has been a member of the Council of the Institution of Electrical Engineers. Amongst his other duties in connection with submarine telegraphy he had charge, under the managing director, of the staff department of the Eastern Telegraph Co., and his genial and energetic presence will be long remembered by those who knew him. His loss will be felt by an unusually large circle of friends in all parts of the world. Mr. Ansell leaves a widow, a son in the electrical department of the Eastern Telegraph Co., and two married daughters.

The funeral took place at Southsea on the 16th inst. and was largely attended, the cable companies being officially represented by Mr. J. T. Crowe. Many other former colleagues were also present. The service was conducted by Canon Blake, a friend of the family.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Law Relating to Injuries to Workmen. By F. G. Neave, LL.D. (London: Effingham Wilson.) 1s. 6d. net.

There are few books which fulfil their professed object so well as Dr. Neave's little volume, which is written in a popular, non-technical manner, and is intended for persons without legal training. Part I. is devoted to the Workman's position at Common Law, separate chapters being devoted to the extent of the master's liability for negligence, the development of the doctrine of Common Employment, and the extent and scope of the maxim "Volenti non fit injuria." In the second part, which is divided into seven chapters, a concise and accurate account of the changes introduced by the Employers' Liability Act of 1880 is given. Part III., which deals with the Workmen's Compensation Acts of 1897 and 1900, contains a good synopsis of the scope of the acts, the persons who are entitled to claim, and the persons liable to pay compensation, the amount of compensation payable, &c. The last two chapters deal with procedure and the choice of remedies where the workman may claim under the Employers' Liability Act or the Workmen's Compensation Acts. Dr. Neave has adopted the wise course of stating the facts of cases and giving the principle to be deduced therefrom, which is preferable in popular books to referring his readers to reports of decided cases. Frequently it is a matter of difficulty even for lawyers to deduce the proper principle from and to ascertain the *ratio decidendi* of a case, and no useful purpose is served by referring ordinary laymen to technical reports. As our readers know, the Factory Act of 1901 made various new undertakings factories, including electrical stations (defined as "any premises or that part of any premises in which electrical energy is generated or transformed for the purpose of supply by way of trade or for the lighting of any street, public place, or public building, or of any hotel or any railway, mine, or other industrial undertaking"), and by this indirect method of legislation the scope of the Workmen's Compensation Act, 1897, was extended. Consequently, most of our readers will be interested in a work, which is clear, concise and accurate, and should prove equally useful to employers and employed.

Die Versorgung der Städte mit Elektricität. By Oskar von Miller. Vol. II. (Stüttgart: Arnold Bergsträsse.) 1903. 18m.

In reviewing the first volume of this book nearly seven years ago, we referred to the fact that no really good technical work existed on the design of electricity supply works. The first volume dealt only with a small part of the whole subject, and we looked forward to the early appearance of a second volume to fill a gap that actually existed in technical literature. Since then, however, two English books on the same subject have been published and one German work, so that when the second volume appeared last year the gap which we have alluded to was already filled. The volume may be recommended to the German electrical engineering student, however, and also to the English engineer who desires a general superficial knowledge of Continental central station practice. It is, however, essentially a text-book for students rather than a treatise written for the benefit of engineers. Numerous excellent drawings of electricity works are given, but the reader is not informed which particular electricity works they represent, and the influence of particular local conditions on the various points of design are not dwelt upon sufficiently. The experience gained in working stations with different patterns of plant and different systems is not related; and, in fact, the book is purely descriptive.

Systematic arrangement of the contents has been carried out to such a degree as to make it a fault, and each constituent part of a central station equipment is described by itself, exactly in its proper place, so that the dependency of the modification of design in one part upon a corresponding modification in another part will frequently be lost sight of. We give the following example as a warning to other book-makers:—Chapter VII. is on the internal equipment of stations and sub-stations, and part B of this chapter is on electrical equipment. This section is divided into sections 1 and 2, continuous and alternating-current systems, which in their turn are sub-divided into sub-sections *a*, *b*, *c* and *d*, of which the last is on switchboard arrangement and equipment, sub-sub-section α being arrangement, and sub-sub-section β equipment. Sub-sub-section α is again sub divided into 1st, 2nd, 3rd . . . . 19th case. The 6th case is "Zweileitersystem mit Hauptdynamomaschinen, mit Accumulatoren und Verwendung einer Zusatzmaschine in Serienschaltung," which only means Two-wire system, with battery and series booster; and under yet another sub-heading we find the connections for the booster motor. Under what section, sub-section, sub-sub-section and heading the reader will learn how he may decide the best output and general design for this motor to meet any particular case, we have not sufficient patience to ascertain. Probably these points are omitted. The index is bad, and affords little assistance in these searches. A third volume is promised, although it was stated in Vol. I. that the work would be completed in the second volume.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Emission of N-rays by Ferments.—In connection with the work of Charpentier and Meyer, M. Lambert has inquired whether the soluble ferments, whose action is so important for the functions of most tissues, do not also emit N-rays. The experiments made in this connection gave an affirmative result, especially in the case of the ferments concerned in the digestion of albuminoid matter. Thus, a small morsel of fibrine placed in a tube containing activated pancreatic juice shows an emission of N-rays whose effect disappears shortly after the tube has been removed. A similar effect is produced by placing a piece of fibrine in artificial gastric juice consisting of a 5 per cent. solution of pepsine mixed with a 0·4 per cent. solution of hydrochloric acid. The tube in which the digestion was going on could be picked out of a number of others containing various substances by means of the luminosity it produced on the screen. The author describes a direct photographic verification of this effect, which is of considerable interest. He took two small portions of the same sulphide screen, and after a short exposure to sunlight placed them on two separate photographic plates, with a digestion tube mounted over one of them. On development it was found that the screen exposed to the digestion tube had produced a darker patch on the photographic plate than the other screen. The author believes that the strains undergone by the fibrine in the digestive process bring the phenomenon into line with Blondlot's experiments on N-rays from strained bodies.

[Lambert, *Comptes Rendus*, January 25, 1904.]

Action of a Magnetic Field upon Faintly Luminous Bodies.—C. Gutton has found that the effect produced by N-rays upon a luminescent screen may be imitated by means of a non-uniform magnetic field. If a piece of cardboard provided with several patches of collodion emulsion containing phos phores-

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cent sulphide is shifted along a bar magnet, it is noticed that the patches near the poles are brighter than the patches near the middle of the magnet. To eliminate any possible effect due to N-rays, the author enclosed the magnet in a leaden box but without thereby affecting the result. The action also takes place in a vacuum, for a screen enclosed in a vacuum shows the same effect. If a solenoid is used instead of a magnet, it is noticed that no effect is produced in the centre of the coil, though the field is strongest there, but that the strongest effect is produced where the field is least uniform. No effect is produced between the pole-pieces of a powerful Faraday magnet, but a decided effect may be observed just outside. Generally, the screen shines out when placed in a field whose lines of force are not parallel. The effect is extremely sensitive. The slight modification of the earth's magnetic field produced by a bar of bismuth, a solution of ferric chloride, or a wire traversed by a current of 10 micro-amperes and placed at a distance of 1cm. suffices to produce an increase in the luminosity of the screen. The author announces provisionally that he has thus succeeded in proving the magnetic effect of electric convection. He also states that the non-uniform magnetic field, like the N-rays, produces an increase in the sensitiveness of the human eye. He employed screens of black paper, lead and other substances in order to separate the various effects.

[C. GUTTON, *Comptes Rendus*, February 1, 1904.

Addendum.—In the *Comptes Rendus* of February 8th, M. Gutton describes how he proved the magnetic effect of electric convection by means of Rowland's arrangement and a luminescent screen. M. Bichat proves that the "conduction" of N-rays takes place by their successive reflection at the inner surface of the wire.

Pysiological Action of N-rays and Conducted Rays.—A. Charpentier has discovered two additional effects of N-rays. If a strong source of N-rays is placed about 4cm. behind the top of the skull, and a little above it, not only are faintly luminous objects perceived with greater brightness and detail, but in absolute obscurity a faint luminous cloud is perceived, evidently due to a slight excitement of the visual nerve centre. The effect is distinctly shown when a copper wire is used to "conduct" the rays from the source to a small copper plate placed at the point indicated. The second new effect is objective, and consists in the enlargement of the pupil when the conducting plate is placed over the seventh cervical vertebra. The dilatation observed varies from ½mm. to 1mm. The apparent increase of luminosity previously mentioned is, however, not due to this enlargement of the pupil, as it remains the same if the objects are viewed through pinholes.

[A. CHARPENTIER, *Comptes Rendus*, February 1, 1904.]

Emission of N-rays by Plants.—E. Meyer has found that plants emit N-rays whether they are kept in the dark or are exposed to light, and that there is no difference due to the action of light. He kept plants for five days in the dark, and found that at the end of that time all their parts emitted N-rays. Seeds, sown and germinated in the dark, and in a closed vessel, emit N-rays in the same manner as plants germinated in the ordinary way. Nor is any difference made by sowing the seeds in a leaden box so as to avoid the storage of N-rays coming from without. Thinking that the action of the containing vessel might have something to do with this uniformity in the results, the author floated the germinating seeds on cotton wool in a large vessel full of water, but the screen shone out in the same manner as before.

[E. MEYER, *Comptes Rendus*, February 1, 1904.]

Arc between Metallic Oxides.—J. Stark has found that in certain circumstances an arc is more easily established between metallic oxides than between the metals themselves. He uses a vacuum tube in which the main current passes between the anode and the cathode and produces the ordinary glow phenomena, while the secondary current passes between electrodes at right angles to the primary electrodes, and is extinguished as soon as the main current is interrupted. At a pressure of over 50 volts and a vacuum of less than 0·5mm., the presence of a film of metallic oxide, or of a few fragments of it, facilitates the production of an arc between the secondary electrodes. The author gives the following explanation of this effect. The lines of electric force proceed straight from the anode to the cathode, but if the latter bears a fragment of metallic oxide, they curve round it and enter the cathode at some other point. Nevertheless, the positive ions, having acquired a certain amount of momentum, go straight on, and impinge upon the oxide, thus increasing its temperature, and causing it not only to conduct electricity, but to evolve electrons in large quantities. Wehnelt has already shown that metallic oxides project more electrons than pure metals at high temperatures, and hence the arc, which requires a liberal supply of electrons, is more easily formed at the oxide than at the pure metal. At atmospheric pressure, the author obtained a small arc between a carbon anode and a cathode of thorium oxide at a pressure of 1,800 volts and with a current of 7 milliamperes. The anode remained quite dark.

[J. STARK, *Physikal. Zeitschr.*, February 1, 1904.]

An Optical Analogy to Hertz's Grating Experiment.—F. Braun has succeeded in producing with ordinary light waves the effect produced by Hertz with a grating of parallel wires, which was found to reflect electric waves vibrating in a plane parallel to the wires while it freely transmitted those waves which vibrated at right angles to the wires. An attempt to discover this effect in the optical sphere had already been made by Du Bois and Rubens, who found a certain amount of polarisation, but a greater transmission of parallel than perpendicular waves. But this is due to the fact that the finest gratings at the disposal of those physicists consisted of wires 0·01mm. thick. The author has succeeded better with wires disintegrated on a glass plate by means of a powerful electrostatic discharge. The disintegrated wire, usually of silver, showed a clear central line where it had lain on the glass. On each side of that there was a narrow band of metal. Outside that again, there were fine metallic needles in the form of very pointed isosceles triangles. Outside those, there was a zone of finely-divided metallic dust. On the border between the needles and the dust, the author discovered portions where light vibrating across the plane of the needles was transmitted more freely than light vibrating parallel to the needles. The author hopes to render the phenomenon more amenable to quantitative measurement by destroying a set of thin plates of a complex organic compound of gold in such a manner that only the gold remains. That ought to give a very fine and regular grating, which might be studied by means of Siedentopf and Szigmondy's ultra-microscopic method.

[F. BRAUN, *Sitzungsber. Akad. Wiss.*, Berlin, January 21, 1904.]

THE DISTRIBUTION OF ELECTRICITY IN SHIPYARDS AND ENGINE WORKS.*

BY J. A. ANDERSON.

The first consideration in designing a distribution system for an engine works and shipyard is the choice of system to be adopted (1) for power, (2) for lighting. Some engineers advocate three-phase and others direct current throughout. The writer is, however, strongly of opinion that a combination of the two systems—namely, three-phase for power and direct-current three-wire for lighting—(and, in special cases, power)—possesses the greatest advantage. This arrangement admits of a large momentary demand on the power side, and three-phase motors of 10 H.P. and under can be started up directly off the mains. The voltage drop does not appreciably affect the speed of the motor-generators for the direct-current supply, so that the lighting is unaffected. As most of my data is in connection with three-phase motors, a short description of the two types in general use, with their respective advantages and disadvantages may not be amiss:—

1. Those with a squirrel-cage or short-circuited rotor, started by means of a compensator which reduces the voltage at the terminals of the motor, the transformer portion being cut out by means of a throw-over switch when the motor has attained maximum speed. Arrangements may be made by which fuses, calculated for the normal motor current, are cut into the motor circuit by the action of the throw-over switch. At starting, the

* Abstract of a Paper read before the Newcastle Local Section of the Institution of Electrical Engineers on Monday.

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motor is protected by fuses, which let a considerable current pass, but when the motor has obtained maximum speed and the switch is thrown over, the lighter fuses are inserted in series with the heavier ones. The switch may be constructed to break the circuit in oil. Compensators usually have three separate sets of connections, designed, as a rule, to give 80, 60 and 40 per cent. of the line voltage.

2. The slip-ring motor is from 10 (for the larger sizes) to 20 per cent. dearer than the squirrel-cage motor, and the latter type is a little more efficient and less complicated, but takes a large starting current.

For ordinary use, therefore, the squirrel-cage motor is the better, although it has to be very heavily fused if started up against a load, as is necessary in many cases in shipyards. It requires, however, much less attention, and the wiring is not so complicated and expensive. The last reason is sufficient to debar slip-ring motors for use on such machines as punches, shears and beam benders, where the starting gear has sometimes to be placed at a considerable distance from the motor. For such machines as winches and cranes, the slip-ring motor is the only one which will prove satisfactory. The Newcastle Electric Supply Co. have now out on hire over 40 3-ton shipyard winches driven by 10 H.P. motors of the slip-ring type, and they are entirely successful from every point of view, especially from the point of view of economy.

A winch was tried fitted with a 10 H.P. squirrel-cage motor, but it could only lift about 15 cwt. unless started with a slack rope, even when switching the motor direct on to the mains.

Most of the machines in a shipyard should be separately driven. They have, as a rule, to be spaced far apart, which would increase the amount of shafting required to drive them in groups, and they have also to work very intermittently.

The following figures taken from a shipyard shed, and until last January driven by a 50-N.H.P. Crossley gas-engine through a friction clutch, illustrate the amount of power wasted in driving shafting. Most of the shafting has been done away with and squirrel-cage motors installed, with very beneficial results.

Gas Engine.

Period of Test, February 16 to July 16, 1902.

Total gas consumption = 1,380,500 cubic ft. at 2s. 6d. per 1,000, less 20 per cent. =	£138	1	0
Man in attendance	48	0	0
Water	4	11	0
Oil and stores	5	0	0
Total	£195	12	0

The average daily gas consumption was about 8,320 cubic ft., and the average indicated horse-power about 62. Of this the indicated horse-power required to drive the main and countershafting was about 40. The attendance expenses above do not include cleaning and repairs beyond the ordinary cleaning and oiling allowance daily.

Three-phase Motors.

Period of Test, February 16 to July 16, 1903.	Motors.	H.P.
Six punching and shearing machines, with a 7½ H.P. motor on each	6	45
One 27ft. by 1¼in. plate rolls	1	30
One scarfing machine and plate-edge planer	1	10
One scarfing machine and plate-edge planer	1	10
One 6ft. 6in. by 1in. straightening roll, two counter-sinks, and one grindstone	1	10
Two counter-sinking machines	1	5
Total	11	110

Units consumed = 32,916 at $1\frac{1}{16}$d. = £145. 14s.

In this case no man was required, the starting and stopping being done by the machine man, so that the saving effected equals £49. 18s. per half-year. The maintenance and other charges on the extra capital is more than counterbalanced by the upkeep on the shafting and belts and overhauling the gas-engine, not previously taken into account. The system of driving is such that practically all machines are stopped when not required to work, the saving being wholly effected by this. On a full day's work the costs of running as taken above are about the same for both systems.

Punching and shearing machines can best be driven by belt from the roof principals or from the top of the machine itself, although this latter position sometimes gives too short a drive. Quadruple punching and shearing machines with an overhead jib crane can only be driven with the motor underground; the use of a guide pulley is also necessary, making a very unsatisfactory drive. Driving such machines by gearing throws very heavy stresses on the motor, which are more or less avoided by using a belt. Belting is also, more often than not, much cheaper.

In one case plate rolls are driven by a 40 H P. slip-ring motor with heavy resistances in the rotor circuit for speed regulation. The motor is geared to the rolls and reversed by the controller. When the rolls are under way the reversing current is very excessive; for this reason the fuses have practically to be short-circuited A foot-brake has been tried to stop the machine before reversing, so as to reduce the rush of current, but it has not been successful. In a boiler shop the plate rolls are driven by a similar motor, but by means of a countershaft and crossed belts for reversing purposes. This arrangement, where possible, is to be preferred, as it saves the momentum in the rotor, and there are no heavy spur wheels to reverse. Although speed regulation of the motor is, perhaps, more satisfactory, it has been found to be practically unnecessary, as the operator can get what regulation is required by allowing the crossed and open belts to slip, but I do not think that the advantage is worth the extra expense incurred by using this type of motor. In another shipyard the rolls are driven by a 30 H.P. squirrel-cage motor by means of a countershaft with crossed and open belts. Although the rolls are lighter than the rolls previously mentioned, they do the same class of work, and are, on the whole, more satisfactorily driven. In engine works, where sometimes direct-current motors are essential, separate mains should be run from the sub-station, but these motors should be as few as possible, and connected across the outers of a three-wire system. They are claimed to be of most benefit when driving variable-speed machines, such as lathes, drilling machines and boring mills, as they do away with belting. This is not altogether an advantage, for, as is well known, the belt forms an elastic coupling between the motor and its load, and thus, if a sudden stress comes on the machine, the belt slips, and may save the motor and gearing from injury.

In engine works the current consumption is not much reduced by separate driving, for, as a rule, the machines are all running simultaneously, and not intermittently as in a shipyard. On the other hand, a great advantage is gained by being able to space the machines independently of the shafting, but as this benefit is greatest for large machines, separate motors for machines requiring 5 H.P. and over, and driving all the others from shafting, would seem a good arrangement. Among the former, one or two lathes might be driven by direct-current motors when a constant speed regulation is a great advantage, but other variable-speed machines, such as boring mills and drilling machines, when the amount of work done at one speed is considerable, might just as well be driven by three-phase motors with belts and stepped cone pulleys.

In reconstructed shops, where some other motive power has been displaced, it is best to cut up the shafting into sections according to the nature of the shop, and at the same time do away with as much belting and shafting as is justified by the cost.

Some engineers advocate the use of three three-phase slip-ring motor cranes where three-phase current only is obtainable, but the high efficiency gained by the three direct-current motor crane is no longer obtainable, due to the inefficiency of the motors when running with a heavy resistance in the rotor circuit, and at the same time the connections are more complicated, and the system necessitates the use of 10 trolley wires between the crane girders.

The following figures taken from a few of the three-phase motors connected to the Newcastle Electric Supply Co.'s system will, I think, help to support some of my remarks and suggestions:—

5 h.p. Squirrel cage Motor, 800 revs., driving two countersinking machines by belt and countershaft.

	Kw.	Remarks.
Shaft and countersinks running light	2·7	—
One head countersinking ⅜in. holes in ⅝in. plate	2·8	Minimum.
Do. do. do.	4·8	Maximum.
Two heads do. do.	2·8	Minimum.
Do. do. do.	7·4	Maximum.

7½ h.p. Squirrel-cage Motor, 800 revs., driving punch and shear by belt on flywheel. 27 punches per minute.

	Kw.	Remarks.
Running machine light	3·1	—
Punching ⅜in. holes in ⅜in. plate	3·8	Minimum.
Do. do.	5·4	Maximum.
Shearing ½in. plate	7·4	—
Do.	8·8	Average.
Do.	9·4	—
Shearing ⅜in. plate 21ft. long	5·4	—
Do. do.	8·0	Average.
Do. do.	11·0	Operation took 1min. 20sec.
Shearing ⅜in. plate 21ft. long, cut about 3in. wide.	5·6	—
Do. do.	9·0	Operation took 1min. 10sec.

In shearing, the load varies with the width of cut as well as the thickness. Some figures taken from another machine, shearing 1in. plate, 2in. to 3in. width of cut, show a 7½ H.P. motor taking from 6kw. to 12kw.

7½ h.p. Squirrel-cage Motor, 800 revs., driving mast rolls by countershaft and open and crossed belts.

	Kw.
Countershafting and loose pulleys	2·8
Rolls running light	3·3
Rolling ⅝in. plate to half circle	4 to 7
Do. do.	

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7½ h.p. Squirrel-cage Motor, 800 revs., driving a double-headed boiler-shell drilling machine by belt and countershaft.

	Kw.	Remarks.
Drills running light	2·6	—
Drilling one 1 5/8in. hole in boiler shell	3·5	—
Do. do.	3·8	—
Drilling two 1 5/8in. holes in boiler shell	4·5	—
Do. do.	5·0	—
Drilling one 1¾in. hole in 1½in. plate	4·5	Sharp drill.
Do, do.	4·7	Operation took 1min. 40sec.
Drilling one 1¾in. hole in 1 7/8in. plate	4·6	Blunt drill.
Do. do.	5·0	Operation took 2min. 5sec.
Drilling two 1¾in. holes in 1½in. plate	6·7	Sharp drill.
Do. do.	7·7	

7½ h.p. Squirrel-cage Motor, 800 revs. driving brick crusher.

	Kw.
Crusher running light	2·8
Crushing bricks	3
Do.	6
Do.	8

7½ h.p. Squirrel-cage Motor, 800 revs., driving a Buck and Hickman mortar mill with a revolving pan, 7ft. diameter, 16 revs. per min., by countershaft and loose pulley.

	Kw.
Countershaft and loose pulley	2·4
Running mill with pan empty	4·4
Mixing with pan full	7·6
Do. do. 5 minutes after	6·8
Do. do. 15 do.	6·4
Do. do. 24 do.	6·4

7½ h.p. Squirrel-Cage Motor, 800 revs., driving Koppel concrete mixer by countershaft and loose pulley.

	Kw.
Running on loose pulley	2·1
Machine running empty	2·6
Hoisting tub filled with ballast and cement	5·2
Mixing with cylinder charged	3·8
Do. do.	4·0
Do. do.	4·4

10 h.p. Squirrel-Cage Motor, 800 revs., driving two headed scarfing machine and a plate-edge planing machine by belt driving a countershaft with loose pulleys, crossed and open belts.

	Kw.	Remarks.
Countershaft and loose pulleys	4·7	—
One-head scarfing cut ⅜in. to ¼in. by 9in. long	5·2	Minimum.
Do. do. do.	7·8	Maximum.
Planing ⅜in. plate 20ft. long	9·2	—
Do. do.	13·0	Average.
Do. do.	16·0	—
Planing ⅜in. plate 20ft. long and scarfing ⅜in. plate	10·0	—
Do. do. do.	13·0	—
Do. do. do.	16·0	—
Do. do. do.	18·0	Maximum for five seconds.

The above motor, although very often considerably overloaded, runs very satisfactorily and does not get too hot.

10 h.p. Slip ring Motor, 800 revs., driving angle-iron planer by worm, worm-wheel, and gearing. Speed controlled and rotation reversed by controller.

	Kw.
Planing 10in. channel iron cut ⅜in. × 1/8in.	3·8
Do. do. do.	4·8
Do. do. do.	5·8
Do. do. do.	6·6
Planing 4in. angle-iron cut 7/16 × 1/8 to ⅜in.	6·0
Do. do. do.	6·8
Do. do. do.	7·0
Do. do. do.	8·0

10 h.p. Squirrel-cage Motor, 800 revs., driving quadruple punching and shearing machine by belt motor underground.

	Kw.
Machine running light	2·4
Shearing ⅜in. steel plate	12
Do. do.	13·2
Shearing ½in. steel plate	13·2
Do. do.	14·4
Punching ⅜in. holes in above ⅜in. plate	13·2
Do. do. do.	14·4
Punching 4in. holes in above ⅜in. plate, ⅜in. holes previously punched round the circumference	10·8
Punching 4in. holes in above ½in. plate, ⅜in. holes previously punched round the circumference	12

All the above readings were taken with the belt slipping very badly. Belt dressing was put on, and the following readings taken :—

	Kw.
Shearing ½in. steel plate as above	14·0
Do. do.	16·0
Punching 4in. holes in ½in. steel plate as previously	16·0
Do. do. do.	18·0
Do. do. do.	20·8*

* Motor slowed up.

This machine had very light flywheels, and the steel plates were, for some special purpose, not often required in ordinary shipyard use. The plate was fed in as fast as possible for the purpose of taking the test.

10 h.p. Squirrel-cage Motor, 800 revs., driving four small planing machines, three small shaping machines, three slotting machines and two screwing lathes by 95ft. of 3in. shafting running at 175 revs. per min., and driving six countershafts.

	Kw.	Remarks.
Shafting and belt running light	4·8	—
Ordinary working	5·6	Readings taken at various dates.
Do.	6·6	—
Do.	8·0	—
Do.	9 0	—
Do.	10·0	Average.
Do.	12·2	—
Do.	14·4	Occasionally.

10 h.p. Squirrel-cage Motor, 800 revs., driving 6 cwt. Pilkington hammer and a fan for two smiths' fires.

	Kw.
Shafting, fan, and loose pulley on hammer	3·6
Hammer cushioning	8·0
Hammer working	11·0
Do. do.	13·0

15 h.p. Squirrel-cage Motor, 600 revs., driving mangles, scarfing machine, and operating gear for lifting large rolls by shafting and belts.

	Kw.
Shafting and loose pulleys	6·4
Scarfing machine cutting light	8·0
Do. do.	9·4
Mangling ⅜in. plate	12·0
Do.	14·0
Do.	16·0
Reversing with plate in time 6 sec.	30·0
Heaving large rolls	15·0
Scarfing, mangling, and heaving rolls simultaneously	21·0

During this last operation the belt came off, and the motor was being lifted off its bed. The motor was then replaced by a 20 H.P., and is working satisfactorily, but I consider it would be worth installing separate motors for each machine—5 H.P. for scarfing and 10 H.P. on each of the other machines.

15 h.p. Squirrel-cage Motor, 800 revs., driving a manhole punch by gearing.

	Kw.
Machine running light	3·2
Punching 24in. by 18in. manholes in 5/16in. plate	19·6
Do. do. do.	21·2
Do. do. do.	22·4

This machine punches heavier plates satisfactorily, although I have not had the opportunity of taking observations when doing so. The time taken for each operation was about 5 seconds.

30 h.p. Squirrel-cage Motor, 480 revs., driving 27ft. by 1¼in. plate rolls by belt on to countershaft with crossed and open belts.

	Kw.	Remarks.
Rolls running light	11·4	—
Lifting top roll	14·4	—
Lowering top roll	11·6	—
Rolling ⅜in. plate	12·8	—
Do.	14·4	—
Do.	40·0	Momentary.
Straightening ⅜in. plate	13·4	—

I have not had the opportunity of getting readings from this machine when rolling 1¼in. plate, but the 30 H.P. motor has proved adequate. With bending and straightening rolls the amount of load is almost entirely in the hands of the operator, and is to a great extent independent of the size of plate.

30 h.p. Slip-ring Motor, driving joggling machine by gearing with the speed varied and rotation reversed by a controller with heavy resistances in the rotor circuit.

	Kw.
Joggler running light	4·0
Joggling ½in. plate at 5ft. 9in. per minute	5·2
Do. do. do.	5·6
Do. 1/16in. do.	7·6
Do. do. do.	8·4
Do. do. do.	10·0
Do. 1/16in. do.	11·0
Do. do. do.	12·0
Do. do. do.	14·0

As will be seen from the above figures, a much smaller motor would be sufficient. I should say a 20 H.P. motor would be large enough to joggle plates up to 1in. thick at the above speed.

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30 h.p. Motor, 480 revs., driving one large horizontal boring mill, one large vertical boring mill, one 10ft. chuck lathe, one 30ft. shaft lathe, 14 lathes (various sizes), and two drilling machines by 160ft. of 3½in. and 70ft. of 2¾in. shaft at 150 revs. per min., with countershaft for each machine.

	Kw.	Remarks.
Large chuck lathe cutting light	17·0	All others off.
30ft. shaft lathe running light, chuck lathe cutting light, and vertical boring mill cutting out propeller boss	20·0	Ordinary working.
Chuck lathe cutting light, 30ft. shaft lathe cutting off centres, vertical boring mill cutting our crank webs	21·0	do.
Do. do. do.	24·0	do.
Do. do. do.	25·0	do.
Do. do. do.	26·0	do.
Do. do. do.	30·0	do.
All machines working except a few small lathes and horizontal boring mill. Large vertical boring mill drilling 5½in. hole in a shaft coupling	26·0	do.
Do. do. do.	28·0	do.
Do. do. do.	31·2	do.
Same as above only with large drill off	20·0	do.
Do. do.	22·0	do.
Do. do.	23·2	do.

A short discussion on the Paper took place:

Mr. RALPH agreed that the use of open and cross belts was the most flexible arrangement of coupling when a considerable amount of reversing was required, and suggested the use of a flywheel on the armature shaft when driving heavy rolls and shearing machines.

Mr. HOLMES thought reversing rolls with open and cross belts to be undoubtedly the proper practice. Friction driving might be used with advantage in special cases.

Mr. W. HEAD said that continuous-current machines were far more adaptable as regards variable speed, and shipyards might well consider the putting down of rotary converters and continuous-current motors for reasons of adaptability.

Mr. RISELEY drew attention to the North-Eastern Marine Engineering Co. of Wallsend, who had had continuous-current machines working in their shops for three years, but who, in their new works at Sunderland, had decided to put in three-phase motors as being superior to the continuous-current type.

Mr. J. McFALE said that in the Burnley Iron Works each machine was separately fitted with an independent continuous-current motor and that these had been working very satisfactorily for 2½ years.

Mr. G. STONEY was surprised that Mr. Anderson advised three-phase motors for cranes, as he had had trouble with them.

The discussion will be continued at the next meeting of the Local Section.

THE BATH TRAMWAYS.

In the following will be found some particulars, supplementary to the data given in *The Electrician* of January 1st and 8th, of the Bath electric tramways, which were opened to the public on January 2nd, and were "officially" inaugurated last Saturday.

The lines, in length equivalent to nearly 16 miles of single track, with another mile authorised, have been built by the Bath Electric Tramways Co. under a light railway order, an agreement having been entered into with the Corporation. Messrs. G. Hopkins & Son, Messrs. Harper Bros. & Co. and Mr. R. D. McCarter acted as consulting engineers to the company. The main contract for the tramways was awarded to Mr. C. Chadwell, who sub-let various portions of the work. To the British Westinghouse Co. was entrusted the erection and equipment of the generating station, this task being completed in less than 7½ months. From Southgate-street, in the centre of the city, four routes radiate, terminating in Bathford, Combe Down, Weston and Tiverton respectively. From the last-named place a short branch traverses the Oldfield Park district.

The boiler house, engine house and car shed are situated in Walcot-street, on the bank of the River Avon. Much of the site is on made ground, in consequence of which the engine foundations had to be carried down nearly 30ft. Boiler house and engine house are both 93ft. long, the former being 49ft. wide, the latter 51ft. wide. The car shed is 130ft. long and 82ft. wide. Over the street end of the car shed are various rooms for offices, &c., while a large basement at the rear end is used as a repair shop. Eight tracks run the full length of the shed, an inspection and repair pit, 30ft. long, being built in each. The engine room walls are lined with glazed bricks to a height of 10ft., and the roof trusses and purlins are of steel. A layer of concrete, finished off with cement, constitutes the engine-room floor. A sheet steel chimney, lined with brick to a height of 60ft., and 140ft. high, with a diameter of 13ft. 6in. at its base, produces the necessary draught. It is fitted with a permanent ladder, and, although self-supporting, as an extra precaution it is held down by bolts to its bed of concrete and brickwork.

Steam at 160lb. per square inch is produced by three Babcock and Wilcox boilers, each possessing a heating surface of 3,140 sq. ft., and capable of evaporating normally 11,000lb. of water per hour. The water tubes are 4in. in diameter, 18ft. long, and are arranged in four sections of 10. Each boiler has a grate area of 59½ sq. ft., and is also supplied with a superheater having a heating surface of 339 sq. ft., sufficient, it is stated, for superheating the steam by 100° to 120°F. After erection, boilers and superheaters were tested to 240lb. per square inch. The superheater consists of 48 solid drawn steel tubes, 1½in. in diameter, and is provided with suitable piping and cocks for flooding it when necessary. A Clay-cross type of economiser, consisting of 240 9ft. tubes, serves for heating the feed water, which is taken either from the river or from the town mains, and is fed into the boiler by one steam pump and one electrically-driven pump. The former, by Messrs. J. P. Hall & Son, is of their vertical slow-speed type, and capable of delivering to the boilers from 30 to 45 gallons of water per minute, with steam at a pressure of 150lb. per square inch, and superheated by 100°F. At full, three-quarter and half load the guaranteed delivery of water per pound of steam is 72lb., 66lb. and 59lb. respectively. When running at 40 revs. per min. the electrically-driven Blake and Knowles pump, with cylinders 5in. in diameter and a stroke of 6in., delivers 45 gallons per minute against the boiler pressure. At full, three-quarter and half load the driving motor absorbs 8·5 H.P., 7 H.P. and 5 H.P. respectively. There are also two make-up pumps by Blake and Knowles, each of a capacity of 300 gallons per hour. Two surface condensers, capable of dealing continuously with 28,000lb. of exhaust steam per hour and 35,000lb. for one hour, have been supplied by the Wheeler Condenser and Engineering Co. They have a combined cooling surface of 2,820 sq. ft., and the brass tubes, ¾in. in diameter and 18 B.W.G. thick, are seamless-drawn and tinned inside and out. Two Wheeler combined air and circulating pumps are installed, the steam cylinder being 12in. and the air and circulating cylinders 14in. in diameter. The condensed water cylinder is 3½in. in diameter, the common stroke being 12in. A Holly steam loop is used for draining the pipe system. Messrs. Masson, Scott & Co., supplied the water softener, capable of dealing with 300 gallons of water per hour, and the purifier, of a capacity of 1,250 gallons per hour. An analysis of the water to be dealt with is given below:—

Carbonate of lime	15·04
Sodium chloride	2·89
Sulphate of lime	2·33
Sulphate of magnesia	1·72
Silica, oxide of iron and alumina	0·55
Magnesium chloride.....	0·47
Total	23·00

While the main live steam piping is 12in. in diameter and the branches 6in. with 3in. pipes to the pumps, the main exhaust piping is 16in. in diameter, with branches 11in. in diameter to the engines. In the main exhaust pipe is inserted a Holden and Brooke grease extractor, capable of dealing with 1,500 gallons of condensed water per hour. An automatic relief valve is fitted, and for the purpose of exhausting to the atmosphere, a galvanised iron pipe, 14in. in diameter, leads up through the boiler-house roof. Coal is carried straight from the railway trucks to the 50-ton storage bins by screw conveyors. From here to the front of each boiler fire-grate the coal is transmitted by a spiral coal conveyor, capable of transporting 10 tons per hour when running at 30 revs. per min. The trough is 14in. in diameter with coal outlets 9in. square.

Three Yates and Thom 320 H.P. horizontal, tandem, single-crank, compound, condensing engines, with cylinders 15in. and 30in. in diameter and a stroke of 36in., are directly coupled to 200kw. Westinghouse compound-wound generators. The Corliss valves are worked by trip gear of the Dobson pattern (for a detailed description and illustration see *The Electrician*, Vol. XLIX., p. 430). A sensitive knock-off appliance is fitted to the governor, the purpose of which is to cut off the steam to the cylinders if the engine should from any cause gain excessively in speed. The engine crankshaft is of mild forged Siemens steel, 16in. in diameter at the flywheel and 14in. at the bearings. Each engine is provided with an 18-ton flywheel, 16ft. in diameter. With steam superheated by 100°F., the steam consumption at full, three-quarter and half load is stated not to exceed 15¼lb., 15¾lb. and 17lb. per horse-power-hour respectively. When running at 100 revs. per min., these 200kw. sets, which are used for traction purposes, generate current at 500 volts at no load and 550 volts at full load. At full, three-quarter, half and quarter load the efficiencies of the generators are stated to be 93, 92·5, 91·5 and 88 per cent. respectively. A small 75kw. set acts as an auxiliary on the traction load, and supplies current for lighting the station, car shed and offices. It consists of a vertical two-cylinder single-acting compound engine, directly coupled to a 75kw. four-pole generator. When running at 300 revs. per min. this set generates current at the same pressure as the larger sets. At full, three-quarter, half and quarter load the guaranteed efficiencies are 91, 90, 89 and 86 per cent. respectively. Two 15kw. boosters are provided, consisting of four-pole dynamos running at 575 revs. per min., the motor voltage being 500 volts, and that of the generator 50 volts. The main switchboard, of the standard British Westinghouse traction

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type, consists of 13 white marble panels, 2in. thick and set in an angle-iron frame.

Concrete, mixed in the proportion of 6 to 1, forms the bedding (6in. thick) of the track. The rails are used in lengths of 45ft., and weigh 95lbs. per yard, the width and depth of the groove being 1¼in. and 1in. respectively. In the specification for the rails it was stipulated that neither the quantity of sulphur nor that of the phosphorus was to exceed 0·08 per cent., that the sulphur, phosphorus and silicon together should not exceed 0·18 per cent., and also that the amount of manganese should not exceed 1 per cent. Some 300yds. of double track, in front of the hospital in Lower Boro Walls, are laid on longitudinal sleepers 8in. by 4in. in section. Every 33ft. the rails are cross-bonded. The points are 8ft. 6in. long, and are chiefly of manganese steel. Wood paving is laid between the tracks in the centre of the city, and granite setts and macadam with granite paving in the outlying portions.

As a rule, the overhead line is supported by brackets (varying in length from 6ft. to 8ft.) from side poles, but in some parts of the city span wires are stretched across the roads by means of rosettes attached to the fronts of the houses. The overhead wire is of hard-drawn copper (0·364in. in diameter), and the guard wires of galvanised steel are earthed through the poles, every third one of which (in the guard wire sections) is bonded to the rails. On an average the sections are ½ mile long, some of the section boxes containing feeder pillars, and one of them a Board of Trade panel. These boxes were supplied by the British Thomson-Houston Co.

About 7¾ miles of paper-insulated and lead-covered cables, laid partly on the solid system and partly in porcelain ducts, distribute energy to the various points. About 270yds. have a cross-section of 0·2 sq. in., 4,700yds. of 0·25 sq. in., and 6,700yds. of 0·3 sq. in. There are altogether 1,760yds. of return cables, their section being 0·6 sq. in. About 6,700yds. of three-core, four-core, six-core and seven-core 7/22 pilot wires and some 8¼ miles of overhead telephone and test wires complete the cable equipment.

Of the 30 cars that are so far running, 26 are of the double-deck type, the others being single-deck combination cars. There is also one watering car. Both the double-deckers, measuring 27ft. overall, and the single-deckers, measuring 28ft. overall, are carried on Milnes trucks of the four-wheel type, the wheel base being 6ft. A Milnes type of life-guard is fitted to each car. The trolleys have swivel heads and graphite brushes. Each car is equipped with two 30 H.P. motors and with Newell magnetic track brakes.

The chief contractor was Mr. Charles Chadwell, who undertook the construction and erection of the track, the overhead work and the system of feeder cables, and the chief sub-contractors were :—For the erection and equipment of the generating station, car shed, office buildings and cars, The British Westinghouse Co. ; for the piping in the boiler and engine houses, the Sir Hiram Maxim Electrical and Engineering Co. ; for the coal conveying plant, the Conveyor and Elevator Co. ; for the overhead travelling crane in the engine room, Messrs. Stothert and Pitt ; for the cables, the British Insulated and Helsby Cables (Ltd.). Mr. R. D. McCarter superintended the erection and equipment of the generating station, &c., and, after completion, took over the general management for the tramways company.

VOLTAGE REGULATION IN ALTERNATING-CURRENT SYSTEMS.*

BY H. S. MEYER.

It is intended to give in the following Paper a general review of some of the most important points connected with the subject of voltage regulation in alternating-current systems, without, however, entering upon a detailed consideration of the theoretical side.

(A) Inherent Regulation of Generators.

1. *Method of Specifying Regulation.*

In common with the custom on the Continent and in America, the inherent regulation should be standardised as referring to the percentage increase in the terminal voltage when full load is taken off the machine, the excitation remaining unaltered, and due allowance being made for variations in speed as caused by the engine regulation. The second method of specifying the inherent regulation, which one finds often used by consulting engineers in this country, refers to the percentage fall in voltage upon throwing on full load, keeping speed and no-load excitation constant. This, as will be shown later (see Table II.), leads to entirely different figures, and should be abandoned so as to conform with the practice of the rest of the world.

* Abstract of a Paper read before the Liverpool Engineering Society on January 20th.

2. *Influence of the Regulation on the Design of Alternators.*

Broadly speaking, the economy of an alternator design for a given frequency and speed is governed by two laws :—

(1) The output is directly proportional to the armature ampere-turns times the magnetic flux, or, in other words, the output of a given carcass, assuming equal specific use of the materials, can be increased directly as the increase in armature ampere-turns.

(2) The cost of a design varies almost as the square of the variation in the air-gap diameter. Therefore, this should be just big enough to accommodate the poles and the exciting winding, giving at the same time due consideration to the question of ventilation, and to the mechanical difficulties introduced by an excessive width of the machine.

Against these requirements for minimum cost and maximum efficiency, one had to consider those determining the regulation of a machine. These may be expressed as follows :—

1. The ratio of $\frac{\text{field ampere-turns}}{\text{armature ampere-turns}}$ should be large.
2. The self-induction and ohmic drop of the armature should be low.
3. The magnetic leakage between poles should be small.
4. The magnetic densities in the poles should be high.
5. The flux distribution should be such as to produce a sine wave.

1. To satisfy the first point, which has the most decisive bearing on the quality of the regulation, it is necessary either to choose a small number of armature ampere-turns, or a large number of field ampere-turns. The former conflicts with the first law, since by reducing the turns on the armature the flux has to be increased so as to obtain the desired output ; but to carry the larger flux, the material—both iron and copper—must also be increased, the latter due to the longer mean length of turn in stator and rotor. An increase in field ampere-turns will be against the second law, as it will always mean an increase in the diameter of the revolving field so as to gain the necessary room for the increased field copper. In actual practice, the designer will have to compromise between both these possibilities whenever a close regulation is required. Here it may be of interest to mention the case of alternators direct connected to steam turbines, where the diameter of the rotating field is once for all fixed by the allowable peripheral speed, and where the machines for this very reason already obtain a great length. To build such machines economically with a very close regulation is extremely difficult if not impossible.

The number of field ampere-turns is almost entirely dependent on the length of the air-gap, and therefore a long air-gap is essential for close regulating machines. An illustration of these points is given in Table III.

2. While a reduced number of armature or back ampere-turns will improve the regulation by weakening the magnetic field of the armature, which tends to counteract the efforts of the main field, a low armature self-induction will further help in this direction by reducing the inductive drop due to the alternating currents flowing in the armature conductors. To obtain a low armature self-induction, the winding has to be properly subdivided and so arranged that at the same time the effect of the end connections is minimised, which is of importance, particularly in machines having a large pole pitch and a small width. However, in modern alternators the influence of self-induction on the regulation is only about one-fourth to one-fifth as large as the influence of the back ampere-turns.

The ohmic drop in modern designs is usually small, due to the heating requirements of the machine lying between ¼ and 1½ per cent. of the output, and it would hardly be economical to try to improve the regulation by a further reduction of this quantity.

3. The leakage between poles should be as small as possible. To obtain this condition, one has to choose short poles, a large pole pitch and the pole arc in maximum 66 per cent. of the pitch—although these requirements lead to a larger diameter and consequently to a more expensive design. The leakage coefficient is further governed by the length of the air-gap, and the iron densities in the machine, and increases with the load in about the same proportion as the excitation. The following table gives some average values for the leakage coefficient at no load in dependence on the diameter per pole for normal machines designed for about 7 per cent. full non-inductive regulation and moderately saturated :—

Table I.

Diameter per pole ..	2	3	4	5	6	7	8 in.
Leakage coefficient..	1·4	1·35	1·3	1·26	1·22	1·18	1·16

4. The magnetic densities in the poles should be high, so as to introduce a saturated part in the magnetic path, which will limit the rise in voltage when the load is taken off the machine. Densities of 110,000 to 115,000 lines per square inch are here quite allowable, provided the designer knows exactly the leakage coefficient of his machine and the quality of his material ; but even then it is dangerous for machines which have to work on a low-power factor, since the leakage factor and its change with the load introduces an uncertain quantity, and a small error in this direction may bring

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one to a part of the saturation curve where a small change in the voltage corresponds to an enormous increase in the excitation; or, in other words, to keep in such cases the terminal voltage at its normal value when working at a low power-factor would require an excessive exciting current, and thereby causes dangerous heating of the field winding.

For the above reason it is advisable to differentiate between machines which are intended to work on unity power-factor, or on a power-factor, say, not below 0·90 and those intended to work chiefly on a low power-factor. In the latter case it would be better to use lower densities than mentioned above—although this leads to a more costly design.

5. All parts in the machine should be so proportioned that the resultant wave shape of E.M.F. and current resembles as closely as possible a sine wave. While this is desirable from a general point of view, it will also be favourable towards regulation, since an inductive circuit will have less harmful influence than with a complex wave form.

To illustrate more in detail some of the above points, the following figures and tables have been prepared. In Fig. 1 a well-known graphical representation is made use of.

Here OA represents in magnitude and direction the resultant ampere-turns of the field and armature; OF, 90deg. displaced from this, represents the direction of the induced E.M.F., whilst the magnitude is represented by the saturation curve. OD and OE represents in direction the generator current on 100 and 80 per cent. power-factor respectively. The magnetising force of these currents is in phase with them, and, therefore, OD and OE can represent the ampere-turns of the armature both in direction and magnitude. (As a matter of fact, OD and OE are rather larger than the actual value of the ampere-turns to take in the effect of

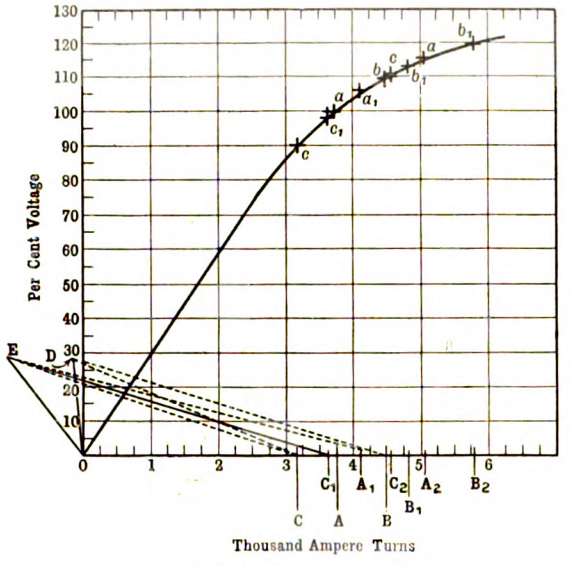

Fig. 1.—Saturation Curve.

% volts.	100% P.F.	80% P.F.
100	$a_1 = 6\%$	$a_2 = 15\%$
110	$b_1 = 3\%$	$b_2 = 7\%$
90	$c_1 = 10\%$	$c_2 = 23\%$

self-induction and ohmic drop of the armature winding; it will also be noticed that OD is not exactly in phase with OF as the self-inductive E.M.F. of the winding tends to throw the terminal voltage slightly behind the induced voltage). The field ampere-turns are represented in magnitude and direction by AD and AE The value of the field ampere-turns must be so large that with any given value and phase of line current the resultant OA is such as to give the required voltage Aa as taken from the saturation curve. This is the condition at any particular load, say full load. If the load is thrown off, the points D and E coincide with O, and consequently, if the field current remains unchanged, the points A will move out to A^1 and A^2 respectively. From the saturation curve we find that the corresponding voltages are A^1a and A^2a^2. It will be seen from the figure that the regulation depends on the ratio of AD to AO; that is, on the ratio of OD or OE to OA, or in other words, on the ratio of the armature ampere-turns to the no-load field ampere-turns, and, further, on the flatness of the saturation curve at normal voltage. In the figure the same construction is shown for points 10 per cent. above and 10 per cent. below normal voltage, so as to illustrate the influence of saturation. The actual values obtained for the regulation are given in Fig. 1, while Table II. gives for the different points the per cent. increase in the excitation necessary to keep the voltage constant from no-load to full load.

Table II.—*Per cent. Increase Excitation from No-load.*

	To full non-induction load.		To full load 80 per cent. P.F.
(A)	10·8	.....	36·5
(B)	7·9	.....	29·2
(C)	14·3	.....	43·5

The saturation curve, as well as the values for the armature reaction, can be pre-determined in normal machines with sufficient accuracy to agree closely with figures obtained in test.

Fig. 2 is intended to illustrate the effect of a load of varying power-factor on the regulation of a machine. Here the analytic method of Mr. Steinmetz has been used for calculating the different characteristics.* Although this method is not quite correct, as it assumes

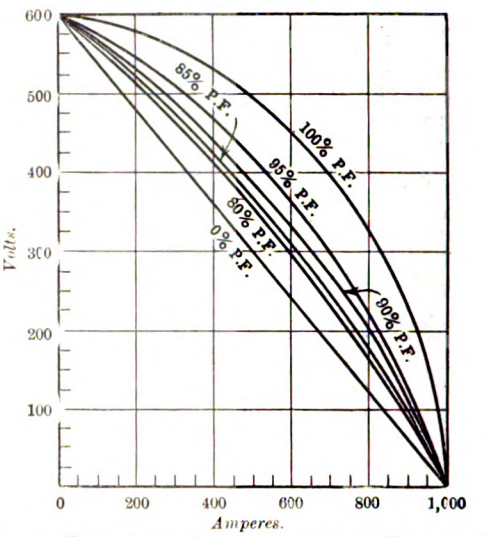

Fig. 2.—Regulation Characteristic for Varying P.F.

$$\epsilon = \frac{E_0\sqrt{R+x}}{\sqrt{(R_0+R)^2+(x_0+x)^2}}; \quad E_0 = 600; \quad R_0 = 0{\cdot}04, \text{ R and } x \text{ variable}; \quad x_0 = 0{\cdot}6$$

constant saturation, it serves well to show what considerable influence a small deviation from unity power-factor will have on the regulation, and how quickly the curves of lower power-factor approach the straight line of zero power-factor.

Fig. 3 shows test results which serve to further illustrate the points brought forth in Fig. 1. Three sets of curves are given, showing the effect of gradually reducing in one case a non-inductive load and the other a highly-inductive load. Curve 2 and curve 2^1

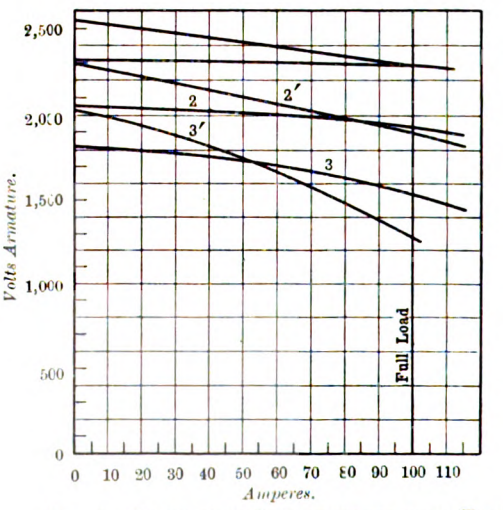

Fig. 3.—Regulation Characteristic from Test.

Per cent. Regulation:—1 = $1\frac{3}{4}$, 2 = $6\frac{3}{4}$, 3 = 16, 1′ = 12, 2′ = 215, 3′ = 565.

show this at normal voltage for non-inductive and inductive conditions respectively. Curves 1 and 1^1 show similar curves for a voltage approximateiy 20 per cent. above the normal, whilst 3 and 3^1 are intended for 20 per cent. below normal, but in the case of 3^1 it was not possible to obtain exactly the condition desired owing to the design of the synchronous motor used for obtaining the inductive load. Therefore this curve corresponds to a voltage of $32\frac{1}{2}$ per cent. below normal.

* Steinmetz, "Alternating Current Phenomena," 3rd edition, p. 302.

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Table III.

Per cent. reg. non-ind. load		Per cent. reg. full and 80 per cent. power-factor.		Amp.-turns field. Amp.-turns arm.	Per cent. weight of field copper.	Per cent. length of gap.	Total amp.-turns—field.	
Rise.	Fall.	Rise.	Fall.				Per cent. gap.	Per cent. iron.
2	2·5	8·0	17·5	6·87	218·1	243·0	95	5
4	5·0	12·5	22·0	4·28	136·1	118·2	89	11
6	8·0	15·0	35·0	3·15	100·0	100·0	83	15
7	11·5	17·0	44·0	2·72	86·5	85·0	85	17
8	13·0	18·0	50·5	2·47	78·6	75·0	82	18
10	19·0	20·0	66·5	2·07	65·8	60·0	78	22

In the above table a normal machine with a saturation curve as shown in Fig. 1 and with a regulation of 6 per cent. at full non-inductive load is taken as basis. The values for field copper and length of air-gap for this machine are taken as unity (100 per cent.), and corresponding figures for machines with a different regulation are given as per cent. of these. The table also serves to illustrate the relation between ampere-turns field and ampere-turns armature, and the division of the field ampere-turns into the parts used for the air-gap and for the rest of the magnetic path. Finally, it gives also the different values when specifying the regulation as fall in voltage as referred to under heading 1. The considerable difference is due to the weaker field with no-load excitation, which is more easily distorted by the armature reaction than the stronger one as given by the full-load excitation.

As a further guide for specifying regulation figures, the following values can be recommended for different classes of service.

(*a*) Machines for lighting load or lighting load with incidental power work.

Sizes.	Regulation in per cent. 100 per cent.	95 per cent.	90 per cent. P.F.
Below 200kw.	5—7	9—11	11—13
Above 200kw.	4—5	7— 9	10—12

Under this class of service belong also generators driving rotary converters or synchronous motors.

(*b*) Machines for power work as given by induction motors.

	100 per cent.	95 per cent.	90 per cent.	85 per cent.	80 per cent.	75 per cent. P.F.
Below 200kw...	7—8	11—13	13—15	15—17	16—18	18—20
Above 200kw...	6—7	10—12	12—14	14—16	15—17	17—19

Lower figures should only be chosen in exceptional cases, as they would mean an increase in cost not any more in proportion to the gain in regulation. On the other hand, in a number of cases—particularly in large "power" plants—somewhat higher figures than those given above are quite in order, and as they allow in all cases a further reduction in cost, they are well worth considering. To guard in cases against obtaining a machine in which regulation is obtained by undue saturation—thereby limiting the possibility of raising the voltage to compensate for any unexpected inductive drop in the feeders, it would be well to specify in addition to the above suggested figures, that the ratio of short-circuit current to full load current should not be less than 2½ to 2½ : 1 in machines below 200kw., and 2½ to 3 : 1 in larger machines.

3.—*Influence of Regulation on Efficiency and Operation.*

Not only the size and cost of alternating-current generators are unfavourably influenced by too close a regulation, but the efficiency and the stability of operation are equally affected.

We have shown above that a smaller armature reaction requires a larger amount of iron to carry the magnetic flux, thus increasing the core losses, which form the largest part of the losses in modern machines. Furthermore, the greater amount of field and armature copper will do their part towards a futher decrease in the efficiency. Altogether, a reduction in efficiency from 1 to 1½ per cent. may be expected when changing a machine with an inherent regulation of, say, 7 per cent., into one with 4 per cent., without resorting to saturation.

In regard to stability of operation, it must be noted that very close regulating machines—due to their low armature reaction and self-induction—will have a large short-circuiting current. In Fig. 4, the approximate relation between short-circuiting current and regulation is given for machines designed on the above principles (moderate saturation and C^2R loss armature assumed as 1 per cent.)

We, therefore, must expect with close regulating machines working in parallel, large cross-currents and a considerable exchange of energy between the 'bus bars and the generators if the cyclic irregularity inherent to all reciprocating engines is not kept to a very small amount by means of an extra large flywheel effect—which, of course, increases, unnecessarily, the cost of the plant. But even if all precautions are taken in this direction, troubles in parallel operation may readily occur with too close regulating machines due to the natural period of the alternator becoming such as to introduce the danger of resonance with the forced oscillations of the engine. The following simple formula for the free oscillation of an alternaton further explains this point.*

$$\text{Time of oscillation} = \text{Const.} \sqrt{\text{moment of inertia} \times \text{self-induction of machine}},$$

or, expressed in words, this means that for a given moment of inertia the natural frequency of an alternator is inversely proportional to the square root out of the self-induction of the machine. For safe parallel operation, it is desirable to have this period as low as possible, so as to keep away from the period of forced oscillation as given chiefly by r. p. m./60 × 1 and r. p. m./60 × 2 the number of steam impulses per revolution. Therefore the self-induction of the alternator should be large, which, however, as shown above, is opposed to close regulation.

Large currents on short-circuit also tend to cause troubles in plants as required for rolling mills and mining work, where, due to the rough service, heavy overloads and even short-circuits may frequently occur. Here the maximum generator-current, as caused by a complete short circuit, should always be limited to about 2¼ to 2½ times its normal value.

4.—*Regulation for Constant Power or Current.*

While within the above-discussed limits a close regulation should be aimed at in all normal machines, there are also cases where a poor regulation is essential. This refers to alternating-current generators for constant power or constant current work, as required for certain electrolytic processes where the current is used for feeding an arc.

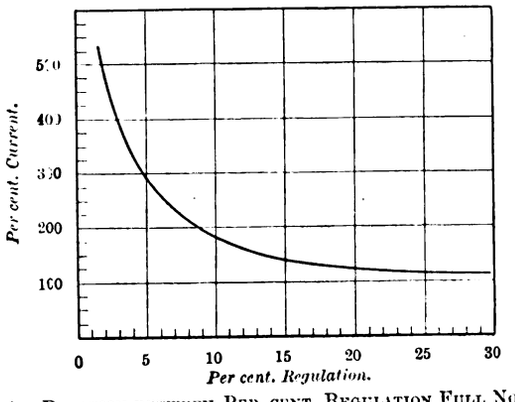

Fig. 4.—Relation between Per cent. Regulation Full Non-Inductive Load and Per cent. Short-Circuit Current for Machine with Moderate Saturation and about 1 Per cent. C^2R Loss in Armature.

5.—*Regulation on Unbalanced Circuits.*

The preceding discussion of inherent regulation applies to balanced circuits only. If the current or the phase relation between the current and E.M.F. becomes different in the different branches of a polyphase generator, the terminal voltages also become different, since, due to the common excitation, the E.M.F. induced in each phase is the same, while the drop, of course, is different. In two-phase machines, where the phases are kept separate, the voltage of the unloaded phase will also drop to some extent when loading the other phase, and therefore in all cases the difference between the E.M.F. of the loaded and unloaded phase is here less than the inherent regulation of the machine. Much more complicated is the matter in three-phase machines, where the phases are interconnected. Here it is almost impossible to predict the resulting conditions to any degree of accuracy, since the current, even if it is in phase with the terminal E.M.F., will necessarily be lagging in regard to one phase of the winding and leading in regard to the other, and consequently its effect on the voltage of these phases will be such as to cause a drop in the first and a rise in the second case. Furthermore, the higher harmonics, especially the third, introduced by unbalancing, will superimpose effects which are almost impossible to predetermine. A more detailed consideration of this question falls outside the scope of this Paper.

(To be concluded.)

Tramcar Collision.—A collision between two tramcars took place on Christmas Eve at Auckland (N.Z.), resulting in three deaths and 100 injured. The motorman of one car lost control of it on an incline, the ordinary ratchet brake failing to act. He then foolishly ran through the car and tried the ratchet brake at the other end, but without effect, and then, running back again, applied the reversing lever so suddenly that the automatic circuit-breakers opened. In his excitement he omitted to apply the track brake.

* See Gorges, *E.T.Z.*, March 8, 1900, p. 19.

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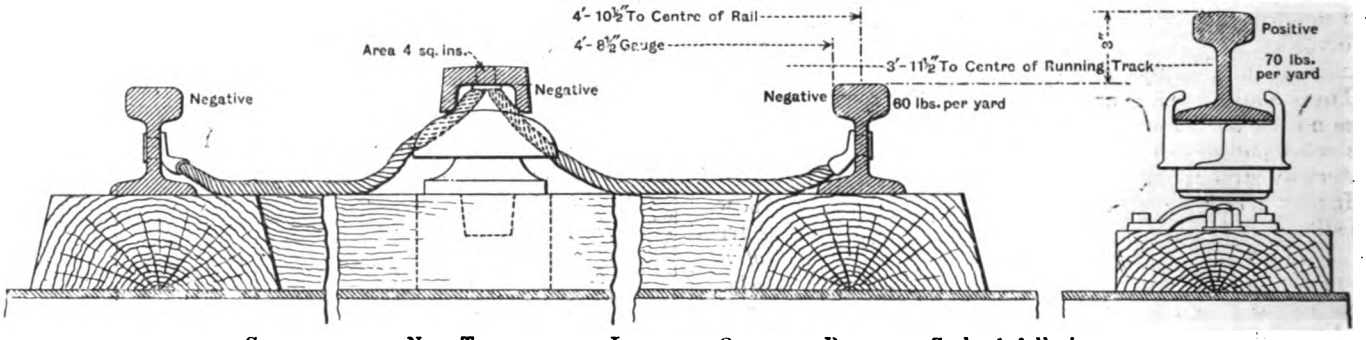
CORRESPONDENCE.

LIVERPOOL OVERHEAD RAILWAY CONDUCTOR RAILS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the illustrations showing the positions of the conductor rails on the various electric railways in England, which you published in your issue of January 22nd, when reporting the proceedings of the Institution of Electrical Engineers on January 14th, I enclose a print showing the new arrangement of conductor rails now being installed on the Liverpool Overhead Railway. The positive conductor rail will be divided into seven sections of average length of 1 mile each. This is in accordance with the standard position of conductor rails adopted by all railways north of the Thames, as announced by Mr. J. A. F. Aspinall. I am indebted to Mr. S. B. Cotterell, chief engineer of the Liverpool Overhead Railway, for this drawing and for permission to publish it. The previous drawing (*The Electrician* of January 22, 1904, p. 536) showed the arrangement of three rails as installed in 1893 on the Liverpool Overhead Railway.—Yours, &c., T. STEVENS.

London, Feb. 13.



SECTION OF THE NEW TRACK ON THE LIVERPOOL OVERHEAD RAILWAY. Scale, ⅛ full size.

THE RECOIL KICK AND OTHER EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find that the Leyden jar experiment, which I called that of the recoil kick when describing it metrically in the *Proceedings* of the Royal Society, Vol. 50, 1891, pp. 23, 26 and 31, and which was also called the experiment of the surging circuit when exhibited in another form—see my 1892 book on "Lightning Conductors," p. 363—is frequently attributed to Prof. Braun; just as the arrangement depicted on p. 336 of the same book is usually attributed to Mr. Tesla or to M. D'Arsonval, when applied, as it often is now, to obtain high-frequency brushes and currents for medical purposes: the secondary coil in oil—Tesla's real addition—being now usually discarded as too strong and unpleasant.

It is a small matter, but I showed the Physical Society of London long ago how a long wire or a pair of long wires (which were stretched on insulators round and round the large room at South Kensington for compactness and darkness), when arranged as an appendage to a closed Leyden jar discharging circuit, would reverberate to the electric vibration of its discharge when they were of appropriate or tuned length, spitting off a strong disturbance at the end of either; and, if too long, would exhibit a brush discharge or glow over regular intervals, corresponding to loops and nodes, at every spark; in precise analogy with Melde's well-known acoustic experiment with a tuning fork and stretched string, or any other method of maintaining stationary waves. Some people will remember this: and readers of *The Electrician* might do me the honour of turning up Vol. XXI., p. 608, of date September 14, 1888, where they will find a brief abstract showing that at the very time when Hertz's great experiments were first brought into public notice by Prof. FitzGerald I had, with the valuable assistance of Prof. A. P. Chattock, already obtained and approximately measured the length of waves along wires by this very means, the experiment being virtually the same as that known in Germany after the name of Prof. Lecher. See, for instance, pp. 241 and 312 of the Lightning Conductor book already referred to.

The employment of a tuned aerial wire as an appendage to a closed Leyden jar circuit, such as that mentioned in sec. 24 p. 23, Vol. 50, *Proc.* Roy. Soc., is of some use in wireless telegraphy, and I have used it for that purpose.

So have Prof. Braun, Count Arco and others; probably in their cases without knowing what had been done previously, and therefore without acknowledgment.

Probably people are too busy to attend to these little matters—as, indeed, I am, too—but occasionally I feel inclined to remind historically-minded students of the facts; and it is interesting to find that the high-frequency arrangements employed in France, and now reintroduced into this country, are arrangements for producing exactly the alternative-path effects and the recoil kick glow exhibited by me to the Physical Society some 14 years ago.—Yours, &c.,

Birmingham, Feb. 15. OLIVER LODGE.

EDDY CURRENTS IN DYNAMO MACHINES.

TO THE EDITOR OF THE ELECTRICIAN

SIR: Before the discussion on this very important matter is closed may I add a few more remarks. It appears from Dr. Thornton's letter in your issue of the 12th inst. that he considers I have misread his Paper and have been too hasty in my criticisms. This, however, is not the case, the Paper interested me very much and I spent several evenings most profitably in its perusal. Indeed, I feel tempted to suggest that "the boot is on the other foot" when I compare Dr. Thornton's quotation from my short article in your issue of the 5th, with the original. Dr. Thornton's version is: "It appears that it is the latter [experiments on solid rings] the author has based his deductions upon. . . . " What I really said was—I give here the context also—"It appears, in the first place, that the author" [Dr. Thornton] "has entirely underestimated the shielding effect of the skin of solid masses on the interior portions, and, in consequence, fallen into the error of assuming the laws of the loss of power due to eddy currents in the skin of solid masses are similar to those which determine the loss in laminated portions. It appears that it is the latter the author has based his deductions upon, with the result that his conclusions are certainly misleading."

In my opinion, there are no two ways of reading this; the word "latter" clearly can only refer to "the law which determines the loss in laminated portions." In the first version Dr. Thornton has evidently himself inserted the four words in the brackets. I contend that throughout the greater portion of his Paper, Dr. Thornton has dealt with the losses due to eddy currents in the solid portions of dynamos, &c., and that he has taken these losses as proportional to $\mu^2 n^2/\rho$, n representing either frequency of alternation or speed of rotation, as the case may be.

With all due deference to Dr. Thornton, I submit that this law is only applicable to the laminated portions and not to the solid portions of dynamos. The remarks, therefore, in my article of February 5th are quite relevant.

Dr. Thornton refers to Mr. Heaviside's formula ("Electrical Papers," Vol. I., p. 364) for the loss in solid cores—viz.:

$$w = \frac{4\pi l}{\rho}(\pi^2 c^2 \mu n)^2 (N\Gamma)^2 Y,$$

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where w = heat generated per second,
l = length of magnetising coil and core under consideration,
c = radius of (round) core,
ρ = specific resistance,
n = number of cycles per second,
μ = permeability,
(NI) = the amplitude of the coil current per unit length of core,

and Y is a very complicated series, involving n, μ, ρ and c, which for iron cores only becomes unity when the diameter is exceedingly small. In other cases it is very much less than unity. I am afraid Dr. Thornton, in quoting this formula, has not examined the context, for on the succeeding page Mr. Heaviside gives several examples, and in example 3 shows that in an iron core of only 2cm. diameter, with a frequency of 100, Y, instead of being unity, is reduced to 1/70. We see, therefore, that, if we except the small yokes and cores of dynamo- and motor-models and such-like toys, the exact expression for w involves μ, n, and ρ in a very much more complicated manner than the simple expression μ^2n^2/ρ.

The formula Dr. Thornton quotes from Heaviside, therefore, does not in the least confirm, as he imagines, that the loss in the solid portions of dynamos is proportional to μ^2n^2/ρ, but materially strengthens the opposite view.

It may here be pointed out that, if in the above formula we substitute unity for Y, we obtain an expression which is true for round wires of small diameter, *where the strength of the alternating induction is at every instant uniform over the cross section.* This law, as I suppose most electrical engineers are aware, is readily deducible in two or three lines of quite elementary mathematics. For large diameters, however (dealing with ordinary frequencies), the induction is not uniform over the cross-section, and uniformity is more and more departed from as μ, n, $1/\rho$ and c are increased. For large diameters, therefore, we have to multiply the loss w, obtained by assuming uniform induction, by a coefficient involving μ, n, ρ and c. This is the coefficient Mr. Heaviside has evaluated, and denotes by the letter Y. For round cores consisting of a bundle of round small wires sufficiently insulated from one another, Y may be taken as unity, but here, of course, we have a *laminated* core.

Dr. Thornton says, "where Mr. Field has obtained his $\sqrt{n}$ law from I do not know." I would refer Dr. Thornton to the article he is criticising. It is fully explained there; and, I would add, it is not *my law*. I merely state the published results of the authority (Prof. J. J. Thomson) I quote, giving all necessary references.

Dr. Thornton tells us his *final* argument relies entirely upon the experiments on laminated cores. These are treated in the appendix of his Paper. He says, both in the appendix and in his letter, that "in every case the hysteresis loss is greater than the eddy current, even at the highest frequencies," (the quotation is from the appendix) and yet in the table of losses we read for the 5kw. ring at 83·5 cycles $W_h + W_e = 50$, $W_h = 25$, $W_e = 30$, $W_h/W_e = 0{\cdot}83$! As I have pointed out, in these experiments the armatures are removed from the magnets, and therefore the flux distribution is quite different from that under working conditions (*i.e.*, when the armature is in place); this will have a material effect on the value of the ratio $W_h : W_e$, which plays so important a part in Dr. Thornton's *final* argument.

It appears that Dr. Thornton and I are unable to agree, and I prefer to "agree to differ" rather than prolong this discussion, lest I be drawn into dogmatic assertions which, of course, can never strengthen an argument. I, personally, am much indebted to Dr. Thornton for his Paper, much of which I found very helpful matter, and also for his reply in your last week's issue.

Lastly, I need hardly add that if further experiments, about which there can be no two minds, be forthcoming corroborating Dr. Thornton's contentions, I shall be only too glad to own myself in error, and to look for some explanation of what will then be, to my mind, an apparent discrepancy between theory and practice.—Yours, &c., M. B. FIELD.

Manchester, Feb. 14.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps you will excuse me if I attempt to take part in the discussion on eddy currents in dynamos since, as you are aware, I also have contributed to the above subject. Dr. Thornton in his Paper mentions the Kapp method for separating eddies from the hysteresis and friction and windage. Although the curve may well approximate to a straight line, it seems to me that the above method is not a fair one for estimating the eddies, nor is it fair for the other components. For example, from innumerable tests it has been determined that the law most nearly fitting the condition of friction and windage in dynamos is that the loss goes up as the *1·5 power* of the speed and *not directly as the speed.* These determinations in all cases were made by an auxiliary motor driving the other machine excited and unexcited. In the appendix, again, Dr. Thornton in his Paper mentions the fact that an alternating E.M.F. was impressed upon the armature windings without taking into account the resultant *flux wave.* Since, surely, this factor would have most to do with determining the relation of hysteresis to eddies, I would draw the attention of Dr. Thornton to Prof. Rössler's work, to Messrs. Barr, Beeton and Taylor and to my own on the effects of flux distribution on hysteresis and eddies. In looking over the curves Fig. 5 in Dr. Thornton's Paper, it occurs to me it would indeed be interesting to calculate the teeth eddy losses taking into account the flux distribution due to visible skewing of flux. As Dr. Thornton will see, the suggestion that the greater portion of the eddy loss takes place in the teeth would not substantiate the dictum that "practically all must, therefore, take place in the solid frame."—Yours, &c., A. PRESS.

London, N., Feb. 12.

PARLIAMENTARY INTELLIGENCE.

Petitions have been presented against the following bills:—London County Council Tramways, by the Camberwell Borough Council and the London, Brighton and South Coast Railway Co.; Cheshire Electricity and Power Gas by the Crewe Corporation, Stockport Corporation Wallasey Urban District Council and the Stalybridge, Hyde, Mossley and Dukinfield Electricity and Tramways Board; East London and Lower Thames Electric Power Bill, by the Grays Thurrock Urban District Council, Woodford District Council, Essex County Council, Great Eastern Railway, the Hackney, Deptford, Bermondsey, Camberwell and Poplar Borough Councils, Ilford Urban District Council and the Leyton Urban District Council; Lancashire and Yorkshire Electric Power, by the local authorities of Gainsborough, Beverley, Grimsby and Lincoln, the Scarborough Electric Supply Co. and the Derbyshire and Notts Electric Power Co.; North and South Woolwich Electric Railway, by the Great Eastern Railway and the Woolwich Borough Council; Manchester Corporation Tramways, by the Cheshire Lines Committee and the Midland Railway Co.; Portmadoc, Beddgelert and South Snowdon Railway, by the London and North-Western Railway, Stretford Urban District Council and the Cheshire Lines Committee; Mid-Cheshire Tramways, by Cheshire County Council and the Midland Railway Co.; Newcastle-on-Tyne Tramways, by the Walker Urban District Council; Ulster Electric Power, by the Londonderry Gas Light Co.

The following have complied with the Standing Orders of the House of Lords:—Clyde Valley Electric Power, Lothian Electric Power, Govan Burgh Electricity, Paisley Tramways, Isle of Thanet Tramways, Portmadoc, Beddgelert and South Snowdon Railway, Derbyshire Electric Power, Leicestershire and Warwickshire Electric Power, Metropolitan District Railway, Metropolitan Railway and Preston and Horwell Tramways.

Non-compliance with the Standing Orders of the House of Commons has been reported in connection with the following bills:—Middlesbrough and Stockton Tramways, Bristol Tramways (Extension) and the Glasgow Corporation Tramwaays. The London, Camberwell and Dulwich Tramways, North-Western Electricity and Power Gas, Lancashire Electric Power, West Riding Tramways, Tyneside Tramways and Tramroads, Victoria University of Manchester, Torquay Tramways and Mid-Cheshire Tramway bills have complied with the Standing Orders of the House of Commons.

The following bills were read a second time in the House of Lords on Friday, Feb. 12:—Barrow-in-Furness Tramways, Bournemouth Corporation Tramways, Bridlington Corporation, Chesterfield Corporation Tramways, Manchester Corporation Tramways, Stretford Urban District Council and the Ulster Electric Power. On Monday the Preston and Blackburn Tramways and the Victoria University of Manchester Bills were read a second time. On Tuesday the Lancashire Electric Power, West Riding Tramways and the Tyneside Tramways and Tramroads Bills were read a second time.

The East London and Lower Thames Electric Power and the North and South Woolwich Electric Railway Bills were read a second time in

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the House of Commons on Thursday, Feb. 11. On Friday the Lincolnshire and Yorkshire Electric Power and the Plymouth Corporation Bills were read a second time. On Monday the Harrow Road and Paddington Tramways, South-Western and Isle of Wight Junction Railway and the Cheshire Electricity and Power Gas Bills were read a second time.

The following Scotch bills are among those which will originate in the House of Lords:—Clyde Valley Electric Power, Govan Burgh Commissioners and the Lothians Electric Power.

The Croydon Tramways Bill has been withdrawn. The application was made by the Rural District Council for a provisional order under the Tramways Act of 1870 to construct electric tramways in Beddington and Coulsden.

The London United Tramways Bill and the London United Tramways (Railways) Bill came before the examiners of Standing Order proofs in the House of Commons on Monday. With regard to the former, it was announced that only tramway No. 2 (from Hounslow to Staines, about 5¼ miles) was to be proceeded with. This line was found to have complied with Standing Orders, and the bill will therefore proceed to first reading. With regard to the railways bill of the London United Tramways Co., the London County Council opposed on the ground that the lines were tramways and not railways. The proposal of the company was to connect its services north and south of the Thames by a tunnel under the river, and also to run a shallow subway tramway connecting up two of its lines in Hammersmith. By calling these proposals railways the promoters had, argued the London County Council, endeavoured to avoid obtaining the consent of the road authorities, but they contended that, inasmuch as the proposed lines were part of the company's tramway systems, they were essentially tramways. The examiner upheld the view of the London County Council, and the bill was referred to the Standing Orders Committee.

The St. Marylebone Electric Lighting Bill will come on for second reading in the House of Commons on Tuesday next, the 23rd inst. Mr. Horner has given notice that he will move the rejection of the measure.

The Standing Orders Committee has decided that the consent of the Holborn Borough Council with regard to the tramway along the Tottenham Court-road, promoted by the London County Council, shall be dispensed with. The bill will therefore proceed. Some lines have, however, been struck out of the bill.

The following bills have been grouped together for consideration by separate committees:—

North and South Woolwich Railway, Baker Street and Waterloo Railway, Charing Cross, Euston and Hampstead Railway, Great Northern and City Railway (extension of time) and the Torquay Tramways.

London, Camberwell and Dulwich Tramways, London United Tramways (Railways), London United Tramways and London County Council Tramways and Improvements.

Soothill Nether Urban District Council Tramways, Harrow Road and Paddington Tramways and Watford and District Tramways. The Committees will not commence sitting until March 9, as one or two of the measures have yet to come before the Standing Orders Committee.

ELECTRIC LIGHTING (LONDON) BILL.

Mr. GERALD BALFOUR, on Wednesday, introduced the above bill into the House of Commons. The bill, which has been introduced on two previous occasions, is to provide for the adjustment, in accordance with the changes of boundary effected under the London Government Act of 1899, of the areas within which local authorities and companies are authorised to supply electricity.

The bill will be read a second time on Monday next.

POST OFFICE TELEPHONE SYSTEM.

In a printed reply to Mr. John Gordon, in the House of Commons, yesterday,

Lord STANLEY said that the Post Office trunk wire system had been extended from Belfast to Ballymena, and exchanges had been opened at Antrim, Ballymena and Kells. He hoped to be able to arrange for a further extension to serve Coleraine, Limavady and Londonderry, when additional funds were available for the development of the Post Office telephone system. A bill to authorise further capital expenditure for this purpose would be presented to the House at an early date.

LEGAL INTELLIGENCE.

Corporation of Eastbourne v. Attorney-General.

In the House of Lords on Monday, before the Lord Chancellor and Lords Macnaghten, Shand and Lindley, the hearing was continued of the appeal of Eastbourne Corporation against a decision of the Court of Appeal affirming an order of the Divisional Court in favour of the respondent.

The point raised by the appeal was this. The Corporation purchased the undertaking of the Eastbourne Electric Light Co. (Ltd.) for £88,700 under statutory powers, and of this sum about £37,929 was in respect of "goods, wares and merchandise" that passed to them as part of the purchase. By sec. 12 of the Finance Act, 1895, it is enacted that where, by virtue of any act (*a*) any property is vested by way of sale in any person, or (*b*) any person is authorised to purchase property, such person shall produce to the Commissioners of Inland Revenue a copy of the act relating to the vesting in the first case, and an instrument of conveyance of the property in the other case, duly stamped with the ad val. stamp duty payable on a conveyance on sale of the property. The Corporation admitted a conveyance was registered for the property acquired, which could only be legally transferred by a written conveyance, but they denied that they were required to produce for stamping a conveyance of the "goods, wares and merchandise" included in the purchase of the property, which could be transferred by mere delivery.

At the conclusion of the appellants' case, the LORD CHANCELLOR gave judgment. The Court of Appeal had held that the word "property" in sec. 12 of the Finance Act, 1895, meant ascertained property, whether real or personal, which was specifically vested by some act in the purchaser, or which the purchaser was authorised by some act to purchase, and in his lordship's opinion that was the right view. It followed, therefore, that the appellants were liable to an ad val. stamp duty on the whole consideration, in respect both of the real and of the personal property they acquired from the Electric Light Company, and this appeal failed.

The other noble and learned lords present concurred, and the appeal was dismissed with costs.

McCullagh v. Queen's College (Galway) and others.

In the High Court, Dublin, last week, the hearing was concluded of an action brought against the president and professors of Queen's College, Galway, Dr. N. W. Colohan and Wm. Haire, by Thomas McCullagh (who sued by his father and next friend) to recover damages for personal injuries alleged to have been caused to plaintiff by negligence of defendants in the use of certain electrical apparatus. The claim was in respect of injuries alleged to have been caused by the use of Röntgen rays in the treatment of an injury sustained to the knee. Defendants denied negligence and unskilfulness. The hearing occupied several days and a good deal of medical and expert evidence was given. It appeared that a needle had entered plaintiff's knee and got broken, the head remaining inside. The rays were employed first by direction of Dr. Quirke, now deceased, and subsequently by Dr. Colohan. A Röntgen ray outfit had been kept at the Queen's College for educational purposes, but a practice had grown up of allowing Haire, the man in charge, to take radiographs for doctors in Galway, both those attached to the hospital and others. For plantiff it was stated that the X-rays operator had placed the X-ray bulb within 2in. or 3in. of the boy's knee while he was taking the radiographs, and the exposures varied from 20 to 30 minutes.

For the defence, witnesses said that the bulb was not held within a less distance than 6in. or 7in. It was strongly pressed for the defence that, under any circumstances, with a science in its infancy, only reasonable skill could be expected in a town like Galway, and Galway College repudiated all responsibility. Dr. Colohan also repudiated responsibility for the way exposures were taken, this being exclusively the work of Haire, who was only the mechanical assistant to the Professor of Natural Philosophy at a salary of £58.

The jury found for defendants on the general issue that there was no negligence.

Electric Tramways Construction and Maintenance Co. (Ltd.).

Mr. Justice Byrne on Tuesday directed that the petition in this matter should again stand over for a week.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Council of the Institution of Electrical Engineers desire to receive applications for the position of secretary vacant by the death of Mr. W. G. McMillan. Commencing salary £500 per annum. Applications to the chairman of the Secretaryship committee, Institution of Electrical Engineers, 92, Victoria-street, Westminster, London, S.W., by March 7. See also announcement in our advertising columns.

An assistant electrical engineer is required by a firm of consulting engineers at Westminster. Preference given to one having experience in designing and working of tramways or electricity supply. See advertisement.

A junior draughtsman is wanted in the drawing office of an electricity supply undertaking. Applications to Engineer and Manager, 27, Osborn-street, Whitechapel, London, E. See advertisement.

Mr. Wm. Burr, station superintendent at Reading electricity works has been appointed (out of 154 applicants) chief assistant electrical engineer at Croydon Corporation electricity works.

Mr. E. S. Rayner, of Swansea, has been appointed borough electrical engineer and tramways manager at Doncaster, in succession to Mr. W. Wyld.

Mr. C. A. Coventry, of the G.W.R. carriage and waggon works, Swindon, has been appointed to the newly-created position of superintendent of the motor department of the company at Paddington.

Mr. E. J. Taylor, of Messrs. W. T. Glover & Co., has been appointed mains superintendent at the Wimbledon District Council electricity works.

Mr. R. W. Kemble, of Bournemouth, has been appointed shift engineer, and Mr. T. C. Hunt, of West Ham, mains assistant, at the Corporation electricity works, West Ham.

Mr. Mills has been appointed junior assistant engineer at Bristol.

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Aberdeen.—The County Road Board have approved the plans of the new suburban tramways from Aberdeen to Bucksburn and Culter.

Arbroath.—Negotiations are proceeding between the Council and the Empire Electric Light and Power Co. for the transfer of the Council's electric lighting order.

Ashford (Kent).—The Council have assented to the application of the Ashford and District Electric Supply Co. for a new provisional electric lighting order and for the revocation of the Council's 1899 order.

Australasia.—The "Australian Mining Standard" states that *Newcastle* (*N.S.W.*) Municipal Council have received authority to borrow £5,000 for extensions to their electric lighting system.

The Minister of Railways for *Western Australia* recently announced, in connection with the proposal to construct the Woodman's Point–Jandacot railway, that that line would ultimately be connected with the South-Western line, but until such junction was made it might be found cheaper to work it by electricity. The line is to be 6 miles long, and the estimated cost is £15,000.

The *Dunedin* (*N.Z*) tramway system, equipped by Noyes Bros., was recently opened for traffic.

The *Victorian* Cabinet have refused consent to the scheme for the construction by Mr. A. E. Morgans of electric tramways in the towns of Flemington and Essenden, on the ground that they are likely to cause injury to the railway traffic.

Sydney Council recently fixed their charges for electrical energy at 4½d. per unit for lighting, with the alternative of 5d. per unit for the first hour's maximum demand and 2d. after, with 2d per unit for power. The increased demand for current consequent upon this step necessitated the issue of municipal stock by the Corporation last month to provide for extensions of the generating plant and mains.

Bath.—The Council are recommended by the Electric Lighting committee not to undertake the extension scheme prepared by their consulting electrical engineer (Mr. E. Manville), "as the committee consider the present capacity of the works sufficient for the next winter's requirements."

Beckenham.—The Council have decided to restrict their immediate expenditure on free wiring to £2,000. Notice has been given to the Crystal Palace and District Electric Light Co. requiring them to sell the portion of their undertaking within the Council's area.

Brighton.—For changing-over the remainder of the area of electricity supply to the higher voltage the Corporation are applying for sanction to a loan of £4,000.

Bristol.—The Electrical committee have purchased from the Thames Valley Electric Launch Co. a second-hand electric service boat for conveying stores, machinery and staff between Avonbank and Temple Back stations.

Broughty Ferry.—It is proposed to expend £2,000 in improving the electricity supply system and Mr. G. Balfour has been asked to prepare a report.

Buenos Ayres.—The construction of an electric tramway from Buenos Ayres to Lanús, Lomas and Androgué will be commenced shortly, and is expected to be completed by October, 1905.

Burnley.—A new 400 H.P. Belliss engine was started on Saturday last.

Burton-on-Trent.—During the past six months the Corporation electric tramways carried 2,019,887 passengers, the receipts being £9,120.

Cable Makers' Association.—The Anchor Cable Co. (Ltd.) has joined this association.

Cardiff.—The borough electrical engineer (Mr. Arthur Ellis) has been instructed to have canvassed the neighbourhood of Broadway to ascertain if the demand for current would justify the extension of the mains to that thoroughfare.

Mr. Ellis presented his estimates of expenditure and receipts for the year ending March 31, 1905, on Tuesday. Expenditure was put at £22,382, compared with £16,386 estimated for the current year and £11,271 actual expenditure in 1903. The receipts for next year were estimated at £37,750, leaving a profit of £5,181. It was resolved that £3,000 be allocated to relief of rates, and that £2,181 be placed to reserve. For the current year the amount in relief of rates is £2,900. At present the equivalent of 105,528 8 c.p. lamps is connected. Sanction to a loan of £38,000 for extensions of cables and feeders is to be applied for.

Cleethorpes.—The Grimsby Street Tramways Co. have offered to sell their electricity generating station to the Council for £19,000.

Croydon.—The Rural Council have withdrawn their bill for powers to construct electric tramways from Beddington along Purley-road to the terminus at Godstone-road.

Crystal Palace Automobile Show.—An excellent display of the latest types of motor-driven vehicles has been made at the Crystal Palace this week, and the show will remain open until Wednesday, Feb. 24. It may be well to point out that this is the official show of the Society of Motor Manufacturers and Traders, which gives the exhibition additional importance. There are comparatively few exhibits of an electrical character, although it may be said that at a large number of the stalls batteries and other electrical accessories of the motor vehicle industry are in evidence. Combined systems of generating power, such as the petrol-electric system, are conspicuous by their absence, but there are a couple of purely electrically-driven carriages, some particulars of which we give below. Apparently, magneto-ignition is gaining in favour, in spite of its higher cost as compared with the older methods of igniting the charges, and several devices are shown by different makers.

A special feature of the electric carriages exhibited by the Electromobile Company is the underslung interchangeable battery. As this company undertakes the upkeep and charging of the batteries at fixed annual charges, this arrangement is a necessity, and we understand that a set of accumulators may be detached from the car and replaced by freshly-charged cells in less than five minutes. It is also claimed that this mode of carrying the accumulators ensures an even distribution of weight on the wheels as well as a low centre of gravity. A wooden battery box containing 44 "Contal" cells, which weigh 10 cwt., is suspended from the carriage. The capacity of the battery when discharging at the normal rate is 135 ampere-hours, and this is sufficient to propel the Victoria type of carriage 40 miles over average roads in fair condition. In the case of the double landaulet, the battery weight forms about one-third of the total weight of the carriage. Each plate of the cell is formed of two thin grids riveted together, and presenting 32 square holes for the active material, which is forced into the grids under hydraulic pressure. Each pellet of active material is perforated with nine holes. A bi-polar series wound motor drives through a double train of double-helical gearing to the differential and thence to the hubs of the rear wheels by live shafts, which revolve in an external tubular axle. The normal rating of the motor is 8 B.H.P. at 1,500 revs. per min. Two separate windings and two commutators are provided, and these afford an easy method of speed regulation. The motor casing is continued into the gear box, so that the entire driving mechanism is dust-proof and waterproof, and can be entirely detached from the carriage by removing some spring clips and a pin by which the motor is suspended from the frame. A compact controller, built on usual lines and designed for several forward and one reverse speed, is placed underneath the footboard and is actuated by a transmission gear leading up to the controller handle, which is placed on the steering pillar just beneath the handwheel. An ingenious form of quick-break switch is connected with the brake pedal, so that the circuit is broken before the mechanical brake is applied. In one position of the controller, the motor acts as a generator and has, therefore, a braking effect.

The London Electro-Mobile Syndicate show a car having one motor only, driving through a differential gear on to the wheels. The accumulators, 40 in number, are of the Hart Company's make, and are placed in a receptacle at the back at the car.

The "Energy" battery, exhibited by Messrs. Peto and Radford, is intended to be used chiefly as a spare accumulator in connection with the sparking device. It is especially adapted for such purposes, as there is said to be no loss through leakage when the cell stands idle. In appearance it quite resembles an ordinary accumulator in celluloid case. It has, however, two positive plates of the usual type, and between them one negative plate, formed by two lead sheets joined together to form a pocket. The battery is charged as an accumulator, but the negative plate, having practically no capacity, renders the voltage of the battery nearly zero. When current is required, a pellet of cadmium is dropped into the negative pocket of each cell, the pressure of which instantly rises to about 2 volts. After the cadmium rod is removed, the voltage drops again to zero. It is claimed that the fully-charged battery, without acid, may be sent by post, rail or sea without heating or damage to the negative plates, and that they then only require acid and water to render them ready for use.

Among miscellaneous exhibits we may mention the following:—The N.S. Electric Storage Co., Horton Kirby, Kent, show improved solid storage cells for general lighting and traction purposes, also railway carriage lighting batteries and batteries for electric launches and motor vehicles, medical and X-ray work, &c., ignition batteries, and cells for lighting motor vehicles; the Electric Battery Co., 180, High Holborn, London, W.C. (accumulators, ignition apparatus, voltmeters, &c.); Longstreeths Limited (Lithanode Electric Storage), 427A, Strand, London, W.C. ("Lithanode" high-rate discharge batteries, electric lighting and traction sets, hand lamps, ignition coils, and 1904-type patent unspillable ignition accumultor, &c.); Langdon-Davies Motor Co., 101, Southwark-street, London, S.E.; W. H. Willcox & Co., Southwark-street, London, S.E. (a large variety of supplies required by motor vehicle builders as well as motor vehicle users); S. Smith & Son, 9, Strand, London, W.C. (This firm show an improved compensated speed indicator, an instrument which can be easily attached to any vehicle and will indicate the speed in miles per hour at a glance. Messrs. S. Smith & Son are well known as makers of instruments of precision of the highest class, and they claim that these speed indicators are absolutely correct, as the construction has been carried out on the basis of mechanical calculations which makes error impossible. The mechanism is, at the same time, very simple. A working model of the indicator is shown driven by an electric motor arranged to run at various speeds up to 50 miles per hour. One of the cars running in the grounds, a 12 H.P. Argyle, is fitted with this apparatus. The indicator is guaranteed to withstand excessive vibration. Spacings on the dial are nearly as uniform for the higher as for the lower speeds, and it is this important feature which the makers claim renders the instrument distinctive from less scientifically-constructed indicators.) The Stern-Sonneborn Oil Co., 57, Gracechurch-street, London, E.C. (oils and lubricants of all kinds); J. G. Statter & Co., Newhall-street, Birmingham; Joseph Kaye & Sons (Ltd.), 93, High Holborn, London, W.C., and Leeds (patent oil-cans, petrol squirts, oil economisers, &c.); Pritchetts and Gold, Feltham, Middlesex; and G. T. Riches & Co., 4, Gray's

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Inn-road, London, W.C. (a large variety of electric and general accessories). The show is certainly the most complete and comprehensive of its kind ever held in this country, and there are indications that, in spite of the tightness of money, the sales effected at Sydenham have already been considerable.

Dorchester.—The Council have decided to continue negotiations with companies for disposing of the Council's electric lighting order 1901.

East Ham.—Sanction to a loan of £14,430 for additional electric lighting plant has been received by the District Council. Katherine-road is to be lighted by arc lamps at an estimated capital cost of £1,206, and an annual expenditure of £432.

Electric Lighting of Public Buildings.—The Commissioners of H.M. Works and Public Buildings have given instructions for the wiring of the metropolitan county courts, and the work has already been commenced. The police courts and other official buildings are also to be fitted up for the electric light.

Exeter.—Acting upon the advice of the city surveyor (Mr. T. Moulding) and the borough electrical engineer (Mr. H. D. Munro), the Council have decided to adopt the overhead system on their projected tramways.

Forthcoming Books.—Messrs. Crosby Lockwood & Son will shortly issue "Dynamo, Motor and Switchboard Circuits," for electrical engineers, artisans and City and Guilds students, by Mr. Wm. R. Bowker, C.E.

"The Electrician" Printing and Publishing Co. will have ready in a few days "The 1903 Revision of the International Telegraph Convention and Service Regulations." This important official publication is issued at 6s. net. In addition to the complete French text of the Convention and Service Regulations, as finally ratified by the Contracting States in December last, there is a full English translation by Mr. C. E. J. Twisaday (of the India Office) and Mr. G. R. Neilson (of the Eastern Telegraph Co.). The work has been further revised by the authority of the British Post Office, and is accepted as the Official Record of the Proceedings at the International Conference in London in June last.

"Free" Wiring by Borough Councils.—At the conference of London Borough Councils held recently at Hackney Town Hall, a resolution was passed urging the London County Council to again introduce a bill to enable borough councils to wire and fit up consumers' premises for electric supply, and to raise loans therefore.

Fulham (London).—Arrangements were completed on Wednesday to take up a loan of £25,000 from the Prudential Assurance Co. at £3. 12s. 6d. per cent. This compares with £3. 15s. charged by the London County Council. The southern branch of the library, Wandsworth Bridge-road, and the librarian's department at the central library are to be wired for electric lighting.

Glasgow and South-Western Railway.—The directors were authorised at the meeting on Tuesday to proceed with provisional orders for, amongst other works, the equipment and working of any part of the company's lines by electric traction.

Gorton.—The Electricity committee recommend the Council to lease their provisional electric lighting order, 1899, to Manchester Corporation.

Great Northern and City Railway.—This line was opened on Sunday last, has been carrying daily large numbers of passengers, and the service promises to become increasingly popular. Vast crowds have patronised the line up to 11 a.m. and between 4 and 6 p.m., and at these hours the 3-minute service hardly meets requirements. We understand that already nearly 6,000 season tickets have been taken up. When the station at Highbury is opened a very important centre for traffic will be tapped.

Grenada.—On Dec. 15 last the Governor of Grenada issued a wireless telegraph ordinance providing that the exclusive privilege of installing, working, maintaining and using in the colony apparatus intended for wireless telegraphy, and also the services of transmitting, receiving, collecting or delivering wireless telegrams, should be vested in the colony. No person will be allowed to instal, work or use such apparatus or perform such incidental services under a penalty of £50 and the forfeiture of the installation.

Hanley.—The accounts of the electricity department for 1903 show a gross profit of £7,507. 0s. 10d., out of which £2,554. 18s. 3d. has been paid for interest and £2,509. 10s. 3d. for sinking fund, leaving net profit £2,442. 12s. 4d. £2,350. 10s. 11d., the amount standing to debit of electric lighting revenue account, has been repaid to district fund account, and the balance (£194. 18s 11d), including £108. 17s. 6d. from previous year, has been carried forward.

Hotel Lighting.—The British Westinghouse Co. have secured a further order from the Savoy Hotel, including a 17-panel switchboard, a Tudor 700-ampere-hour battery, a 17½kw. automatic reversible booster, one milking booster, &c. The plant has a total capacity of 900kw. A notable item is the elaborate switchboard, 34ft. long and 7½ft. high, the panels of 2in. thick white marble. This board provides an ingenious and effective means of interconnecting the different circuits with either the private supply or the mains of the Charing Cross and Strand Corp.

Hove.—Sanction to a loan of £14,800 for electric lighting has been received by the Council.

Huddersfield.—The Electricity committee report that for 1903 the income of the electricity department was £26.005 against £23,159 in the previous year. The expenditure was £12,627 (against £10,404) and the gross profit £13,378. After paying interest and sinking fund instalment the profit was £3,915 against £2,945 last year. The balance has been transferred to depreciation and contingencies account, which now amounts to £11,853.

Ilford.—The lighting committee have reduced the charge for electric current from 4½d. to 4d. per unit. As an alternative current will be supplied on the maximum demand system at 6d. per unit for the first hour, and 2d. after. The charge for public incandescent lamps will be £4 per annum.

Islington (London).—An arrangement has been come to with the contractors for the arc lamps in the Highbury district to substitute new lamps (76 in number) for those erected, the work to be completed within two months.

Kingston-on-Thames.—An offer of Edmundson's Electricity Corp. to supply electricity in bulk at 2½d. per unit has been declined by the Council.

Knutsford.—The question of revoking the Knutsford electric lighting order, 1899, has been deferred for six months by the Board of Trade.

Lampeter.—Prof. Ferrier, of Liverpool University, has been engaged to prepare a preliminary report upon electric lighting for the Council.

Leeds.—The Corporation's electric tramways (of which there are 84 miles of single track in operation) are being extended from Beckett-street to Harehills-lane, and the line will probably be ready for official inspection in a fortnight. Other extensions are in hand.

The Lighting committee recommend the Council to fix the charge for electric current for street lighting at 1½d. per unit. The total cost of generation, with interest and sinking fund charges, is 3d. per unit.

The Works sub committee recommend the construction of 25 new cars with covered tops, as designed by the tramways department. The Kirstall-road car-repairing depot is to be considerably increased, and tenders are to be advertised for material required during the 12 months.

Light Railways.—The Bideford, Westward Ho and Appledore Railway (Light Railway Extensions) Order has been submitted to the Board of Trade for confirmation. Objections by March 12.

The Light Railway Commissioners held an inquiry last week into the application for an order to construct a light railway from Hope station to Castleton, Yorks., and, after hearing evidence, the Commissioners decided to grant the application.

Liverpool.—During 1903 the Corporation tramways carried 113,057,234 passengers, an increase of 3·40 per cent. on 1902.

Nothing in the nature of a serious collision occurred, and the fatalities fell to 1 in 28,000,000 against 1 in 13,000,000 for 1902. The Liverpool plough lifeguard had been most successful, and had never failed in operation, notwithstanding the largely-increased speed of the cars, which now (it is stated) exceeds that of any other city in the country. Under the new speed regulations the average speed between the tramway termini, including all stops, was between 7 and 8 miles per hour. The total income amounted to £531,483, an increase of £18,058 over 1902. The expenditure amounted to £341,484, against £339,811 in 1902, an increase of £1,652, compared with an increased income of £18,058. Interest and sinking fund charges were £107,014, against £102,627 for 1902, increase £4,387. The car-mile earnings had increased from 10·34d. in 1902 to 10·73d. for 1903, increase 0·39d. The percentage of operating costs to total revenue fell from 65 per cent. in 1902 to 64·24 in 1903, and the gross profits rose from £178,124 to £203,256, increase £25,133, or 10·9 per cent. on total capital expenditure, against 9·7 per cent. in 1902. The net profit amounted to £96,242, against £75,497 in 1902, increase £20,745. It was proposed to place £64,161. 18s. 7d. to reserve, renewal and depreciation account, and to transfer £32,080. 19s. 4d. to general rate. The average fare per passenger showed a slight increase over 1902—1·111d. against 1 113d. The length of track operated in 1902 was 101 miles, and was 103 miles at present. The renewal and depreciation account stood at £487,000. That fund had never been touched, general repairs being effected out of revenue.

The Tramways committee recommend application be made for powers to construct a double-track tramway along Edge-lane.

The accounts of the electricity supply department for 1903 show total income of £206,311. 13s., including £118,684. 9s. 3d. from the sale of current for lighting and power, £2,290. 6s. 2d. from public lighting, and £77,930. 10s. from the supply of energy to the tramways department, meter rentals produced £2,362. 13s. 6d. and there was a profit of £4,262. 9s. 11d. on the manufacturing department. Generation expenses came to £69,216. 15s. 9d. and cost of distribution to £4,319. 19s. 10d.; rents, rates and taxes were £12,743. 4s. 5d., management expenses £10,855. 9s. 6d., and special charges (including insurances, certification of meters, stamp duties, telephone rents, &c.) £1,640. 1s. 1d., and after writing off £62. 15s. 1d. for bad debts, the balance was £107,473. 7s. 4d., which, with £663. 12s. 8d. from interest account, left £108,173 for disposal. Interest absorbed £43,577. 1s., and sinking fund instalment £33.259. 4s. 8d.; £10,000

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has been placed to reserve, and £11,002. 7s. 5d. transferred to the renewal fund, leaving £10,298. 6s. 11d. as contribution to general rates. The total capital expenditure to date is £1,553,808. 10s. (an increase of £217,099. 14s. 9d.) including £67,663. 12s. 7d. on mains, £85,098. 8s. 6d. on machinery, £32,579. 11s. 9d. on buildings, and £19,655. 15s. 6d. discount and expenses of creation of issue of 3 per cent. Corporation stock.

London County Council.—At Tuesday's meeting a loan of £1,040 was granted to Islington for electric lighting purposes.

Tramways.—Replying to a number of questions, Mr. Benn, chairman of the Highways committee, said he was not prepared, until the accounts were made up, to give the cost per car-mile of the electric tramways, but members were not to take it that it was largely in excess of the estimates. He hoped to bring up a report on the inquiry which had been made in regard to the conditions of labour, &c., in Belgium, next week, but they could get no information from Government departments. With regard to the statement of the chairman of the North Metropolitan Tramways Co. that the company had not had fair play, he contended that the company had known for a twelvemonth what the Council's plans were, and had not tried to assist them. Had assistance been forthcoming, the work of electrification might have made great progress.

The report recommending the acceptance of the tender of Messrs. W. Griffiths & Co. (Ltd.), London, of £86,623. 19s. 11d. for the reconstruction for electrical traction of the Streatham cable tramways and construction of authorised tramways was withdrawn by the chairman of the committee.

Salaries.—It was agreed to make the following advances to members of the staff employed in the chief office of the London County Council tramways. Mr. J. Welling, permanent-way engineer, from £400 to £450; Mr. E. L. Pope, electric mains engineer, from £350 to £400; Mr. H. Vorley, accountant, from £300 to £350; Mr. C. R. Johnson, assistant traffic manager, from £220 to £235; Mr. J. Glover, claims officer, from £200 to £225; Mr. G. Franklin, assistant paymaster, from £190 to £200; Mr. G. Dickens, storekeeper, from £180 to £200; Mr. J. McClure, bronze coin distributor, from £176 to £185; Mr. A. Heitzmann, banking clerk, from £135 to £150; Mr. G. Bartle, collector, from £120 to £130 and Mr. R. E. Meatyard, clerical assistant, from £100 to £110.

New Tramways.—It was agreed that the application to Parliament for the following tramways be abandoned:—from Clapham Common to East Hill, Wandsworth, and from Deptford to the Herbert Hospital, Woolwich.

London County Council Tramways.—The estimates deposited by the Council in their 1904 bill, in connection with their proposed tramway extensions, show that the cost will be £1,729,845, of which £657,300 will be for street widening.

Westminster City Council have petitioned against so much of the bill as relates to the construction of tramways over the Thames bridges and along the Embankment.

Lourenco Marques.—The electric tramway system of the Delagoa Bay Development Corp. was opened for traffic on Wednesday. The opening ceremony was performed by the Governor. Already extensions of the system are projected.

Lynn.—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £11,500 for electricity extensions and for meeting bankers' overdrafts on expenditure over and above authorised loans. Evidence of the progress made by the department was given by the borough electrical engineer (Mr. J. Pilling) and the town clerk (Mr. J. Woolstencroft). There was some opposition.

Manchester.—Mr. A. E. McKenzie, resident engineer at the Stuart-street station of the Manchester Corporation electricity works, has been severely burned about the hands and face by an electric arc, due to the failure of an extra high-tension switch. Three other persons standing close by also received injuries, and it is expected that one of these, Mr. Schleep, as well as Mr. McKenzie, will be in hospital for some weeks.

Marylebone (London).—At the meeting of the Council last evening, on the question of the passing of accounts

Mr. Edwin White opposed the payment of an item of £800 to Mr. H. F. Parshall as fees to him as an expert witness during the recent arbitration proceedings and asked for particulars. The sum seemed a very heavy one. Was there no regular scale for payment of expert witnesses?

Mr. E. R. Debenham (chairman of the Electric Supply committee) said Mr. Parshall was engaged as a gentleman occupying a high position as an electrical expert at the special request of their legal advisers, and the engagement was reported to the committee. Their solicitor thereupon entered into a contract with Mr. Parshall for his attendance, at a fee of 5 guineas per hour, at the arbitration proceedings. Under this contract the amount due to Mr. Parshall would be £2,600, but, on the representation of the Electric Supply committee, the amount had been reduced by Mr. Parshall to £1,300.

Mr. E. White moved that the matter be referred back for the committee to present to the Council a report from the solicitors on the matter.

The Town Clerk said a writ had been issued for payment of these fees and it was necessary for this £800 to be paid forthwith to prevent the matter going to Court and further costs being incurred.

Mr. White's motion on being put to the meeting was lost, and the payment of the £800 was agreed to.

Municipal Telephony.—Swansea Telephone committee on Wednesday recommended the Corporation, before applying for sanction to a further loan of £15,000 for adding 750 lines to the present capacity of the telephone service, to obtain a report from an accountant on the financial position of the undertaking up to March 31, and a report from the consulting engineer (Mr. A. R. Bennett) as to the cost of carrying out the new work. After discussion, it was agreed to have the financial statement prepared as suggested, and the preparation of the report by the consulting engineer has been postponed.

Scarborough Telephone committee are obtaining information from towns where municipal telephone exchanges are in operation.

Pemberton.—The Council have received sanction to a loan of £16,155 for extensions of the electricity undertaking.

Perth.—The report of the consulting engineers, Messrs. Kincaid, Waller, Manville and Dawson, upon the reconstruction of the tramways for electric traction, is before the Council, and will be discussed at the next meeting. The estimated cost of the reconstruction and electrical equipment is put at about £46,000.

Pleasley.—The Parish Council have entered into an agreement with the Shirebrook Colliery Co. for public electric lighting.

Presentation.—Mr. Andrew Gray, the chief of the technical staff of the allied Marconi Wireless Telegraph companies was entertained to dinner at Chelmsford on Saturday last, when the members of the staff presented him with an oak chest, containing silver plate as a wedding gift. Mr. G. Langdon Bullocke, who presided, made the presentation, and Mr. H. St. Vincent Pletts was in the vice-chair. Members of the staff at Chelmsford, London and other places were present, and letters expressing good wishes for Mr. Gray were received from representatives on the Congo, in the United States, Canada, Newfoundland, the Continent, &c.

Private Fire Brigades.—At the sixth annual tournament of the London Private Fire Brigades' Association on 6th inst., the Robertson Electric Lamp Private Fire Brigade, for the third year in succession, met with considerable success, winning a prize in every competition which they entered, and carrying off three 1st prizes, two 2nds and one 3rd. In addition, the brigade won the championship for the whole of London, and are now holders of the Marshall Challenge Cup given for the best all-round performances in all competitions. The brigade also hold the Hibbert Challenge Cup for the best individual performance at the tournament.

St. Pancras (London).—A special meeting of the Council was held on Wednesday to consider the judgment in the action "Colwell and others *v.* St. Pancras Borough Council" (fully reported in our last issue).

The Chief Engineer (Mr. Sydney W. Baynes) stated that, after conference with experts, and having regard to the whole of the circumstances and the machinery installed, if the works were again in contemplation it would not be possible to do anything else with regard to choice of plant than had been done. The whole trouble appeared to be that the subsoil and surroundings were unfortunately synchronous with the beat of the engines, and that could not and had not been ascertained in any case before installing such plant. It was necessary that the engines should be absolutely balanced, so that there were no stray forces imparted to the foundations. The engines installed were those supplied as a commercial engine, and it was not the usual practice to balance them beyond a certain extent. Prof. Dalby, in conjunction with the makers, had the work of balancing well in hand. The Electricity committee felt confident that the three new engines would be properly balanced, and that there would be no vibration arising from their use on the expiry of the six months allowed by the Court.

Considerable discussion took place on the reports, and a special committee was ultimately appointed to supervise the carrying out of future arrangements.

Shoreditch (London).—On Tuesday the Borough Council decided to apply for sanction to a loan of £14,069 for electric lighting extensions.

South Africa.—The "British and South African Export Gazette" states that the introduction of electric power in the Sheba mine (Barberton) in 1896 has resulted in a saving in working expenses of £10,000 per annum since that date. A similar installation by the same contractors (Messrs. Johnson and Phillips) is said to have effected a reduction of £6,000 a year in the working costs of the Burma Ruby mines.

East London municipality will shortly invite tenders for the construction of a short extension of their electric tramways.

An electric tramway is to be constructed between Cape Town and Maitland.

It is stated that additional plant will shortly be required for Port Elizabeth electricity works.

Orders will shortly be placed for the electrical plant required for the Arcadia (Natal) electricity works.

Plant about to be installed at the Dutoitspan mine will include three electrically-driven pumps with a capacity of 8,000 gallons per hour each, and transformers for converting current for working five electric locomotives for hauling trucks.

Johannesburg Municipal Council have arranged to take electrical energy from the Braamfontein Electric Co. for the next two years pending the equipment of the municipal works.

The exports from the United States to South Africa during October last included electrical machinery to the value of £229 (a decrease of

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£3,901 compared with the previous October), and scientific instruments, "including telegraph material," £4,775 (decrease £485).

Southend.—The basalt setts with which the track of the Corporation electric tramways was paved on the construction of the lines three years ago, are to be replaced by granite setts, and tenders for their supply are being invited.

Southwark (London).—The Lighting committee is holding an inquiry into the working of the electricity undertaking.

Stepney (London).—On Wednesday the Electric Lighting committee reported that an arc lamp attendant had met with an accident caused by the ignition of accumulated gas in the base of an arc lamp column. The gas had escaped from a pipe of the Commercial Gas Co., upon whom the town clerk was instructed to serve a cautionary notice.

Stoke Newington (London).—Messrs. Talbot and Stevenson have been appointed consulting engineers to the Council in succession to Messrs. Hopkinsons and Talbot.

The Council will offer no objection to the adoption of the conduit system of electric traction on the High-street tramways.

Theft of Electric Cable.—At Newington (London) Sessions yesterday Robert Tiffen, fitter, and Herbert Ellis, clerk, pleaded guilty to stealing, and Alfred Toms, marine store dealer, was convicted of receiving with guilty knowledge, a large quantity of electric cable the property of Messrs. Siemens Brothers & Co.

It appeared that Toms purchased the cable for a few pence per pound, and subsequently disposed of it to a metal merchant. It was stated that Toms was already undergoing a sentence of six months' imprisonment for a similar offence. Toms was sentenced to three years' penal servitude, Ellis to 18 months' hard labour, and Tiffen to one month in the second divison.

At the same sessions John Emanuel, fitter, pleaded guilty to stealing two ingots of solder the property of Messrs. Siemens Brothers & Co., and was sentenced to five months' imprisonment in the second division.

Theft of Telegraph Wire.—For cutting and stealing telegraph wire forming part of the trunk telegraph lines between London and the eastern counties, George Walker was last week sentenced at the County of London Sessions to 18 months hard labour, Alfred Joyce to 14 months and George Hibbard to six months.

Torquay.—The Corporation have withdrawn their opposition to the bill of the Dolter Electric Traction Co. for the construction of electric tramways.

Weybridge.—The charge for electric current has been reduced from 7d. and 4d. to 7d. and 3d. respectively.

Walton.—The Council have assented to the application of the Urban Electric Supply Co. for an electric lighting order, provided certain amendments are inserted.

Windsor.—The Corporation have accepted the tender of the Windsor Electrical Installation Co. for public lighting for five years, the agreement to be determinable by the Corporation at the end of the first two years on six months' notice in writing. The tender is for 10 2,000 c.p. arcs, 21 500 c.p., and 260 twin 16 c.p. incandescents at an annual cost of £1,375.

Winsford.—The question of revoking the Council's electric lighting order, 1899, has been deferred for six months by the Board of Trade.

Worthing.—The resident electrical engineer (Mr. G. Porter) has prepared a report on the alleged unreliability of the arc lamp lighting.

Mr. Porter attributes the failures which have occurred to the action of damp in corroding the moving parts of the lamp mechanism and causing them to stick. In the ordinary course arc lamps would do their work without requiring more than ordinary daily attention for three years, but the exceptional weather of last year had necessitated a general overhaul at the end of the second year. The work was being steadily persevered with, about one-third of the lamps having been brought in, taken to pieces, readjusted and sent out again, and that course, it was considered, would be effective.

Mr. Porter has been requested to submit estimates of cost of installing incandescent lamps on brackets to the existing arc lamps, and also of the estimated saving on the supposition that the arc lamps are extinguished at 10 p.m. and the incandescents turned on at 10 instead of 11 p.m.

Dinner.—Old Faradians of Manchester and neighbourhood dined together at the Midland Hotel, Manchester, on Saturday, with Mr. C. D. Taite, borough electrical engineer of Salford, in the chair.

Mr. Robert Hammond replied to the toast of "The Electrical Standardizing, Testing and Training Institution," confessing that when he remembered it was more than 20 years since he first started the college in Red Lion-square, London, he realised that time passed rapidly. Referring to an ambition he had when a boy to plant trees, which ambition he had not found it possible to satisfy, he felt that in planting the number of electrical engineers (about 500) who had passed through the institution to the work of their profession he had achieved his ambition in more valuable form.

Mr. E. Cowan, chairman of the Local Section of the Institution of Electrical Engineers, responded to the toast of "The Visitors."

The gathering was a great success, and will be repeated next year. Mr. J. T. Tiplady was hon. sec. of the dinner committee.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1904 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date, and the Directorial Division of the new volume has been corrected up to February 11th, 1904. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates over 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes.

TENDERS INVITED.

The Council of the Metropolitan Borough of *Bermondsey* invite tenders for wiring buildings and supply and erection of fittings and materials for the installation of electric light at the generating station, Bermondsey. Specifications from the Town Hall, Spa-road, Bermondsey, and may be inspected at (but not obtained from) the offices of the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson), 29, Great George-street, Westminster, S.W. Tenders to the town clerk (Mr. Frederick Ryall), Spa-road, Bermondsey, London, S.E., by noon March 1. See also advertisement.

The Council of the Metropolitan Borough of *Shoreditch* invite tenders for the supply of stores for their electricity works department, &c., for the year ending March 31, 1905. Tenders to the town clerk (Dr. H. Mansfield Robinson), Town Hall, Old-street, London, E.C., by 3 p.m. March 8. See also advertisement.

Salford Corporation invite tenders for various stores for their electricity department, particulars of which are set out in an advertisement. Specifications from the borough electrical engineer (Mr. C. D. Taite), Frederick-road, Pendleton. Tenders (addressed chairman of Electricity committee) by 9 a.m. 29th inst.

Weymouth and Melcombe Regis Corporation invite tenders for the lighting of their generating station and the supply of electricity meters. Specifications, &c., from the town clerk (Sir Richard Nicholas Howard, J.P.). Specifications and drawings can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to the town clerk by March 7. See an advertisement elsewhere.

Kilmarnock Corporation invite tenders for the supply and erection of pipe-work, feed-pump, economiser, jet-condensing plant, &c.; arc and incandescent lamps, posts and gear; lighting and traction feeders, mains, switch pillars and road-work, and electricity meters. Specifications from the town clerk (Mr. W. Middlemas), and may also be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to the town clerk (for arc lamps, &c.) by Feb. 29 and (for pipe work, &c.) by March 14. See advertisement.

The *Great Central Railway Co.* invite tenders for the supply (during the 12 months ending April 30, 1905) of stores and materials, including telegraph and electric light materials, wire, asbestos, &c., packing, glass, iron, indiarubber, oil, screws, signalling materials, &c. Patterns can be seen from Feb. 22 to 29 inclusive on application to the store-keeper (Mr. A. W. Longden), Cornwall-street, Ogden-lane, Openshaw. Specifications and forms of tender from the secretary (Mr. Oliver S. Holt), London-road Station, Manchester, to whom tenders by 10 a.m. March 1. See also advertisement.

Wimbledon District Council invite tenders for various stores required during the year ending March 31, 1905, including engine-room stores, cables, joint boxes and jointing materials, transformers, meters, lubricating oils, incandescent lamps and carbons. Specifications, &c., from the chief electrical engineer (Mr. H. Tomlinson Lee), electric light works, Durnsford-road, Wimbledon. Tenders to the clerk (Mr. R. H. S. Butterworth) Council offices, Wimbledon, S.W., by noon March 18. See also advertisement.

St. Anne's-on-the-Sea District Council invite tenders for the supply and erection of a steam dynamo. Specification from the chief engineer (Mr. James H. Clothier). Tenders to the clerk, Council Offices, St. Anne's-on-the-Sea, by noon Feb. 27. See also advertisement.

Tenders are invited for the supply of arc lamps and accessories for the general lighting of the forthcoming *Cape Town* Exhibition, 1904-1905. Plans, &c., from the Torque Electrical Engineering Co., 20 and 28, Dalling-road, Hammersmith, London, W. See advertisement.

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The Scottish Office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring the installations set out in an advertisement for direct connection to the fire brigades at Aberdeen, Dundee and Edinburgh. Tenders close 24th inst. Particulars from the managing director (Mr. Geo. H. Oatway), 49, Queen-street, Glasgow.

Electrical contractors willing to make a speciality of fire-alarm signalling with direct brigade connection should keep in touch with the company's head offices, 92 and 94, Paul-street, Finsbury, London, E.C., where urgent contracts are given out without advertising.

Kirkcaldy Corporation also require tenders by 27th inst. for permanent way work inside the car-sheds extension.

Tenders are invited by March 7 for six months' supply of stores to *Newcastle-on-Tyne* tramway department.

Tenders are invited for electric light fittings, &c., to Richmond (Dublin) District Asylum for 12 months. Tenders by 23rd inst. to chief clerk to managers, Grangegorman-annexe, *Dublin*.

The Metropolitan Borough Council of *Islington* will meet on Feb. 26 to consider tenders for various electrical stores. Forms of tender at Town Hall, Upper-street, London, N. Tenders by noon Feb. 25.

Islington (London) Borough Council also invite tenders for the supply and laying on the solid system and drawing into existing conduits of lead-sheathed, paper-insulated, double-concentric and triple core, high-tension feeders and low-tension distributors, and pilot cable, with feeding junction and service boxes. Tenders to the town clerk (Mr. Wm. F. Dewey) by noon Feb. 24.

Guardians of St. Mary, *Islington*, require tenders by 11 a.m. March 10 for stores during ensuing 12 months, including electrical requirements.

The *New General Traction Co.* invite tenders for the construction of about 3 miles of new tramways and the reconstruction of 5½ miles of tramways at Coventry. Tenders to the engineer (Mr. I. E. Winslow), 20, Bishopsgate-street Within, London, E.C., by 1 p.m. March 5.

Tenders are invited for electricity meters, house service boxes and fuse boxes, to be supplied during ensuing 12 months to the Metropolitan Borough of *Hammersmith*. Tenders to the town clerk, Town Hall, Hammersmith, by 6 p.m. Feb. 24.

Blackburn Electricity and Tramways committee invite tenders for stores for the Electricity and Tramways departments for year ending March 25, 1905. Tenders to chairman of committee, Town Hall, Blackburn, by noon Feb. 29.

Sunderland Corporation invite tenders for a travelling crane and a storage battery. Tenders to chairman of Electric Lighting committee, Town Hall, Sunderland, by noon Feb. 26.

Ealing Corporation invite tenders for one 750kw. steam alternator, central service condenser, &c. Tenders to chairman Electricity committee, Town Hall, Ealing, W., by 4 p.m. Feb. 25.

Fulham (London) Borough Council invite tenders for the supply of electrical stores for year ending March 31, 1905. Tenders to the Town Hall, Fulham, by 4 p.m. March 2.

Hornsey Town Council invite tenders for stores for electricity works and cable and cable stores, &c. Tenders to the town clerk by 4 p.m. Feb. 29.

Greenock Corporation invite tenders for one 400kw. steam-driven traction and lighting generator. Tenders to town clerk (Mr. Colin MacCulloch), by 10 a.m. Feb. 25.

The *Metropolitan Asylums Board* invite tenders by 10 a.m. March 8 for installation of fire alarms and telephones at Caterham Asylum.

Halifax Corporation require tenders by noon 29th inst. for one year's supply of stores for electricity and tramways departments.

The *Norwegian State Railways Department* invite tenders (until 3 p.m. Feb. 26) for telegraph and telephone material, including 3,000kg. galvanised iron wire 2·9–3·1mm. dia., 1,000kg. galvanised binding iron wire 1·5mm. dia.; 1,000 metres seven-strand insulated copper cable (7 by 0·4), 1,000 porcelain insulators, 1,000 carbon plates for Leclanché batteries, 400kg. salammoniac, 4,000 (3,000 large and 1,000 small) rolled battery zincs. Conditions and drawings can be seen at the office of the Inspector of Telegraphs, Christiania. Apart from usual Customs duties, a preference of from 10 to 15 per cent. is given to Norwegian tenderers.

The municipality of *Port Elizabeth* (South Africa) invite tenders for the supply of telephone material for the Sand, Palmiet and Bulk River water scheme. Tenders to the agents of the municipality (Messrs. Davis and Soper), 54, St. Mary-axe, London, E.C., by 10 a.m. Feb. 22.

Retz (Austria) Municipal Council invite tenders until March 20 for the erection of electricity works.

The "Madrid Gazette" of Feb. 9th contains a notice calling for tenders up to March 21st for a concession to establish and work for 20 years a telephonic system in the city of *Figueras*, Spain. Particulars and tenders to Director-General of Posts and Telegraphs, Carretas 10, Madrid.

The same "Gazette" announces that, as no contract resulted from the competition on December 26th last for the supply of "electric fluid" for the lighting of *Plasencia*, fresh tenders are called for up to March 28th.

TENDERS RECEIVED AND ACCEPTED.

Salford Council have accepted following tenders for supplies to the electricity and tramway departments:—

J. Fowler & Co., switchboard panel, £60; Smith and Coventry, large lathe £294. 10s., small do. £157. 10s., radial drill £196; Kendall and Gent, planing machine, £232; Hulse & Co., shaping machine £109, milling machine £105, screwing machine £42, punching and shearing machine £98; Holroyds & Co., light drill, £50; Cunliffe and Croom, sensitive drill, £18; Miller & Co., wheel press, £85; Cravens Limited, wheel borer, £275; B. and S. Massey, power hammer, £130; Tattersall & Co., emery grinder, £32; Davidson & Co., blowing fan and motor, £51; Reavells & Co., air compressor £73, and air receiver £22; Binns & Co., bending rods, £60; Lumsden & Co., for oil groove cutting machine, £44; Herbert & Co., hack saw, £23; Carters Limited, oil pumps £7, oil cisterns £21. 17s. 6d., grindstone £12, shafting brackets and bearings £203. 4s. 6d.; Lees & Co., band saws £67, circular saw £25. 10s., small saw £16. 10s., wood planer £34, panel thicknessing machine £31. 15s.; Robinson & Co., mortising machine, £77. 7s. 6d.; Burton, Griffiths & Co., rail saw, £26. 15s.; Selig, Sonnenthal & Co., portable crane, £30; British Thomson-Houston Co., portable electric drill, £70. 10s.; British Westinghouse Co., re-babbiting plant, £120; Hadfields Limited and Baker & Co., steel-tyred wheels, £9 per pair.

Newcastle-on-Tyne Corporation have placed an order with the British Thomson-Houston Co. for 50 additional G.E.-58 tramway motors and equipments. Over 200 G.E.-58 motors are already in use on the cars at Newcastle.

Whitby District Council have accepted the tender of Callender's Cable and Construction Co. for feeding and distributing mains at £1,396. 1s. 1d. There were 10 tenders, varying from £1,242. 6s. 7d. to £1,508. 1s. 1d.

Bradford Corporation have placed an order with Bolckow, Vaughan & Co. for 750 tons of girder steel rails at £5. 13s. 11d. per ton and steel fishplates at £7. 3s. 11d. per ton.

Leigh (Lancs.) Council have accepted the tender of the Horsfall Company for a four cell refuse destructor at £2,204.

High Wycombe Guardians have accepted the tender of R. C. R. Potter for electric bell and telephone installation at the workhouse.

The British Westinghouse Co. have received an order (by cable) from the Dunedin (N.Z.) branch of Messrs. Noyes Bros. for a 5,000-volt alternator of the rotating field type, with direct-connected exciter.

A. W. Penrose & Co. have secured the order for electricity generating plant for the premises of Messrs. Harvey, Greenacre & Co., Johannesburg.

A contract for the supply of generating plant (also electric motors) for operating the East London (South Africa) Harbour Board's cranes, capstans, &c., has been placed with the Allgemeine Elektricitäts Gesellschaft, Berlin.

Mather and Platt have obtained an order for supply to the De Beers Consolidated Mines of two electrically-driven centrifugal pumps capable of pumping 1,000 gallons per min.

Beckenham District Council have accepted the tenders of Buchanan & Curwen, G. Dean and E. Newbold & Co. for the wiring of premises under their prepayment scheme.

Harrismith (Orange River Colony) Municipality have accepted the tender of Mather and Platt for two 80kw. steam alternators, two water-tube boilers, ejector condensers, switchboard, &c., and that of Graham, Morton & Co. for corrugated iron buildings.

BUSINESS NOTICES.

The Lancashire Dynamo and Motor Co. (Ltd.), Trafford Park, Manchester, have, owing to extension of their business, removed their London offices from 49, Queen Victoria-street, E.C., to Victoria Mansions, 28, Victoria-street, Westminster, S.W.

We are informed that Mr. J. F. Lister, late general manager of the Lister Electric Mfg. Co., has resigned his position and has joined Veritys Limited as manager of the motor and machinery department at Aston, Birmingham.

Messrs. J. Foxcroft and W. J. V. Duncan, electrical engineers, 24, Queen's-road, Dalston, N.E., have dissolved partnership. Debts by Mr. Duncan.

Messrs. Holdsworth & Sons, boiler makers, Bradford, have appointed Messrs. Frank Jordan & Co., 15, George-street, Mansion House, London, E.C., their sole representatives in London and the south-eastern district.

Messrs. Doddrell Bros., 11, Bothwell-street, Glasgow, have been appointed agents in Scotland for Combe Barbour (Ltd.).

LIQUIDATIONS, BANKRUPTCIES, &c.

S. Gardner, trading as Gardner Bros. & Co., electrical engineer, Horninglow-street, Burton-on-Trent, has been adjudicated bankrupt. The public examination took place at Burton on Wednesday.

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Liabilities, £2,811; assets, £101. Failure due to lack of capital and bad trade, the latter extending over some months. Examination adjourned.

The public examination of Max Margowski, financial agent and managing director of the Automatic Telephone Co. (1903), Ltd., took place on Friday last:—

The gross liabilities were £13,507. 7s. 6d., of which £1,607. 7s. 6d. was expected to rank; assets £651. Debtor stated that he came to England from Central America in 1892. By birth he was a German, and a naturalised American. He formerly carried on business in New York. He came to England to develop concessions he had acquired for building railways, mining and establishing certain industries in Honduras. He sold the concessions to a company of which he was appointed a director. He had also been connected with other undertakings, in which he had lost £175,000 in cash. These losses were the cause of his bankruptcy. He had also been interested in other things, including telephone patents. Examination concluded.

A receiving order has been made against the Electrical Contracting and Maintenance Co., lately of 3 and 4, High-street, Ilford. First meeting of creditors on 26th inst, and public examination on March 24 at Bankruptcy-buildings, London, W.C.

Winding-up Petitions.—A petition for the winding-up of the Automatic Telephone Co. (1903), Ltd., will be heard on 23rd inst. in the High Court. At a meeting on 11th inst. it was resolved to wind up the company voluntarily, Mr. J. Cheves, 16, South-street, Finsbury, London, E.C., to be liquidator.

A petition for the winding-up of the National Electric Traction Co. (Ltd.) will be heard on 23rd inst. in the High Court.

Sales by Auction—Messrs. Wheatley Kirk, Price & Co. have received instructions from the liquidator (Mr. J. P. Garnett) of Heaton and Smith (Ltd.) to sell by auction on March 3 and 4, at 11 a.m. each day, on the premises, Salford Switch Works, Frederick-road, Salford, Lancs., the entire stock-in-trade, work in progress, loose tools and utensils, office furniture and other effects. The catalogue will comprise a large number of enclosed motors, switchboards, distribution boards, electroliers, wall and other brackets, pendants and a variety of fittings, switches, &c. Further particulars are given in an advertisement. Catalogues from Messrs. David Smith, Garnett & Co., C.A., 22, Booth-street, Manchester; Messrs. Parkinson, Slack and Needham, solicitors, 10, York-street, Manchester; or from the auctioneers, Albert-chambers, Albert-square, Manchester, and 46, Watling-street, London, E.C.

Messrs. Fryer, Cooper & Co. will sell by auction on the premises on Feb. 25, at 1 o'clock, the lease of the manufacturing premises, No. 28A, Chatham-place, Mare-street, Hackney. The property, which is well built and exceptionally well lighted, is admirably adapted for manufacturing purposes. Particulars and conditions of sale from Messrs. Hind and Robinson, solicitors, 8, Stone-buildings, Lincoln's Inn, London, W.C., and of the auctioneers, 3, Whitecross-street, E.C. See also advertisement.

Plant for Sale.—The Metropolitan Electric Supply Co. have for disposal a few 100-period motors for 100 and 200 volt circuits and a few Elwell-Parker, Johnson and Phillips and Westinghouse transformers in iron cases, for which they have no further use. Further particulars from the superintendent, testing department, 10, Sardinia-street, London, W.C. See also advertisement.

The Western Electric Co., North Woolwich, London, E., have for sale a Peache patent high-speed engine direct-coupled to a 75kw. direct-current generator, a Wheeler surface condenser, a power and light switchboard, a horizontal engine, a feed-water heater and boiler feed pump, and four steam-driven hydraulic pumps. Further particulars are set out in an advertisement.

Premises to Let—An exceptionally well-built, fireproof factory warehouse (over 14,000 superficial feet), in close proximity to Liverpool-street Station, London, E.C., is to be let or sold. Further particulars from Messrs. W. J. Bush & Co. (Ltd.), Ash-grove, Hackney, London. See advertisement.

A large light warehouse, conveniently situated near King's Cross (London, N.) railway stations, and specially suitable for motor works, is to be let. See advertisement.

Electric Motors Required.—Offers are invited for the supply of small motors for the Cape Town Exhibition, 1904-5. See advertisement.

"**The Journal.**"—Part 164 of *The Journal* of the Institution of Electrical Engineers is now ready, price 2s. Particulars of contents are given in an advertisement.

"**Technics.**"—No. 2 of this new magazine for technical students, published by George Newnes, London, is issued, and amongst the contents are articles by Mr. James Swinburne and Mr. H. M. Hobart.

New Magazine.—Mr. George Offor is editing a new monthly magazine entitled "Electric Light and Power," intended for circulation among residents in streets through which mains have been laid.

Speed Indicators.—Messrs. Geipel and Lange, Vulcan Works, St. Thomas-street, London, S.E., are introducing a new form of speed indicator (the Vulcan) for automobiles, tramcars, &c., and for which advantages in respect of lightness, ease of fixing and accuracy are claimed.

The apparatus consists of a magneto driven off one of the wheels, and a hot-wire voltmeter, connected to the magneto by means of a flexible wire, which forms the speed indicator. The indicator is of watch pattern, 2in. in diameter, and weighs 3oz. It is preferably fitted on the steering wheel, to be immediately under the eye of the driver. The dial is calibrated to indicate from 5 to 45 miles per hour, and as the needle is perfectly dead beat, speed indications can, it is claimed, be read under the worst conditions of vibration. The magnet is only 6in. by 2in. and weighing 1½lb. It is arranged preferably for fixing on the steering horn of the front wheel, from which it is driven by means of a rubber band passed round a small aluminium pulley, fixed on the inside of the wheel. The armature consists of iron only, and there are no moving wires or electrical contacts whatever, as the coils in which the current is generated are placed inside the magneto sealed in by paraffin wax. The indicator may, of course, be placed in any other position than on the steering pillar if desired, while the magneto may be driven from one of the hind wheels.

"**Deadfit**" **Keyway Slotter.**—Whenever a special key-slotting machine tool is not available, it is usual practice to cut a keyway in bosses by hand with hammer and chisel. This method is slow and inaccurate, and the aim of the new "Deadfit" slotter (made by Rimington Bros., 63, Queen Victoria-street, London, E.C.) is to provide means for carrying out the operation with speed and accuracy. The tool consists of a steel bar with a cutting edge at one end and a blunt head at the other, sliding in a slotted guide. After this body has been rigidly fixed inside the boss by means of screws, the tool is driven through by a hammer, the tool being guided by the slot in the body. Cut is given by means of packing strips which are placed successively behind the cutters. Various sizes of these useful tools are made.

Catalogues.—Messrs. P. Walters & Co., of 249 and 251, Kensal-road, London, W., have compiled a useful and very well-arranged catalogue of telegraph and telephone instruments, railway block and signalling apparatus, line material, linesman's tools and materials for electric light and power systems. The catalogue is illustrated throughout with a number of excellent photo process and wood blocks, and much care has been shown in the arrangement of the matter. In nearly 100 quarto pages an infinite variety of apparatus and material is listed and described. The accompanying illustrations show three of the items listed. Fig. 1 is a neat portable telephone set, consisting of micro-telephone with battery key in handle and 4 conductor cord, induction coil, magneto-generator and bell, lightning protector and a dry battery. Fig. 2 is a compact box for fixing to semaphore posts, provided with three single contact springs and three terminals. Fig. 3 is a fuse wire lightning protector used in submarine cable working.

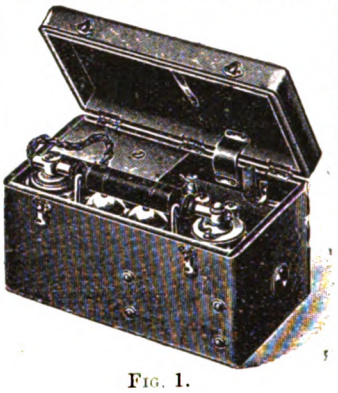

FIG. 1.

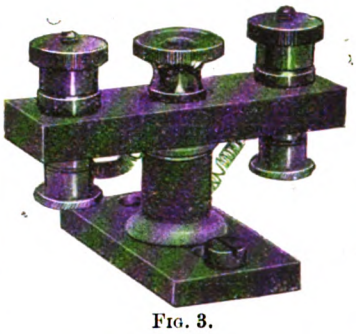

FIG. 3.

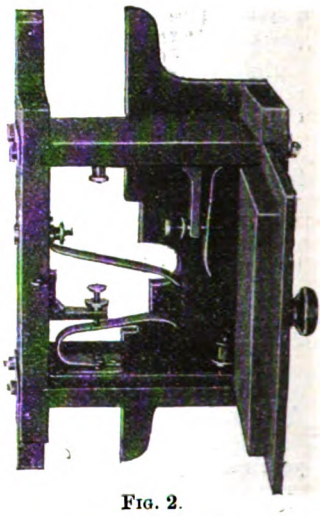

FIG. 2.

The Crypto Works Co., 29, Clerkenwell-road, London, E.C., have ready Section II. of their new catalogue, which deals with a variety of Crypto electrical specialities.

The British Thomson-Houston Co. have ready a new list (pamphlet 164) of type H transformers.

Patent Amendment.—Mr. Henry Harris Lake (Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, London, W.C.), seeks leave to amend the specification of letters patent No 2,376, 1902, granted to him for "Improvements in and Relating to Electrolysis." Particulars of the proposed amendment are set out in the "Illus-

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trated Official Journal" (Patents) of 17th inst., and notices of opposition must be given within one calendar month from that date.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Feb. 10 to 16, with the ports of destination:—

Africa—Alexandria, £223; Delagoa Bay, £6,827 (telegraph material); Durban, £1,880 (including £1,028 telegraph material); East London, £2,874 (including £1,338 telegraph material). *Argenina*—Buenos Ayres, £250. *Australasia*—Adelaide, £73; Auckland, £35; Brisbane, £59; Hobart, £450; Lyttelton, £35; Melbourne, £590 (including £535 telegraph material); Otago, £24; Perth, £35; Rockhampton, £36; Sydney, £787; Wellington, £2,521. *Brazil*—Rio Grande, £29. *Ceylon*—Colombo, £638. *China*—Shanghai, £611. *Colombia*—Santos, £19. *Gibraltar*, £989. *Holland*—Amsterdam, £95. *Hong Kong*, £733. *India*—Bombay, £15; Calcutta, £1,446 (including £847 telegraph material). *Italy*—Messina, £16 (telegraph material). *Japan*—Tokyo, £28. *Portugal*—Lisbon, £547. *Russia*—Odessa, £40; St. Petersburg, £1,338 (telegraph material). *St. Helena*—£70 (telegraph material). *Seychelles*—£20 (telegraph material). *Siam*—Bangkok, £28. *Spain*—Bilbao, £17. *Straits Settlements*—Penang, £102; Singapore, £3,571. *Turkey*—Salonica, £64 (telegraph material). Total £37,115, against £14,529 in the corresponding week last year (Feb. 11 to 17).

COMPANIES' MEETINGS AND REPORTS.

Kensington & Knightsbridge Electric Lighting Co. (Ltd.).

The seventeenth ordinary general meeting was held yesterday, Lieut.-Col. R. E. Crompton, C.B., in the chair.

The SECRETARY (Mr. R. S. Erskine) read the notice calling the meeting,

The CHAIRMAN then said: Gentlemen, our late chairman, Sir Frederick Bramwell, commenced his last year's address to you by deploring the loss of two directors who had served you since the formation of your Company. We have now to mourn the loss of Sir Frederick himself, who had been with us from the very first. My colleagues have done me the honour of selecting me as their Chairman in Sir Frederick's place. I feel it will be hard indeed for me to follow worthily in his footsteps, but the condition of your affairs, both financially and from an engineering point of view, is so good that my task should prove an easy one. The shareholders will, I hope, believe with me that everything relating to our company is in a thoroughly satisfactory condition, and bodes well for the future progress and to a continuance of satisfactory dividends. Turning to the report itself, we show a satisfactory increase in the number of lamps that we supply. The point to which our renewal fund has reached is satisfactory, and is a feature of great strength. That fund, gentlemen, is now upwards of 15 per cent. of our actual capital expenditure. It is not easy to compare this fund with that of other companies as the accounts are not kept quite in the same way, but, as far as I can judge, no other company has set aside so large a sum in proportion to its capital expenditure as we have done. Turning now to our proposed distribution of profits we are able to declare a 10 per cent. dividend, and we advise in addition a bonus of 2 per cent., bringing the total distribution this year to the rate of 12 per cent. per annum. The Directors have adopted this method of distributing the profits after very careful consideration. You are aware that from time to time as we have reduced our cost of production, we have given back part of it to our consumers in the shape of reduced prices, but it is not possible or convenient to give these reductions yearly. They must be made at longer intervals of time, as after each reduction for some little time our profits are somewhat diminished until the increased consumption following on the reduction comes to our assistance. Then in a year or two the amount carried forward mounts up until, as in the present case, we consider that we should distribute part of it to you in the form of a bonus. By distributing these surplus profits in this manner in the form of a bonus, we feel we are carrying out the policy of maintaining your dividends at as steady a level as possible, and thus avoid any chance of a set-back during years when fuel is dear. Turning now to the working accounts, I am somewhat in the position of an expert in these matters, and am, therefore, able to call your attention to points in which the accounts appear, to my mind, exceedingly satisfactory. I think that you, the shareholders of this Company, have every reason to be proud of the position of your undertaking. Turning to the other side of the account—working cost—I think the shareholders ought to congratulate themselves, and to thank our staff who have obtained such excellent results. It gives me great pleasure to point out that the total working cost this year has reached the lowest figure ever reached in London. We have produced cheaply and have been able to sell cheaply. There is one item in our accounts on which I feel quite as strongly as our late chairman—namely, the iniquitous manner in which we are assessed for rating purposes. The assessment as at present carried out is in the nature of an income tax—that is to say, is based on our profits. The more we reduce our working expenses the greater is the sum on which we are assessed and on which our rates are levied. As a consequence, we now pay in the form of rates to the two metropolitan parishes in which our works are situated a sum equal to 60 per cent. of our coal bill, whereas the other companies adjoining us only pay two-thirds of this amount. This assessment question is entirely beyond our control, but it is right that the shareholders should know what a large proportion of their receipts already go to the public authorities. I may add that the Directors have decided to notify a considerable reduction in the charge for electric current under certain conditions of supply. I now move the adoption of the report and accounts.

Mr. R. W. WALLACE, K.C., seconded the motion, which was unanimously agreed to.

Resolutions approving the dividends, re-electing the retiring directors (Sir Henry W. Bliss, Mr. C. C. Wyllie and Mr. G. H. Hopkinson), and reappointing the auditors (Messrs. Price, Waterhouse & Co.) were then approved, and a cordial vote of thanks to the Chairman terminated the proceedings.

Anglo-American Telegraph Co. (Ltd.).

The general meeting of this company was held on Friday last under the presidency of Mr. S. Barber (who, in the absence of Mr. F. A. Bevan, chairman of the company, who was in Egypt, and of Sir Gerald Fitz-Gerald, who was absent through illness, was voted to the chair).

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: Gentlemen, it is the practice of the chairman at these meetings to give a general account of the stewardship of the company during the past year. Turning to the accounts you will see that in the past year there has been a falling off in the traffic. The prosperity of telegraph enterprise is greatly dependent upon the prosperity of other trades, and in these there has been little if any improvement in the past year. The balance left available for dividends for the half-year is £109,628, against £117,206 in 1902. Notwithstanding this, we have been able to pay 31s. per cent. on the ordinary stock, against 33s. in the previous year. For the half-year ended June 30 last the revenue admitted of the payment of 30s. per cent. on the ordinary stock, against 27s. 6d. in 1902. The result, therefore, after placing the usual £24,000 to renewal fund, is to give a dividend of £3. 1s. per cent. on the ordinary stock, compared with £3. 0s. 6d. for the previous year, the preferred stock receiving its full 6 per cent. and the deferred stock 2s. per cent., which is 1s. more than last year on the latter. I may say that we owe a good deal of this dividend to the earnings of our cable steamer "Minia," working on repairs on behalf of our partners. This vessel has earned £14,890 in excess of her earnings the previous year, or, in all, £19,290 There has been an increase in expenditure, due to increases in salaries and wages at stations and some alterations in buildings, &c. As regards the renewal fund, this now amounts to £983,103, as shown in the accounts, but if we were to take to-day's market prices it would be short of this amount by £44,000. The directors are giving careful attention to the question of dealing with the renewal fund, but I may say that the necessity for the fund is made apparent when I tell you that during the past year the 1873 cable was interrupted twice and the 1874 cable three times. For a short period four of our cables were interrupted at one time. We have had two deep sea repairs and eight repairs in shorter sections during the past year, but I am pleased to say that at the present moment all our cables are in good working order and have been so practically since the end of 1903. During last year we carried 1,500,000 more words than in the previous year, which shows that our staff is working in the best possible manner; in fact, I cannot find words to express the feelings we have for the admirable work done by our staff, particularly by the superintendents at the stations and by our general manager (Mr. Carson), who, I think, may be classed as one of the leading experts in telegraphy. I fear I can give no great hope for the coming year. Business generally is very slack, but everything that can be done will be done to secure the traffic, and, if we can get it, to carry it. I daresay you will have noticed that we have been carrying some traffic via the Pacific from Australia at a very high rate of speed; in fact, we have brought the distance between Australia and London to 3½ minutes, which, I think, is a record. I now move the adoption of the report and accounts, and that the dividends set out therein be declared and paid.

Mr. W. S. CUNARD seconded.

Mr. LEE-SMITH said he would have liked to have heard something about Mr. Marconi, and made an appeal on behalf of the deferred shareholders.

Mr. TUCKER asked whether it would not be advisable in a company of such magnitude, as the Anglo-American, that the reserve fund be written down. The chairman had said, too, that in the past year they had carried a million and a-half more words, and yet there was a decrease in the traffic receipts of over £14,000.

Mr. WOOD could not agree that the investments of the reserve fund should be written down, otherwise the fund would vary up and down with every change. He urged that the proper course was to put the fund at the cost price of the investments. He hoped before the directors altered their policy with regard to the deferred fund they would carefully consider the matter. There was much to be said on both sides.

Mr. RUTTER complained that all the additional expenses of the company were borne by the deferred and the ordinary shareholders only, the preference shareholders taking all the profits.

Mr. W. EDMUNDS said he had been a shareholder in the Anglo Company and its predecessor for about 40 years, but this was the first meeting he had ever attended. He held £10,000 in ordinary and preferred stock in the company, and was very well satisfied with his investment, and recommended other shareholders to average their holdings and they would have no cause to grumble. He wished to know how the French litigation stood. How was this matter going on and how did the expenses stand in the accounts?

Mr. BAKER urged that there should be no longer a deduction of £24,000 a year from the revenue, or that if a sum must be taken it should be reduced to £12,000 only.

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Mr. JOHN NEWTON hoped the board, in considering the position of the deferred shareholders, would view the matter from the same point of view as hitherto, that the splitting of the stock was the result of a bargain —that one should be considered an investment stock and the other speculative. He urged that they should still continue their policy of keeping the renewal fund at or about £1,000,000. He would like to know whether the Anglo Company was getting some of the traffic coming over the Commercial Pacific cable to London, There was a large reduction in the traffic of some of the companies who got it when it came the other way, and now that it was coming over the Atlantic the Anglo ought to get some of it. With regard to their investments, he urged that they were not in any way similarly placed to a bank, and therefore it would not do for them to move the values of their investments up and down. He felt that the directors had acted in such manner during the last 30 years of the company's existence, that they could be thoroughly relied upon to protect the interests of the stockholders.

Mr. CHARLES BURT said he had been connected with the company from the beginning. He considered the directors had to look at the interests of the £7,000,000 of stock of which the company consisted, and if they were to consider in one year the preferred stock and in another year the deferred stock there would be no peace nor any certainty as to the line the directors would take. They must look at the interests of the company as a whole.

The CHAIRMAN, in reply, said that as regarded Mr. Marconi, there was really nothing to say. He might be affecting the atmosphere, but he was certainly not affecting deep sea cables. With regard to the million and a-half extra words they had carried, he would point out that they had benefited by the earnings of their cable steamer "Minia," and those earnings had been due to the unfortunate mishaps of their partners. They had a benefit on the one hand and had to pay for it on the other. With regard to the Pouyer-Quertier suit, from the contents of a letter received from their solicitor he found that the case would have been already disposed of but for the congestion in the French courts over matters of great public interest in that country. He (the solicitor) hoped that the hearing might take place in about April next. The French action, so far as they were concerned, had been wiped off, and anything they might receive would be to the credit of profits.

The motion was then carried unanimously.

The retiring directors (Mr. Robert H. Benson and Mr. Herbert S. Leon) were re-elected, as were the retiring auditors.

A cordial vote of thanks to the general manager and staff was carried unanimously, and the proceedings terminated.

National Telephone Co. (Ltd.).

The thirty-third ordinary general meeting was held yesterday, the Right Hon. Sir HENRY FOWLER, M.P., presiding.

The SECRETARY (Mr. Albert Anns) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: So far as the past half-year is concerned, I think you will regard the report as satisfactory. Our income has amounted to upwards of £941,000, compared with £868,000 in the corresponding period of last year. After meeting all expenses, including Post Office royalties, there is an available balance of £269,421. The board recommend the same dividends as before—namely, at the rate of 6 per cent. per annum on the first and second preference, 5 per cent. on the third preference, 6 per cent. on the preferred stock, and 5 per cent. on the deferred stock (less tax in all cases). In addition, we propose to transfer £110,000 to reserve fund and to carry forward £10,505. Taking 1903 as a whole, our income has been £1,835,000, against £1,691,000 in 1902. When the Post Office royalties have been deducted, the increase is £130,000. Having regard to all the circumstances, I think the record is encouraging. In 1902 we spent £562,000 on capital account, and in 1903 £747,000. The item of rents, rates and taxes, which form no small part of the working expenses, has grown by £10,150. I see the chairmen of most of our great railway companies and manufacturing concerns have been calling attention to the rapid and continuous increase in the rates that they have been called upon to pay. I am not complaining of them—I have my own opinion with regard to this matter—but I agree with my railway friends and others in thinking that this is a case where taxation and representation should go together. I believe that the contribution last year to the local rates by railway companies was upwards of £3,000,000, and yet they have no representation on the local boards. I must say a word or two respecting our unexecuted orders. You frequently see complaints by people who say that they have given an order to the company for the telephone but that it has not been carried out. There are two reasons why such orders cannot be executed with the same facility as an order for a pound of tea or some other article. In the first place, we have to provide additional capital for every order, and in the next place we are constantly confronted with difficulties as to wayleaves. Last year at this time we had 8,315 unexecuted orders, and this year the number is 10,563. These figures at least show that our business is not a dwindling one. The increase in the Post Office business has brought about no diminution in ours, but, on the contrary, has been accompanied by an increase in the number of our subscribers. The question which has occupied the attention of your board for many months is this—that if our telephone business is to be carried on efficiently and successfully it will be impossible to discontinue further capital expenditure. Every new subscriber means additional outlay, and the difficulty is not to obtain new subscribers, but the lamentable alternative of discouraging any increase in their number. The telephone business is essentially a progressive one. In London especially, where the company is working in harmony with the Post Office, we must incur additional outlay to maintain the efficiency of the service and also to provide necessary extensions of plant. If London is to be provided with anything like an adequate telephone service, both the Post Office and the company must at once face the question of large additional capital outlay, and this applies to the company's business in all the other big towns. To assist them in connection with this question the board thought it wise at the Christmas holidays to get the general manager (Mr. Gaine) and the chief engineer (Mr. Gill) to visit America to see what was going on there with regard to latest improvements. I have asked Mr. Gaine to prepare for my use at this meeting a memorandum giving the general results of his visit, and this is (in brief) what Mr. Gaine says:—

"Accompanied by the engineer I visited a considerable number of the principal towns in the United States and in Canada, including New York, Boston, Montreal, St. Louis, Washington, Baltimore and Philadelphia, and we made a close and exhaustive examination into the telephone systems in the cities and places visited. My previous visit to the States was in 1900. The development which has taken place during these three years has been extraordinary. We may for this purpose compare London with greater New York, Liverpool with Philadelphia, Edinburgh with Washington, Boston with Manchester, and Montreal with Bristol.

London and New York.—The telephone area of London covers 640 square miles, and the population is about 6½ millions. Greater New York (which includes New York City, Brooklyn, Jersey City, Newark, Long Island, and suburban districts) covers an area of about 400 square miles, with a population of 4 millions. In London the National Company has about 65,000 lines, whilst the Postmaster-General recently stated that the Post Office had 15,000, making together 80,000; in greater New York the number is upwards of 200,000. In Manhattan Island alone, which constitutes the centre of New York, and which has an area of about 21 square miles, and is about equivalent to the area covered by the City, Westminster and Kensington, there are upwards of 110,000 lines at work. The New York service is not a cheap service—the charges are at least three times more than those which are now in operation in London—but, notwithstanding the high prices charged, the New York service is popular, and it fulfils the public requirements. The lowest charge for service in New York proper—that is, in Manhattan —is £15. 12s. 6d. per annum to cover 600 local calls in Manhattan only (calls to Brooklyn, New Jersey, &c., being charged extra at rates varying from 7½d. to 1s. per call), and the scale goes up to £47. 10s. per annum to cover 4,500 local calls, after which the charge is 2½d. for each local call. The charges in London which compare with these are £17 per annum for an unlimited service over the whole 640 sq. miles of the London area, and a message rate of £5 per annum with a 1d. or 2d. for each local call, depending upon whether the call is in inner or outer London.

Liverpool and Philadelphia.—In Philadelphia, with a population of 1,350,000, there are about 45,000 lines working; in Liverpool, including Birkenhead and Bootle, with a population of upwards of a million, about 20,000.

Edinburgh and Washington.—Washington, with a population of 300,000, has about 12,000 lines working; Edinburgh (excluding Leith), with a population of 317,000, between 4,000 and 5,000.

Manchester and Boston.—Manchester, including Salford, Eccles and their suburbs, has a population of 1,120,000, and has 13,815 lines at work, while Boston telephone area, with a population of something over 1,000,000, has 54,000 lines.

Bristol and Montreal.—Bristol and suburbs, with a population of 385,000, has between 3,000 and 4,000 lines working, and Montreal, with a population of upwards of 350,000, has 13,000 lines.

The charges in these American areas are, generally speaking, about three times as much as those of this company. For instance, the unlimited-service rate in Boston is £32 per annum; in Philadelphia the scale commences with £14 for 800 calls, and goes up to £30 for 3,000 calls. In the British towns named this company gives unlimited service for £10 per annum. In Montreal the charge is the same as in the large towns in this country—viz., £10 per annum. Generally throughout the States and Canada the development is on a par with the instances I have given. The capital invested in the telephone enterprise in America and controlled by the American Telephone and Telegraph Co. is about £48,000,000, and during the past 3 years the new capital brought into the business has averaged each year upwards of £8,000,000. During the past year it will exceed £10,000,000. I am satisfied that if this company was in a position to canvass freely and to develop the business properly, the number of telephone users in this country could be more than doubled in a comparatively short time. I am of opinion that provision will have to be made for the expenditure on the telephone system of this country of upwards of £10,000,000 of new capital within the next few years.

In examining into the telephone systems of America and Canada we naturally devoted time and attention to the question of plant. Acting upon the advice of its technical officers, this company has, during the last few years, arrived at the conclusion that the common battery or central energy system of working is that which is ultimately going to survive. Very large sums have already been spent in equipment of this character both in London and the provinces, and the company has heavy commitments in this direction before it especially in London. The Post Office has adopted this plan for its London system. With few exceptions all the great towns both in America and Canada are working common battery switchboards. The conclusion at which I arrived after my previous visit to the States is fully confirmed, and I am quite clear that all the money which the company has spent and is pledged to spend in this connection is, and will be, money well spent."

Continuing, the CHAIRMAN said: I think this is a very valuable report, and we will take care that every shareholder has the opportunity of reading it. Now, our capital expenditure at Dec. 31, 1894, was £4,560,000, and it now is £9,773,000. Almost the whole of the increase

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has been spent on new plant to provide for growth in the business. Besides that, there has been spent out of revenue, in maintenance of plant and renewals, £1,952,000. The income during these nine years has risen from £738,000 to £1,825,000, and the net income divisible among the shareholders from £279,000 to £630,000. During its existence, the company has paid to the Post Office in royalties £1,599,258. The company's telephone messages during the past year numbered 939,000,000, compared with 84,570,000 telegrams sent by the Post Office. The chairman concluded by moving the adoption of the report and the payment of the dividends there set out.

Mr. GEORGE FRANKLIN seconded the motion.

Mr. LEA SMITH, referring to the Post Office competition, said that, for the period ended March 31 last, their gross revenue was £6,168, and, after deducting various charges, 3 per cent for interest on capital, &c., the year's working showed a net loss of £54,702. That was what a Government department had been able to accomplish, although it started with public opinion in its favour. He protested against this proceeding.

The CHAIRMAN said the Post Office report, to which Mr. Lea Smith had referred, was well worth studying. It showed what discrepancies there often were between statements made by people as to how cheaply a great public service could be provided and the actual facts.

The motion was agreed to.

A resolution altering the articles so as to give the directors wider powers in reference to the issuing of new capital having been carried,

Votes of thanks to the Chairman and board of Directors, and also to the general manager and staff, terminated the proceedings.

BRITISH ELECTRIC TRANSFORMER CO. (LTD.)—Mr. E. Phillips presided at the meeting on Wednesday. At the outset a resolution was moved to adjourn the meeting until after the extraordinary general meeting had been held, and till the two proposed new directors, if elected, had had an opportunity of approving the accounts in company with the existing directors. The chairman said the proposal was not agreeable to himself and colleagues, and he suggested that the ordinary business should proceed. A discussion ensued as to the appointment of a solicitor, and a resolution to engage the old firm of solicitors (Messrs. Faithful and Owen) was carried on a show of hands, but the chairman then refused to act on it. He proceeded to analyse the accounts, which appeared in our last issue in brief. Although the past year had not been a fat one, the directors were able to distribute 7 per cect. on the ordinary shares, which compared well with dividends paid by the old company. Although in the early part of last year business was not brisk, a marked improvement took place later, and had continued without interruption. Orders on hand far exceeded in volume the best figures of the past. The chairman then entered into an explanation of the difference which had arisen between the directors. He contended that Mr. Stewart Bain and Mr. Petersen had stood in the way of the company's progress, and it was for the shareholders to decide between Mr. Bain and Mr. Berry. The latter was the company' technical adviser, and by his ability they had been able to keep abreast of the times. He moved the adoption of the report, and this was seconded by Mr. Berry. Mr. Petersen denied that there was any truth whatever in the chairman's statement that Mr. Bain and himself wished to obtain control of the company. They asked for the election of two independent directors, who would be able to look into the position and give their support to the side they found in the right. Mr. Bain spoke in justification of his action as chairman of the company, and on a show of hands the report was then adopted. This was confirmed by a poll subsequently taken. At the extraordinary meeting which followed, a resolution for the election of Mr. Kolle and Mr. Beevor as additional directors was carried by a small majority on a show of hands, but was defeated on a poll.

BRISTOL TRAMWAYS AND CARRIAGE CO.—Mr. George White presided at the meeting on Wednesday, and said that the receipts from the tramways department increased from £197,133 to £211,904 this year, about 7½ per cent., although the mileage of tramways operated was exactly the same as in the preceding year. Including the receipts from the carriage departments and miscellaneous receipts the total income was £237,447. Traffic expenses were £99,762 against £98,511; general expenses, £26,098 against £26,373; renewals and repairs, £38,902 against £30,545. The total expenditure was £164,763, leaving a net profit for the year of £88,387 against £82,017. Their capital expenditure only amounted to £6,203 in the year. Their investments outside the company's business, however, increased from £104,413 last year to £112,133. The report and accounts were adopted, and at a subsequent special meeting the bill for power to construct the proposed extensions of the system was approved.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—The directors' report for 1903 states that parliamentary powers obtained in the 1903 session enables the company to supply electrical energy in the district surrounding the borough. Mains have now been laid in several portions of the area and a supply of electrical energy commenced. In reference to the question of moving the generating station, the directors have come to the conclusion that, having regard to all the difficulties and expense that that course would entail, it is impracticable. They are, therefore, taking steps to utilisise the whole of the site of the existing works for generating purposes, and have purchased additional freehold property, to which they intend to move the stores and workshops. These alterations and additions to the machinery and mains necessitate further capital expenditure, and the directors propose to make a further call of £1 per share, payable March 31, and to create £30,000 4½ per cent. debentures, a portion of which will be offered to the shareholders during the year. During 1903 the equivalent of 5,482 8 c.p. lamps were added to the mains, making the total 44,038. The number of units supplied was 471,510, an increase of over 40,000. After paying all charges and placing £1,500 to depreciation, the balance is, with £688. 1s. 6d. from last year, £6,955. 13s. 9d. An interim dividend absorbed £1,782. 10s. 4d., interest £323. 3s. 10d., leaving £4,849. 19s. 7d. The directors now recommend a dividend of 4½ per cent., making 7 per cent. for the year. This will absorb £3,507. 11s. 8d., leaving £1,342. 7s. 11d. to be carried forward.

LONDON UNITED TRAMWAYS (1901) (LTD.)—The report of the directors for 1903 states that the gross receipts were £280,241. 16s. 1d., working expenses and renewals £176,391. 12s. 7d., leaving, with balance from last account, £108,107. 17s. 3d. After payment of interest and preference dividends there remains £49,281. 7s. 9d., out of which an interim dividend at the rate of 8 per cent. per annum (less tax), absorbing £24,065. 3s. 3d., has been paid, leaving £25,216. 4s. 6d. It is proposed to appropriate £24,429. 1s. 5d. in payment of a final dividend on the ordinary shares to Dec. 31 at the rate of 8 per cent. per annum, less tax, and to carry £787. 3s. 1d. forward. The extensions to Hampton Court and the Thames Valley were opened in April last, and the results of the operations during the first season, although satisfactory, fell far short of the traffics which would have been secured without any additional expense, if weather conditions had been normal. The total number of passengers carried during the year was 45,293,473. The construction of the extension from Hammersmith Broadway to Uxbridge-road is well in hand, and will shortly be completed and opened for traffic. The provision of this line will allow of through services between Hanwell, Ealing and Acton, and the District Railway station at Hammersmith Broadway. Good progress has also been made with the construction and equipment of the line to Uxbridge, via Hayes and Hillingdon, about 1 mile of route only remaining to be built. A bill was introduced this session to authorise further extensions, including proposed lines from Hounslow along Staines-road to Staines, and along Bath-road to Slough and Maidenhead, a line to connect Ealing and Brentford, and a tramway across the new Kew Bridge. The exorbitant demands of most of the local authorities concerned as the condition of their assents have, however, compelled the directors to withdraw the proposals with the exception of the Hounslow-Staines extension. Powers will also be taken under the bill for the requisite extension of time for construction of the Kingston and Surbiton group of lines, which the directors have determined shall be the next in order to be carried out after the works now approaching completion. For facilitating the interchange of traffic at Hammersmith between the company's tramways and the Metropolitan District Railway, and also with a view to connecting up the company's authorised tramway from Barnes and Mortlake to Richmond with the main system, the directors are promoting a bill to authorise underground electric railways to convey the company's cars from the surface of the street at Hammersmith Broadway and at the south side of Hammersmith Bridge, direct to the platform of the District Company's Hammersmith station.

METROPOLITAN DISTRICT RAILWAY CO.—The chairman (Mr. R. W. Perks, M.P.) gave some particulars at the meeting last week of the progress made with the work of conversion of the company's lines to electric traction. The branch railway from Ealing to Harrow was already being worked electrically, and was the nursery for the Underground Electric Co., where they were training a staff and conducting a variety of experiments with the cars which would be used on the District Railway. A scheme would be submitted to Parliament by the London United Tramways whereby their cars would run from the street level to the level of the District Railway at Hammersmith, so that travellers on the District line who wished to go on to the United Tramways could do so. Great progress had been made with the important work of converting the railway from steam to electricity. The key of the whole position was the great power house at Lot's road, where electrical power for the whole of their railway, and for four other lines, would be generated. 940 men were engaged at the station; the engine room was roofed in, travelling cranes were at work and machinery was being placed in position. Their engineer (Mr. J. R. Chapman) had informed them that he hoped to get the works in operation in July, and by the autumn to work electrically from the power house. The first of the steam turbines was now due, and the foundations were ready. Between Lot's-road and Earl's Court the passages through the streets for conveying the cables from the power house to Earl's Court, where the cables distributed over the railway, had all been completed. The South-Western Railway had entered into a contract with the Underground Company for electrically equipping the line from Ravenscourt Park to Turnham Green and from Putney to Wimbledon; so that they had the assurance that the branch lines belonging to the South-Western would be finished simultaneously with their branch and main lines. At night 1,000 men were at work on the District Railway works. Contracts had been let for all the cables from Earl's Court to Putney, as had those from Earl's Court to Charing Cross, and tenders were being invited for the cables from Charing Cross to the East. A very important sub-station at Charing Cross was under construction. That sub-station would supply the Charing Cross, Euston and Hampstead and the Baker Street and Waterloo Railways, the latter line being now almost completed. At Mill Hill they were building a large car shed for repairing and storing the cars. Contracts had been invited for the whole of the rolling stock required on their lines. The Underground Co. were inviting tenders for the rolling stock for 60 new trains, and they already had two working at Ealing. Those 60 new trains would each consist of seven cars; three would be motors and four trailers. Nothing used in the construction of the cars would be capable of burning. Their staircases would also be removed, and the overhead ways would be built of non-flammable material. They had spent up to the present £300,000 upon equipment, and from £800,000 to £900,000 would still be required to complete the work.

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They had entered into contracts with the Underground Co. whereby that company took debentures at par and preference and ordinary stock at a discount in payment for the work. He thought when once they electrified their railway and gave the public a good article at, possibly, too cheap a price, they should then see better days than with their old undertaking.

METROPOLITAN ELECTRIC TRAMWAYS (LTD.) –The report for 1903 states that the company holds 78,504 out of 110,923 issued shares in the North Metropolitan Tramways Co. The company has also acquired about two-thirds of the issued share capital of the Harrow-road and Paddington Tramways Co., and has entered into an agreement for the purchase of that company's undertaking in Paddington and Willesden. The conversion of these tramways to electric traction has been authorised conditionally upon certain widenings being carried out. Willesden District Council has agreed not to exercise it rights of purchase under the Tramways Act, 1870, until June, 1930. The County Councils of Middlesex and Hertfordshire have entered into agreements to construct and to lease to the company about 49½ miles of light railways, of which 37½ miles have been authorised, and the remainder are awaiting confirmation by the Board of Trade; 11½ miles, which are under construction by Middlesex County Council, are being electrically equipped by the company. The company's own tramways, 8½ miles in length (of which 7½ miles are in Middlesex and the remainder in London), are still worked by horses, but the work of reconstruction for electric traction, which was commenced early last year, is nearing completion. It is anticipated that these 20 miles of tramways and light railways will be opened for public traffic by electric traction this summer. The company, as lessee of the Hertfordshire County Council, will be entitled to running powers over the lines authorised by the Watford and District Tramways Act, 1901, and the Watford and District Light Railway Order, 1903, when constructed, and has entered into an agreement with Walthamstow District Council for mutual running powers. In July last the company acquired by the issue to the British Electric Traction Co. of 43,652 ordinary shares of £1 each, fully-paid, 1,710 shares of £10 each in the North Metropolitan Electric Power Supply Co., of which 1,460 shares are fully-paid and the remainder £2 paid, and also the benefit of a claim for £13,551, recoverable from the Power Supply Company, The company has since subscribed for 1,500 further shares of £10 each in the Power Supply Co., out of the proceeds of which the debt of £13,551 has been liquidated. The Power Supply Co. has rights in perpetuity, under three acts of Parliament, for the supply of electricity in bulk within an area of about 325 square miles in Middlesex, Hertfordshire and Essex. The authorised share capital is £500,000, divided into 50,000 shares of £10 each; 3,212 shares have been issued, upon which £30,104 has been paid. The company is erecting a main power station at Brimsdown, near Enfield, and has purchased from Willesden Council the power station built by that Council. Mains are being laid to connect those stations with the various sub-stations which are being constructed at suitable points in the area for supplying current for the light railways and tramways and to other consumers in bulk. The company is now supplying electricity in bulk for electric lighting at Hertford and Willesden, and negotiations are proceeding for agreements to supply other local authorities. The issued capital of the company is 500,000 5 per cent. cumulative preference shares of £1 each, fully paid; 177,789 ordinary shares of £1 each, fully paid; 40,750 ordinary shares of £1 each, 6s. paid; 314,016 deferred shares of £1 each, fully paid. On Feb. 28, 1903, the outstanding 4 per cent. debentures (£29,100) were redeemed at par. As part of the purchase price of the 8½ miles of tramways, the company has assumed the obligations, both as to principal and interest, of the £150,00 3½ per cent. debentures of the North Metropolitan Tramways Co., and there is also due to that company £10,000 in cash. £22,160 2½ per cent. Consols have been borrowed from the British Electric Traction Co. for deposit with the County Council of Middlesex, to secure the performance by the company of its obligations under the agreement for the lease of light railways. Under the contract for purchase of Willesden power station the company has guaranteed the payment by the Power Supply Co. to the Council of the purchase price of £72,034, plus interest, by half-yearly instalments extending over about 24 years, or at the option of the Council in one sum without interest, upon the Council giving six months' notice. Pending the issue of further capital, the directors have obtained a bank advance of £64,000 to meet payments due on contracts for the construction and equipment of tramways and light railways, for the erection of the power station at Brimsdon, the laying of cables and the building of car sheds and sub-stations. In view of the further capital requirements for work in progress, the directors propose to make an issue at an early date of debenture stock. Gross revenue for 1903 covered by the account amounted to £92,276, including dividends on shares held in the North Metropolitan Tramways and Harrow-road and Paddington Tramways Companies.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors' report for 1903 states that 9,033,625 units of current were sold during the year, an increase of 3,496,125 upon the previous year. The profit, including £759. 14s. 4d. brought forward, was £41,826. 18s. 4d. Interest (£14,031. 12s. 9d.) and interim preference and ordinary dividends (£11,038. 0s. 1d.) had been paid, leaving £16,757. 5s. 6d., and the directors recommend the payment of the balance preference dividend and a further 4 per cent. on the ordinary shares, making 8 per cent. for the year; also the payment of the 5 per cent. on the preference shares and 6 per cent. on the ordinary shares allotted in connection with the purchase of the Walker and Wallsend Gas Co.'s electrical undertaking; leaving £1,099. 0s. 8d. to be carried forward. In view of the large expenditure on capital account during the past two years, of which at least £200,000 is as yet unproductive, the directors have not dealt with the general question of depreciation on plant further than by transfer from reserve of the £100,000 referred to in the last report. Expenditure on capital account has been increased during the year by £357,256, including purchase of the assets of the electricity undertaking of the Walker and Wallsend Union Gas Co., and outlay on a new generating station at Carville and extensions to the company's system generally. The directors have obtained an interest in the Priestman Power Co.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—At the meeting on Friday, the chairman (Mr. H. S. Leon) expressed regret at the accident which had occurred at their station a few days earlier and resulted in the death of one of their men. The supply of current in the market was interrupted for a few hours. It was the first accident that had taken place there, and no fault could be attributed to anyone. The general position of the company continued to give satisfaction. In spite of the price of current having been reduced to a uniform rate, the net profit was £628 more than last year. There had been also an increase in the number of lamps. The capital account had been increased during the year owing to the cost of the new machinery, which came to £4,182. All the cost of this new machinery had been paid for entirely out of earnings, and no money had been borrowed. Although the output of electricity was about 7 per cent. more than last year, the cost of production had decreased considerably. £1,500 had been placed to depreciation and £2,000 to reserve, raising that account to £4,000. They expected to purchase this year a new boiler.

WESTMINSTER ELECTRIC SUPPLY CORP. (LTD.)—The report of the directors for 1903 states that the supply of current, which on Dec. 31, 1902, was provided for the equivalent of 602,976 lamps of 8 c.p., had increased by Dec. 31, 1903, to the equivalent of 662,129 lamps, and applications for supply continue to come in at a satisfactory rate. The length of roadway in which continuous-current mains have been laid now exceeds 73 miles, making about 279 miles of ways, into which upwards of 230 miles of copper (strip and cable) have been drawn. In addition, 3 miles of trunk mains (12 miles of ways) are laid in the company's area to connect the stations with the Central Electric Supply Co.'s station at St. John's Wood, which station has supplied a considerable amount of current to this company during the year. The directors have acquired a long lease of a site in Duke-street for an underground transforming station. The first section of plant for the equipment of the station is on order, and the station will be ready for the heavy load of next winter. The result of the year's working is again very satisfactory, and the directors recommend the payment of an increased dividend. An interim dividend at the rate of 13 per cent. per annum on the ordinary shares and the 5 per cent. preference dividend for the period to June 30 has been distributed, and, after allowing for depreciation, sinking fund, &c., the net balance is £49,586, from which the balance preference dividend (£3,357) has been distributed, leaving a balance of £46,239, and the board recommend payment of a dividend at the rate of 14 per cent. per annum (less tax) for the past half-year, carrying forward £9,494.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26 7/16d. per oz. (Feb. 18). Consols 86 7/16—86 7/16 for money, 86¼—86⅜ for account; 2½ per cent. annuities 86¼—86½ (Feb. 18). Consols Pay Day, Mar. 1; Stocks and Shares Continuation Days, Feb. 23 and Mar. 8; Ticket Days, Feb. 24 and Mar. 9; Pay Days, Feb. 25 and Mar. 10; Mining Share Carry-over Days, Feb. 22 and Mar. 7.

BAKER STREET AND WATERLOO RAILWAY CO.—At the meeting on Tuesday, the chairman (Mr. T. J. Hare) said that capital expenditure during the last half-year was £204,175, and the estimated expenditure for the current half-year £300,000. Satisfactory progress had been made with the works, and the tunnelling from Waterloo to Dorset-square was completed with the exception of about 40yds. It was believed that the work would be finished by the end of the year. Equally satisfactory progress was being made with the Elephant and Castle extension.

BROCKIE-PELL ARC LAMP (LTD.)—The report for the 18 months ended Dec. 31 states that, after writing off £632 for depreciation on tools and patterns, there is a debit of £65 to be carried forward. The present depression of trade and the extremely keen competition both of English and foreign arc lamp manufacturers, have caused a reduced turnover and smaller manufacturing profits. The company has, however, received large (extension) orders for lamps for the lighting of St. Pancras and Partick, besides orders for Glasgow, Shoreditch, Southend, Leeds, Stretford and West Ham.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The revenue credit balance for 1903 is £29,234, which, with £888 forward and £335 balance of interest received, makes a total of £30,457. It is proposed to apply £7,500 to depreciation, £4,732 for dividend on 7 per cent. preference, £13,239 for dividend of 10 per cent. on the ordinary shares, and £807 for directors' additional remuneration, leaving £4,179 to be carried forward.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The directors have resolved, subject to audit, to transfer £45,500 to reserve, and to recommend payment of following dividends:—*Preference:* 6s. per share for half-year ended Dec. 31, making (with interim) 12s. per share, the full rate of 6 per cent. (less tax). *Ordinary:* 5s. per share, making (with interim of 5s. per share) 10s. per share for 1903, or at the rate of 5 per cent. per annum (less tax). The carry forward will be about £22,000. The transfer books and register of members will be closed from 24th inst. to March 9 inclusive.

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BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors recommend a dividend on the ordinary shares at the rate of 8 per cent. per annum, less tax, for 1903, carrying forward over £3,000, after providing for depreciation, &c.

BRITISH ELECTRIC TRACTION CO. (LTD.)—It was announced in the leading financial papers that the recent issue by this company of second debenture stock had proved a failure, so far as the public subscription was concerned. We have been asked to publish the following explanation:—"Statements have been circulating to the effect that the recent issue of second debenture stock by the British Electric Traction Co. (Ltd.) was not a success, and the price of the shares has been falling in consequence. As a matter of fact, the issue was entirely underwritten by responsible firms, and the failure of the public to take up the whole of the stock offered does not affect the financial position of the company in the least degree, as, of course, it will get its capital just as if the public had subscribed for the whole issue."

CITY OF CARLISLE ELECTRIC TRAMWAYS CO. (LTD.)—For 1903 the surplus was £3,112, an increase of £73 over 1902. Dividend 2 per cent.

GREAT NORTHERN RAILWAY CO.—At the meeting on Friday, the chairman (Lord Allerton) said the estimated capital expenditure for the current half-year was £275,000, of which £100,000 was for expenditure on the Great Northern and City, the Great Northern and Piccadilly and Brompton lines.

IMPERIAL TRAMWAYS CO. (LTD.)—In the report for 1903 it is stated that the receipts from the Middlesbrough, Stockton and Thornaby electric tramways amounted to £49,963. 7s. 7d., and the passengers carried were 9,576,125, compared with £49,254. 16s. 4d. and 9,367,027 in the preceding year. The net profit for the year is £16,353. 14s. 6d. Net available balance is £41,899. 6s. 1d., and after payment of interest and interim dividends on preference and ordinary shares to June 30, it is proposed to pay the balance dividend on the preference capital (paid Jan. 1), a final dividend at 10 per cent. per annum (making 9 per cent. for year) on the ordinary capital (less tax), and to carry forward £565. 19s. 5d.

LONDON GENERAL OMNIBUS CO.—The subject of motor traction was referred to by the chairman (Ald. J. Pound) at the meeting on Tuesday. He said that, though the experience gained since last meeting had been of a somewhat negative character, yet he was a firm believer that a great factor in the solution of the problem now before the London Traffic Commission would be found in free running stage carriages, and not in trams. They had not yet seen a car which would suit the company.

SOMERSET AND DISTRICT ELECTRIC POWER CO.—At the meeting last week the chairman (Mr. P. Napier Miles) said that owing to the financial and commercial depression the directors had hitherto refrained from offering their share capital for public subscription. They had, however, entered upon negotiations which should shortly enable the company to start.

STOCK EXCHANGE NOTICE.—Application has been made to the Stock Exchange committee to allow £75,000 5 per cent. registered first debentures of £50 of the *City of Wellington Electric Light and Power Co. (Ltd.)* to be quoted in the official list.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

CLARKSON BROS. (LTD.)—Reg. in Edinburgh Feb. 7, capital £10,000 in £1 shares, to acquire the business carried on under the name of Clarkson Bros., Glasgow, and to carry on the businesses of electrical, hydraulic and general engineers, &c. Reg. office, 8 and 12, Little Hamilton-street, Glasgow.

A. CUNNELL & CO (LTD.)—Reg. Feb. 4, capital £2,000 in £1 shares, to acquire the business carried on by A. B. Cunnell as Baxter and Cunnell, and to carry on the business of manufacturers of electric lamp shades, &c. Reg. office, 68, Long-lane, London, E.C.

ELECTROID LIMITED.—Reg. Feb. 12, capital £60,000 in £1 shares, to adopt a certain agreement for the acquisition of a secret process for the manufacture of "Electroid." The first directors are L. Stokes, W. Campbell, H. N. Beeman, I. Perrott, R. Cheltam Strode, L. Owen and H. King. Reg. office, 109, Victoria-street, London, S.W.

STATUTORY RETURNS.

ELECTRIC LIGHT AND POWER CO. OF JAPAN (LTD.)—The return to Dec. 26 gives the capital as £3,000 in £1 shares, of which seven shares have been taken up. No calls have been made. No mortgages or charges.

ELECTRIC SUPPLY CORP. (LTD.)—In return to Nov. 19 the capital is £250,000 in 50,000 shares of £5 each, of which 3,400 have been taken up. £4. 10s. per share has been called up. No mortgages or charges.

INTERNATIONAL ELECTRIC TRACTION AND POWER CO. (LTD.)—In the return to Jan. 14 the capital is given as £25,000 in 2,500 shares of £10 each, of which 179 have been taken up. £7. 10s. has been called up on each share. No mortgages or charges.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—According to the return to Dec. 31, the capital is £350.000 in £1 shares, of which 204,056 have been taken up. 15s. per share has been called up on 99,056 shares. 105,000 shares considered as fully paid. No mortgages or charges.

MUTUAL TELEPHONE CO. (LTD.)—The return to Jan. 1 gives the capital as £250,000 in £5 shares (20,000 5 per cent. cumulative preference), of which 6,283 preference and 10,348 ordinary have been taken up. 6d. per share has been called up on 16,631 shares. No mortgages or charges.

MORTGAGES AND CHARGES.

ABERYSTWITH AND CHISWICK ELECTRICITY SUPPLY CORP. (LTD.)—Issue on Jan. 20 of £4,000 4½ per cent. debentures, part of series created by resolutions of Nov. 2, 1900, and March 8, 1901, to secure £50,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £28,000.

DERBYSHIRE AND NOTTINGHAMSHIRE ELECTRIC POWER SYND. (LTD.)—A 5 per cent. debenture, dated Jan. 20, 1904, to secure £15,000, has been registered. Property charged (as floating security) company's undertaking and property, present and future, including uncalled capital. Holders, Nottingham and Nottinghamshire Banking Co. This debenture is in substitution for security dated March 19, 1902, given to same holders and covering £9,000 and interest.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Feb. 13	1,094	+ 278	37	45,216	+ 8,846
Ayr Corporation	,, 13	162	+ 5	39	11,361	+ 181
Barnsley	,, 5	146	- 10	5	739	- 51
Bexley District Council	,, 12	144	...	19	2,879	...
Birkenhead	...	...	...	...	...	...
Birmingham Corporation	,, 13	802	...	...	...	...
*Birmingham Tramways Co.	,, 13	5,317	+ 319	6	30,752	+ 2,257
*Blackburn Corporation	,, 12	768	+ 99	§46	38,818	+ 1,864
Blackpool Corporation	,, 11	298	- 11	§15	39,641	- 231
Blackpool and Fleetwood	,, 13	186	- 2	7	1,187	- 16
Blackp'l, St. Anne's & Lytham	,, 11	178	+ 178	‡15	2,208	+ 1,629
Bolton Corporation	,, 14	1,579	+ 47	46	83,578	+ 8,922
Bournemouth Corporation	,, 10	863	...	6	5,072	...
*Bradford Corporation	,, 14	3,359	+ 154	44	171,590	+ 22,265
Brighton Corporation	,, 14	709	- 42	45	41,346	+ 2,634
Brisbane Tramways	Dec. 30	2,781	+ 210	26	62,331	+ 989
*Bristol Trams & Carriage	Feb. 12	4,604	+ 281	12	54,367	+ 2,638
*Buenos Ayres & Belgrano	Jan. 17	2,965	+ 13	13	44,548	+ 2,138
Burnley Corporation	Feb. 13	889	+ 221	46	45,177	+ 8,616
Burton Corporation	,, 14	302	...	28	9,712	...
Calcutta Tramways Co.	,, 13	R35,736	+ R5,231	7	R238,697	+ R48,869
Camborne-Redruth	,, 15	94	...	15	7,769	...
Cardiff Corporation	,, 13	1,912	+ 347	46	89,765	+ 22,537
Carlisle Tramways Co	...	...	...	...	...	...
Central London Railway	,, 13	7,095	+ 168	7	48,883	+ 242
Chatham & Dist. Lt. Rys.	,, 11	526	+ 116	6	3,020	+ 666
City & South London Rly.	,, 14	3,297	+ 190	7	22,586	- 726
Cork Electric Trams Co.	,, 11	377	- 22	6	2,868	+ 31
Darwen Corporation	,, 13	210	+ 13	46	10,380	- 217
Devonport & Dist. Trams.	,, 5	450	+ 63	5	2,358	+ 880
Dover Corporation	,, 13	169	- 2	†46	10,179	+ 49
Dublin & Lucan Railway	,, 14	93	+ 3	7	601	+ 36
Dublin Southern District	,, 12	702	- 58	6 ¶	26,824	+ 813
Dublin United	,, 12	3,672	+ 13			
Dudley—Stourbridge	,, 5	713	+ 35	5	3,623	+ 170
Dundee Corporation	,, 10	800	+ 18	38	32,566	+ 2,065
East Ham Council	,, 13	599	+ 84	†46	30,267	+ 8,182
Gateshead & Dist. Trams	,, 5	881	+ 67	5	4,424	+ 234
Glasgow Corporation	,, 13	12,685	+ 54	37	504,581	+ 52,102
Gravesend—Northfleet	,, 5	202	+ 31	5	1,035	+ 158
Greenock & Port Glasgow	,, 5	507	+ 98	5	2,431	+ 868
Halifax Corporation	,, 3	1,137	+ 97	} 45	60,182	+ 6,303
	,, 10	1,058	+ 24			
Hartlepool Tramways	,, 5	249	+ 39	5	1,260	+ 176
Huddersfield	,, 18	1,078	+ 31	...	...	...
Hull Corporation	,, 13	2,039	+ 324	†46	87,700	+ 6,764
Ilkeston Corporation	,, 10	127	...	13	1,553	...
Ipswich Corporation	,, 13	382	...	6	3,556	...
Isle of Thanet Co.	,, 14	229	- 26	...	...	...
Kidderminster & District	,, 5	92	- 1	5	461	- 41
Kirkcaldy Corporation	,, 10	188	...	50	9,044	...
Lanarkshire Trams Co.	,, 16	542	...	6	3,551	...
Leeds Corporation	,, 13	4,902	+ 50	47	250,089	+ 15,377
Liverpool Corporation	,, 6	9,648	+ 520	6	57,388	+ 2,684
*Liverpool Overhead Rly.	,, 14	1,481	- 1	7	10,745	+ 354
*London County Council	,, 6	9,373	+ 1,330	†45	439,356	+ 77,856
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 13	10,556	+ 2,247	34	403,582	+ 184,208
Mersey Railway	,, 13	1,372	+ 383	6	8,585	+ 2,248
Merthyr	,, 5	192	+ 21	5	945	+ 102
Middleton	,, 5	247	+ 48	5	1,226	+ 68
Newcastle-on-Tyne Corp.	,, 13	3,478	+ 418	6	20,915	+ 3,318
Newport (Mon.)	,, 18	461	+ 239	20	8,793	+ 4,576
Oldham, Ashton & Hyde	,, 5	497	- 2	5	2,494	- 162
Perth (W. A.) Elec. Trams.	,, 12	1,329	+ 125	6	8,630	+ 1,155
Peterborough	,, 5	107	- 44	5	550	- 115
Poole and District	,, 5	214	- 13	5	1,108	- 29
Portsmouth Corporation	,, 13	1,373	+ 168	†46	79,360	+ 5,335
*Potteries	,, 5	1,668	+ 186	6	8,106	+ 411
Reading Corporation	,, 11	572	...	...	...	...
Rothesay	,, 5	39	- 1	5	232	+ 18
Salford Corporation	,, 15	3,568	+ 693	46	175,176	+ 48,807
Sheerness	,, 3	46	...	5	222	...
Sheffield Corporation	,, 14	4,160	+ 82	†47	210,224	+ 17,507
*Southampton Corporat'n	,, 11	893	+ 72	6	5,047	+ 226
Southend Corporation	,, 10	205	+ 19	45	14,181	+ 2,182
Southport Tramways	,, 6	259	+ 53	5	1,224	+ 145
S. Staffordshire Trams.	,, 5	701	+ 16	5	3,649	+ 261
Sunderland Corporation	,, 14	1,078	+ 67	46	55,444	+ 2,608
*Swansea Trams	,, 5	418	...	5	2,329	+ 39
Taunton Trams	,, 5	48	+ 1	5	238	- 9
Tynemouth and District	,, 5	198	- 3	5	1,038	+ 8
Tyneside Trams Co.	,, 10	280	+ 41	6	1,601	+ 362
Wallasey District Council	,, 13	571	+ 48	†46	31,297	+ 3,790
Weston-super-Mare	,, 3	31	+ 4	5	112	- 2
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 5	323	- 12	5	1,631	- 54
Wrexham	,, 5	95	...	5	432	...
Yorkshire Woollen District	,, 5	483	...	5	2,016	...

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Feb. 17.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS WEEK TO FEB. 17	
				£ s. d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4½–5	5 0 0	April, Oct	4¹⁵/₁₆	4¹³/₁₆
St.	6%	Do. Permanent 6% Deb. Stock	125 –130	4 12 4	..	..	..
10	10/0	Barcelona Tramways Ord.	7 –8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 –95	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	95 –98	5 2 0	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 –3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 –102	4 8 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	20 –21	3 10 10	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼–10½	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	80 –83	3 12 6	..	81½	81¼
St.	5%	Do. Pref. Ord. Stock	92 –95	5 6 5	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 –10½	4 15 3	..	..	..
4	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝–105⅞	4 7 0	..	..	..
100	4½	Do. Vancouver Power Debs.	98 –101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9½–10½	7 12 5	..	10¼	9⅞
10	6/0	† Do. 6 per Cent. Cum. Pref.	10 –11	5 9 1	Feb, Aug	11	10⅝
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –123	4 1 4	..	122½	121½
5	..	Buenos Ayres and Belgrano Ord.	3 –3½	..	..	3½	..
5	3/0	Do 6 per Cent. "A" Cum Pref.	5½–6¼	5 4 0	..	..	..
5	3/0	Do. "B"	4½–5¼	5 14 3	..	5⅛	..
St	5%	Do. 5 per Cent. Debs.	104 –107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs	98 –101	4 19 6	..	..	..
St.	..	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 –100	5 0 3	..	..	..
5	2/6	Calcutta Tramways	6½–7	4 12 10	..	6¾	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 –107	4 4 2	..	106½	105½
1	1/0	Cape Electric Tramways Shares	1⅝–2	8 10 0	..	1⅞	1¹³/₁₆
St.	4%	†Central London Ordinary Stock	93 –96	4 3 4	June, Dec	94¾	94
St.	4%	† Do. 4 per Cent. Pref. Stock	96 –99	4 0 10	..	99	94
St.	4%	† Do. Deferred Stock	87 –90	4 9 0	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 –115	3 9 9	..	112	..
5	2/6	City of Birmingham Trams.5% Cm. Prf	4¾ 5¼	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	100	99½
St.	2%	†City and South London Rly. Con Ord	49 –52	4 11 4	Feb, Aug	51	50
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	123 –126	3 19 4	Feb, Aug	..	..
St.	5%	† Do. (1896)	119 –122	4 2 0	..	121½	120½
St.	5%	† Do. (1901)	118 –121	4 2 8	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 –112	3 11 7	May, Nov	110½	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.	102 –105	4 16 5	..	..	..
10	6/0	†Dublin United Trams. (1896) Ltd., Ord	12½ –13½	4 1 6	..	..	..
10	6/0	† Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf	3 –4	7 10 0	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 –97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 –8	3 15 0	..	7⅞	7⅛
10	3/4	†Gt. Northern, Piccadilly & Brompton Ord., Spever Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	Imperial Tramways Ord	20 –21	4 13 0	Mar, Sept	..	..
10	6%	† Do. 6 per Cent. Pref.	14 –14½	4 2 10	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Debs.	103 –110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	..	..	..
10	11%	†Liverpool Overhead Railway Ord.	4¹³/₁₆–4¹⁵/₁₆	2 16 5	Feb, Aug	..	..
1	5%	† Do. 5 per Cent. Pref.	9⅞–10¼	4 17 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98¾–100½	3 19 10	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11¼–11⅝	4 5 1	..	11⅝	11⅜
St.	4%	Do. 4% 1st Mort. Deb. Stock	103 –105	3 16 4	..	104½	104
St.	..	Mersey Con. Ord. Stock	6 –9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞–1⅛	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞–1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	103 –105	4 17 1	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	104 –106	4 4 11	..	..	..
5	..	New General Traction Ord.	⅛	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1¼–2¼	..	..	..	..
St.	5%	Perth (W.A.)Elec. Trams. 1st Mt. Db. Stk.	99 –102	4 18 0	May	..	..
10	10/0	Potteries Electric Traction Ord.	8½ - 9½	5 5 3	..	101	..
10	5 0	† Do. 5 per Cent. Cum. Pref.	8½ - 9½	5 5 3	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 –106	4 5 11	Feb, Aug	..	..
1	..	South Lancs. Elec. Trac & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..
St.	3¼%	Waterloo and City Ord.	91 –94	3 9 8	Jan, July June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 –102	3 18 5	Jan, July	101	..
10	..	Amazon Telegraph	2½–3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	50 –53	6 0 9	F,My,Ag,N	50	..
St.	30/0	Do. Preferred	94 –96	6 7 7	F,My,Ag,N	95½	94½
St.	1/0	Do. Deferred	7½–8	0 12 8	F,My Ag,N	7⅞	7¾
100	82	Commercial Cable Capital Stock	180 –190	4 4 5	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 –91	4 8 3	Jn Ap,Jy,O	90⅜	90⅜
10	7/0	Cuba Submarine Ord.	7 –8	10 0 0	Feb, Aug	7⅜	7½
10	10/0	Do. Preference 10 per Cent.	16 –17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½–8½	5 17 8	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝–101⅞	4 9 1	Jan, July	..	..
20	3/6	Direct United States Cable	10 –10½	6 3 10	Ja,Ap,Jy,O	10¼	10⅛
100	4½%	Direct West India Cable 4½% Rg. Db.(rd.)	98 –101	4 9 1	Jn, Dec	..	..
St.	20/0	Eastern Ordinary	119 –124	5 12 11	Ja,Ap,Jy,O	121	119
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 –90	3 17 10	Ja Ap,Jy,O	87½	87¼
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 –108	3 14 1	May, Nov	107	..
10	2/6	Eastern Extension	10¾–11½	6 4 5	Ja,Ap,Jy,O	10¾	..
St.	4%	Do. 4 per Cent. Deb. Stock	104 –107	3 14 9	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	98 –101	4 0 0	Feb, Aug	98	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞–102⅞	3 18 11	May, Nov	100	..
10	5/0	Great Northern of Copenhagen	22 –23	5 8 8	Jan, July	..	..
100	4½%	Halifax & Bermuda4½%1stMt.Db.(red.)	98 –101	4 9 6	June, Dec	..	..
25	12/6	Indo-European	38 –41	6 1 11	May, Nov	38½	..
100	6%	London Platino-Brazil. 6% Debs., 1904	100 -103	5 19 5	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 –100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 –6	1 13 4	..	..	..
2½	..	West Coast of America	¼–¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 –98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅝–¾	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 –6½	9 4 8	May, Nov	6⅝	..
10	..	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	11⅞–12½	5 14 3	Mr,Jn,O,D	12⅛	11¹⁵/₁₆
100	5%	* Do. 5% Debs. (2nd Series, 1906)	99 –102	4 18 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 –101	3 19 3	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 –5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8¼–8½	4 11 5	Ja Ap Jy O	8½	8½
10	3/0	Do. 6 per Cent. Pref.	12 –12½	4 16 0	Ja Ap,Jy,O	12½	12¼
8	4/0	Reuter's	6¾–7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 –122	5 0 0	April, Oct	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Feb. 17.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS WEEK TO FEB. 17	
				£ s. d.		Highest.	Lowest.
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	4¾–5¼	5 14 3	August ..	5	..
St.	6%	National Co. Pref. Stock	102 –104	5 18 0	..	103½	103
St.	5%	Do. Def. Stock	78 –81	6 1 2	..	79½	78⅝
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13½ -14½	4 2 9	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	14 –15	4 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–5¾	4 13 0	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 –97	3 12 2	June, Dec	95½	95¼
St.	4%	Do 4 per Cent. Deb. Stock (red.)	100 –102	3 18 5	..	101½	100½
1	0/7½	Oriental	⅞–1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 –1⅛	..	..	..	..
5	3/0	United River Plate	5¼–6	5 16 8	July.....	5⅛	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾–5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 - 105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Greenwich Dist. Ord.(f.p.)	¾–1	..	..	..	..
1	..	Do. 7% Cum. Pref.	1⅜–1⅝	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	114 –117	3 17 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½ 13½	5 18 6	..	..	..
10	4/6	† Do. 4½ per Cent. Cum. Pref	9½–10¼	4 5 9	..	..	..
10	6/0	† Do. 6% Cum. Second Pref.	10¼–11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 –104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 –103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–10¾	4 13 0	..	1⅛	..
5	3/6	Do. 7 per Cent. Pref.	9⅜–10¼	3 8 4	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord. ex rights	6 – 7	4 12 10	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 109	3 18 8	..	..	..
5	4/0	†Charing Cross & Strand Electric Sup.	7⅜ - 8¼	4 17 0	Feb, Aug	8⅛	8
5	2/3	† Do. 4½ per Cent. Pref.	5⅜–5¾	4 0 0	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¼– 5	4 10 0	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 – 105	3 16 3	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5¾–6¼	4 8 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb Stock (red.)	106 –109	4 3 1	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¾–11¼	6 13 4	Feb, Aug	10⅞	..
10	£/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 –126	3 19 4	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	8 – 9	4 8 11	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 6	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 – 110	4 1 10	..	..	..
St.	27/6½	Do. Second Deb. Stock Prov. Certs.	99 –102	..	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5¾–6¼	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 – 102	4 8 3	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	⅞– 1	..	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	11 –12	4 3 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station; 4% Deb. Stck.(red.)	103 –106	3 16 2	..	..	..
5	..	London Electric Supply Ord.	1¾–2¼	..	..	2	..
5	3/0	Do. 6 per Cent Pref.	5½–6	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 –98	4 2 1	Mr,Jn,S,D	97	..
10	8 0	Metropolitan Electric Sup. Ord.	17½ -18½	4 3 9	April, Oct	18¾	18
5	..	Do. 4½ per Cent. Cum. Pref.	5⅜–5⅝	..	..	5½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	3 19 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 –100	3 10 6	..	..	..
100	4½	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 –98	4 11 9	..	..	..
10	6/0	Notting Hill Electric Ord.	13 –14	4 5 9	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5½ 6	4 11 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97 –100	4 0 3	..	97½	..
1	..	Rand Electric	⅛ -⅜	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 –102	4 8 11	April, Oct	..	..
5	9 6	St. James' & P.M. Elec. Ord. xd & bonus	14 –15	4 16 8	Feb, Aug	1⅛	..
5	3 6	† Do. 7 per Cent. Pref	8 - 9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 –100	3 10 6	..	..	..
5	2/6	Smithfield Markets Electric Sup. Ord.	3½ - 3¾	3 6 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 – 90	4 9 6	..	..	..
5	1/9	South London Electric Supply Ord.	3¾ 4¼	4 2 4	..	..	..
5	2/6	Urban Electric Supply Ord.	4¾ 5	5 0 0	..	..	..
5	2/6	Do. 5% Cum. Pref.	4¾–5¼	4 17 7	..	..	..
5	6/6	Westminster Electric Supply Ord.	12½ 13¼	4 16 4	Mar, Sept	13⅛	12¹⁵/₁₆
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6¾	3 16 11	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	†Alliance Electrical Co. 5% Cum. Pref.	½–¾	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅜–⅝	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 –6¼	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5¼–5½	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –107	4 4 1	..	..	..
St.	4½%	British Thom'n-Houst'n 4½% 1st Mt. Db.	103 –105	4 5 8	..	..	..
5	3/0	†British Westinghouse 6% Pref.	3¾–4¼	7 1 2	..	4⅛	3¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 –96	4 3 4	..	96	..
2	..	Brush Electrical Engineering	¾–1¼	..	March ..	⅞	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 –1½	8 0 0	Mar, Sept	1	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	98 –101	4 11 2	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	75 – 80	5 12 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10¼–11½	6 10 5	Jan, July	11½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5¾	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.)	104 –108	4 3 3	Nov, May	106½	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅛–⅜	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 14 9	..	..	..
1	0.7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½–2	7 10 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	97⅝–100⅝	5 0 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8¾–9¾	..	..	..	..
		Do. 6% Cum. Pref.	5¼–5¾	..	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102 –104	4 7 2	..	..	..
5	..	Edison & Swan United("A" Sh.) (£3 pd.)	½	..	Feb, Aug	..	..
		Do. (£5 paid)	½–1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 –77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 –81	6 3 5	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5¾–6¼	5 12 0	H'lf-yearly	6⅛	5¹⁵/₁₆
5	3/0	Do. 6 per Cent. Cum. Pref.	5¾–6¼	4 16 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 –106	4 4 11	..	..	..
2	1/2½	Electric Construction Co.	1½–1¾	6 71 2	Jan, July	1¾	1⅝
2	2 9⅜	Do. 7 per Cent. Cum. Pref.	2¾–3	4 18 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	½–¾	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾–1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¼–9¾	5 2 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 –98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	12 –13	7 13 10	Feb, Aug	13⅛	12½
5	2/3	Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	5½	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 –112	4 0 9	Feb, Aug	..	..
10	16/0	India Rubber, Gutta Percha, &c., Wrks.	18 –19	5 5 3	Feb, Aug	18⅞	18⅝
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 –103	3 17 4	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾–11¼	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33 –36	6 13 4	Mar, July	34½	33⅜
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –104	3 17 8	Jan, July	102½	..
5	3/0	Willans and Robinson Ord.	4 –5	6 10 0	Apr, Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5½–6	5 0 0	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 –102	3 18 5	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

The question of cable cutting in time of war was much discussed during the Spanish-American war, and the logical conclusion was arrived at that a belligerent is entitled to cut or take possession of any cable belonging to a neutral within the territory of either of the two nations who are at war. In the case of the cables between Russian, Japanese and Corean stations, however, the case is different, as, in addition to the lines owned by the Japanese Government itself, there are a number of cables which, while serving as important links in affording telegraphic communication with Japan, are not situated in either Russian or Japanese waters. The various lines of communication are shown in the map published on another page of this issue. It may be reasonable to suppose that if a Russian or Japanese ship were to attempt to cut an English cable landing on neutral territory only, she would be acting in defiance of international law and committing what would theoretically be an act of piracy; but such cases occurred during the Franco-Prussian war, and also during the war between Chili and Peru. Protests were made on both these occasions, and the English companies owning the cables received compensation.

On the other hand during the Spanish-American war, possession was taken by the Americans of certain cables belonging to the Cuba Submarine Telegraph Company. These cables landed within the area covered by the war. The Cuba Submarine Company, although it received the support of the Foreign Office and of the late President McKinley, has so far not only failed to obtain any compensation (£8,174 was claimed as the cost of repair), but the subsidy of about £2,000 per annum which it previously received from the Spanish Government towards the working and maintenance of the coast cables around Cuba has not yet been resumed by the United States or Cuban Government, and is five years in arrear. The Senate authorised the payment of the £8,174, but this was not passed by the House of Representatives. The matter is still open, and we trust that the company will receive fair treatment, for the claim is a moderate one, and, moreover, the indirect damage to the company's property during the war was considerable. The Eastern Extension Company's cable at Manila was also cut by the Americans and the actual cost of the repair was claimed at the conclusion of the war, but this Company also is still awaiting the decision of the United States Government.

The Metric Weights and Measures Bill has been relegated to a Select Committee of the House of Lords in spite of protests by its mover, seconder and several supporters. A full report of the debate on the second reading will be found in our Parliamentary columns. The arguments for and against the compulsory adoption of the metric system are too familiar to need recapitulation here, but there is not the slightest doubt that its universal use in England would be of ultimate benefit to the country. It is to be hoped, however, that the system if adopted at all will be adopted in its entirety and that no makeshift, such as an English decimal system different to the metric system, will be permitted, as that would only make confusion worse confounded. Lord Kelvin was most emphatic in favour of passing the Bill without delay. To drive home his arguments, his lordship even condescended to an anecdote, with the gratifying result that it was immediately "capped" with a better one by Lord Lansdowne. We think, however, that the question is essentially

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one to be dealt with in a Government measure, and in co-operation with the United States Government. At the present moment when a large number of the Government's supporters are advocating protective tariffs, the introduction of such a measure by the Government would naturally be deemed somewhat inconsistent.

ALTHOUGH Mr. W. CHILTON'S description of the Brush-Parsons steam turbine, reproduced in another part of this issue, does not contain any data with regard to actual performances of the new design, it is worthy of careful reading on account of the particulars given as to the detail construction of the turbine, especially with regard to the manner in which the blades are fixed to the rotor. One interesting point brought to light in the discussion was the comparatively high cost of maintenance of the brushes of the turbo-generators installed at the Dickinson-street works of the Manchester Corporation. Why copper brushes should have been used there instead of carbon brushes can only be conjectured. Probably it is on account of the smaller friction offered by the copper brushes, the commutator not being large enough to dissipate the heat that would be generated by carbon brushes. From the point of view of the commutation, however, carbon brushes are to be preferred, and even by their adoption it is by no means easy to obtain good commutation.

THE question of commutation, in fact, is one of the most difficult problems in connection with continuous-current turbo-generators, and has not yet been perfectly solved. With the high speeds of the turbines and the voltages for which the generators are now usually built, it is impossible to keep the reactance voltage within the limits which experience has proved should not be surpassed, and artificial means for reducing sparking have to be employed. Amongst these may be mentioned the employment of two armatures or armature windings, each with its own commutator. Another method for reducing sparking consists in the insertion of resistances between the windings and the commutator segments, and THURY has successfully employed the use of condensers between each two adjoining segments for the same purpose. Other designers have advocated the use of hollow commutators, containing oil, so that the current would be interrupted in oil. No practical tests seem to have been made in this direction, and it is to be feared that the electric resistance of the film of oil would constitute a serious objection against this device. A host of other proposals, with the same end in view, have been and are still being made, but, so far, nothing of practical value has been developed. This being the case, it is not surprising that the facetious suggestion has been made that the turbines be coupled to alternating-current generators, and that continuous current be then produced by rotary converters.

THE London United Tramways Company has suffered severely in the past at the hands of the local authorities in the West of London, and its most recent experience only tends to emphasise once more the great advantage which would accrue if the technical grounds upon which tramway schemes are at present prevented from coming before Parliament were removed. As we have reported in our Parliamentary columns, the London United Tramways, under the advice of Mr. YERKES, had prepared a scheme for linking up its tramways on either side of the river by a deep level tunnel at Hammersmith, and incidentally running its cars alongside the platforms of the District Railway Company there. Obviously the greater portion of the works involved in these proposals would have been on private property. Fully realising the impossibility of obtaining the consent of the London County Council if the lines were promoted as tramways, the Company designated them railways, under which condition the Standing Order requiring the local authority's consent does not apply. When the Bill came before the Examiners of Private Bills in the House of Commons for proofs of compliance with Standing Orders, however, the London County Council opposed on the ground that the lines were tramways and consequently had not complied with the Standing Orders. This view was upheld by the Examiners and was subsequently confirmed by the Standing Orders Committee, so that the Bill is now "dead" for this session at any rate.

IT is satisfactory to know, however, that Parliamentary officials are strongly of the opinion that the local veto should be abolished, and this may confidently be anticipated as one of the recommendations of the Royal Commission on London traffic. On the other hand, a motion to make these very amendments in the Standing Order in question failed to pass in the House of Commons in 1902. Returning again to the Tramway Company's proposal, the object was to secure a much needed communication across the river. In order to accomplish this, the Company, in 1902, sought powers to run a double line of track over Hammersmith Bridge, but was unsuccessful against opposition of the London County Council. In 1903, the County Council itself proposed to build a single line of track over the bridge, but although supported by the Company, the Council's own evidence of the year before as to instability of the bridge for the purpose killed the project. Now for the third time the London County Council has prevented the reduction of the traffic congestion at one of the worst points in London. Another matter worthy of mention in this connection is the fact that owing to the exorbitant demands of the various local authorities outside London, the Company has decided to abandon the whole of its Tramways Bill with the exception of 5 miles from Hounslow to Staines.

WE report in another column a judgment of considerable importance in connection with the working of tramways, which decides that the Public Authorities Protection Act of 1903 is a valid defence to an action for injuries sustained on municipal tramways through the negligence of the servants of the owners, unless the action has been commenced within six months of the accident. There have been many decisions on the scope of the Act in question, but the latest is by far the most startling. The Act was passed mainly for the protection of municipal officials from the consequences of carrying out the orders of the Corporations in whose service they were, and Parliament never intended that Corporations who embark in commercial enterprise should be protected to a greater extent than private firms.

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Royal Society.—Among the Papers down for reading yesterday were the following:—"Electromotive Phenomena in Mammalian Non-Medullated Nerve," by Dr. N. H. Alcock, communicated by Dr. A. D. Waller, F.R.S.; "On Mechanical and Electrical Response in Plants," by Prof. J. C. Bose, communicated by Prof. S. H. Vines, F.R.S.

Large Donation to Sydney University.—According to Reuter Mr. P. N. Russell, who carried on extensive engineering works in Sydney for some considerable time, but has latterly resided in London, has made a further donation of £50,000 for additional endowment to the School of Engineering at the University of Sydney. Mr. Russell founded this school some seven years since by an endowment of £50,000, and has thus bestowed the sum of £100,000 on the Institution.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903
Tarifa—Tangier	Jan. 18, 1904
Oran—Tangier	Feb. 3, 1904

Electric Power Supply to Local Authorities.—We have received a pamphlet bearing the above title from the Yorkshire Electric Power Co. On the second page is a map showing the company's area, and the remaining pages are devoted to an explanation of the advantages which accrue to local authorities by the purchase of electricity "in bulk" from power companies. By obtaining supply in bulk instead of building separate stations, it is pointed out that the loss on the first few years' working is obviated, and the local authorities are not saddled with plant which may become obsolete in the course of a short time. There are disadvantages, too, in connection with small stations which are obviously not possessed by large undertakings such as power companies. The issue of such a pamphlet as we have before us is a distinct novelty, and it remains to be seen to what extent the example will be followed by other power companies.

Telephone Patent.—Particulars with regard to Prof. M. J. Pupin's application of Mr. Oliver Heaviside's method of improving the working of telephone lines by inserting therein self-induction coils of certain values and at certain intervals have been repeatedly published in *The Electrician* (Vol. XLV., p. 598, Vol. L., pp. 722, 817, Vol. LII., p. 259). The application for a German patent to cover Prof. Pupin's invention was keenly contested, and it was only on February 5th of this year that the patent was definitely granted after lengthy consultations with technical and legal experts. In 1901, Messrs. Siemens and Halske purchased the patent rights of the Pupin invention for all countries outside America, and, as was recorded in one of the articles referred to above (Vol. L., p. 817), applied the method to the Berlin–Potsdam long-distance telephone cable and to the long-distance line between Berlin and Magdeburg with excellent results.

Central Technical College Old Students' Association.—The annual dinner and annual general meeting of this Association was held on Wednesday under the presidency of Prof. W. C. Unwin, F.R.S. Over 50 old students were present, and the guests included Prof. J. Perry, F.R.S., Prof. A. D. Waller, F.R.S., Mr. A. L. Soper (assistant secretary of the City and Guilds of London Institute), and Mr. C. J. Robertson. Prof. H. E. Armstrong and some other members of the college staff were also present. The toast of the evening, proposed by Prof. Unwin, was replied to by Prof. W. J. Pope, F.R.S., and Mr. F. C. Raphael, the two senior old students present. Prof. Perry and Prof. Waller responded for the visitors, Prof. Perry speaking with pride of the careers of students he had taught in Japan, and Prof. Waller upholding the new organisation of the London University, and speaking favourably about the scheme for the higher technical college proposed by the committee of which Lord Rosebery is president. Prof. H. T. Davidge gave the toast of the honorary secretary of the Association, Dr. E. Frankland Armstrong and the other editor of *The Central*, Mr. M. Solomon, and, after replying, Dr. Armstrong proposed the health of the president, Prof. Unwin, referring to the loss which the Central Technical College would sustain on Prof. Unwin's retirement. The Association now numbers over 300 members, and any old students who have not yet joined should communicate with Dr. E. F. Armstrong at the Central Technical College.

The Prince and Princess of Wales at the Battersea Polytechnic.—The 10th anniversary of the opening of the Battersea Polytechnic was celebrated on Wednesday evening, when the Prince of Wales distributed prizes and certificates gained by evening students during the past year, and the Princess of Wales opened a number of new rooms devoted to instruction in domestic economy. The Royal party were received by members of the governing body, the principal, Mr. S. H. Wells, and the Mayors of Battersea and Wandsworth. The chairman of the governors, Mr. E. Tate, read an address, in which he said that the work of the Institution was increasing very rapidly, the buildings having been enlarged no less than four times. They were closely associated with the London University, and provided fully approved courses for internal students in science and engineering. In reply, H.R.H. the Prince of Wales said how fully he appreciated the valuable work being done by the various London polytechnics, and especially that by the Battersea Polytechnic, which could boast of an almost unique record in its growth and success. He mentioned the fact that the London and South Western Railway permitted over 70 of their apprentices to attend early morning classes before commencing the day's work. Keen competition and rivalry characterised the existing relations between communities and nations, and he agreed with Huxley and Sir Norman Lockyer that we were in the presence of a new struggle for existence. Scientific spirit and brain power must not be limited to the workshop when other nations utilised it in all branches of administration. After a report of the past year's work had been read by the principal, the prizes were then distributed by the Prince of Wales, after which a vote of thanks to their Royal Highnesses was proposed by Lord Londonderry and seconded by Lord Monkswell.

Notes on the Cost of Generating Electrical Energy.—In a Paper bearing this title, read before the Cleveland Institution of Engineers on Monday, Mr. E. J. Fox gave the following table, which sets forth the working costs in a few private power stations with a large output per unit of plant installed:—

—	Units per year per kw. installed.	Units per week.	Lbs. coal per unit.	Cost of fuel per ton.	Cost per unit in pence. Coal.	Oil, waste, stores, &c.	Wages.	Repairs.	Works costs.
					d.	d.	d.	d.	d.
Watson, Linwood....	5,400	64,000	3¼	8/0	·138	·011	·011	·018	·185
Do.	5,400	57,000	3	8/0	·153	·012	·021	·021	·207
Do.	5,400	44,190	4	7/9	·171	·016	·027	·027	·242
Do.	5,400	50,880	3 1/10	7/9	·131	·014	·023	·023	·191
Dorman, Long & Co., '03	5,037	151,122	2·8	10/0	·15	..	..	..	..
Do. '02	5,050	60,400	3·04	11/6	·179	·019	·085	·03	·313
Kynoch. Day load ..	1,240	18,400	5·5	6/6	·190	·045	·065	·043	·343
Do. Day & night	1,490	22,400	7·0	6/6	·243	·050	·075	·045	·413
C. & S. L. Railway ..	2,817	132,195	4·16	13/9	·307*	·037	·064	·038	·446
Crompton & Co., Chelmsford	2,820	22,800	4½	15/0-19/0	·43	·018	·109	·022	·579
Vickers, Sheffield, S.	2,000	50,000	..	7/3	·255	·032	·101	·081	·469
Do. N.	3,280	40,300	..	9 9	·313	·063	·102	·101	·579

* Water 0·01.

These costs are made up of cost of fuel, oil, waste, water and petty stores, wages and repairs, which constitute the working costs, in addition to which two further items (which are, however, not touched on here)—namely, interest on capital and depreciation—should be added before the total costs can be arrived at.

The General Electric Co.'s Staff Dinner.—The General Electric Co. entertained their staff and a large number of guests at their fourteenth annual dinner on Saturday. After the usual loyal toasts had been duly honoured, Mr. Gustav

Byng, the chairman, proposed the Navy, Army and Reserve Forces, referring briefly to the Electrical Engineers Volunteers and the new policy at the War Office. Lieut.-Col. Crompton, who responded, mentioned the fact that he himself, as well as Lord Roberts, would cease to be at the War Office as a consequence of the reorganisation, and he expressed a hope that additional volunteer corps of young engineers would be formed. Mr. G. Byng then proposed the toast of the staff, alluding to the fact that it was the twenty-fifth anniversary of his founding the enterprise together with his brother Max and Mr. Hugo Hirst. It had given him pleasure, treasure—but not leisure. The policy of the company now was decentralisation; new branches were being established abroad, and the various branches in this country were being made more independent. The new Witton works were doing well, and turning out, with profit, plant as good and better than Continental plant, and at a lower price. The carbon works had also been improving their output during the past year, and the enterprise is being continued in the hope that the industry would eventually have "Protection." The company had recently received an order for 340 lift motors from the Underground Railways Company of London in the face of keen American competition. Mr. Byng then referred briefly to the fiscal question. As director of a company, upon which he computed 15,000 people depend for their daily bread, he contended that he had a right to speak out on this question. There was, he said, not sixpennyworth of electrical machinery and apparatus imported during the last few years that could not have been made in England, and, with the exception of a few articles, such as carbons, all could have been made and sold as cheaply in this country. When Protection came he would be willing to sell at prices 5 per cent. lower than those now ruling. Mr. W. White responded for the staff in an amusing speech and proposed the health of the directors, to which Mr. Max Byng and Mr. Hirst replied, Mr. Hirst then proposing the toast of the guests. Mr. R. Wallace, K.C., Mr. Manville and Mr. Rashleigh Phipps acknowledged the compliment in laudably brief speeches, and the final toast was that of the Chairman proposed by Sir Richard Awdry, K.C.B. In the course of the evening "The General Electric Co.'s March," a bright little march composed specially for the occasion by Mr. Louis Hillier, but printed in Belgium, was performed with much success, and after the speeches the proceedings terminated with a smoking concert.

University College, London.—The annual general meeting of the members of University College, London, was held on Wednesday. Lord Reay (president) occupied the chair, and was supported by Lord Monkswell (vice president), Dr. G. Carey Foster (the principal), Lord Edmond Fitzmaurice, M.P., Dr. Benson, Mr. H. Lucas, Mr. W. Bailey (chairman of the committee of management), and Dr. T. Gregory Foster (secretary). In addition to the ordinary election of persons as Fellows of the college, the following list of those nominated for admission as life governors, "having special claims in consequence of benefits conferred upon or services rendered to the college," was approved:—Profs. O. Chadwick and Sir John Macdonell, Mr. Charles Hawksley, Mr. T. W. P. Lawrence and Miss Rosa Morison. The following "persons distinguished in public life or for their services in the cause of education" were also elected as life governors:—Sir Francis Mowatt, Messrs. R. K. Gray, J. R. Macdonald, Felix Schuster and P. Bence Trower. The President, in moving the adoption of the report, said that the fees for 1902-3 amounted to £25,518, as compared with £24,086 for 1901-2. He referred in feeling terms to the deaths of members of the college during the past year, and said that in Sir John Blundell Maple they had lost a great benefactor. The council had created a new grade of teachers in the college, in the faculties of arts and science, who to a certain extent were equivalent to the *Privat-dozenten* of German universities and thus it was possible to do justice to a number of subjects which it was not easy to crowd into the regular curriculum. The session 1902-3 was the first in which the new arrangements and regulations on the internal side of the University of London in the faculties of arts, science, engineering, and economics were in full working order. It was satisfactory that these new regulations had given complete satisfaction to both professors and students of the college. They had now obtained the status which they ought to have had for some time past in the University of London, and he hoped that even more extension would be given to the principle which, he believed, was fully accepted in the United States, where they attached importance to teaching, and gave examinations a secondary place. With regard to the appeal for funds, less than £60,000 was now wanted, and there was reason to believe that that sum would soon be obtained, and that the incorporation of the college in the University would take place. The activity in the college and the scientific vitality of the institution probably never stood higher than at present. The motion was seconded by Lord Monkswell, and the report was adopted unanimously. A letter was read from Sir Richard Farrant (treasurer), who stated that the financial position of the college continued to improve steadily.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, February 26th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, South Kensington, Agenda: (1) "A New Dilatometer," by Mr. Bornikson. (2) "A Quartz Thread Vertical Force Magnetograph," by Dr. W. Watson. (3) "On Stresses in a Magneto-static Field," by G. W. Walker. (4) "Some Hints on the Preparation of Diagrams," by Dr. W. Watson.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. General Meeting in the Literary and Philosophical Society, Westgate-street, Newcastle-on-Tyne. Included in the business of the evening will be Mr. Max Wurl's reply to the discussion on his Paper "Technical Education in Germany," and a Paper by Mr. B. C. Laws on "Technical Education."

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Ordinary Meeting at 25, Great George-street, Westminster. Paper to be read: "Boiler House Design," by L. G. Crawford.

ELECTRO HARMONIC SOCIETY.

8 p.m. Concert (Ladies' night) in the King's Hall Rooms of the Holborn Restaurant. Chairman: Lord Claud Hamilton.

ROYAL INSTITUTION.

9 p.m. Evening discourse on "New Developments in Electric Railways," by Alexander Siemens.

SATURDAY, February 27th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture II. on "The Life and Work of Stokes," by the Right Hon. Lord Rayleigh, F.R.S.

MONDAY, February 29th.

INSTITUTION OF ELECTRICAL ENGINEERS: NEWCASTLE LOCAL SECTION.

7:30 p.m. Meeting at the Durham College of Science, when the discussion on Mr. Anderson's Paper "Power Distribution in Shipyards and Engine Works" will be continued, and if time permits a Paper on "Regulating Impedance Coils" by C. Faraday Proctor will be read.

TUESDAY, March 1st.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

3 p.m. Annual General Meeting at the Hotel Cecil.

7:30 p.m. Meeting at Owen's College. Paper to be read: "The Mersey Railway: Multiple Control System," by H. L. Kirker.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION.

WEDNESDAY, March 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at the Offices of the Institution, 92, Victoria-street, Westminster. Paper to be read: "The Determination of the Correct Proportion of Condensing Plant in a Central Station," by P. V. Hunter.

THURSDAY, March 3rd.

ROYAL INSTITUTION.

5 p.m. Afternoon Lecture II., by Prof. H. L. Callendar, F.R.S., on "Electrical Methods of Measuring Temperature."

RÖNTGEN SOCIETY.

8:30 p.m. Ordinary General Meeting at 20, Hanover-square, W., when the Right Hon. Lord Blythswood will deliver his Presidential Address on "Some Laboratory Notes of the Last Six Months."

FRIDAY, March 4th.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "Some Notes on Electric Storage Batteries." By G. C. Allingham.

SATURDAY, March 5th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SEC

9:30 a.m. Visit to the Works of Messrs. J. I. Thorneyc & Co. (Ltd.), Chiswick.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture III., by the Right Hon. Lord Rayleigh, F.R.S., on "The Life and Work of Stokes."

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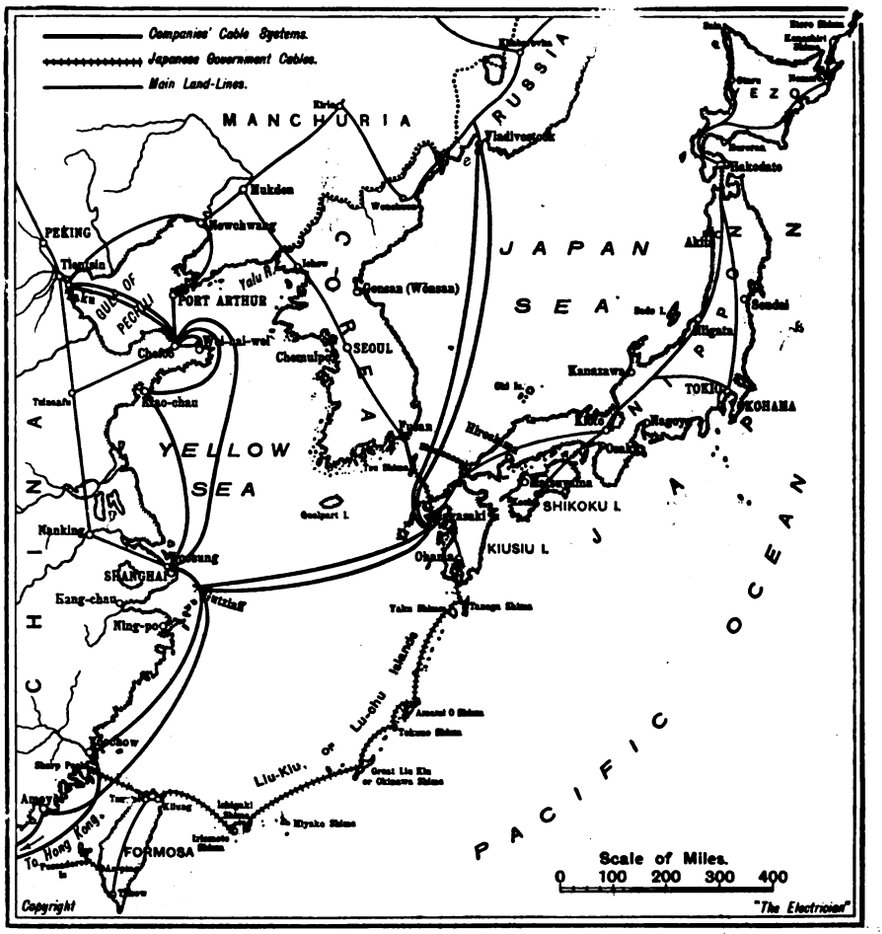
CABLES AND THE RUSSO JAPANESE WAR

Cable communication is one of the most interesting factors in modern warfare, and in the case of the present war between Russia and Japan it is of more than usual importance. Japan itself being an island empire is dependent on submarine cables for its telegraphic communication with the rest of the world; and, as Russia has complete control of the overland telegraphic routes to the seat of the war on the mainland, practically all our direct news from Corea and the Liao Tung peninsula is transmitted through the cable system of the Eastern and Eastern Extension Telegraph Companies. The Great Northern Telegraph Co. announce this week the completion of their new overland route via Kiakhta to China to replace their Vladivostock route, but of course this also passes through Russian territory and the news sent through it will presumably be subjected to strict censorship. It will, therefore, be opportune to pass shortly in review the present cable connections with China, Japan and Corea, and the map which we give below will be of considerable assistance in following out the routes and tracing the means of communication which we possess at present.



The two main cables through which the major part of the traffic must necessarily pass are those completing the Eastern Extension Telegraph Co.'s route to Shanghai. These are the lines from Hong Kong to Shanghai. One, via Foochow, is owned by the Eastern Extension Company, and the other is the property of the Great Northern Telegraph Co., and calls at Amoy and Gutzlaff, an island 50 or 60 miles to the south east of Shanghai. A cable to Amoy from Tourane (Annan), belonging to the French Government, has been interrupted since November 10th last. The Eastern Extension cables from Hong Kong to Foochow and Foochow to Shanghai were laid in 1884 and 1883 respectively. The Great Northern cables are considerably older, however, having been originally laid in 1871. That company, moreover, in 1883, laid a three-conductor cable from Shanghai—or, rather, from Woosung, the adjoining town which serves as the company's landing place—to Gutzlaff, with a view of connecting up the two cables from that island to Nagasaki, in Japan, laid in 1871 and 1883 respectively. With the exception of the second Woosung–Gutzlaff cable all the cables mentioned in this article are single-core.

From Nagasaki to Vladivostock the Great Northern Company has two cables, 771 and 754 miles in length respectively, but these cables have been closed to traffic by the Russian authorities. Nagasaki is connected by landlines and short cables to Tokio, Hakodate, and all the more important towns in the Japanese islands, including Ohama, from which a cable owned by the Japanese Government itself, runs to Formosa, connecting up the smaller islands en route. This is connected with the mainland by the Japanese Government cable to Tamsui. There is yet one more link between Japan and the mainland—viz., from Nagasaki, by means of the Japanese Government cable to the island of Tsu Shima, and thence by a Great Northern cable to Fusan in Corea. The *Daily Express* special correspondent at Tokio reported on Sunday that a Russian cruiser had been reported to the west of Yezo engaged in grappling for the island cables and cutting them. Japan, we may be sure, will use every effort to guard her cable communications, and as she owns a cable ship herself—the "Okinawa Maru" (see *The Electrician*, Vol. XXXVII., p. 365), with a gross tonnage of 2,100, and an engine power of 350 H.P.—she will, doubtless, be always successful in keeping some of these lines in repair, so that it is not likely that she can be cut off telegraphically. The Great Northern Telegraph Co. has one cable ship, the "Store Nordiske," usually stationed at Shanghai, and the Eastern Extension Company have the "Recorder" and the "Patrol" usually at the Singapore depot ready to carry out repairs at any moment. The "Patrol" is one of the newest cable ships, and was especially equipped as a cable repairing steamer (see *The Electrician*, Vol. L., pp. 757 and 800). Russia has, we believe, no cable ships of her own, but, of course, there is no reason why her war vessels should not be able to cut a cable and perhaps even work it also at any time this might be necessary. An American warship, we believe, made considerable use of one of the Cuba Submarine Company's cables in the Spanish-American war.

To return to the remaining cable routes. The Chinese and German Governments' cables go from Woosung to Chefoo, one via Kiao Chau, the port recently acquired by Germany, the other direct. From Chefoo, again, there are two Chinese Government cables to Taku and one Russian Government cable to Port Arthur, and a short cable belonging to the Eastern Extension Telegraph Co. connects Chefoo with the British port Wei-hai-wei. There are also Chinese landlines connecting Woosung with Chefoo, Tientsin, Taku, Newchwang and Port Arthur, and these connect up to the Corean landlines at Lao Yang, near Mukden. The telegraph lines between Seoul and the main Corean ports are under military control and subject to censorship. The same applies to the cable between Port Arthur and Chefoo, which, whether cut or not, has at any rate been closed.

A Reuter telegram published in yesterday's evening papers, states that the United States Government had decided to sanction the laying of the new telegraph cable between the Japanese coast and Guam, to connect with the Commercial Pacific cable, on the ground that the use of commercial facilities did not constitute a breach of neutrality. The object of the projected cable is to prevent the isolation of Japan in the event of Russia's cutting all existing cables.

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RADIO-ACTIVITY.*

BY FREDK. SODDY, M.A.

(*Concluded from p. 682.*)

Conclusions.—If the positions that have been developed in the preceding articles are reviewed in a general way, we find the very remarkable and varied phenomena of radio-activity are all simple consequences of a single cause. The life of the individual atom of certain of the heavier forms of matter is not infinite, but is limited to a definite period of time by considerations inherent to its structure, of which we have at present no knowledge, and over which we can exert no control. There is no gradual alteration of its properties, nor, apparently, any other indication of the approaching end, but suddenly, by some internal cataclysm, the atom flies into fragments, and, as such, ceases to exist. Its disintegration is marked by an outburst of energy which is unparalleled in any other natural phenomenon. Small parts of the atom, positively charged, and of the same order of mass as the hydrogen atom, are expelled with the velocity of 20,000 miles a second, so that the kinetic energy of these particles in relation to their mass is of a higher order of magnitude than matter has ever before been known to attain. The radial flight of these particles from the disintegrating element gives rise to the so-called α-radiation of the radio-active substances and constitutes the fundamental and essential feature of radio-activity (p. 296). In consequence of the enormous kinetic energy of the α particles, and the delicate means we possess for their investigation, the effect of a single particle is not greatly, if at all, beyond the range of experimental detection. Even if the absolute number of atoms disintegrating per second is small, the course and characteristics of the disintegration can be accurately studied. It follows that the surprising and wonderful energy manifestations which characterise radio-activity are, even in the case of a powerful example like radium, due to the disruption of an almost infinitesimal fraction of the total quantity, so that these effects may be produced without sensible diminution continuously over many years or even centuries.

The proportionate amount changing even over long periods of time is so small that its detection by the ordinary methods of chemistry is a difficult task. Only in the case of one element has definite evidence yet been obtained by these means of the nature of the product of the disintegration. The element helium has been shown to be continuously generated in excessively minute amount by radium (p. 682). We have as yet no direct knowledge as to the final products of uranium, thorium, polonium, &c., but it may be confidently expected that these questions will soon be experimentally attacked. Even in the case of radium it is extremely unlikely that helium is the only element to be produced, but being, of all the elements, perhaps the one most easily detected, it is naturally the first product to be recognised. If, as seems likely from general considerations, the α particle is actually an atom of helium, then, since the α-rays of all the radio elements are very similar in character, we may expect to find helium produced by every radio-active element.

Less important than the α-rays from a theoretical standpoint, but very striking in their experimental qualities, are the more penetrating β and γ-rays. The β-rays are also caused by the flight of radiant particles, but the latter are not atoms but the familiar electron or unit charge of negative electricity. In this they are analogous to the radiant matter of the Crookes tube or the cathode rays; but the β particles are moving with a far higher velocity than the latter, in certain cases approaching very nearly the speed of light (p. 255). The γ-rays are probably a type of X-rays accompanying the production of the β-rays, but are vastly more penetrating than any other kind of radiation known. This renders them very remarkable and interesting. Both the β and γ-rays together represent probably less than 1 per cent. of the total energy of radiation.

The disintegration of an atom is, as a rule, not completed in a single disruption. The atom does not pass from its initial to its final state in one stage, but there are several successive disruptions, each suddenly and explosively consummated by the violent expulsion of α particles, which follow one another after definite and characteristic intervals of time. We may suppose, without falling into serious error, that the atom in the first disintegration is resolved into one α particle, and a residual particle, which though somewhat lighter than the parent atom, is still relatively heavy. After a definite "life" this residual atom again disrupts, another α particle is expelled, and a new residual atom, again a little lighter than before, is produced. This process may be repeated several times before the expulsion of the α particles ceases and the matter passes into its ultimate form. In consequence, there exists, intermediate between the parent element and the final products of its disintegration, a series of new unstable elements which may be described as transition-forms in the step-by-step process of degradation. In the case of thorium, the first transition-form to be produced is known as thorium X, and it is separated from the thorium by differences in their chemical properties (p. 323). The transition-form produced from thorium X is known as the emanation (p. 402), and is characterised by volatility, so that it diffuses away from the thorium compounds of its own accord. The last transition-form is again non-volatile, and is the matter which causes the imparted activity of thorium (p. 446). In uranium only one intermediate form, uranium X, is known at present (p. 323). In radium a gaseous form, also known as the emanation, is the first to be produced, and this changes similarly to the thorium emanation into a non-volatile type of matter, which causes the imparted activity from radium (p. 574).

In every individual disintegration, whether of the original slow-changing parent element or of the more rapidly changing intermediate products of its change, the same law holds. A definite fraction of the total, which is represented by the symbol λ, and is known as the radio-active constant, changes per second. But the different types vary widely in the value of their radio-active constants, and since the latter is unalterable by any known agency, it serves to characterise the type of matter in question, and to differentiate the various types now known from one another.

It might be thought that the α and β-rays, as representing the positive and negative electric charges, would be produced in equivalent quantities at each disintegration. This is not the case. In by far the majority of instances only the α or positively charged particle is expelled. In the case of all three radio-elements, uranium—thorium and radium—the β particle or electron is only expelled at the last stage of disintegration. In the case of uranium, or, more strictly, of uranium X, it results by itself without the simultaneous production of an α-ray. There is evidence that the residual atom after the positive ray is expelled is in some cases itself positively charged. This is one of the most fundamental questions at the present time in radio-activity, and undoubtedly the matter will soon be thoroughly sifted by new experimental researches. Is the disruption of an atom accompanied by an alteration in the state known to us as electrical neutrality? (p. 614). If matter is composed entirely of electrons, and positive electrification is due to a deficit of electrons, what is electrical neutrality, and what is chemical valency? To change the valency of an atom, as for example in the conversion of the divalent iron of ferrous compounds into the trivalent iron of ferric compounds, the iron atoms must be supplied with electricity.

If we could combine several atoms of one valency to produce a single new atom of different valency, would the matter, if electrically neutral before, remain so after the change had been effected? Conversely, in the disruption of an atom of one valency to form new atoms of different valency, is the electrical neutrality of the matter preserved? These questions, involving as they do the possibility of a process in which electricity of one kind is created without a simultaneous production of an equivalent quantity of the opposite kind,

* These articles are based on a series of 12 lectures which Mr. Soddy has delivered at University College, London. After publication in *The Electrician* they will be revised and amplified by the author, and be published in book form by "The Electrician" Printing and Publishing Co.

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would have been regarded as highly unorthodox a few months ago. To-day radio-activity affords the means of putting them to direct experimental test.

A few primary considerations with regard to the transition-forms will indicate their general character. The initial change of the parent element producing them must be slow, otherwise none would have survived to the present day. The actual quantity of transition-form produced in short periods must, therefore, be excessively small, and for the most part quite below direct methods of recognition. Their rapid rate of disintegration, and the expulsion of α particles, makes their detection possible. But being in minute amount and disintegrating rapidly, their quantity, after separation from the parent element, rapidly diminishes, and the radio-activity correspondingly decays. Concomitantly a new crop is produced by the further disintegration of the parent element, and the total quantity in existence, although always being renewed, remains constant at a certain value.

This state, which is known as the radio-active equilibrium, is satisfied when the number of atoms disintegrating per second equals the number formed in the disintegration of the parent element. As the quantity of the latter is approximately constant, it follows that the quantity of a transition-form which accumulates and can be in existence at any one time is inversely proportional to its rate of change or radio-active constant. On the other hand, the radio-activity contributed by each transition-form in a series of successive disintegrations is, after radio-active equilibrium is attained, defined by the amount changing, and, therefore, is of the same order for each type, independent of its rate of change. This is a compensating principle of great importance. A rapidly changing transition-form accumulates only in small quantity; a slowly changing transition-form in correspondingly greater quantity. For different types, produced in the same series of disintegrations, the respective equilibrium quantities give similar effects—*i.e.*, the same or a similar number of α particles are expelled per second. If equal quantities are examined the radio-activity is proportional to the rates of change, represented by λ.

So long as the rates of change are rapid—if, for example, the quantity present is reduced to half value in a period of time represented by a few weeks at maximum—the quantity of the transition-form that can ever accumulate in any ordinary quantity of parent element is, and must be, below that required for direct recognition by the methods of chemistry. If, on the other hand, types exist which take longer than this to change, then the quantity accumulating becomes proportionately greater, and if sufficient number of tons of material are operated upon, enough may be obtained to give definite chemical reactions. It is a question simply of the rates of change and the quantities of material extracted. But as the rate of change diminishes, the transition-form will lose more and more its characteristics, its radio activity will decay more and more slowly and it will approach in properties a so-called "permanent" radio-element. As this occurs, the time required for the equilibrium value to be attained after it has once been separated from the parent element increases, and may be years or centuries. Hence this condition cannot be experimentally realised, and just as in the case of the problem of the nature of the ultimate products of the disintegration, we must turn to the natural minerals in which the radio-elements are contained if we would obtain evidence of the existence of these slow-changing forms.

Viewed in this light it is probable that all the new radio-elements, polonium, radium and actinium, found in the mineral pitchblende are themselves slowly changing transition-forms rather than original elements. This is one of the, as yet, unverified consequences of the theory of atomic disintegration, and the identity of the parent element in whose disintegration they are produced remains unknown. The presumption, naturally, is in favour of considering uranium as the prototype, since that element is the heaviest known and the chief constituent of pitchblende. This is one of the most interesting problems which the future developments of the science may be expected to unfold. It is certain that the polonium in pitchblende, when separated, lasts but a few years before it completely changes into inactive matter, and it is no less certain that the same holds equally true for radium in the course of a few thousand years. For actinium an intermediate period is indicated. The continued existence of these three elements at the present time demands, of necessity, a regeneration process. It is philosophical not to postulate a special complementary process of atomic up-building, of which we have as yet no evidence at all, to account for their existence, until it has been definitely shown that they are not merely special cases of the proved process of atomic disintegration which radio-activity has revealed. Should future results confirm the view indicated there is no difficulty in supposing that the processes of radio-activity have been proceeding continuously as at present for periods of time so long that they carry us back into the past to the beginnings of scientific knowledge. If uranium and thorium are considered, for the sake of illustration, as the two primary elements from whose disintegration all the known types of radio-active matter are derived, the known rates of change of these elements (p. 646) is so slow that thousands of millions of years would not suffice for their complete disappearance from the earth. The cosmical processes of analytical separation on a large scale which took place in the early history of the earth and which resulted in its non-homogeneous composition—the processes in short which brought about the distribution of the elements into the various minerals known to us to-day—probably occurred within the lives of the existing uranium and thorium found therein, and there is no immediate necessity for supposing a process of atomic up-building to have taken place during the existence of the earth in its present state. The possibility that such a process may have, in fact, been going on concurrently with that of atomic disintegration is, of course, not for a moment to be denied. The revelations of the last few years in science at least should make us hesitate to ascribe limits of possibility and impossibility to the processes of Nature. All that is here intended to be conveyed is that it is not as yet necessitated by the facts.

If we would push the inquiry further into pre-terrestrial times and demand to know how the elements uranium and thorium came to be formed in the first instance, the problem becomes merely a part of the fundamental one, on which no science has yet thrown light. Cosmical evolution, so far as it has been revealed, seems to proceed only in the one direction, and to be tending to exhaust itself. How, therefore, did it originate? The possibility of sub-atomic change in cosmical processes has enormously extended the period over which continuous evolution in one direction may be maintained. But it has not yet solved the riddle of its origin.

Regulation of Steam Dynamos.—M. Routin, of Lyons, has devised an electro-mechanical governor which is described in a recent article by M. F. Brock in the *Elektrotechnische Zeitschrift*. The device consists essentially of a solenoid, magnetised by a few series turns and a coil which is in shunt with the generator. The magnetomotive forces of the two windings are opposed, that of the shunt coil, however, predominating under normal conditions. The field switch, the valve mechanism and a rheostat in series with the shunt coil of the solenoid are mechanically connected to the armature of the solenoid. The last-named switch performs the function of securing the predominance of the shunt coil of the solenoid for any position of the latter's armature. Assuming additional load to be put on the generator, the armature of the solenoid will drop a certain distance, because the increased magnetomotive force of the series winding of the solenoid will, by more nearly balancing that of the shunt coil, diminish the strength of the electro-magnet. In falling, the armature will have acted upon the valve gear, at the same time cutting out resistance from the field circuit of the generator as well as from the circuit of the shunt coil of the solenoid. If load is taken off, the action is reversed and the armature is drawn higher up into the solenoid, and if a short circuit takes place the series coil largely predominates, the armature is drawn right up and steam is shut off. If the fuse blows in the generator circuit, the same thing occurs, the shunt coil now being responsible for this.

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THE BARKING-BECTON LIGHT RAILWAY.

The Barking-Becton Light Railway Order was obtained in 1899, and contracts were let in 1900, the delay in completion being due, principally, to legal difficulties in connection with the purchase of land on each side of the River Roding for the construction of a bascule bridge and its approaches. Messrs. Wm. Griffiths & Co. secured the contract for the permanent way, of which there are 1·3 miles of single track with loops. The gauge is 4ft. 8½in., and the rails, in 45ft. lengths and 83lb. to the yard, were supplied by the Leeds Steel Co., the tie-bars and points and crossings being by Messrs. Askham Bros. and Wilson. The heaviest gradient is 1 in 25 and the radius of the sharpest curve two-thirds of a chain. Part of the route—viz., Gascoigne and Boundary-roads, is paved with basaltic lava setts, while in that portion from the bridge to Becton the rails are laid on wooden sleepers, with the treads of the rails on a level with the road surface, there being practically no vehicular traffic.

Messrs. R. W. Blackwell & Co. erected the overhead equipment, which consists of a 2-1/0 hard drawn trolley wire on bow strings, supported principally by side poles and brackets; span wires are used on curves. The cars were supplied by the Brush Electrical Engineering Co., and each is equipped with two 25 H.P. B.T.-H. motors and K. 10 type controllers. They are all single-truck, double-deckers, mounted on Peckham trucks having a wheel base of 6ft. The British Electric Car Co. supplied the destination signs. Four cars are to be fitted with Magrini top-deck covers.

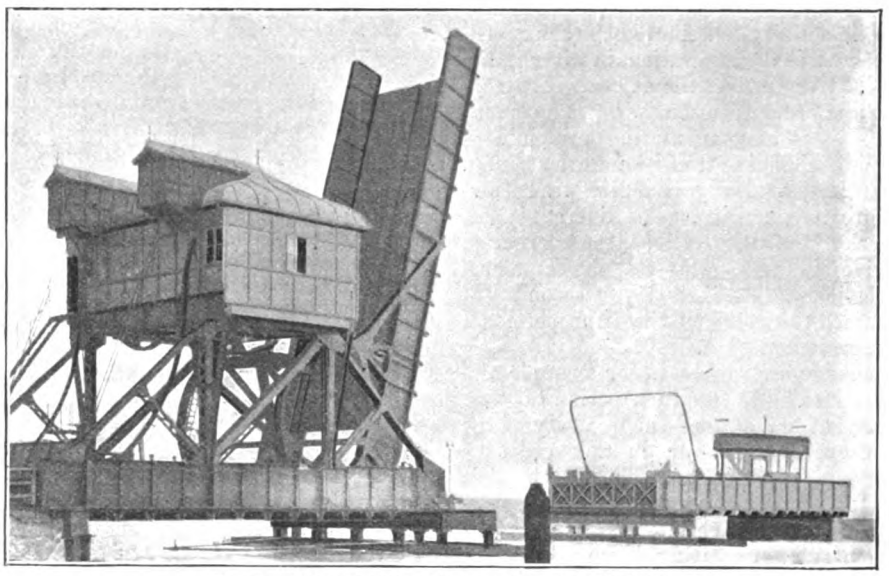

Fig. 1.—The Barking-Becton Bascule Bridge.

There are three feeder cables having sections of 0·1, 0·15 and 0·2 sq. in. respectively. These are of Messrs. Henley's make, lead-covered, paper-insulated and laid solid in wood troughing. The same firm also supplied three-core pilot and telephone cables, section boxes and telephones. The latter are on the C.B. system, the 25-line exchange being on the switchboard at the power station. Matters are so arranged that it is possible to signal either from the power station to the sub-telephones or vice versa; it is also possible to establish communication between sub-telephones which are situated in small iron boxes carried by the trolley poles. The car shed is 75ft. by 42ft. and has four tracks capable of accommodating eight cars.

Owing to the fact that the line carries very few passengers other than workmen employed at the Becton gas works the load is a very variable one and a system of split shifts has been adopted.

When it was proposed to run the line over the River Roding, the Board of Trade stipulated that some arrangements should be made whereby it was impossible to open the bridge whenever a car was within 100yds. on either side. To comply with these requirements certain interlocking devices were designed, which will be described hereafter. The bascule is lifted by means of steel ropes, and on rising it travels backward on circular heels until it finally reaches the position shown in Fig 1. The working of the bascule is assisted by a heavy counterweight, and its heels are anchored by steel ropes to prevent it travelling in a horizontal direction when being raised. The bridge machinery is worked by two 33 H.P. Mather and Platt motors, supplied with power from the traction mains. In the cabin is a tide indicator and bridge indicator, the latter showing the bridgemaster the position of the bascule when being raised or lowered. Owing to the design of the bridge it was found impossible to get a trolley wire across it, and therefore each car is fitted with a skate which is lowered when the car crosses the bridge and enables power to be picked up from side contacts which are fitted with rollers. The skate is folded up flush with the side of the car when the latter is running with the trolley in the ordinary way.

In the bridge cabin is a change-over switch (see Fig. 2) which puts current on to either the bridge motors or to the bridge section trolley wire and bridge contacts. The bridge section trolley wire runs 100yds. either side of the bridge. This change-over switch is interlocked mechanically by means of slides with the handwheel that opens and shuts the gates across the track; the interlocking is so arranged that when the gates are open for traffic the switch can only be in the bottom contacts, putting current on to the trolley wire, and when the gates are shut against traffic the switch can only be put into the top contacts, putting current on to the bridge motors. This handwheel is also electrically interlocked with the change-over switch, making it impossible to move the handwheel (and thus the gates) so long as the change-over switch is in either the top or bottom contacts. The locking of this wheel is effected by means of a steel band stretched round the rim of the wheel, and pulled tight by a powerful iron-clad electromagnet, the circuit of which is closed by the change-over switch when in either the top or bottom contacts. The handle of this change-over switch carries an iron plate, which, when the switch is in the bottom contacts, faces another iron-clad electromagnet, which becomes energised whenever a car comes on the bridge section in either direction, and remains energised until the car has crossed the bridge and leaves the bridge section. When this magnet is energised it is impossible for the switch to be pulled out of the bottom contacts, and, therefore, it is impossible for current to be taken off the trolley wire so long as a car is on the bridge section.

Each car carries two Leclanché batteries, and has three brushes fixed under the framework which make contact with some brass strips (called locking strips) fixed on the track between the running rails. These locking strips consist of strips of brass 2in. wide by 8ft. long and $\frac{3}{32}$in. thick, mounted on timber and projecting 1¼in. above the level of the rails. The up-line strips are placed 5½in. from each rail, and the down-line 5½in. from one rail and 2½in. from the other. On one side of the bridge there is only a single track, so the up and down locking strips are placed side by side. On referring to Fig. 2, it will be seen that the locking strips are placed at the ends of the bridge section (100yds. from bridge); these are called first locking strips, and another set, placed 50yds. from bridge, are called second locking strips. A car going over the locking strips sends current from the battery in the car to the strip, through the brush mentioned above, and then by wires laid by the side of the track to the bridge cabin, where it pulls down the armature of a relay. The movement of the armature of this relay sends up a green disc marked "Car on up line No. 1 lock," covering the white disc marked "Bridge section clear," and at the same time sends current round the locking

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coil (which has a red lamp in series, showing the bridge attendant that the switch is locked) and also lights up two red signal lamps fixed outside the bridge cabin, indicating to any car coming in the opposite direction that a car is crossing the bridge. When the car reaches the second locking strips it causes the relay to send up a second green disc marked "Car on up line, No. 2 lock," which is immediately behind the first disc, and, therefore, not shown in the drawing, and also closes

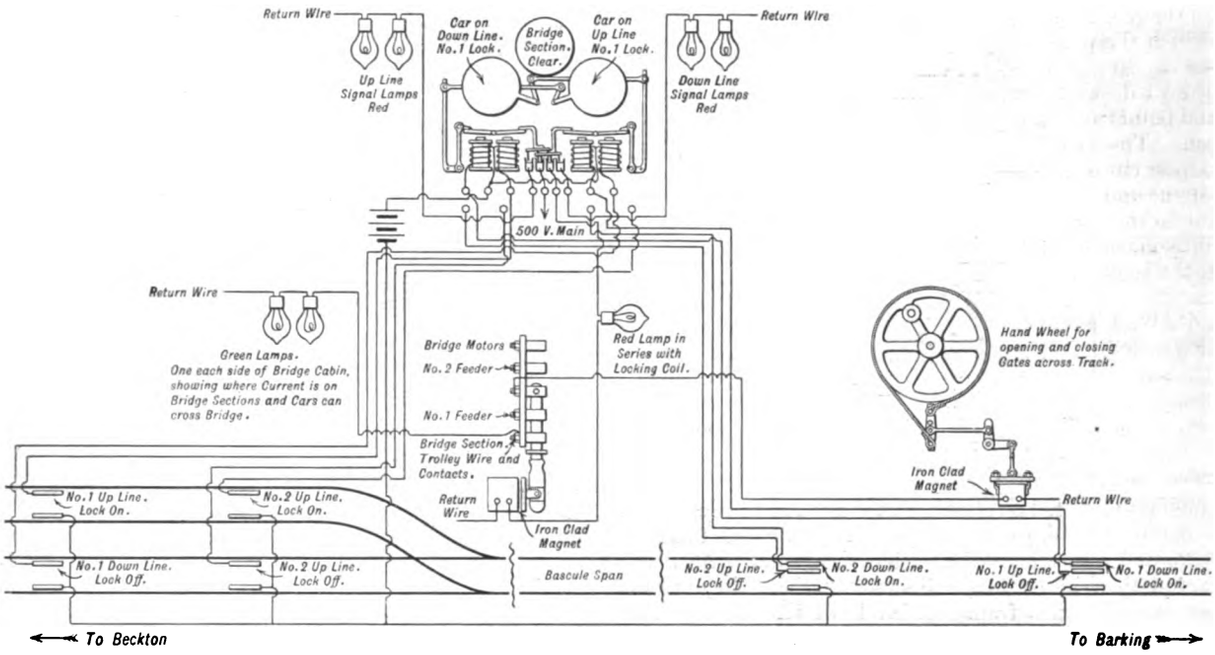

Fig. 2.—Diagram of Connections of Interlocking Devices.

the circuit for the locking coil and signal lamps. The car, on going over the bridge and continuing its journey, passes over the next strips and causes No. 2 locking disc to drop; finally, when it passes over the last strips, No. 1 locking disc drops and takes off the lock and signal lights. A down-line car sends up red discs, lights up signal lamps on either side of cabin and puts on the lock in a similar manner.

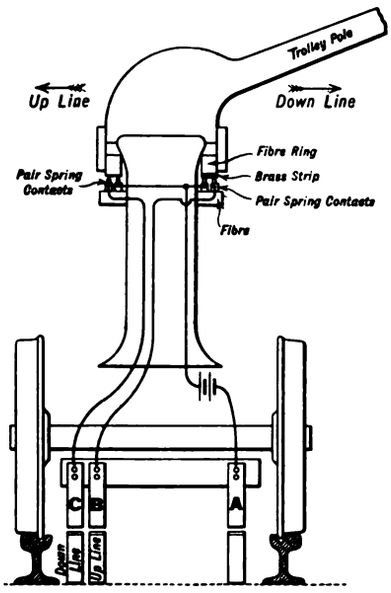

Fig. 3.—Discriminating Device on Trolley Pole.

Owing to there being only single-line track on one side of the bridge, it was found necessary to put on each car a discriminating device by which an up car works the up-line signals and discs, and a down car the down signals and discs. The discriminating device is illustrated by Fig. 3, and consists of a fibre ring fixed to the swivel head of the trolley standard. The fibre ring has a strip of brass fixed on its under face three-eighths of the way round, and fixed to the trolley standard, on opposite sides, are two pairs of spring contacts pressing on the under side of the fibre ring, so that when the trolley pole is trailing in one direction the strip of brass is under one pair of contacts, joining them together electrically, and when trailing in the other direction the other pair of contacts are electrically connected by the brass strips. One pole of the battery in the car is joined to one brush, A, under the car direct; the other pole is joined to one contact of each pair on the trolley standard, and the other contacts of each pair are joined respectively to the other two brushes B and C under the car. Thus the car going in one direction has the battery between brushes A and B, and when going in the other direction the battery is between brushes A and C, so that when an up-line car runs over the locking strips on the single line, although all three brushes press on the strips, the battery is only across brushes A and B, and the up-line locks and signals are worked; but when the car comes back again over the same strips, the trolley pole, of course, trailing in the opposite direction, the battery is across brushes A and C, so that only the down-line locks and signals are worked.

We are indebted to Mr. A. Hugh Seabrook, chief engineer and manager, for his courtesy in giving us facilities for obtaining the above information, and to Mr. R. J. J. Swan, assistant engineer, for giving us the details relating to the ingenious interlocking devices which were designed by him and fitted by the Council's staff under his supervision.

THE NEW TRUNK TELEPHONE EXCHANGE.

(Concluded from page 684.)

The relays employed in connection with the line and cord circuits are (with one exception) of similar design throughout, the only difference being in the arrangement of the windings. Fig. 13 shows the construction of the relay, which was specially designed by the British Insulated and Helsby Cables (Ltd.) for the complex circuits of this exchange. The armature A is controlled by the helical spring S, and is prevented from moving in a horizontal plane by the two pins PP, thus differing considerably from the heavy armatures with gravity control employed in the American types of telephone relay. The white metal contact tongues TT are screwed to the armature, and the contact surfaces as well as the points of the contact screws are, of course, platinised. There are two windings on the coil of each relay, these in most cases having each a

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resistance of 500 ohms. They can thus be connected in parallel for the 250-ohm relays and in series for the 1,000-ohm relays, or they may be connected differentially. In other cases different windings are employed, having resistances as marked on the diagrams already given.

The relay and condenser rack is of the ordinary skeleton iron construction, and the intermediate distributing frame has been built to a similar specification as that for the Post Office "Central" local exchange. The frame is of iron, and the connection tags are mounted on ebonite strips fixed to wooden bases. Wire insulated with silicated worsted said to be non-inflammable, serves for cross connecting. The cables containing the trunk and junction lines enter in the basement, where they are led to the main distributing frame, which is of the usual pattern and similar to the one in the same basement belonging to the "Central" local exchange. From the vertical side of this frame cables are led to the test-board where they are connected to the inner springs of five point jacks (*see* Fig. 15). The outer springs of these jacks are connected to the horizontal side of the intermediate distributing frame, and from the vertical side connection is made through the fuse-board to the switchboard. The fuse board consists of rows of terminals, each of which is connected to a German silver spring by means of a fine wire. When a fuse "blows" the corresponding spring falls back on a contact bar; the local circuit of a relay connected therewith is closed; an alarm bell rings; and a lamp lights up at the bottom of the vertical row of terminals in which the failure has occurred. By this means the failure of any power signalling circuit is immediately brought under the notice of the attendant and quickly remedied.

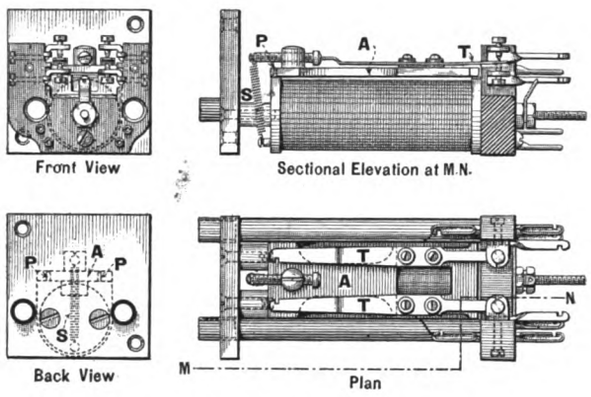

Fig. 13.—Helsby Pattern Relay. ½ Full size.

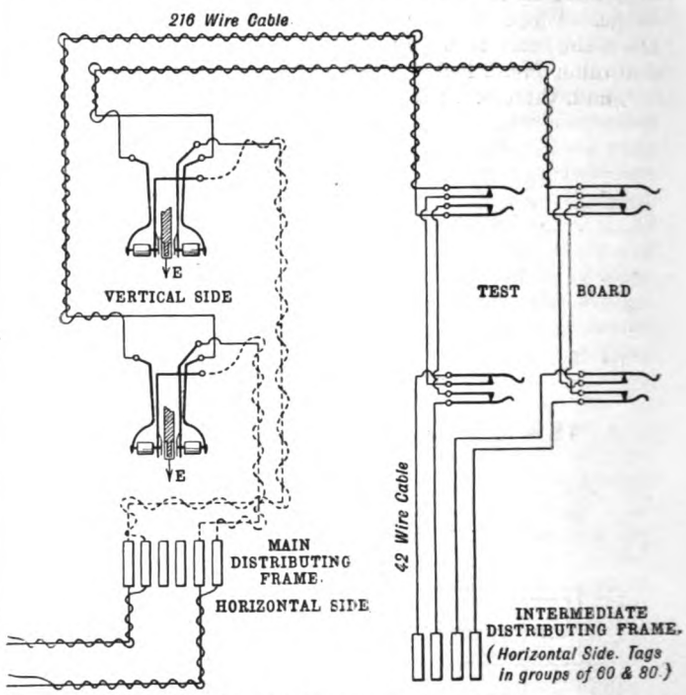

Fig 15.—Wiring Diagram of Trunks, Junctions, &c., between Incoming Cables and Horizontal Side Intermediate Distributing Frame.

Fig. 14 is a photographic view of the test-board. The five-point jacks to which the trunk and junction lines are brought

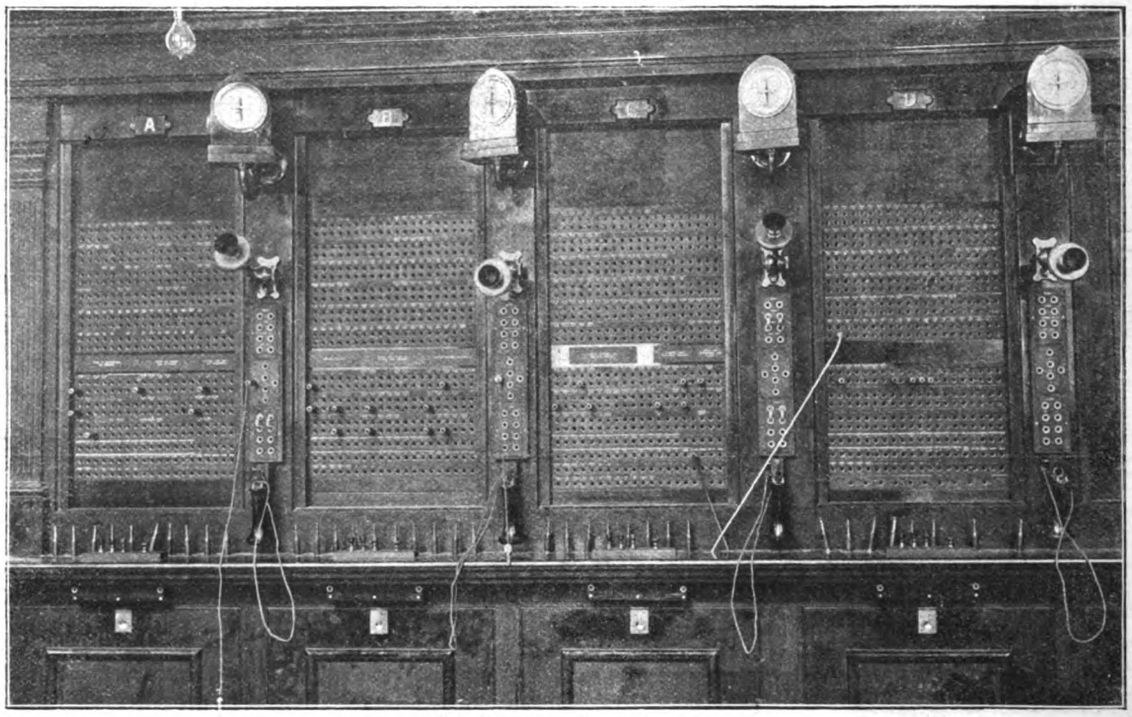

Fig. 14.—The Test Board.

are of the ordinary pattern, the fifth point (to the bush of the jack) not being made use of. They are placed at ¾in. centres in strips containing two rows of 20. To serve each of the four panels are six pairs of plugs and cords. The left-hand pair is connected to one of the four keys in front of the plugs, which is a simple speaking key making connection to the speaking set on the panel; the remaining five pairs of plugs

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and cords are not connected to any instruments. The other three keys are for ringing, one connecting to the magneto-generator, the others to the 24-volt battery and sending ringing currents in reverse directions. At the side of each panel are tablets of jacks connected to the differential galvanometers on the board, and to tangent galvanometers, Wheatstone bridges and other instruments on a special testing table.

The test-board and record tables were manufactured at the Post Office's own factory. All the remaining plant, including the switchboards, relay and condenser rack and intermediate distributing frame were supplied and erected by the British Insulated and Helsby Cables (Ltd.) to the detailed specifications of the Post Office. To Mr. John Gavey, C.B., the engineer-in-chief of the Post Office, we are much indebted for permission to inspect and photograph the exchange, and for the information and assistance which he has furnished to us in order to enable this series of articles to be presented to our readers

A NEW PROCESS FOR WELDING ALUMINIUM.

The Cowper-Coles process for welding aluminium requires no flux, and does not necessitate the hammering of the joint when in the semi-fluid state. The process is especially suitable for wire rods and tubes and other drawn or rolled sections, and consists in placing the parts to be welded, after being faced off square, in a machine (Fig. 1) fitted with clamping screws, which are capable of moving horizontally on guides; the movement of the clamping screws is controlled by the levers D. The aluminium to be welded is heated by means of an ordinary benzine lamp. As soon as the rods have arrived at the necessary temperature, slight pressure is applied to the levers D, which causes the aluminium rods to unite, and a ring of metal is squeezed out. This ring is largely composed of aluminium oxide, and acts as an insulating and supporting collar, the molten metal being retained within this collar. The weld is then instantaneously quenched by turning a handle attached to the screen A, which allows water, under pressure, to be projected on to the joint from the reservoir F. The same handle H which turns the water on places a screen, A, in front of the heating flame; the water pressure is maintained by air supplied by the hand pump E. Finally the rod is moved from the machine and the collar filed off, when it is found that the joint is as strong as the rest of the metal. An oxygen-hydrogen flame or ordinary gas, with or without air, may be substituted for the benzine lamp. The process is a simple one, and can be worked by any unskilled workman.

Dimensions.		Reduction of area at fracture.	Extension on 4in. at fracture.	On original area.			
				Elastic limit (yield point).		Maximum stress.	
Diam. in.	Area. sq. in.	Per cent.	Per cent.	Lbs. per sq. in.	Tons per sq. in.	Lbs. per sq. in.	Tons per sq. in.
0·249	0·0487	7·4	8·0	11,491	5·13	20,249	9·04
0·248	0·0483	7·4	13·0	8,803	3·93	22,265	9·94
0·254	0·0507	7·5	8·0	11,043	4·93	19,868	8·87
0·252	0·0499	7·4	11·7	14,358	6·41	16,150	7·21
0·252	0·0499	7·7	13·0	21,996	9·82	21,996	9·82
0·250	0·0491	7·6	9·0	14,134	6·31	19,622	8·76
0·250	0·0491	7·7	9·0	14,134	6·31	14,134	6·31
0·254	0·0507	7·9	11·0	15,030	6·71	24,304	10·85
0·251	0·0495	7·8	7·8	14,940	6·67	20,361	9·09
0·253	0·0503	7·7	14·0	10,236	4·57	19,152	8·55
0·250	0·0491	7·7	9·0	12,320	5·50	20,070	8·96
0·247	0·0479	7·7	9·0	8,422	3·76	18,704	8·35

In every case the fracture occurred outside the datum points.

Fig. 2 shows the molten aluminium supported by a pipe or case of aluminium oxide, the cone having been pricked with a steel point to allow some of the molten metal to flow out.

The above table gives the result of tests for tensile strength on 12 consecutive welds (not picked specimens) made by the pro-cess just described. As a proof that the metal had not deteriorated at the weld, it was found that the fractures occurred at a considerable distance from this point. In the 12 tests referred to, we are informed that not one specimen broke through the welded portion.

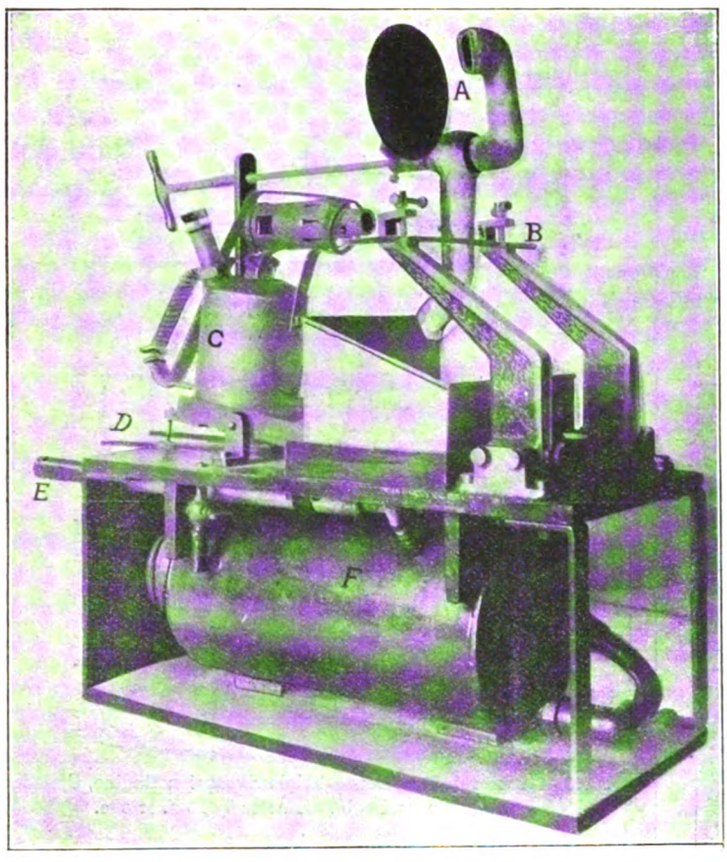

Fig. 1.—Cowper-Coles' Machine for Welding Aluminium.
A, Screen; B, Aluminium Rods; C, Lamp; D, Levers for applying Pressure; E, Pump; F, Water Reservoir.

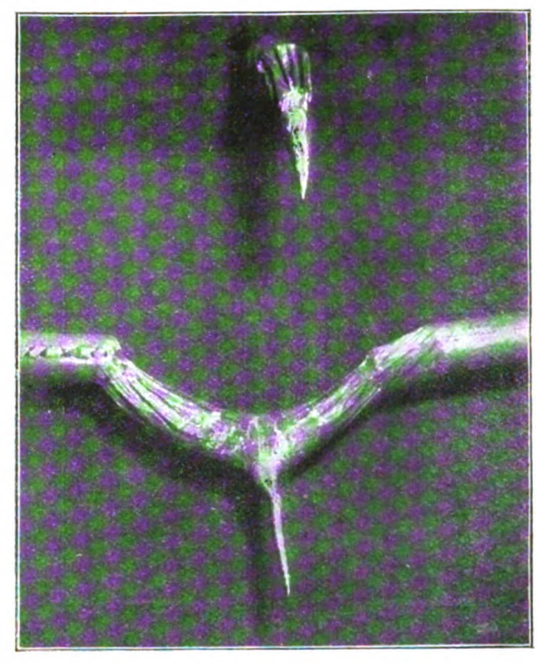

Fig. 2.—Molten Aluminium Supported by Sheath of Aluminium Oxide.

Rating of Machinery.—The question of re introducing the Rating of Machinery Bill this session has been discussed by an influential body of members of Parliament, and it was decided to request Mr. Chapman, who has been in charge of the measure on two previous occasions, to give notice to introduce it and put it down for second reading on March 18.

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FRENCH HIGH-TENSION CONTINUOUS-CURRENT LOCOMOTIVE.

A portion of the French railway line between St. Georges de Commiers and La Mure has recently been converted to electric traction. Owing chiefly to the narrow gauge (3ft. 3in.), the long gradients (2·5 to 2·75 per cent.) and the sharp curves (110yds.), steam propulsion was not considered easily adaptable to purposes of increasing the present carrying capacity of the line. The electric

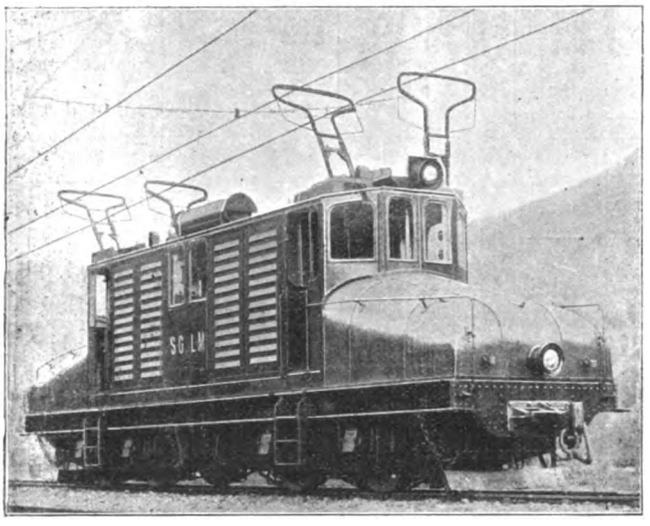

FIG. 1.—HIGH-TENSION CONTINUOUS-CURRENT LOCOMOTIVE.

locomotive—the first one so far—was required to haul a number of coal trucks, weighing on the aggregate 100 tons, at an average speed of 14 miles per hour. In the tests, even better performances are said to have been accomplished. Current is conducted to the locomotive on the three-wire system, with the rails as middle wire, and a voltage of 1,200 volts between them and the outers. Fig. 1

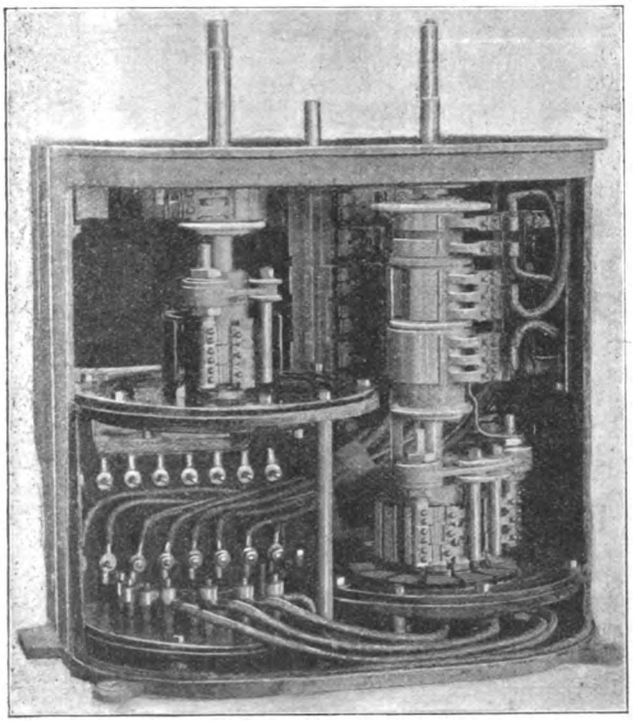

FIG. 2.—CONTROLLER OF LOCOMOTIVE.

is a general view of the locomotive, and it will be noticed that the current is taken from the overhead conductors by means of four bows. The locomotive weighs 50 tons, and has an overall length of about 43ft. Four 125 H.P. motors, connected permanently in series, transmit their power through a single reduction gear to the driving axles. At 600 volts, and with a current of 185 amperes, the motor speed is 400 revs. per min. As usual, the magnet carcase is of steel, the six poles being laminated. Two mechanically-connected controllers (Fig. 2) are installed in the cab, one at either end, and they rotate synchronously. The customary interlocking devices for preventing mistakes are introduced, and an interesting feature of the controller is that the high-tension current is always interrupted by the same contact, which is quite separate from the others and is immersed in an oil bath. A hand-brake, a vacuum brake and an electric brake are provided. A 4 H.P. 1,200-volt motor drives the vacuum pump. The locomotive was built by the Compagnie de l'Industrie Electrique (Brevets Thury) of Geneva.

Electric energy is generated by a Thury continuous-current set, consisting of two 1,200-volt dynamos, connected in series and installed in an electric station already existing near the railway. Current is conveyed to the locomotive by means of S-shaped overhead wires with a cross-section of 0·177 sq. in.

AN ALLEN HIGH-SPEED TRIPLE EXPANSION ENGINE.

Messrs. W. H. Allen, Son & Co. have sent us an interesting account of a 580 I.H.P. triple expansion engine which they have recently completed for coupling directly to a 375kw. continuous-current Westinghouse dynamo, and to run at 325 revs. per min. It has been built to the order of the Fairfield Shipbuilding and Engineering Co. The engine is of Messrs. Allen's standard three-

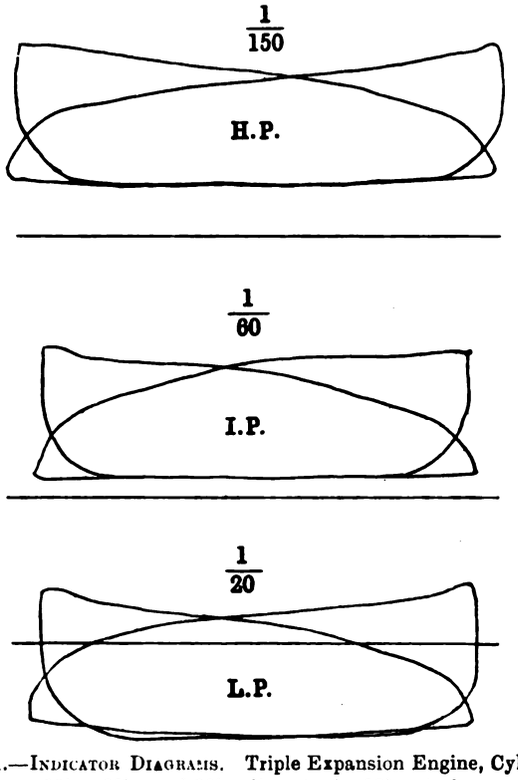

FIG. 1.—INDICATOR DIAGRAMS. Triple Expansion Engine, Cylinders 13in., 20in. and 30in. diameter by 13in. stroke.

cylinder double-acting triple-expansion vertical enclosed type; the cylinders driving three cranks are set at angles of 120deg., and it has been designed throughout with a view to obtaining economical results over widely varying conditions of load, when working with dry saturated steam at 150lb. per square inch at the stop valve and exhausting against a maximum absolute pressure of 4in. of mercury. It has to be, moreover, capable of developing an overload of 25 per cent. for a period of two hours.

The dimensions of the cylinders and the successive points of cut-off are so arranged as to produce an equal distribution of power between the three cylinders, thereby ensuring an even turning moment throughout the revolution of the engine. The weights of the reciprocating parts on each crank are also equalised in order to eliminate the resultant vertical and horizontal forces due to the inertia of the moving parts; there remain, consequently, only two couples to be balanced respectively in vertical and horizontal planes. As is well known, the complete elimination of these latter couples by an arrangement of revolving weights is a practical impossibility, but in the case under notice they have been reduced to a minimum

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by a somewhat novel arrangement of balance weights securely fixed to the crank-webs. These weights are so arranged that the radii of their respective centres of mass are set at a small angle to the crank radius, in order to reduce the unbalanced couples due to the inertia of the valve gear, as well as those of the main reciprocating parts. The success of this system of balancing was a noticeable fact during the trials and was amply demonstrated by the steadiness of the engine when running without holding-down bolts and standing on a smooth surface plate. The three cylinders are respectively 13in., 20in. and 30in. diameter, and have a stroke of 13in., and are made of a special mixture of hard and tough close-grained cast iron, having a tensile strength of from 12 to 15 tons per square inch. They are also provided with the usual accessories in the way of drains, relief valves and provision for indicating.

The intermediate and low-pressure pistons are of cast steel and are fitted with "Rowan's" packing rings, and the high-pressure piston is of cast iron, of solid block type, and is fitted with a solid packing ring of rectangular section, all three pistons being of equal weight for balancing purposes.

The valves are all of the solid piston type and take steam on the inside edges, thereby diminishing the pressure on the glands, as compared with valves taking steam on the outer edges. The whole of the working parts of the engine are enclosed in a neatly designed and substantial cast-iron trunk, the walls of which carry the slides for the main crossheads. Easy access to the interior of the trunk is provided by three large doors ranged along the front of the engine, each door being furnished with a smaller hinged panel in its centre which permits of inspection of the working parts.

Between the cylinders and the top of the trunk upon which they stand is a distance-piece, which is cast in one piece with the body of the cylinder and permits of easy access to the piston rod and valve rod glands The top of the trunk is also fitted with a special form of bush which effectively prevents oil being carried up from the crank chamber to the cylinder and also prevents the water from entering the crank chamber.

Each cylinder, with its distance piece, is completely isolated from each of the other cylinders, this design having been adopted by the makers

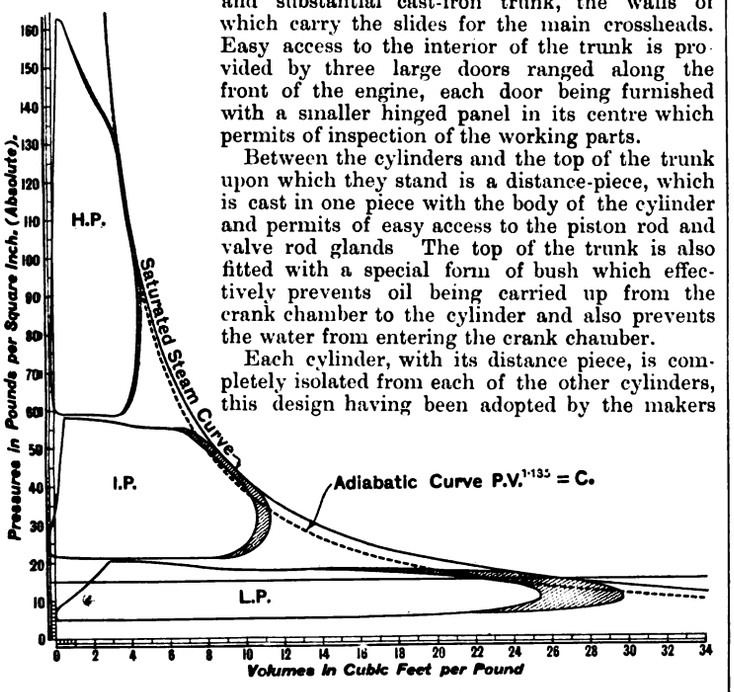

FIG. 2.—DIAGRAM FOR ONE POUND OF STEAM PASSING THROUGH ENGINE.

for all their standard types of engines, excepting the smaller two-cylinder types, as it ensures that there shall be no distortion of the frame of the engine under any conditions of varying temperature, consequently the working parts are always correctly "in line" and work freely. The whole trunk and cylinders complete are mounted upon a massive cast-iron bed-plate, which forms a reservoir into which the oil drains and from which the oil is supplied at a pressure of about 15lb. per square inch to all the working parts by means of a small valveless force pump driven from one of the eccentrics of the engine.

The crankshaft, piston rods, valve rods, connecting rods and eccentric rods are all of Siemens-Martin steel, having a tensile strength of 28 to 32 tons per square inch and giving under test an elongation of 27 per cent. in a length of 2in. The eccentrics are all of solid forged steel, the high-pressure valve eccentric being securely keyed on to the shaft, and the remaining two eccentrics being forged in one piece with the shaft.

The whole of the bearings throughout, with the exception of the crosshead bearings, which are of gunmetal, are lined with white metal, and receive oil under pressure from the force pump described above.

The governor is of the company's standard crankshaft type, and can be regulated by hand whilst the engine is running to give a speed variation of at least 5 per cent. above and below the normal, and operates a compound double-beat valve of special design placed between the stop-valve and the engine, and so arranged that at overload steam is by-passed direct to the low-pressure cylinder. It was specified that the steady speed variation from no-load to full-load should not exceed 3 per cent., and the momentary variation in speed when the whole load is thrown off or on should not exceed 10 per cent. On the official trial, we are informed, the tests of the governor showed a steady speed variation from no-load to full-load of 1·9 per cent., and a momentary variation when the whole load was thrown off or on of 5 per cent., being thus well within the specified maximum variation.

The flywheel is of the solid disc pattern, being forced on to the end of the crankshaft and securely keyed. The dynamo side of the flywheel is accurately faced up to form the coupling for the armature.

The cylinders, steam stop-valve, governor valve and steam separator are all properly lagged with asbestos non-conducting composition and are neatly covered with blue planished sheet steel, the whole presenting a very neat appearance.

Messrs. Allen have sent us the following diagram and test figures taken from the official trial recently carried out at the Queen's Engineering Works, Bedford:—

Trial Results (Official), 13in., 20in. and 30in. by 13in. Triple Expansion Engine.

Main steam pressure	160lb. per square inch.
Throttled steam pressure	143lb. ,, ,,
Mean indicated horse-power	578
Mean brake horse-power	540
Mean revolutions per minute	330
Mean vacuum at engine exhaust	25·35in. mercury.
Total pounds of water per hour	8,190lb.
Water per indicated horse-power per hour	14·2lb.
Water per brake horse-power per hour	15·2lb.
Mechanical efficiency	93·5 per cent.

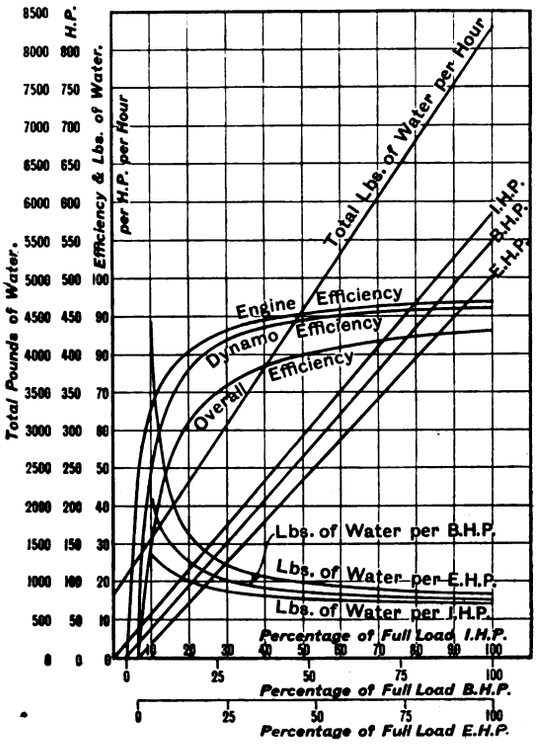

FIG. 3.—EFFICIENCY AND CONSUMPTION CURVES OF TRIPLE EXPANSION ENGINE. Cylinders, 13in., 20in. and 30in. diameter by 13in. stroke. Steam pressure, 150lbs. Revs., 325. Vacuum, 25in.

The indicator cards shown in Fig. 1 are samples of those taken during the official trial, and the order in which the cranks lead and follow is that given.

None of the cylinders are steam jacketed, as experience shows that their effect at such high speeds is so slight as to make it not worth the increased first cost in fitting them.

Fig. 2 shows the diagrams of Fig. 1 combined under a common saturation curve and an adiabatic curve. The whole diagram is for 1lb. of steam passing through the engine, and to enable the use of a common saturation curve and adiabatic curve for all three cylinders, the cushion steam has been eliminated in each case, as a quantity which does not pass through the engine. The shaded areas indicate the quantity of moisture in the steam during expansion and at release in each cylinder.

Fig. 3 gives a number of curves deduced from readings taken during the official trials and shows the efficiencies and steam consumptions throughout.

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THE BRUSH-PARSONS STEAM TURBINE.*

BY WILLIAM CHILTON.

There are two principal types of turbines. One, in which nearly the whole available energy of steam is used in an expanding nozzle to give to itself a very high velocity, before being utilised in giving rotary motion to a wheel. The other, in which the steam passes alternately through many rings of fixed guide blades and of revolving blades, and expands by a small amount during its passage through each ring, until it leaves the last row and is discharged into the exhaust, having parted with the greater portion of its usable energy.

The De Laval turbine is of the first order, the Parsons of the second, the Rateau and the Curtis turbines combine some of the features of both. All these turbines may be either of the parallel or of the radial flow type, but have mostly been developed on the former lines. The velocity attained by steam in the Parsons turbine, compared with that in the De Laval turbine, is low, as it depends on the small difference of pressure on the two sides of a ring of blades, and, as this pressure difference can be made very small, depending, as it does, on the number of rows of blades, it is possible to reduce the velocity of the steam, and therefore the speed of rotation of the wheel, to very manageable limits.

In the De Laval turbine the steam is wholly expanded in a diverging nozzle down to the pressure of exhaust, and nearly the whole of its available heat energy converted into kinetic energy before it is delivered on to the blades.

The turbine is governed by a centrifugal governor, acting on a throttle valve, and in some cases by closing or opening the valves controlling the admission of steam to the nozzles. The high velocities required for efficient working and the gearing necessary for arriving at practical speeds are disadvantages of this turbine.

500kw. output, the bearing is formed of a solid gunmetal bush, in which the spindle of the rotor revolves. The bush is made with a solid collar at one end and a loose collar at the other. Between these collars and surrounding the bush are three tubes. Small clearances are allowed between the outside of the bush and the inside of the first tube and between the outside and inside surfaces of the tubes themselves. These small clearance spaces are arranged so that oil can be forced into them. A flexible bearing is thus obtained, which allows the rotating mass to take up its natural centre line of revolution, and the viscous friction of the oil in the clearance spaces helps to damp any vibration set up by small inaccuracies in balance. In the larger sizes of turbine, where the speed of rotation is lower, an ordinary split bearing lined with white metal is used.

The casing is divided into three main portions, which may, for convenience, be referred to as the high-pressure, intermediate-pressure, and low-pressure cylinders. Each of these is again divided, as shown in Fig. 1, into two or more stages of increasing diameter. The stages, the cylinders, and also the areas of the passages through the blades are proportioned so as to deal in an efficient manner with the steam as it passes through the turbine in its continuously expanding course from the steam inlet to the exhaust end.

Steam enters through the regulating valve V into the circular chamber O. It first passes through a ring of fixed guide blades, which directs its path, so that on leaving them it glides on to the entrance sides of the moving blades absolutely without shock. The moving blades, again, are so fashioned that the steam will flow without shock into the entrance opening of the next row of fixed guide blades until it is discharged at the exhaust end after having been expanded down to the pressure of exhaust, and issues into the exhaust chamber E from the last row of moving blades without drop in pressure. To balance the end thrust in the rotor, there are three dummy pistons—D_1, D_2, D_3; circumferential grooves are

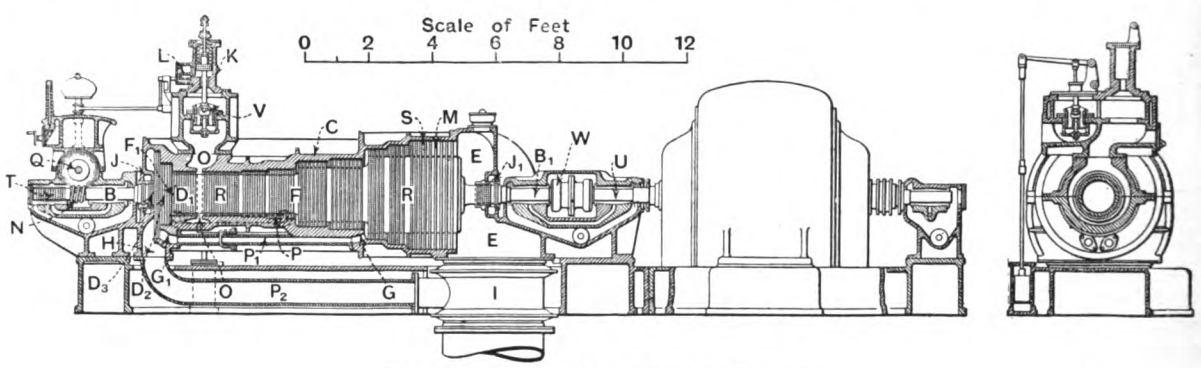

FIG. 1.—SECTION OF BRUSH-PARSONS TURBINE.

The Rateau turbine is of the compound multi-cellular type, but differs from the Parsons in that each row of revolving blades is enclosed in a separate compartment. The rotor consists of a large number of discs made of thin polished steel plates, flanged on the outer periphery. These discs are firmly fixed to the spindle, and the buckets or blades are made of steel and riveted to the flange of the disc mentioned above. The fixed or guide blades are secured to circular diaphragms, which fit into circumferential grooves cut on the inner circumference of the cylinder or casing.

These diaphragms divide the turbine into a number of cells, in each of which works one revolving disc. The diaphragms are fitted with bushes, through which the turbine spindle passes. The bearings are usually outside the casing and a gland of special design prevents leakage from the end of the spindle which projects from the casing. The turbine is governed by an ordinary centrifugal governor and throttle valve. One advantage of this cellular type of construction is that the revolving discs can be made with rather more clearance than is the case in the Parsons turbine; but, on the other hand, the arrangement is not so accessible. The diaphragms have to be made in halves and well fitted together to prevent leakage, and the viscous frictional losses must be considerably greater than in the Parsons turbine. As each of the rotating discs revolves in an enclosed chamber, surrounded by steam of uniform pressure, the arrangement is balanced, and no balancing pistons are required.

The Brush-Parsons steam turbine is shown in section in diagram Fig. 1. It consists primarily of the casing C, which carries the stationary guide blades S, and the rotor or spindle R, which carries the moving blades M. The rotor is carried by two main bearings, B, B_1, which are the only portions of the turbine proper subject to mechanical friction. In the smaller turbines, up to about

cut in these pistons, into which corresponding brass rings fixed to the casing engage. The sides of the grooves and of the rings are ground up face to face, so as to prevent leakage of any but very small quantities of steam. The first and smallest balance piston balances the end pressure of the high pressure, the second that of the intermediate, and the third that of the low-pressure cylinder. There are also the balancing passages P, P_1, P_2, which equalise the pressures at FF_1, GG_1, HE. Passage P, balancing spaces F, F_1, is shown dotted.

To keep the moving blades always in correct relative position to the guide blocks, and also to take up any small unbalanced force, a thrust block is supplied, shown at T in Fig. 1. It is divided horizontally; the lower half is fixed, and the left-hand faces of the thrust collars on the spindle bear against the right faces of this lower block; the upper block can be set to the left, so that the right-hand faces of the collars bear against the left faces of the upper block; the rotor is thus prevented from moving either way. J, J_1, Fig. 1, are the spindle glands, which are made in the form of circular bushes in halves, with grooves on their inner surfaces, and collars turned on the spindles engage in these grooves. The spaces J, J_1 round the glands are, in the case of condensing turbines, supplied with a small quantity of low-pressure steam, and through holes in the bushes this steam can find its way into the grooves, and from the grooves into the exhaust passages H and E. By this simple device air leakage into the spaces subject to vacuum is prevented. When the turbine is worked non-condensing, steam, which may have a tendency to leak past the glands into the engine room, is drawn off through spaces J, J_1 by means of a small ejector not shown on the drawing.

The double-beat valve V is attached to the piston of a steam relay cylinder K, which is continuously supplied with a small amount of throttled steam on the underside of its piston. A strong spiral spring on the upper side of the piston tends to keep the valve down on its seat against the upward pressure of the steam on the under-

* Abstract of a Paper on "The Steam Turbine" read before the Manchester Local Section of the Institution of Electrical Engineers on February 2nd.

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side of the piston. The small piston valve L of the steam relay controls the exhaust of this cylinder. When the relay opens to exhaust the steam under the piston is free to escape, and the spring can close the double-beat valve V. When the exhaust is throttled or closed by the piston valve L the steam pressure overcomes the push of the spring, and the valve is lifted. The relay piston valve L receives an intermittent reciprocating motion from a cam on the shaft Q.

The position of the relay piston valve L in relation to its exhaust port passage is controlled by an ordinary centrifugal spring governor in such a way that at light loads and at no load the exhaust is more fully open than at the higher loads, and consequently the regulating valve V is open to steam for shorter periods at the lighter than at the heavier loads. At full and overload the valve is almost continuously full open. Although at first sight this gear may seem to be of the cut-off type, an examination of the curves of total water consumption show that these follow the Willans straight line law, which is the characteristic of throttle-governed engines. A second governor, exactly similar to the first, controls a second double-beat emergency valve, which only comes into play if, perchance, the main governor fails to act. The emergency valve can also be controlled by hand.

The throttled steam mentioned above, which works the steam relay cylinder, is used after exhaust from this cylinder to supply the glands, J, J_1 with the steam necessary to prevent air leakage into the vacuum chambers. The crankshaft Q is driven by the worm-reducing gear N. It drives, besides the cam already mentioned, the two governors by means of bevel gears, and also the oil pump which supplies oil under pressure to the two main bearings of the turbine and also to those of the generator. The weight of the rotor of a 1,000kw. turbine is about 6,300lbs., and is distributed in the proportion of about 2,830lbs. on the bearing at the steam end, and 3,470lbs. on the other; this gives a pressure per square inch on the area of the bearing (taking the area as length by diameter) of 38·5lbs. on the first and 46·5lbs. on the second, or a mean of 42lbs. The surface

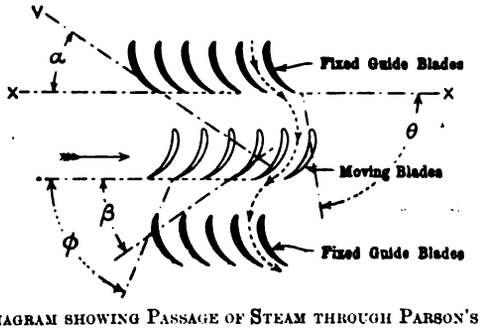


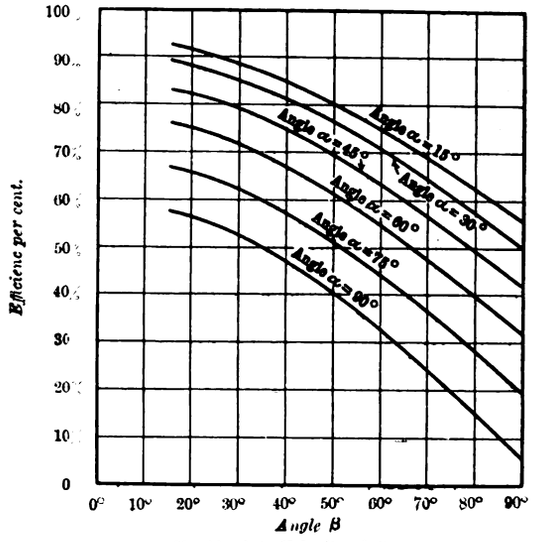
Fig. 2.—Diagram showing Passage of Steam through Parson's Turbine.

velocity of the journal varies from about 1,950ft to 2,350ft per min., or a mean of 2,150ft. Multiplying mean surface speed per minute by mean pressure on bearings, or 2,150 by 42, we get the figure 90,300. It is interesting to compare these figures with the corresponding ones obtained in high-speed reciprocating engine work; pressure per square inch on main bearings 160lbs., surface speed 575ft. per min., product of these two figures 92,000, or approximately the same as in the turbine. I is an expansion pipe joining the exhaust of the turbine to the condenser, and is made as flexible as possible, so that the cylinder shall not be distorted by its connection to the condenser or the exhaust pipe. U is the main bearing of the generator. The turbine spindle and generator spindle are joined by a flexible coupling enclosed in the box W.

The method of securing the blades in the rotor and the cylinder is effective and cheap. The blades are drawn to the correct section from a special mixture of brass, or from copper, in lengths of 12ft. to 15ft., and are cut to the required length. Grooves about ¼in. deep are turned circumferentially on the outer sufaces of the rotor and on the inner surfaces of the cylinder. The blades, after being cut to to the correct length, are placed in the grooves in a radial direction. The width of the grooves is regulated, so that when the blades are in place they take up their correct angular position relatively to the axis of rotation. Caulking pieces of soft-drawn brass and of a length equal to the depth of the grooves are placed in the grooves alternately with the blades; first a blade, then a caulking piece, and so on, until the row is complete. The caulking pieces are then tightly caulked home into the groove with special tools. When finished the whole forms a piece of sound work very well adapted to the function it has to perform.

In all machines designed to abstract kinetic energy from a moving mass in an efficient way, it is most important that the mass should glide on to that portion of the machine, generally a rotating wheel, whose function it is to absorb kinetic energy, absolutely without shock. That this may be so in the steam turbines we are considering, it is necessary to observe certain relations between the path of the steam and the angles of the blades, and also between the velocity of the steam and the speed of the blades. In Fig. 2 the line V represents the absolute velocity of the steam on leaving the guide blade, and the angle a indicates the direction into which the steam is guided by these blades in relation to the line XX parallel to the plane of rotation of the moving blades. θ is the angle which the side of the moving blade at entrance makes with XX and β the angle between the sides of the moving blade at exit and the line XX.

The speed of the moving blades is always a fraction of V, and, generally, the larger this fraction the higher the efficiency of the turbine. In practice the velocity of the moving blades is often one-half of



V = Absolute Velocity of Steam,

$W = \text{Velocity of Blades } W = \frac{V}{4}$

Fig. 3.—Blade Efficiency Curve.

the absolute velocity of the steam. The angle a, the absolute velocity of the steam and the speed of the blades having been fixed, the entrance angle θ of the moving blades must be formed so that the resultant path of the steam obtained by combining absolute velocity with speed of blades shall be parallel to the surface of the moving blades at entrance.

The steam will now flow along and parallel to the surface of the blade until it reaches the point of exit, making with the line XX the

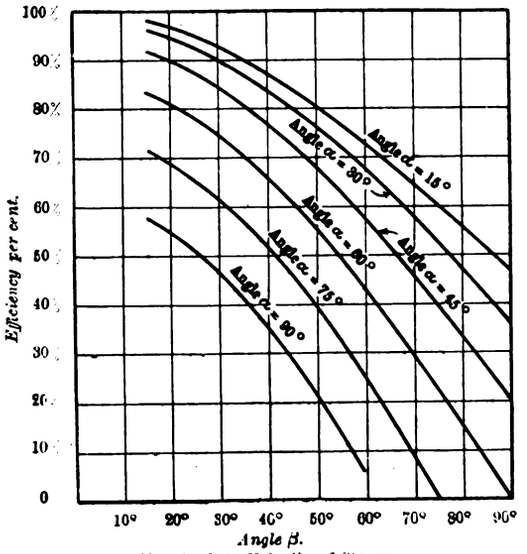


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Fig. 4.—Blade Efficiency Curve.

angle β. If free to choose this angle, we will naturally make it so as to give as high an efficiency as practicable. This angle, however, once fixed, the angle ϕ must be constructed so that the resultant path of the steam, obtained by combining the velocity of the steam at exit relatively to the blades with the speed of the blades, shall be parallel to the surface of the fixed guide blades at entrance. The shape of the curved portion of the blade between the inlet and outlet surfaces is not of much importance, provided it

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is smooth and takes the steam from one side to the other by a short and easy path.

The curves shown in Figs. 3 and 4 give the theoretical efficiencies, not taking into account losses due to friction, to be expected from turbine blades with different angles of entrance and of exit. Each curve is drawn on the assumption that the angle α is constant and the angle itself is marked on the curve, but the angle β varies from 15 to 90deg. All the curves on Fig. 3 are drawn assuming the relation absolute velocity steam : velocity blades = 4 : 1; those on Fig. 4 = 2 : 1. It will be seen that there is a large range of choice in speeds and angles, but that, on the whole, velocity steam : velocity blades = 2 : 1 is the best, although when this ratio is even 4 : 1, by making careful choice of the angles fairly good results may be expected.

With regard to turbines and reciprocating engines, at present there is room for both. For the smaller units and when working non-condensing the reciprocator has undoubtedly the advantage, but from 400kw. to 500kw. output and upwards, and when working condensing with a good vacuum that can be obtained at a small cost, the advantages are often on the side of the turbine. It is well known that the steam efficiency of the ordinary engine only increases to a small extent when the vacuum rises beyond 25in. of mercury, and this is more marked in high-speed than in slow-speed engines. The reason is obvious, as a consideration of the following table will show. The volumes are here given of 1lb. of saturated steam at atmospheric pressure, and also at vacua, varying from 25in. to 29in. of mercury; in the top line are given the actual volumes in cubic feet; in the lower line, for the sake of more easy comparison, the volume at atmospheric pressure is given as unity; the others in multiples of unity :—

Vacuum in inches of mercury	0	25	26	27	28	29
Volume of 1lb. of saturated steam in cubic feet....	26·36	145	177·6	237	347·6	709
Comparative volume — volume at 0in. vacuum = 1	1	5·52	6·75	9	13·3	27

The table shows how greatly the volumes increase with each inch drop in the absolute pressure beyond that due to 25in. of mercury, and how great is the volume to be dealt with when the vacuum reaches 28in. or 29in. of mercury.

Now, it is not that reciprocating engines, as such, would not give better results at high vacua than at low, but because the low pressure cylinder, valves, passages and exhaust pipes would have to be made of such inordinate sizes to deal with the enormous volumes at low pressures, that 25in. vacuum is generally found to be about the economical limit. In high-speed reciprocating work, too, it is mostly found necessary to place the condenser at some distance from the engines. In turbine plant, on the other hand, it is convenient and also economical in first cost to place the condenser immediately below the turbine. If we require a mean vacuum during exhaust of 23in. inside the low-pressure cylinder of a high-speed engine it will be unwise to design the condenser to give less than 27in. vacuum, whereas in a turbine set 27in. to 27·5in. vacuum could be expected in the cylinder with 28in. vacuum in condenser.

Fig. 5 shows two curves giving approximately the saving which may be effected per each 1in. increase of vacuum from 0in. up to 28in. vacuum. The rapid rise of the lower curve well illustrates how much the turbine gains by working with a good vacuum.

The following tabular comparison of the condensing plants required for reciprocating and turbine sets of 500kw. output will be of interest :—

Particulars.	Reciprocator.	Turbine.
Consumption of steam per kw. hour, lbs..	25	22·5
Steam to be condensed per hour, lbs.....	12,500	11,250
Tube surface in square feet	1,050	1,540
Vacuum in condenser, in. of mercury ..	26·5	28
Air pump cap., cub. ft. per min.....	125	150
B.H.P. to drive air pump	3·3	3·85
Circulating water, gals. per min.....	780	830
B.H.P. to drive circulating pump	5 5	6·3
Temperature circulating water inlet	65°F.	65°F.
,, ,, ,, outlet....	95°F.	96°F.
Mean temperature in condenser	119°F.	100°F.
Cost prime mover and generator.....	£3,250	£3,250
,, condensing plant	£556	£659
Total cost.....	£3,806	£3,909

Extra cost of turbo plant over reciprocating plant about 2·7 per cent., but inasmuch as the engine will probably be fitted with an oil filter for extracting the oil from the exhaust steam, the cost of the turbo plant will probably not be more than the other. The turbine requires no holding-down bolts, the foundations and buildings are less costly and the crane capacity required is less; add to this that no lubricating oil is necessary for cylinder lubrication, and the turbine comes out very favourably in comparison with the reciprocating engine. With regard to superheat, both types of engines derive great benefit from its use, but for different reasons.

One source of great loss in reciprocating engines using saturated steam is initial condensation, and this loss can be reduced by superheating. In the turbine there is little or no initial condensation, as the metal surfaces with which the steam comes into contact do not change in temperature on steady load. On the other hand, water, which may come over with the steam, in addition to that formed by condensation due to work done, produces in its passage through the turbine a large amount of viscous friction and reduces the mechanical efficiency. Superheating the steam reduces this loss.

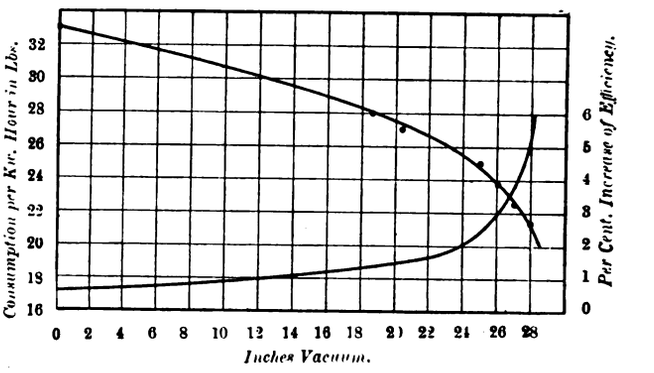

Fig. 5.—Gain in Steam Efficiency per each inch Increase of Vacuum from 0" Vacuum to 28" Vacuum.

The curves in Fig. 6 show the increased efficiency to be expected by superheating the steam, the rising curve gives the percentage gain for various degrees of superheat on the consumption with no superheat, the falling curve gives the actual consumption in pounds per kilowatt-hour for various degrees of superheat.

The table in Fig. 7 gives comparative weights of slow-speed engines, high-speed engines and of turbines.

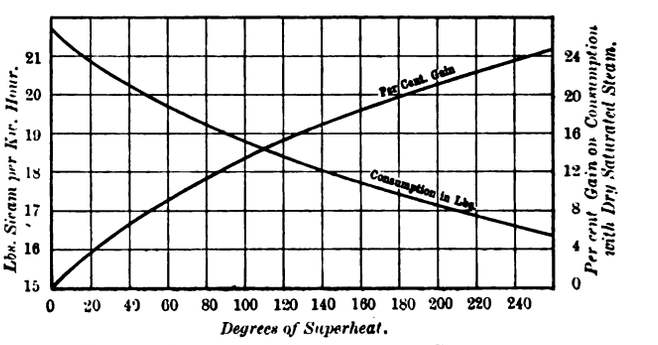

Fig. 6.—Curves showing Effect of Superheat.

In conclusion, the author tenders his best thanks to Messrs. the Brush Electrical Engineering Co. for the great help they have given him in the preparation of the diagrams, and to Messrs. C. A. Parsons & Co. and to Mr. J. H. Barker for the data and information with which they have supplied him.

Fig. 7.

Kilowatts output.	Weight of slow speed engine.	Ditto : weight of flywheel.	Weight of high speed engine.	Weight of turbine.
500	140	27	30	9
750	190	43	45	12
1,000	250	59	60	14
1,500	380	88	90	21
1,800	450	100	110	23
2,000	530	120	120	25
2,500	700	145	155	27
3,000	—	—	—	32
3,500	—	—	—	35
5,000	—	—	—	42

Comparative weights in tons.

Below is an abstract of the discussion which followed the reading of the Paper :—

The CHAIRMAN (Mr. Cowan) asked what progress had been made in making turbines reversible, and, with regard to the employment of superheat, said that there was, undoubtedly, less condensation; but, he asked, did not a loss occur in the flow of heat from the hot to the cold end? He also desired to know how far it was safe to go with superheat, as they were given to understand that superheat had a very bad effect on the blades in some cases. He would like some information on the ratio of initial to final temperature and the deterioration of the blades.

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Mr. W. J. A. LOUDON (British Westinghouse Company), referring, first, to the cases of the stripping of turbine blades which had recently been reported, said that, according to his experience, there was practically no wear in turbine bearings. The Westinghouse turbine had been designed with a view of combining the qualities of the De Laval and the Parsons. Steam at the high-pressure end was treated as in the De Laval construction and steam expanded to 50lb. or 60lb., and then was dealt further with in a portion constructed on the Parsons parallel flow principle. In studying the author's comparative table he had found that the saving in oil in one year by using the turbine would be £70, and the saving in coal would pay for the extra cost of condensers in 16 months.

Mr. F. H. WHYSALL gave some information concerning the two 1,800kw. Parsons continuous-current turbo-generators installed at the Dickinson-street works of the Manchester Corporation. In the adjacent Bloom-street station, he said, there were installed slow-speed reciprocating sets of the same output. The total weight of each turbo-generator complete, without condenser, was 85 tons, slightly over 0·2 of the total weight of one of the Bloom-street reciprocating sets and about 0·7 of the weight of the flywheel. The floor space occupied was 47ft. 6in. by 8ft. 6in., or 400 sq. ft.—*i.e.*, 0·22 sq. ft. per kilowatt. The height averaged only 9ft., and the highest point was 11ft. above the floor level. The guaranteed steam consumption with 27in. vacuum and saturated steam was 20lb. per kilowatt hour at full load and 23lb. at half-load, the steam pressure at the stop valve being 125lb. per square inch. There were two armatures connected in parallel, with automatic brush rocking gear fitted to each. The turbine possessed one cylinder, and was of the compound parallel flow type. Mechanical governors were used, and the variation in speed from no-load to full-load was not more than 3 per cent. Compared with the reciprocating sets, some results were as follows:—

	Turbine.	Reciprocating set.
Capacity	1,800kw.	1,800kw.
Speed	1,040 revs. per min.	75 revs. per min.
Steam consumption at full load	19·59lb.	19·83lb.
Vacuum	26·5in.	27·4in.
Steam	125lb. saturated	156lb. saturated.
Capital cost per kw., minus foundations and including condensers	£8. 8s.	£10
Cost of oil per unit	0·0018d.	0·006d.
Cost of generator brushes	0·0062d.	0·00005d.

The cost of brass wire brushes on the turbo-generators outweighed the saving in oil. The above table showed that the capital cost of the turbines at Dickinson-street was smaller than that for the reciprocating sets. With regard to priming, mentioned by the author, this was a serious thing when happening to turbines driving continuous-current generators. It not only caused the turbine to slow down and drop most of its load momentarily, but the high initial pressure necessary to recovery seriously affected the brush regulating gear, causing it to take up a bad position, and fusing of the brushes at the ends ensued. The chief trouble was with the commutation, the peripheral speed of the commutators being 6,000ft. per minute. These disadvantages, however, were far outweighed by the many advantages possessed by turbines. He would be glad if the author would say if the turbines at Dickinson-street would stand 100deg. superheat without structural alterations. They were designed for 125lb. saturated steam at a temperature of 352 F.

Mr. BARKER said that, being responsible for the design of the Manchester turbines, he could assure Mr. Whysall that they would stand 100deg. superheat. The remedy for the commutation trouble was to use alternating current. He was often asked about the cutting action of the steam on turbine blades. If engineers understood the slight differences of pressure that existed between blades they would not ask. He had examined turbines after 10 years' use, and had found no signs of cutting action. He remembered stripping of blades had happened at West Bromwich; but there it was due to the quality of the material, and did not apply to turbines generally. With regard to the effect of superheat on the blades, he thought copper the best material for extra high temperatures, and in that case 800°F. might safely be used. He wished to correct an impression emanating from Dr. Anderson that the exhaust steam from turbines was dry. This could only be the case if they were very inefficient, and it was not so. In reply to a question by Mr. Cowan, he said that the conveyance of heat along the shell of the turbine was negligible.

Mr. RHODES found fault with the figure given for the reciprocating set used for comparison in the Paper, and said that 16lb. per kilowatt-hour was quite possible.

Mr. ANDREWS mentioned that at Hastings the steam turbines maintained a lower steam consumption than the guarantee for 12 months. They had had blades ripped out on one occasion, and only found it out by the increased consumption. Although there were thousands ripped out, the turbine was repaired in 36 hours. He thought reciprocating engines were better than turbines when non-condensing. Vacuum made a great difference to output. When condensing, the Hastings turbine would give 550kw., when non-condensing only 350kw.

Mr. WELLS spoke in favour of reciprocating engines. He thought 26in. vacuum the economical limit with them, as further striving for economy meant larger masses and more inertia to overcome. Hammering had been mentioned as causing reciprocating engine bearings to wear out sooner than turbine bearings, but Willans engines and Belliss engines would run 40 or 50 years without appreciable wear.

Mr. NEILSON asked what was the limiting speed for white-metal bearings. He considered the best vacuum 24in. to 26in., and wished to know if superheat added work to the condenser.

Mr. COOPER (Colne) mentioned that the Siemens Company used carbon brushes on their turbo-generators for continuous current.

Mr. CHILTON replied briefly, and the meeting adjourned.

BRITISH ASSOCIATION SMALL SCREW GAUGE COMMITTEE.

In the final report of the above committee, which has now been issued, a brief review of the origin of the committee and the objects for which it was appointed is given. It was at the York meeting of the British Association in 1881 that the committee was first formed, and a report was presented at the Montreal meeting in 1884 recommending a series of small screws. These recommendations were generally adopted for electrical apparatus, watches, &c. In 1895, at the Ipswich meeting of the British Association, the committee was reappointed to consider a complaint that the screws of the B.A. thread, proposed in the 1884 report, were not interchangeable. The committee came to the conclusion that the difficulty arose from want of some ready means of constructing gauges for testing the screw threads, and endeavoured to remedy this state of affairs by the construction of a series of such gauges. At Dover, in 1899, the committee reported, recommending that they should be reappointed in order to consider whether the form of thread for small screws should be modified. The recommendation was adopted, and the committee reported, in 1900, to the Bradford meeting that it was desirable to replace the present form of screws from No. 0 to No. 11 by one having a flat top and bottom to the thread. The committee was subsequently reappointed to obtain a set of the proposed screws, with screws and gauges. Additional members were added to the committee, and, after a lengthy consideration of the matter, the committee now report that, in view of the facts and figures which have been placed before them, they do not now propose to alter the form of the B.A. screw thread, and they withdraw the recommendations accepted at Bradford in 1900.

The original form of the B.A. screw thread was laid down in the Montreal Report, 1884, to the following effect:—The angle of the thread was defined to be 47·5deg. The values of the pitches and of the external

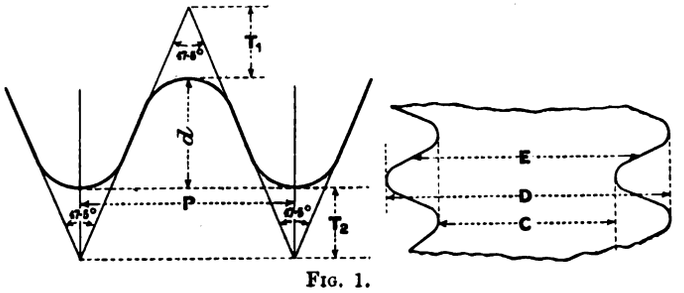

FIG. 1.

diameters of the screws were scheduled in millimetres; the depth of the thread was defined to be sixteenths of the pitch, and the radius of the rounding was to be the same at root and crest. The radius of the rounding was very nearly two-elevenths of the pitch by this rule. This definition, closely adhered to, led to inconveniently small fractions in those quantities which had to be calculated from the scheduled dimensions, but this may be avoided if the definition is replaced by an equivalent schedule of dimensions of all parts from which the insignificant figures are omitted.

Retaining the angle of 47·5deg. in all cases the committee adopt the following schedule:—

British Association Screws.

Schedule I.—*Schedule of Dimensions in Millimetres.*

Designating number.	Pitch P.	Outside diameter D.	Effective diameter E.	Core diameter C.	Depth of thread *d*.
0	1·0	6·0	5·4	4 8	0·6
1	0·9	5·3	4·76	4·22	0·54
2	0·81	4 7	4·215	3·73	0·485
3	0·73	4·1	3·66	3·22	0·44
4	0·66	3 6	3·205	2·81	0·395
5	0·59	3 2	2·845	2 49	0 355
6	0·53	2·8	2·48	2·16	0·32
7	0·48	2 5	2·21	1·92	0·29
8	0·43	2·2	1·91	1·68	0 26
9	0 39	1·9	1 665	1·43	0 235
10	0·35	1 7	1·49	1·28	0·21
11	0·31	1·5	1·315	1·13	0·185
12	0 28	1·3	1·13	0 96	0 17
13	0 25	1·2	1·05	0 90	0·15
14	0·23	1 0	0 86	0·72	0·14
15	0·21	0·9	0·775	0 65	0·125
16	0·19	0·79	0·675	0·56	0·115
17	0·17	0·70	0·6	0·50	0·10
18	0·15	0·62	0·53	0 44	0·09
19	0·14	0·54	0·455	0·37	0 085
20	0·12	0·48	0·41	0·34	0·07
21	0·11	0·42	0·355	0 29	0·065
22	0·10	0·37	0·31	0 25	0·06
23	0·09	0·33	0 275	0·22	0 055
24	0 08	0 29	0·24	0·19	0·05
25	0·07	0·25	0·21	0 17	0·04

In all cases the length of bearing surface on the sides of the screw must not be reduced below that given by the standard form of screw.

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In Schedule I. the effective diameter is a mean of the outside and core diameters, and the dimensions figured T_1 T_2 in Fig. 1 (called truncations) are equal to each other. The values of T_1 T_2 are tabulated in Schedule II.

Schedule II.—*Schedule of Truncations of Normal Threads in Millimetres.*

Number.	Truncation.	Number.	Truncation.
0	0·268	13	0·067
1	0·241	14	0·061
2	0·218	15	0·057
3	0·195	16	0·051
4	0·178	17	0·047
5	0·158	18	0·040
6	0·141	19	0·037
7	0·128	20	0·033
8	0·114	21	0·030
9	0·104	22	0·027
10	0·094	23	0·024
11	0·084	24	0·021
12	0·074	25	0·020

For the convenience of English measurement, the nearest equivalents of the pitches and diameters of screws in thousandths of an inch are given in Schedule III.

Schedule III.—*Schedule of Approximate Dimensions in Thousandths of an Inch.*

Number.	Pitch.	Diameter.	Number.	Pitch.	Diameter.
0	39·4	236	13	9·8	47
1	35·4	209	14	9·1	39
2	31·9	185	15	8·3	35
3	28·7	161	16	7·5	31
4	26·0	142	17	6·7	28
5	23·2	126	18	5·9	24
6	20·9	110	19	5·5	21
7	18·9	98	20	4·7	19
8	16·9	87	21	4·3	17
9	15·4	75	22	3·9	15
10	13·8	67	23	3·5	13
11	12·2	59	24	3·1	11
12	11·0	51	25	2·8	10

In practice, interchangeability has been to some extent secured by allowing clearances at the root and crest of the thread. The committee think it desirable to suggest the amount of these clearances in the gauges, and they have agreed—

(*a*) That clearance should be provided at the root of the thread of the screws, and should be obtained by cutting the thread of the screw deeper than the normal, thereby reducing the diameter of the core;

(*b*) That clearance may be provided at the crest of the thread of the screw, and should be obtained by the use of a tap whose outside diameter is greater than the normal;

(*c*) That the limits of these clearances be defined by the figures of Schedule IV.

Schedule IV.—*Schedule of Maximum and Minimum Diameters of the Cores of Screws, and of the Outside Diameters of Taps, where Clearance is Provided.*

Designating number.	Cores of screws.		Outside diameters of taps.	
	Maximum.	Minimum.	Maximum.	Minimum.
0	4·74	4·6	6·2	6·06
1	4·16	4·04	5·48	5·36
2	3·68	3·57	4·86	4·75
3	3·17	3·07	4·25	4·15
4	2·77	2·68	3·77	3·64
5	2·45	2·37	3·32	3·24
6	2·13	2·05	2·91	2·83
7	1·89	1·82	2·60	2·53
8	1·65	1·59	2·29	2·23
9	1·41	1·35	1·98	1·92
10	1·26	1·21	1·77	1·72
11	1·11	1·07	1·56	1·52
12	0·94	0·9	1·36	1·32
13	0·88	0·85	1·25	1·22
14	0·71	0·67	1·05	1·01
15	0·64	0·61	0·94	0·91
16	0·55	0·52	0·83	0·80
17	0·49	0·47	0·73	0·71
18	0·43	0·41	0·65	0·63
19	0·36	0·34	0·57	0·55
20	0·33	0·32	0·50	0·49
21	0·28	0·27	0·44	0·43
22	0·24	0·23	0·39	0·38
23	0·21	0·20	0·35	0·34
24	0·18	0·17	0·31	0·30
25	0·16	0·15	0·27	0·26

If clearances up to the amount indicated in Schedule IV. be generally adopted by makers, interchangeability will, in the opinion of the committee, be promoted; and the committee recommend that, except in the case of screws made for special cases, the above clearances in the core and outside diameters of the screws be adopted as normal. The committee do not attach great importance to the exact form of the thread at the crest and root.

While adhering, then, to the form of the thread as laid down in the Montreal report, and in Schedule I. above, they would advise the acceptance as B.A. screws of all screws which pass the nut gauge (1) described below and have the requisite core and outside diameters, and of which the straight portions of the sides are not less than those of the standard screw.

The committee have given a very long time to the consideration of various forms of gauges. As appears from their earlier reports, it is clear that the difficulty of constructing gauges with rounded crests and roots has not been overcome, and the committee are reluctantly compelled to relinquish the task of making gauges of the ideal B.A. form following the the outline A, B, C, D, E, F, G, H, K (Fig. 2). Two possible forms of flat-

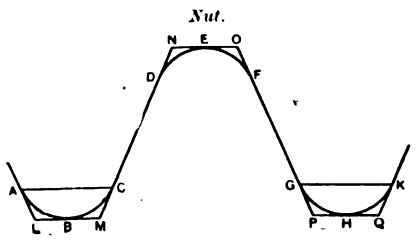

FIG. 2.

topped gauges for screws have been considered: (1) a gauge following the outline A, C, N, O, G, K; (2) a gauge following the outline A, L, M, N, O, P, Q, K. With regard to (1) it is clear that while it will test the pitch and the effective diameter, it will not gauge the root of the thread, and will not, therefore, separate screws which are interchangeable with a standard nut from those which are not. Besides testing a screw with a nut gauge of this form, it will be necessary to test its core diameter by means of a gap or notch gauge. If the screw pass the nut gauge, and have at its root the clearance recommended, it is practically certain it will be interchangeable with a nut of standard form. A screw which passes this gauge and has the requisite diameters as given in Tables I. and II. at the core and outside, and the requisite bearing surface, may be called a B.A. screw.

The other form of flat-topped gauge which has been considered follows the outline A, L, M, N, O, P, Q, K. A gauge of this form will test the minimum diameter, as well as the pitch and effective diameter of screws, and all screws which pass it are interchangeable with the standard nut. Moreover, in view of the clearance recommended at the

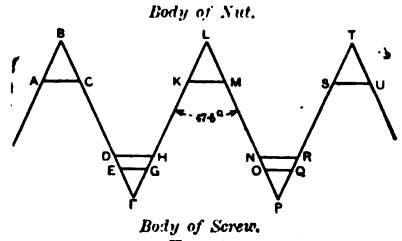

FIG. 3.

root, the committee anticipate that in practice this gauge could be usefully employed. At the same time it is clear that it will not pass a screw any part of which lies above the lines LM, PQ, and that itwould, therefore, reject a screw having the standard form.

Thus, in conclusion, the committee recommend—

I. That the form of the standard B.A. thread be that defined at the Montreal meeting in 1884, and which follows the outline A, B, C, D, E, F, G, H, K of Fig. 2.

II. That the form of the B.A. gauge for screws be that defined by the outline A, C, N, O, G, K, and that this be used with a gap or notch gauge, as described in the report.

III. That the dimensions of the notch gauge be such as to ensure that the core diameters lie between the limits given by Schedule IV.

IV. That a screw which passes the B.A. gauge, and of which the core and outside diameters are given by Table II. and Table I. respectively be accepted as a B.A. screw, provided that the length of the bearing surface is not reduced below the length corresponding to D, C in Fig. 2.

A machine has been made for the accurate measurement of screw gauges of which the following is a description. The machine has been placed in charge of the committee of the National Physical Laboratory, and the director of that institution is prepared to undertake the measurement of gauges and screws submitted for examination.

The machine is designed for measuring small screws microscopically. In Figs. 4 and 5 are given drawings of the instrument, of which Fig. 4 is a plan of the compound stage with the microscope removed, and Fig 5 is an end elevation showing the arrangement of the microscope. The

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screw to be measured is held in a spring chuck in the spindle A. By means of the two micrometer screws S_1, S_2, the screw is moved along geometric slides in two directions at right angles. The screw is aligned parallel to the micrometer S_1 by the adjusting screws B, C. The pitch of the micrometer screws (which were supplied by the Browne and Sharpe Company) is 0·5mm., and the heads are divided into 50 parts, enabling readings to be taken directly to 0·01mm.

The screw is illuminated from below by a plane mirror and is observed by the microscope M. Rough focussing is effected by sliding the microscope in the tube T, the fine adjustment being accomplished by the micrometer screw S_3, which raises and lowers T. The tube T can also be rotated about its axis without disturbing the focus, and the amount of rotation measured by means of a scale on D. The eyepiece and object-glass of the microscope are by Zeiss. The eyepiece is furnished with suitable cross-wires in silver.

A series of spring chucks for different diameters of screws accompanied the machine.

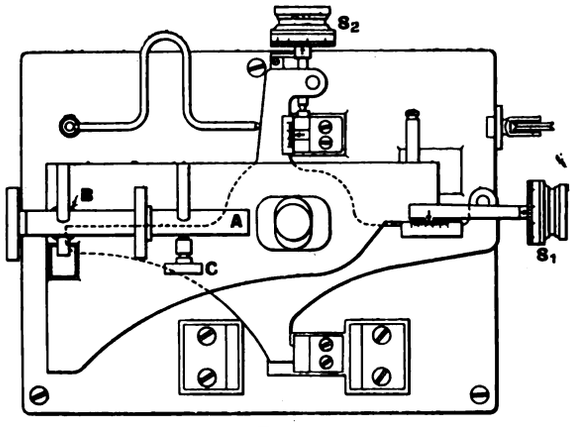


FIG. 4.

The committee further report that the Engineering Standards Committee have appointed an influential sub-committee to deal with the standardisation of gauges of all kinds, including screw gauges, and that in their opinion the work which they have been doing may with advantage be left to this committee and to the National Physical Laboratory to carry on. The committee have not considered in detail the question of the limits of error in screws purporting to represent the B.A. thread. This matter they think it desirable to leave to the Engineering Standards Committee, who will be able to discuss it in connection with larger screws and gauges. On the other matters submitted to them they do not wish to report further. They present this as their final report, and do not ask for reappointment.

The undersigned members of the committee, do not accept in its entirety the above report, and recommend with reference to threads Nos. 0–11 :—

1. That sets of gauges should be made and verified, each set consisting of six pieces as follows, A–F.

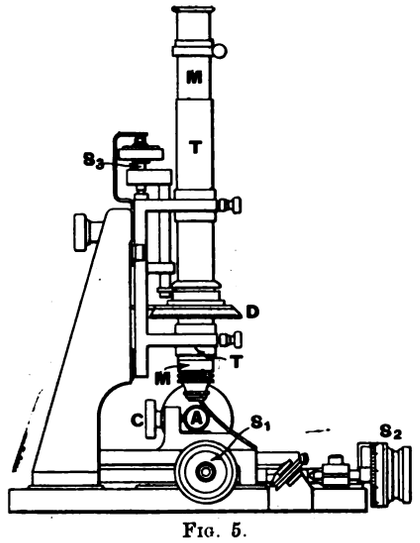


FIG. 5.

A. A male gauge screw of the pitch and effective diameter laid down for the distinguishing number in Schedule I., the thread having a V-shaped root, and a crest flattened cylindrically to the overall diameter laid down in the table. The outline of the thread is in Fig. 3, A, C, F, K, M, P, S, U. This piece A is for the purpose of testing nuts and nut gauges to check the correctness of the pitch, angle of thread, effective diameter, and root diameter, and for checking the hole gauge E.

B. A tap, a copy of A in all respects, except that it is fluted and backed off as a tap, and that the crests are left nearly approching the sharp V form as is possible, so as to maintain a cutting edge with this angle of thread—*i.e.*, 47·5deg. The outline of this thread is in Fig. 3, A, B, F, L, P, T, U. This piece B is to be used solely for cutting the thread of the nut gauge C.

C. A nut gauge, the thread of which is cut by the tap B, the crest being afterwards reamered out to such a diameter as experience may show is necessary to give suitable minimum clearance at this point to ensure that machine-made screws will enter the nuts or tapped holes. The outline of this is A, B, E, G, L, O, Q, T, U.

D. A notch gauge to test the core diameters of male screws.

E. A hole limit gauge to test crest diameters of male screws and to be checked by piece A. The diameter of this is diameter D, Fig. 1, Schedule I.

F. A cylinder plug gauge to test the diameter of the hole in the gauge nut C in commercial nuts or tapped holes. The diameter of this is diameter C, Fig. 1, Schedule I.

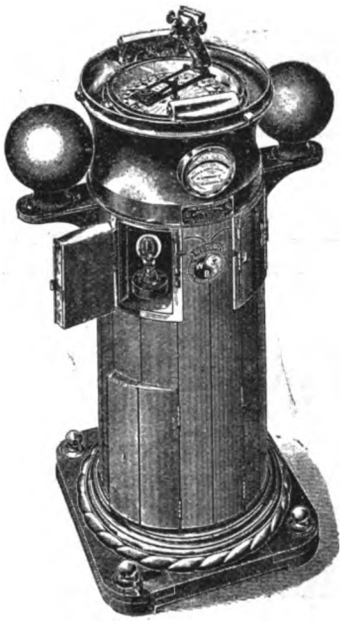
2. That the standard B.A. screw be defined as a screw which conforms to the gauges described above in all respects except in the form of the crest and root of the thread, which are unimportant.

R. E. CROMPTON. C. V. BOYS.
J. M. GORHAM. O. P. CLEMENTS.
G. K. B. ELPHINSTONE. W. A. PRICE.
MARK BARR.

LORD KELVIN'S COMPASS.

When Sir William Thomson introduced his well-known mariners' compass, the chief feature of the instrument was the extreme lightness of the card and shortness of the magnetic needles. Since then many improvements have been made by Sir William Thomson (now Lord Kevin) in the binnacle and other accessories of the compass.

The compass, as now made, is mounted on a pedestal strongly built up of teakwood staves, and containing the necessary accommodation for the correcting magnets. Accommodation is also provided in the stand both for oil lamps and electric light for the



COMPASS AND CORRECTORS.

illumination of the compass at night. The illumination is now effected from underneath the bowl, and this constitutes one of the new improvements. The under part of the compass bowl is made of strong thick annealed glass to allow the light to pass through, and this glass portion is also utilised to contain the viscous oil, which is very effective in calming vibrations in the bowl caused by the rolling or pitching of the vessel in heavy weather. An arrangement is also provided inside the stand for reducing the light to any required extent when taking bearings of stars or other faint lights. The bowl is suspended inside the binnacle by a new system of springs, which are designed to prevent the vibration of the vessel affecting the compass bowl. This new pattern of suspension has already been found very successful on board ships having a large amount of vibration. In the new pattern of compass the helmet is conical in shape, and is provided with rifle sights on the top to enable quick bearings to be taken of the sun, lights, buoys, &c. The helmet is so constructed as to move round freely in any direction. In addition to the rifle sights on the top there are corresponding sights inside to permit of the bearings being read directly upon the compass card. The new helmet is also constructed to allow of the azimuth mirror being used in wet or stormy weather without removing the helmet.

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RADIUM AND RADIO-ACTIVITY.

The new branch of physical research which was opened up when BECQUEREL discovered the existence of radio-active substances, has during the last few months achieved a popularity among ordinary laymen seldom accorded to science before it has been applied by the practician to the use and convenience of man. When the X-rays were discovered by RÖNTGEN it was but natural that the possibility of "seeing their bones" had considerable attraction to those ever athirst for a new sensation, while the immediate and evident value of this discovery to the surgical profession earned for it the attention of the more seriously minded. Radium—for it is the concrete substance rather than the abstract idea of radio-activity that has appealed to the general public—offers none of these attractions. Yet the newspapers chronicle day-by-day any information that may be obtainable about it, and a popular lecture on "Radium" is making a provincial tour, and has been drawing crowded audiences nightly. It is, we fear, the high market price of radium that attracts a large proportion of the audiences and newspaper readers with the idea that they may learn how best to set about on a search for this hidden treasure, in others it is a general and indefinable love of the mystical; but we trust that some, at any rate, desire to study the subject with a view to becoming better acquainted with the latest developments of modern scientific thought and research. To these we do not hesitate to recommend a perusal of the serial on "Radio-activity" by Mr. FREDERICK SODDY, which we conclude in the present issue of *The Electrician*. At our suggestion Mr. SODDY has wound up this article with a summary of the present position with regard to the subject, and has expressed his views as to those problems to which research may be directed most usefully in the immediate future. It should be an encouragement to British physicists that the more recent and more important developments have been carried out by our own people. To M. BECQUEREL we owe the discovery of radio-activity, and to Madame CURIE the discovery of the new radio-active elements, after a laborious and painstaking examination of almost every known form of mineral. But Prof. RUTHERFORD, a New Zealander, and now working at the Canadian McGill University, was the first to apply to the study the exact methods as the result of which the three types of radiation came to be distinguished. He also made the most important discovery of the thorium emanation, and gave at once the correct explanation of the real nature of the phenomenon of the induced or excited activity. Subsequently, in conjunction with Mr. SODDY, he took the first step towards establishing our present working hypothesis by finding the true significance of the new transitional element uranium X, which Sir WILLIAM

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CROOKES had separated out two years previously, and by discovering a similar thorium X. Then RUTHERFORD and SODDY further developed the disintegration theory by their extended examination of these transition-forms, and finally Sir WILLIAM RAMSAY has given this theory a firmer foothold by identifying the element helium with the ultimate product of the α-radiation of radium.

The whole line of research, it is true, is beset with difficulties. In the first place we have a scarcity of minerals containing radio-active elements, and then the minute portion of radio-active element contained in every ton of ore,. So small is this, indeed, that no separation of metallic radium has been possible, although this is of less moment, owing to the fact that, as the phenomena under investigation are atomic properties, the radium bromide or chloride will, therefore, sufficiently answer the purposes of experiments in radio-activity. The great difficulty, in the further extension of the chemical side of the subject, is that the radio-active elements radiate away such a small proportion of their whole mass in the unit of time, so that even Sir WILLIAM RAMSAY'S skill and experience in spectrum analysis has been taxed to the utmost in investigating the nature of the ultimate product. On the other hand, many of the physical problems alluded to by Mr. SODDY in his present article do not require very large quantities of material for their elucidation. They call rather for time and patience. The whole region of research is one that will repay prolonged labour, and we trust that the logical English school of physicists will continue in the front rank and work hand in hand with their neighbours on the Continent in throwing more light on the phenomenon of radio-activity, its causes and consequences.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Transactions of the American Electrochemical Society. Vol. IV., 1903. (Published by the Society.)

This volume is a record of the *Proceedings* of the Society at the fourth general meeting held at Niagara Falls in September, 1903. It is interesting to note that the Society has nearly 600 members, and that it is rather more than solvent—achievements very creditable to so young a body. Excellent relations have been established with the Faraday Society in this country, and the journals of the two associations are exchanged, each member of each society receiving a copy of the cognate journal. The Faraday Society, as being more lately formed, has a smaller membership than the American Electrochemical Society, and is thus, for the moment, at some disadvantage in the exchange; this fact should constitute an additional stimulus to its expansion.

In the *Transactions* are many interesting Papers, some of which might well claim individual review if space permitted. We must be content with indicating their titles and the nature of their contents. The first in position in the volume is one by Mr. F. A. J. FitzGerald, long associated with Mr. Acheson, who appropriately considers those principles which govern the design of electrical furnaces for their different purposes. Mr. FitzGerald states in mathematical form the conditions that should be observed for obtaining the best results from furnaces applied to the manufacture of graphite and carborundum, and while admitting that the factors influencing the efficiency of a furnace are too numerous and complex to be strictly reducible to a formula, maintains, with much reason, that regard should be paid to the limitations indicated by theory, so that waste of time and money in designing furnaces which cannot possibly fulfil their intended purpose may be avoided.

A Paper by Mr. Ruthenburg on a process for smelting iron, in continuation of the author's previous communication, must be read in conjunction with the discussion, which extends and elucidates the ideas in the Paper itself. Mr. Ruthenburg is doing much towards the establishment of the electrical smelting of iron on a manufacturing basis. This subject is being rapidly developed and a practical issue may almost be in sight.

Of minor industrial importance but attractive from its neatness is the process described by Mr. C. F. Burgess for cleaning superfluous brazing from such goods as bicycle frames. The frame is made the anode in a solution of sodium nitrate; the iron becomes passive and the brass is dissolved.

Mr. W. D. Bancroft's Paper on copper refining describes an attempt to determine the influence of such variable conditions as current-density and temperature on the economy of the electrolytic process. Owing to the difficulty of reproducing in the laboratory all the significant factors governing the cost of a manufacturing process, the Paper cannot be regarded as conclusive, and the deductions drawn from it would not be likely to be received without demur by those actually engaged in the industry.

There is a long Paper by Prof. Richards on the theory of electrolytic dissociation in its relation to thermo-chemistry. We venture to think that the author is thrashing a dead horse. Nowadays, no one regards electrolytic dissociation in any real sense; it is a method of expressing the fact that substances in solution behave in a curious way. It would be a bold man who was prepared to assert that on dissolving sodium chloride that salt was broken into sodium and chlorine. But as there is still much sad confusion of thought in this matter, the Paper may be justified. Several succeeding Papers deal with the same theory, and the situation is summed up in a sentence due to Mr. Reid in the discussion, when he says: "The most fatal objection to the theory of dissociation is one concerning energy." The whole matter can be boiled down to the simple statement that the ionic theory has sufficed to correlate a number of different phenomena which had previously no obvious connection; that, as far as this goes, it is a satisfactory and useful hypothesis; that it has, by its less temperate advocates, been pushed without regard to fundamental energy considerations; finally, that it has used a kind of pseudo-mathematics, in which there are plenty of constants (of a variable character), much as the cuttlefish uses its own most preservative secretion. But all this is passing, and those people who have kept their heads in a whirl of irrational advocacy are grateful alike to the fierce disciple who would sever the stablest compound by mere solution in water, and to the stoutest negationist of the effect of the solution. There would have been good hope of attaining a definite conclusion had the advent of radio-activity been a little delayed; now the ion is almost *vieux jeu*. B. B.

The Colliery Manager's Pocket Book, Almanack and Diary for 1904. Edited by R. A. S. REDMAYNE. (London: "Colliery Guardian" Co., Ltd.)

The electrical references in this year-book are on the whole better written than is usual in this class of book. Under notices of recent Papers on coal mining appears a short abstract of an American Paper comparing compressed air with electricity in mining operations. It is evidently written with a strong prejudice in favour of compressed air. A concise review is given of mechanical coal-cutting in longwall work in the United Kingdom. This little article gives an excellent summary, with practical data, of the present practice and the results obtained in the application of power transmitted by compressed air and by electricity to coal-cutting. The section in the book entitled "Electrical Engineering" is poor and hardly reliable in much of the information contained. A folding map is given showing the lines of equal magnetic declination for January 1, 1904, and based on the Rücker-Thorpe survey of the British Isles.

Annuaire pour l'an 1904. Published by Le Bureau des Longitudes. (Paris: Gauthier-Villars.) 1fr. 50c.

This bulky little annual contains the usual figures and tables relating to astronomy, optics, electricity, chemistry and other branches of natural philosophy, besides including much information of a most varied and general nature. As in former years, the book concludes with several original treatises, but none of these are on electrical subjects.

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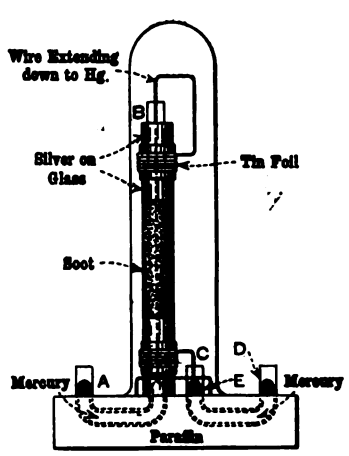
L'année Electrique, Électrothérapique et Radiographique. By Dr. Foveau de Courmelles. (Paris: Ch. Béranger.) 1904. 3fr. 50c.

This annual sketches in an entertaining and descriptive manner the history of electrical progress in all its more important branches during the year 1903, and its contents will no doubt prove pleasant and instructive reading to engineers and mechanically-inclined amateurs during their leisure hours. The book starts with the enumeration and description of improvements wrought in electrical machinery and instruments, touching upon, amongst many other things, an electric dynamometer for the direct measurement of transmitted energy; very high and cheap resistances, obtained by the well-known property of an aluminium pencil to leave—when written with on a plate of glass—a fine film of aluminium on the surface; various inventions regarding primary and secondary batteries, amongst which figures the Edison accumulator. Electric furnaces, electrolytic processes, electric lighting, welding, heating, cooking, telegraphy and telephony are a few other of the many subjects treated. A large portion of the book is devoted to therapeutics, intermixed with which is much matter referring to radio-activity, and the various kinds of rays, the knowledge of which has been advanced during the past year.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier d'Albe.]

Carbon Resistances.—A. W. Gray has devised a modification of Longdon's carbon resistance which can be very easily mounted. A tube of glass is substituted for the plate. The ends, after being silvered, are wrapped with a ribbon of stout tinfoil, which is firmly bound on with copper wire so as to make good contact with the silver. Then the soot is deposited and hardened as described by Longden. To mount the resistance thus prepared, a J-shaped glass tube, AB, and a shorter U-shaped one, CD (see diagram), are fastened vertically into a block of paraffin as indicated. The lower portions of these tubes are filled with mercury. The resistance tube is simply slipped over the long arm B of the J-tube, and the end of the wire binding the tinfoil at the top is carried down through B until it makes contact with the mercury. The soot coating is protected by covering it with a large test-tube. A and D form the terminals.



[A. W. Gray, *Phys. Review*, January, 1904.]

Theory of Aluminium Rectifier.—S. R. Cook describes a number of experiments which go to prove that the apparent resistance of the aluminium anode in potassium-aluminium sulphate is not an ohmic resistance but a resistance of transition of the ions, manifested in a counter E.M.F. The value of the latter, and also of the critical pressure, depends upon the temperature. The critical E.M.F. for 1deg. is approximately 47 volts, and for 48deg. only 22 volts, the counter E.M.F. increasing with decrease of temperature. When the electrical pressure is greater than the critical value the film becomes crystalline in structure, and in crystallising exposes free metallic surfaces to the action of the anions, allowing them to discharge to the metallic surface. At the temperature at which aluminium decomposes water—*i.e.*, 100deg.—the high anodic resistance greatly decreases.

[S. R. Cook, *Phys. Review*, January, 1904.]

Magnetic Effect of Convection Currents.—C. Gutton's observation of the increased brightness of a luminescent screen under the influence of a non-uniform magnetic field has been confirmed by Guéritot at Nancy and Jégou at Paris. He now describes in detail the manner in which he proved the magnetic effect of electric convection by means of the new phenomenon. A simple experiment is to lay a luminescent screen on an earthed sheet of lead and to put an electrified ebonite rod underneath. As long as the rod is at rest it exerts no influence, but if it is agitated or made to rotate about its own axis the luminescence becomes temporarily greater. An unelectrified rod has no such action. If there is no sheet of lead, the screen shows a brightening even when the rod is at rest. The rod thus appears to emit N-rays, which are intercepted by lead. To eliminate all possibility of conduction currents simulating the effect described, the author produced a convection current by Rowland's method, using a charged rotating disc. The best position for the screen was against the rim of the disc, where the field due to convection is least uniform. There is no effect when the disc is either charged and stationary or uncharged and in motion. But when it is charged and in motion—*i.e.*, when there is electric convection—the screen brightens up. A corresponding effect may be produced by sending a current round the rim of the disc, and the author found that that current need only be $\frac{1}{6000000}$th of an ampere to produce a visible effect. In one of the experiments, the disc was 16cm. in diameter, and was opposed to another disc at a distance of 1cm. It made 22 turns per second, and the difference of potential was about 30 electrostatic units. The theoretical convection current was therefore $\frac{1}{280000}$th ampere, or double the minimum observable. The result is the same if the disc is split into 12 sectors.

[C. Gutton, *Comptes Rendus*, February 8, 1904.]

Conduction of N-rays.—E. Bichat has found a simple explanation for the apparent anomaly that N-rays, being a form of radiation, can be "conducted" by a wire. The conduction is a case of successive reflection. Light may be similarly conducted along a curved glass tube. The author gives the following data in support of his explanation. The transmission is really due to the wire and not to the medium in which it is placed. For no difference is produced by immersing the wire in water. In order that the conduction may take place, it is necessary that the material of the wire should itself transmit N-rays. A lead wire does not conduct the rays. Wires of copper, aluminium and zinc, and rods of glass do. A tube containing salt water, which is transparent to the N rays, conducts them. A tube containing pure water, which is opaque to them, does not. The shape of the tube or wire is without influence so long as there is no sudden bend. A copper wire may be curved in various ways, but as long as the radius of curvature is large throughout it transmits the N-rays. If there is an elbow or kink, the rays are arrested there, and on moving a screen along the wire it is noticed that it shines out at the kink, where the rays emerge under refraction. Since the mechanism of conduction is based upon successive reflection, it may be presumed that the state of the surface has some influence upon it. That is found to be the case, for whereas a polished aluminium wire will transmit the rays freely, a wire with a rough or irregular surface will not. If a portion of a copper wire is oxidised in a flame, the rays will stop and emerge at that portion. The oxidised portion may be discovered in the dark by means of the screen. On polishing the portion with emery, the rays are again freely transmitted. It is not necessary to provide the transmitting wire with a terminal plate. If the screen is placed at the side of the wire instead of placing it against the end, the effect becomes much weaker. The author worked only with N-rays of a non-physiological origin.

[E. Bichat, *Comptes Rendus*, February 8, 1904.]

Doppler Effect in the Electric Spark.—The influence of the motion of the source upon the pitch of the oscillation as it appears to a stationary observer is easily proved in the case of sound waves, and has been at least qualitatively demonstrated in the case of light. It is obviously possible that the lines of a spark spectrum may be influenced by the motion of the projected particles which give rise to them. A. Hagenbach has endeavoured to utilise this principle in order to arrive at an estimate of the velocity with which the particles travel in the spark. To do that, he arranged two spark-gaps, one above the other, so that they were traversed by the same current in

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succession, but that in one of them the anode was next the slit, and in the other the cathode. Any difference of oscillation frequency due to motion would thus be doubled. He observed the spectrum with an echelon spectroscope and also with a concave grating. In both cases the displacement observed was less than 0·01 Angström unit, and was barely measurable. This would give a velocity of about 300 metres per second, and would approximate to the value found by Mohler, but would only be about one-tenth of the values found by Schenk, Schuster, and Hemsalech. A calculation of the probable velocity of projection of the metallic vapour goes to support the higher velocities, but the author points out that the particles emitting the light are not necessarily newly projected. The newly projected particles would impart a luminosity to those which they encountered in the gap.

[A. HAGENBACH, *Ann. der Physik.*, Nr. 2, 1904.]

Maximum Speed of Electrons.—If in the formulæ given by Searle (1897) for the energy and by Abraham (1903) for the impulse of a constantly moving electron the velocity of the latter is put equal to the velocity of light, it is found that those quantities become infinite. Hence, the steady motion of an electron with the velocity of light is impossible. But this does not exclude the possibility of the electron acquiring the speed of light in some other way. P. Hertz shows that a finite force suffices to suddenly project an electron from a state of rest with the velocity of light, and to maintain it at that speed for a finite time. At the instant of projection, an ether wave is formed which exerts a retarding force upon the electron until it has spread beyond it. During this short time, an accelerating force of a calculable amount must act upon the electron in order to counterbalance the retardation of the wave. Fields of the required intensity may very well occur in the radium molecule. They are somewhat feebler than the field at the surface of an electron.

[P. HERTZ, *Phys. Zeitschr.*, February 15, 1904.]

ON THE MAGNETIC DISPERSION IN INDUCTION MOTORS, AND ITS INFLUENCE ON THE DESIGN OF THESE MACHINES.*

BY DR. HANS BEHN-ESCHENBURG.

(Continued from page 649).

III.—EXPERIMENTAL PART.

§ 1. FLANK DISPERSION.

The member σ_3 in formula (7) obviously may be eliminated most easily, since σ_3 is the only quantity which depends on the length of iron in the core-body. If, therefore, we compare the values of σ for two motors in which the number of poles, the number of slots, shape of slots, and the air-gap are maintained the same, while the iron-breadth in one motor amounts to b and in the other to b', then the coefficients σ_1 and σ_2 for both motors will be the same, whereas the total values σ and σ' of the dispersion-coefficient will differ from one another by the difference of the coefficients σ_3 in the two cases. Whence we get

$$\sigma - \sigma' = 5\delta \cdot K_3 \cdot \left(\frac{1}{b} - \frac{1}{b'}\right) \cdot \quad \ldots \quad (8)$$

Now the Oerlikon Machine Works builds various series of normal types of motors, amongst which are found motors with diameters, numbers of poles and shape of slots that are equal amongst themselves, and which differ only in their iron-breadth. We will apply the above calculation to some of these types of motors, and first for motors with the usual coil-winding, in which the hand-shaped coils projecting at the flanks of the core-body are bent down over one another against the end plates.

(1) *Motor Type* 358: *Insulated Coil-winding in Stator and Rotor.*

With 4 poles, $\sigma = 0{\cdot}06$; with 6 poles, $\sigma = 0{\cdot}09$.
$D = 29$; $\delta = 0{\cdot}065$.
$N_1 = 72$; $N_2 = 96$.
$b = 10$.

Motor Type 359: { With 4 poles, $\sigma' = 0{\cdot}045$. / With 6 poles, $\sigma' = 0{\cdot}075$.
$D' = 29$; $\delta' = 0{\cdot}065$.
$N'_1 = 72$; $N'_2 = 96$.
$b' = 14{\cdot}5$.

The difference of the values of σ in the two motor types gives for 4 poles:—

$\sigma - \sigma' = 0{\cdot}015$; for 6 poles, $\sigma - \sigma' = 0{\cdot}015$; and $b' = 1{\cdot}45 \times b$.

According to formula (8) one would have $\sigma - \sigma' = K_3 \times 0{\cdot}01$. By comparison with the above we should obtain for these types of motors

$K_3 = 1{\cdot}5$.

The same types of motor, but provided with a non-insulated short-circuited winding in the rotor, gave

Type 358 (4-pole) $\sigma = 0{\cdot}05$.
Type 359 (4-pole) $\sigma' = 0{\cdot}04$.
$\sigma - \sigma' = 0{\cdot}01$; $K_3 = 1$.

(2) *Motor Type* 838: { With 6 poles, $\sigma = 0{\cdot}050$. / With 8 poles, $\sigma = 0{\cdot}063$.
$D = 49$; $\delta = 0{\cdot}08$.
$N_1 = 72$; $N_2 = 120$
$b = 19$.

Motor Type 840: { With 6 poles, $\sigma' = 0{\cdot}042$. / With 8 poles, $\sigma' = 0{\cdot}056$.
$D' = 49$: $\delta' = 0{\cdot}08$.
$N'_1 = 72$; $N'_2 = 120$.
$b' = 28$.

With 6 poles, $\sigma - \sigma' = 0{\cdot}008$.
With 4 poles, $\sigma - \sigma' = 0{\cdot}007$.

By formula (8)

$$\sigma - \sigma' = 5 \times 0{\cdot}080 K_3 \left(\frac{1}{19} - \frac{1}{28}\right) = K_3 \times 0{\cdot}065.$$

By comparison of observation and calculation we have

$K_3 = 1{\cdot}25$ for 6-pole winding;
$K_3 = 1{\cdot}1$ for 4-pole winding.

Motor Type 8052: With 12 poles, $\sigma = 0{\cdot}067$.
$D = 90$; $\delta = 0{\cdot}1$.
$N_1 = 144$; $N_2 = 180$.
$b = 17$.

Motor Type 3068: With 12 poles, $\sigma' = 0{\cdot}046$.
$D' = 90$; $\delta' = 0{\cdot}1$.
$N'_1 = 144$; $N'_2 = 180$.
$b' = 40$.

Therefore, from observation, $\sigma - \sigma' = 0{\cdot}067 - 0{\cdot}046 = 0{\cdot}021$; by calculation, $\sigma - \sigma' = K_3 \times 5 \times 0{\cdot}1 \left\{\frac{1}{17} - \frac{1}{40}\right\} = K_3 \times 0{\cdot}017$; whence we get

$K_3 = 1{\cdot}24$.

From these examples, for motors with similar arrangements of windings—that is, with coils bent down over the flank surfaces—the coefficient K_3 may with tolerable accuracy be set down at the value 1·25. We will, however, add an example which shows the influence of the arrangement of the windings at the flanks.

The dispersion-coefficients were measured of a motor the stator winding of which consisted of coils which were laid over one another in three planes, and having at one time a rotor which was also wound with insulated coils in three separate phases, and at another time a rotor the winding of which was carried out in the well-known squirrel-cage form. In both cases the number and shape of the slots in the rotor were alike, so that the two cases are distinguished only by the special arrangement of the conductors on the flanks of the rotor. It must be premised that the flank dispersion of the conducting pieces of the squirrel-cage rotor is very small in comparison with the dispersion of the curved bights of the coils fastened in the former case against the clamping rings. The observations gave

Motor Type 363: With 8 poles.
$D = 58$; $\delta = 0{\cdot}09$ / $N_1 = 96$; $N_2 = 144$ / $b = 24$. } Rotor with phase-winding, $\sigma = 0{\cdot}054$.
Rotor with squirrel-cage, $\sigma = 0{\cdot}037$.

The greatest part of the difference $\sigma - \sigma' = 0{\cdot}017$, may now be attributed to the flank dispersion of the rotor with coil winding. One part of the difference will anyhow arise, winding-coefficients, σ_1 and σ'_1 being different in the two cases. If the flank-dispersion of the rotor in the first case is taken as equal to the flank-dispersion of the stator, then accordingly we may set

$$K_3 \times 5 \times 0{\cdot}9 \times \frac{1}{24} = 2 \times 3{\cdot}017;$$

whence $K_3 = 1{\cdot}8$,

while we had found above as a mean value for the coil-winding $K_3 = 1{\cdot}25$. We will attribute to the winding-coefficient the half of the mean of these two values, and take, therefore, for this motor $K_3 = 1{\cdot}5$.

* The researches described in this communication were imparted in April, 1903, to Prof. Silvanus P. Thompson, on whose suggestion they were communicated in their present form to the Institution of Electrical Engineers in the summer, and have since been translated into English. The Paper was read in abstract by Prof. Thompson at the meeting of the Institution on January 15, 1904.

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§ 2. Peripheral Dispersion.

After obtaining in the first section the value of the flank-dispersion, let us now investigate the value of the peripheral-dispersion, which was above defined by formula (5) as

$$2\sigma_2 = \frac{K_2 \delta}{X \times N \times \tau}.$$

This dispersion is by definition characterised by its correlation with the magnetic resistance (reluctance) of the slot apertures at the peripheral surfaces of stator and rotor. If the flank-dispersion is known with accuracy, then the peripheral-dispersion may also, in consequence of its dependence on the air-gap δ, be distinguished and separated from the amount due to the winding-coefficient σ_1. Examples will be adduced of both modes of determining σ_2.

A large number of normal types of motor of the Oerlikon Machine Works were built with closed slots in stator and rotor. The iron bridges which close the slots at the peripheral surfaces were machined down to a thickness of about 0·1mm. and to a breadth of 1mm. to 2mm. Obviously such a thin bridge of iron will already be fully saturated with a proportionately small magnetic flux. The magnetic resistance of such a bridge is variable according to the degree of saturation. The saturation augments with the number of ampere-turns which excite the stray flux over the peripheral surface. These ampere-turns are equal to the product of the number of turns in the slots of one phase into the strength of current in these turns. Motors with slots closed in this manner must be, therefore, so proportioned that the number of ampere-turns in their slots attains a sufficient value to saturate fully the iron bridges over the slots. For such motors the short-circuit current will, up to saturation, increase rapidly with the increase of the voltage applied during the short-circuit; and the value of σ will, therefore, fall off rapidly with the increase of the short-circuit current. Obviously, we must here abandon those methods for the estimation of the characteristic values of the motor which are in the diagram based upon the assumption that σ is of constant value.

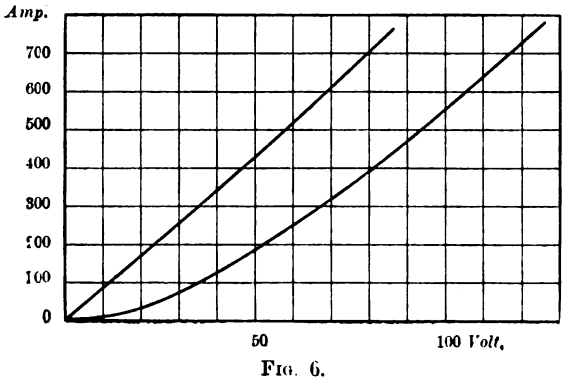

Fig. 6.

From the course of the curve of the short-circuit current as a function of the short-circuit voltage, it may be approximately read off at what point the saturation of the iron bridges sets in, since from that point onwards the curve runs on in a straight line. Let comparison be made between the value of σ, which corresponds to this point of the curve, and the value, for a similar motor, of σ which is obtained when the iron bridge over the slots is slit through with an air-gap. Always, when the slots are opened by such air-slits, the short-circuit currents are proportional to the short-circuit voltage, and σ becomes constant. In the formulæ (5) and (5A) the difference of the peripheral-dispersion was tentatively given from theory as being for open slots 10 times smaller than for closed slots with saturated iron bridges.

As a first example, let us take a motor of type 367, which was first examined with closed slots with iron bridges about 0·1mm. thick, and of a breadth of about 2mm. Then, in the same motor, the slots in the stator and rotor were provided with slit openings of 3·5mm. By these proportionately broad slits the effective length of the pole-arc τ is reduced, and with it the mean value of air-induction and of the magnetising current J_0* was raised in the proportion of 100 : 80. The normal current of the motor amounts to about 600 amperes at 190 volts. For this current the number of ampere-turns per pole per phase in stator and rotor is 2,400. From the curves, Fig. 6, it is seen that with a current of 700 amperes the iron bridges are sufficiently saturated. The quantity X, which determines the magnetic resistance of the slot-opening, is, according to the foregoing, for slots with slits, equal to the width of the slit, to be set at X = 0·35.

The observations of the short-circuit currents for the motor under consideration are set out in Fig. 6. The no-load current amounted, in the first case, with closed slots at 190 volts, 50 periods, to 80 amperes; in the second case, to 100 amperes. The remaining data run:—

Motor Type 367:

$D = 90$; $\delta = 0{\cdot}11$.
$N_1 = 144$; $N_2 = 180$.
$b = 32{\cdot}5$. $P = 12$.
Sloth-breadth, 11mm.

In the first case, for a short-circuit current of 700 amperes

$$\sigma = \frac{100}{190} \times \frac{80}{700} = 0{\cdot}06;$$

in the second case $\sigma' = \frac{80}{190} \times \frac{116}{700} = 0{\cdot}07$;

therefore, $\sigma' - \sigma = 0{\cdot}01$.

Of this difference a portion is due to the increase of the coefficient of flank-dispersion, which in the second case is increased proportional to the augmented value of the no-load current. The difference of the coefficients of flank-dispersion, for this type of motor, in accordance with the previous chapter (see Note on p. 649) amounts in both cases to

$$2(\sigma'_3 - \sigma_3) = \frac{K_3 \times 5 \times \delta}{b}\left\{1 \times \frac{100}{80} - 1\right\};$$

therefore for $K_3 = 1{\cdot}25$

$$2(\sigma'_3 - \sigma_3) = 0{\cdot}0048.$$

After deduction of this difference there remains for the difference of the peripheral-dispersion the value

$$2(\sigma'_2 - \sigma_2) = 0{\cdot}0052.$$

Let us insert, according to the definition for the open slots in the formula,

$$2\sigma_2 = K_2 \times \frac{\delta}{N \cdot \tau} \times \frac{1}{X};$$

where $X = 0{\cdot}35$; $\delta = 0{\cdot}1$ $N = 13$; $\tau = 23{\cdot}5 \times \frac{80}{100}$ (reduced in proportion to the no-load current);

$K_2 = 1$.

Hence one has $2\sigma_2 = 0{\cdot}0011$,

and further $2\sigma'_2 = 0{\cdot}0041$.

The magnetic resistance of the saturated iron bridges of the closed slots is therefore about four times smaller than the resistance of the open slots.

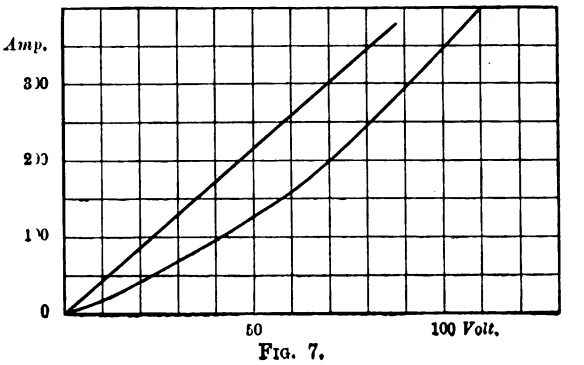

Fig. 7.

As a second example, which shows still more clearly the proportionately very small value of the so-called peripheral-dispersion, we adduce the results of a motor, type 368, the stator of which was executed *first*, with 96 closed slots; *secondly*, with 96 completely open slots with an opening of 18mm. The slots of the second stator were arranged for the insertion of former-wound coils. The rotor had in both instances 144 slots, which in the first case were closed, in the second were slit with slits about 1mm. wide. The iron bridges over the closed stator and rotor slots had a thickness of 0·1mm. and a breadth of about 2mm. The normal current of the motor amounted to about 200 amperes at 190 volts. In the first case the stator winding was carried out with two conductors per slot in star-grouping; in the second case, with four conductors per slot joined in triangle grouping.

The curves, Fig. 7, depict the short-circuit currents in the two cases.

The no-load current amounted, in the first case, to 35 amperes at 200 volts; in the second case, to 53 amperes at 200 volts. The air-gap was, in the first case, 0·9mm.; in the second, 1·1mm. If reduced to equal length of gap, and equal numbers of conductors, the no-load current in the second case would, therefore, be about 1·6 times greater than in the first case. The short-circuit curve in the first case runs in a straight line from about 250 amperes. For 300 amperes one obtains, in the first case,

$$\sigma = \frac{35}{200} \times \frac{93}{300} = 0{\cdot}054;$$

* Compare the foot-note to equation (5) on p. 648.

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in the second case— $\sigma' = \frac{58}{200} \times \frac{70}{300} = 0{\cdot}062.$

The dimensions of the motor are (compare the last example in Chapter III., § 1),

Motor Type 363 : With 8 poles.

$D = 58$; $b = 24$.

$N_1 = 96$; $N_2 = 144$.

Slot-breadth, 13mm. ; slot-pitch, 22·5mm.

The magnetic resistance X of the slot-opening is in the first case considerably smaller than in the second case. But, now, although the value of the total dispersion coefficient σ is larger in the second case than in the first case, the diminution of the peripheral-dispersion in the second case must be masked by an increase of the contributions to σ from other sources. In part, the dispersion coefficient σ_3 due to flank-leakage in the second case is relatively greater in consequence of the considerably greater magnetic resistance in the second case, as evidenced by the 1·6 times greater no-load current. According to a calculation made in Chapter III., § 1, for the same motor, the value for the coefficient of flank-dispersion was found

$$2\sigma_3 = 0{\cdot}028.$$

If for the second case one raises this value in the proportion 1·6 : 1, and deducts the difference of the flank-dispersions from the observed difference of the total disperson, then the remainder represents approximately the difference of the peripheral-dispersion in the two cases

$$\sigma - \sigma' = 0{\cdot}054 - 0{\cdot}062 = -0{\cdot}008;$$

$$2(\sigma_3 - \sigma'_3) = 0{\cdot}028 - (1{\cdot}6 \times 0{\cdot}028) = -0{\cdot}017;$$

therefore, $2(\sigma'_2 - \sigma_2) = 0{\cdot}009.$

Putting $K_2 = 1$; $X = 1{\cdot}3$; $N = 15$; $\delta = 0{\cdot}11$; $\tau = 23 \times 0{\cdot}75$ (for τ will be reduced in proportion to the no-load current, regard being had to the different air-gaps); then we get

$$2\sigma_2 = 0{\cdot}00031, \text{ and } 2\sigma'_2 = 0{\cdot}009.$$

From this it follows that the magnetic resistance of the closed slots was about 30 times smaller than that of the open slots.

We adjoin the remark that there lie before us a very great number of observations on the most diverse types of motors with closed and open slots, which all indicate that the peripheral-dispersion, which depends on the magnetic resistance of the slot-opening, can in general possess only a very small value. The difference between the values of σ for the two forms of slot shows in all cases a very slight value, provided the value of σ is removed from that range of the curve of short-circuit currents in which the saturation of the iron bridges above the slots is considerable. Only when the saturation of these bridges is very low can the leakage exercise any notable influence on the value of σ.

(To be continued.)

VOLTAGE REGULATION IN ALTERNATING-CURRENT SYSTEMS.*

BY H. S. MEYER.

(Continued from page 703.)

B.—Influence of Voltage Regulation on the System.

While the question of voltage regulation has been dealt with as far as the generators are concerned, we now have to consider the effect which such changes in voltage as caused by the inherent regulation will have on the system.

1.—*Incandescent Lighting.*

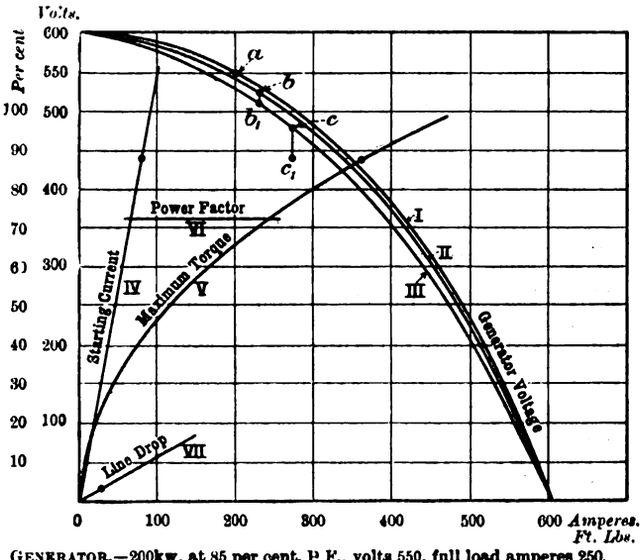
The supply of incandescent lamps demands an almost perfect regulation, since changes—even if only of the order of 2 to 3 per cent.—will have serious consequences for the life and efficiency of the lamps, and, therefore, it is evident that all ordinary generators, when left to themselves, cannot satisfactorily supply a lighting system. In all cases careful attendance at the switchboard is required which follows any change in load, with a corresponding change in excitation. In larger stations this method meets all the requirements of a first-class illumination, but in smaller plants, with, perhaps, only one generator, a noticeable flicker in the lamps can hardly be avoided every time the load is suddenly increased or decreased to any extent. These conditions are considerably aggravated as soon as motors are on the system, and it is this point which has forcibly brought before the engineers the question of automatic voltage regulation.

2.—*Induction Motors.*

Under full load and at standard speed the power-factor should lie, with a well-designed polyphase induction motor, between 90 and 95 per cent. (the latter figure for 25-cycle machines), but when running partially loaded or with slow-speed motors or single-phase machines figures much below those mentioned must be expected, and since on a system of motors hardly ever all of them will run under the most favourable conditions for the power-factor, we can assume that where motors are used on a supply system they will introduce lagging currents amounting to about 60 per cent. of the rated load current of the motor load. By combining separately the wattless and the energy current thus introduced with the corresponding currents of the rest of the load, the resultant power-factor will be obtained on which the regulation of the generator depends.

To illustrate the influence that a comparatively large induction motor starting under heavy load will have on the generator regulation, and also the influence of the voltage regulation on the torque of such motors, Fig. 5 has been prepared. Here we have assumed a generator rated to give 200kw. at 85 per cent power-factor. The normal voltage to be 550, and the regulation on full non-inductive load to be 6 per cent. Fig. 1 to represent again the saturation curve of this machine. It is further assumed that the generator at a given moment is running under a mixed power and lighting load of 200 amperes at 95 per cent. power-factor, the voltage for this load (point *a*) being adjusted to 550. Curve I. shows the regulation characteristic at 95 per cent. power-factor. Under these conditions, a 26 H.P. polyphase induction is started first under full-load torque, second under twice full-load torque.

The induction motor of the slip-ring type to be designed for intermittent service and a synchronous speed of 750 revs. per min. With the proper resistance inserted in its secondary, it will start with 182 foot-pounds torque, taking about 30 amperes—the value of full load current of the motor—at 86 per cent. power-factor. The effect of starting a motor under these conditions will be to load the



GENERATOR.—200kw. at 85 per cent. P.F., volts 550, full load amperes 250.
MOTOR.—26 H.P. at 750 revs. per min., 500 volts. 1. Full current = 30 amps., full load torque = 182 ft. lbs., P.F. at starting = 86 per cent. 2. Twice full torque = 364 ft. lbs. Starting current = 79 amps., P.F. at starting = 73 per cent.
(1) Resultant Current = 229 amps (2) Resultant current = 274 amps.

FIG. 5.

generator with a resultant current of 229 amperes at 94 per cent. power-factor. By referring to curve II., which shows the characteristic at this power-factor, we find that the corresponding generator voltage will now be 525 volts (*b*). It is further assumed that the line drop between 'bus bars and induction motor at 80 amperes is 8 per cent., so that the available voltage at the terminals of the motor is 510 volts, or above the rated voltage.

In the second case, the motor has to start under twice its normal torque, or 364 foot-pounds. To find whether the motor will be able to comply with these requirements, its maximum torque has been plotted in curve V., whilst curve IV. shows the starting current, and curve VI. the power-factor when starting under these conditions. It will be seen that to exert a torque of 364 foot-pounds 435 volts are required, which gives 79 amperes at 73 per cent. power-factor. By combining the corresponding currents, a resultant power-factor of 90 per cent. is obtained, for which the regulation characteristic has been plotted in curve III. To simplify matters, the line drop has been taken as a straight line—*i.e.*, depending on the ohmic drop only, though probably in a great number of cases overhead conductors are used, and in that case, the inductive drop for such large currents may be considerable, and should be carefully figured. Point (*c*) 480 volts gives for this case the generator voltage, and after subtracting the line drop of 8 per cent. a voltage of 435 remains available at the motor terminals, or just sufficient to give the required torque as a maximum possible torque.

While the above Fig. 5 was drawn for the specific purpose described, it also serves to show that it is wrong and unfair to

* Abstract of a Paper read before the Liverpool Engineering Society on January 20th.

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restrict the starting current of an induction motor to a certain per cent. of its full-load current, as this is done by a great number of supply stations in this country. Such restriction permits a 10 H.P. motor in the same way as a 1 H.P. motor, though the disturbance in the voltage regulation in the former case would be 10 times as large. Furthermore, it gives the advantage to the poorer motor, as this will have a larger full-load current, due to the lower apparent efficiency. The correct way is to either place a limit on the amount of current, which may be taken at starting, or, still better, vary the restrictions for each size and grade of motor.

In Fig. 6 a further illustration of the above discussed interference between the generator regulation and the starting of a large induction motor is given. The curves represented were obtained from an ondograph as described in detail by M. Hospitalier before the Institution of Electrical Engineers on December 10, 1903.* In the case given—*i.e.*, for a frequency of 50 cycles per sec.—it takes 20 seconds to

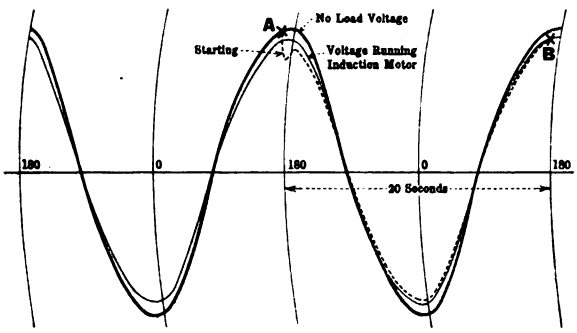

FIG. 6.—EFFECT OF STARTING 30 H.P. INDUCTION MOTOR ON VOLTAGE CURVE OF 100KW. GENERATOR TAKEN BY HOSPITALIER'S ONDOGRAPH.

plot one complete cycle of the E.M.F. wave. The heavy lined curve in Fig. 6 shows the no-load voltage of a 100kw. three-phase generator. While the needle was registering a second time, point *a*, a 30 H.P. induction motor starting against a full load torque was switched on. The dotted line shows the effect on the generator voltage—*i.e.*, it causes a momentary drop of about 20 per cent., part of which is undoubtedly due to the momentum of the needle, which explains also the following sharp upward movement. Altogether, it took about 19 seconds until the final running voltage, which lays about 7 per cent. below the no-load voltage, was reached in point B—which was found when the needle passed a second time through B, registering now the thinner full-drawn curve. The time of disturbance agreed well with the time it took the motor to get up to speed.

3.—*Synchronous Motors.*

The power-factor of a synchronous motor can be made leading or lagging at will by varying the strength of the field excitation. Hence, this type of motor offers a simple method of compensating for the effects of inductive loads in other parts of a power system.

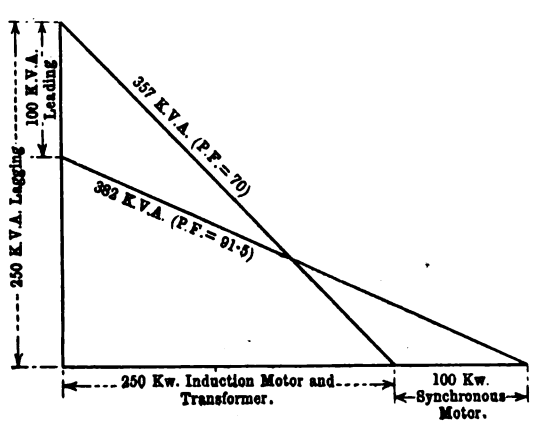

FIG. 7.

The amount of over-excitation necessary to compensate for a certain lagging current can be readily predetermined.† It might, roughly, be stated that if a synchronous motor is over-excited so as to take a resultant current 5, 10 or 15 per cent. greater than its normal load current, it is capable of compensating for a lagging current 32, 46 or 57 per cent. as great as its normal load current.

The most efficient way of using such machines as "rotary condensers" is by loading same with 71 per cent. of their rated output mechanically, and then raising the excitation until the resultant current is equal to the rated current. We thus obtain a leading component = $\sqrt{1{\cdot}00^2-0{\cdot}71^2}=71$ per cent.—*i.e.*, of the same magnitude as the energy component. The principle set forth above is used in America in a number of practical cases—for instance, in the transmission system Montreal-Chambly, and in Butte Montana and other places.

The following may serve as a general example of the results obtainable by this method:—

Assuming a mixed power and lighting plant having an average day load of 350kw. consisting of induction motors and transformers supplying the lighting network. Since the latter during the day are only very lightly loaded, the resultant power-factor will probably be not more than 70 per cent., which means the apparent station output is 500 kilo-volt amperes plus the losses in the transmission. Now, if, instead of using induction motors throughout, part of the power—say, 100kw.—had been installed as synchronous motors, these being so designed as to allow by proper over-excitation a continuous output of 141 kilo-volt amperes, the conditions would be changed to those represented graphically in Fig. 7. One now has to combine 250kw. at a lagging power-factor of 70 per cent. with 100kw. at a leading power-factor of 71 per cent. This gives 350kw. at a resultant power-factor of 91·5 per cent., or 382 kilo-volt amperes as against 500 kilo-volt amperes in the first case. This is a clear saving of 118 kilo-volt amperes, or 24 per cent.

In spite of such considerable advantages as may be obtained by controlling the power-factor, a more general introduction of this class of alternating-current motors for power work is greatly hampered by their inferiority in regard to starting torque.

It must not be overlooked that too many synchronous motors on one system may also lead to trouble, as they are extremely sensitive to any fluctuations in the voltage or impressed frequency as may be caused by the prime movers. In the Niagara power transmission, for instance, this trouble became very noticeable, and only ceased after installing some large induction motors, which acted as electrical dash-pots against surging. Another point which must be considered wherever synchronous motors are used is the possibility of abnormal rise in voltage, due to resonance effect either at the fundamental frequency or at those corresponding to higher harmonics.

(To be concluded.)

* The *Electrician*, December 11, 1903, p. 298.

† See E. J. Berg, *Electrical World*, January 13, 1900.

EXPERIMENTS ON EDDY CURRENTS.

W. M. THORNTON, D.SC.

After the reading of his Paper on "Experiments on Eddy Currents" before the Newcastle Local Section of the Institution of Electrical Engineers (see *The Electrician* of Jan. 1st, 8th and 22nd), Dr. Thornton gave a demonstration of some experiments to illustrate it, and of which he has sent us the following account:—

In curve 6, Fig. 2. of my Paper (*The Electrician*, Jan. 1st, p. 420) was shown the magnetic disturbance through an exploring coil around one pole. The wave oscillated at the speed of the machine, and it is now seen from curves 3 that its amplitude does not change when the machine is on load. The magnetic movement, and therefore the eddy-current loss due to variation of reluctance, can be taken as constant at all loads. When the brushes are central the ripples are barely seen in curves 1, 3 and 5. They are, therefore, *not caused by the passage of the core teeth.*

When the brushes are in the neighbourhood of either pole the rapid field ripples (curves 2) appear *before any sparking is visible.* They are then not an effect of sparking but indicate its cause—viz., the reaction of the armature current on the steady field.

This is twofold in nature, the leakage fringe is blown to and fro by the passage of the conductors, and the small peripheral shift of the conductor during commutation causes the magnetising intensity in the air-gap to vary at the frequency of commutation.

The variation in position of the lines producing the changes of voltage which cause the ripples can take place anywhere on the conductors between two brushes. The peripheral shift only causes the current rectangle of curve 1 to oscillate sideways, an effect which can be observed by the blurring of the ends, without affecting its height; but both the internal and external current (curves 1 and 5) show the same vertical ripple. In perfect commutation the current emerges from or enters the brush without shock. The characteristic feature of commutation in a strong field is the sudden release of lines at the end of each short-circuit, which, in collapsing, affect the main voltage, and this, if great enough, causes a small portion of the current to leap the mica, producing sparking. It is this inductance voltage which no doubt causes the ripple in the armature voltage or current at the frequency of commutation. The amplitude of the ripple—not the wave—in the exploring coil voltage (curve 3) does not greatly increase when the machine is loaded, and it must, therefore, be regarded as caused more by the position of the brushes than by peripheral shift. As they stand the curves can scarcely be compared, for the amount of brush movement necessary to produce the ripples shown is less when on load. In each case here the brushes were placed where sparking was about to begin. A surprising effect is seen in curve 5, for in a multipolar machine with a distributed winding, one would scarcely expect to find the external current to show a wave having

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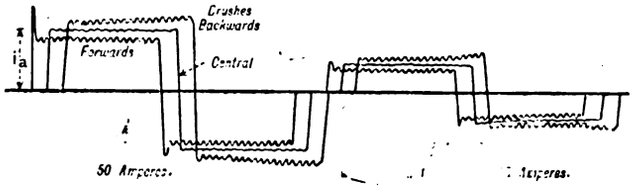
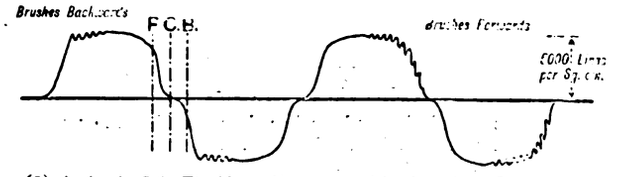
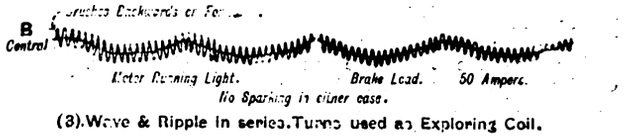
a frequency twice that of the machine. Yet by comparing curves 3 and 5 at all loads the correspondence is so close that one must conclude they have the same origin. No wave was observed in the external current of the bipolar machine first tested. Small air-gaps render machines very sensitive to slight imperfections in construction, and one would expect to find in large rotary converters where there is also the alternating current reaction, a state of very active magnetic disturbance. Curves 4 were obtained by winding copper wire on asbestos and mica to form a temporary slip ring over the commutator and connecting it to a segment, the adjacent one being already joined to a special slip ring at the other end of the armature. They are of interest as showing the voltage between two segments, more especially the influence of commu-



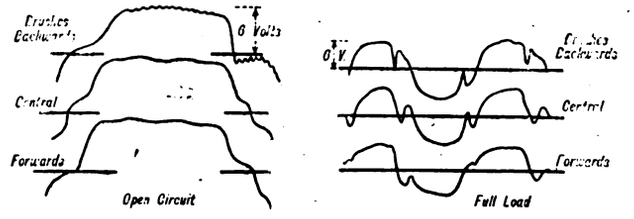
(1). Internal Armature Current.



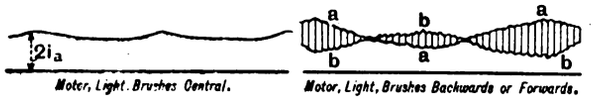
(2). Ripples in Pole-Tip Magnetism, caused by Armature Current.



(3). Wave & Ripple in series. Turns used as Exploring Coil.



(4). Voltage between adjacent Commutator Segments.



(5). Current entering Brushes of Motor.

tation in a strong field. The positions of the brushes are seen by the sudden drop at right angles to the zero line. The strength of the revers in field and the change in voltage at the end of each short circuit under th brushes can be observed in this way.

ROYAL COMMISSION ON LONDON TRAFFIC.

Friday, February 12.

Sir John Wolfe Barry, one of the Royal Commissioners, Sir Benjamin Baker, and Mr. W. Barclay Parsons, consulting engineer to the Board of Rapid Transit Railroad Commissioners of New York, have been nominated to advise the Commission on certain important technical questions connected with the problem under consideration. They will report upon the engineering and other technical considerations involved in the numerous proposals put before the Commission which it is suggested would alleviate existing conditions of traffic and afford further facilities. It will not be the duty of the technical advisers to the Commission to make any report upon specific schemes which have formed the subject of applications to Parliament.

Mr. J. E. WALLER, continuing his evidence, said that the Locomotion Board he suggested should have the power to investigate and sanction, with or without modification, the schemes brought before it. It should also have the power to call upon promoters to carry out widenings or other works requiring the acquisition of property not scheduled in the application. Any regulations framed by this Board would require grave consideration, and if the Tramways Act of 1870 were taken as a basis, there were several details which specially needed revision. There was, of course, the question of purchase, and also a modification in respect of the obligations of tramway authorities to existing gas and water companies. Serious demands were frequently made by the latter, and it was desirable that in future there should be no doubt as to what the liability of the tramway authorities was. Assuming the creation of a Board to consider all applications for powers in connection with tramways, light railways, &c., the next point for consideration was whether such Board should be absolute, and whether decisions given by it should be subject to Parliamentary sanction. His opinion was that the Board should have absolute legislative powers, but subject to a right of appeal to Parliament, with the sanction of the Board, such sanction being granted in all cases where it was thought that the interests of the opponents were of such magnitude that the proposals of the promoters ought to be submitted to Parliament. Such appeal should come before a Standing Joint Committee of the two Houses. He also favoured the view that the powers of the Board of Locomotion should not be confined to legislation, but it should also have the right to deal with the various questions arising from time to time in connection with the construction and working of the undertakings authorised. These latter powers should be absolute. The Board should also appoint any arbitrators in connection with the value of lands and properties to be acquired. Likewise the inspection and certification of the tramways as fit for public traffic should also be in the hands of the Board. Through bookings with railway companies should also be within the powers of the board. In cases of municipal tramways, he suggested that a clause should be inserted in every order, by which, in the event of a rate being levied for the working of the tramways, on an application by 20 or more ratepayers, an inquiry should be held to determine whether the loss incurred was due to mismanagement. If this were proved, then the board should be empowered to require a revision of fares, hours of labour and the rates of payment to the employés. The question of borrowing powers should also be left to the board. All the present notices and deposits required by Parliament at the instance of promoters, he thought, should be adhered to, and the inquiry should be held under similar conditions to those obtaining with Parliament. Generally speaking, the powers, duties and responsibilities of such a Board would be extensive and onerous, but he believed the creation of such an authority, constituted of members having the necessary technical experience, would provide the most practical means of solving the problem before the Commissioners.

Mr. C. E. BAKER, secretary of the Urban District Councils Association, said he had circularised a large number of local authorities around London with regard to the proposed tribunal, and the result had shown a general feeling in favour of such a body.

Mr. A. E. GAYTHORNE HARDY, chairman of the East London Railway Co., spoke with regard to the disagreement between the various companies who owned the lease of this railway, and the possibility that when the Metropolitan and District Companies' lines, were electrified the present physical junction between these and the East London line would be broken. This he considered would be disastrous, and he appealed to the Commission to see that the possibilities of the East London line were fully considered in connection with any new scheme of locomotion for London.

Mr. C. G. MOTT, chairman of the City and South London Railway Co., said that in 1897 he had advocated that the Board of Trade should exercise a controlling influence over future metropolitan railways. But this suggestion had received no support, and in consequence the City and South London Railway Co. had developed its line independently of any official supervision such as he had mentioned. The idea of the company had been to link up as many of the already constructed (and constructing) underground railways as possible, and there were now along its short length of line a considerable number of exchange stations with other lines. The company had suffered considerably by the opening of the electric tramways in the south of London, but there were indications that the traffic which had thus been lost was being slowly regained. When the City and South London Railway Co. took over the powers of the City and Brixton Railway, its intention had been to proceed with the construction of the line at an early date, and to connect it with the existing station at the Bank. But the effect of the low fares charged upon the London County Council tramways had so reduced the average fare upon the railway that the company's stock had diminished somewhat in value, and it was, therefore, at present impossible to raise the funds necessary for the construction of the City and Brixton line. The City and South London Company was, however, making arrangements to proceed at an early date with the construction of its extension from the Angel (Islington) to King's Cross and Euston, by which it was anticipated that a large amount of traffic which now passed from the three northern railways there through the City and over London Bridge would travel by this line underground, and so relieve the streets. After 40 years' experience of bills in Parliament, he considered that the present mode of procedure was, on the whole, the best. He was of the opinion that in London and for, say, 20 miles around, the powers of the Light Railway Commissioners should be withdrawn, and no tramways allowed unless sanctioned by Parliament, so as to get complete unity of action as regards all traffic carried on the roads within the metropolitan area. Whilst urging that the responsibility of the Government should in no way be lessened, he thought a permanent committee should be appointed, consisting of two members appointed by the Home Office, two by the Local Government Board and three by the Board of Trade. This committee should sit frequently and report to Parliament at the commencement of each session on all bills affecting railways in the metropolitan area. One of the duties of this committee should also be the constant consideration of how best to improve the means of locomotion, to draw up comprehensive plans for that purpose and to lay its views before Parliament. It should also make suggestions to the London County Council and the various metropolitan borough councils upon any matters affecting the problem of traffic facilitation. This committee, however, should have no power to enforce any of its suggestions.

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Thursday, February 18.

Mr. ALBERT GRAY, counsel to the Chairman of Committees in the House of Lords (Lord Morley), said he regarded it as a disadvantage that each Committee considered the bills before it quite without reference to anything that had gone before it. Another disadvantage was the fact that all Parliamentary Committee work was crowded into about three months of the year, and was conducted under great pressure. But he did not favour the suggestion that a Joint Committee of the two Houses should consider all railway bills for London unless there were a preliminary hearing before a separate board. He laid great stress upon two hearings. Such a practice had a great effect in getting a bill into proper shape. At present no Committee inquired into agreed clauses after the first hearing, and the second hearing, therefore, enabled the whole scheme to be thoroughly inquired into, with its amendments. Even assuming a preliminary inquiry by a locomotive board, he thought the advantage gained thereby would be confined to the scheme itself and that certain parliamentary details might be overlooked. If, however, one of the members of the board had parliamentary experience, this would not be an insuperable objection. He considered it highly inconvenient that there should be three methods of procedure for powers for the construction of tramways and light railways, and he proceeded to point out certain anomalies which had already been gone into by other witnesses. He was especially severe with regard to the action of many local authorities in the matter of giving consent to tramway promoters. When electric traction came into force the terms of purchase under the Tramways Act ought to have been increased to 42 years, and the powers of purchase should have been vested only in the County Council. Discussing the question of the establishment of a special tribunal, he thought the experiment of a body of an advisory nature was well worth trying. The Board could make annual reports to Parliament, making suggestions for improving means of communication and improved methods. The promoters of all light railway and tramway schemes should place their schemes before this body, and no doubt the London County Council would assist by placing the reports of its own committees upon the various branches of the subject before this Board. The reports of the Board would be quoted for what they were worth in Committees of Parliament. Such a body would have to consist of from five to seven members, two of whom should be engineers who were in practice as consulting engineers and not in constructive work. With regard to parliamentary procedure, he advocated, as far as possible, the appointment of special committees in each House for London traffic schemes, to consist, as far as possible, of the same members year by year. This was already done in the case of the Police and Sanitary Committees, and it had done much to attain continuity of policy.

Mr. W. H. PARSONS, secretary and general manager of the East London Railway Joint Committee, described the conditions obtaining in connection with several of the stations on the line, to correct previous evidence.

Friday, February 19.

Sir THEODORE MARTIN, K.C.B., who is a Parliamentary agent, said that his experience had been largely with railway promotion. Beyond the Metropolitan District Railway deep level tube he had had no experience with tube railways. But it seemed to him that before any tube railways had been sanctioned in London, some general scheme of London railways should have been propounded. He thought it would now be best to wait until all the authorised lines were constructed and working before new ones were sanctioned. He regarded tube railways as being in a large degree experimental, for it was not conclusively proved that they were what they should be as regards ventilation (a point to which attention had not hitherto been sufficiently directed) and also as regards risks and dangers in the use of the lifts, and in the event of accidents. If any further lines were to be sanctioned, they should certainly take the shape of a comprehensive scheme, and he thought no body would be better fitted to carry this out than the present Royal Commission. Their experience in connection with their proceedings made them quite as fit to deal with this matter as any newly constituted body. If, however, it was thought advisable to establish a new body, the members must be men of large experience, and any decision it might come to should be subject to the revision of Parliament. The public and private interests involved were so enormous that any other decision than a Parliamentary one would be unsatisfactory. From this it could be inferred that he regarded the present system of submitting all schemes to two Parliamentary committees a thoroughly satisfactory one.

In answer to questions by various members of the Commission, Witness said he did not think there would be sufficient work for a permanent tribunal, and he also saw other difficulties in the way of its existence. If it laid down a comprehensive scheme, and no one would promote schemes to comply with it, there would be a complete deadlock. Again, Parliamentary committees would object to merely endorsing the views of such a tribunal. They existed to sanction these matters after consideration by themselves. Even at present House of Commons committees ignored the opinions of the House of Lords and vice versa.

Mr. C. S. MEIK, who put detailed proposals for new streets and railways before the Commission on February 5 (see *The Electrician*, February 12), was recalled for the purpose of further cross-examination. In reply to Sir John Wolfe Barry, Witness said he had approached the problem from the point of view that the pressing need of London locomotion was more roads, and that in constructing these he wished to take advantage of the wayleaves thus afforded to increase the railway and tramway accommodation, the combination rendering both more feasible from the point of view of finance.

Sir JOHN WOLFE BARRY: This principle has already been adopted in London?—I am not aware of it.

In the completion of the Circle line a new street was made from King William-street to the Tower, under which the railway ran?—Yes, but that is hardly an example of what I have in view, because it was only a small portion of a street.

I gather from your evidence that you propose to have an upper and a lower street?—Yes.

And that you devote the lower street to the heavy traffic and the upper street to the light and through traffic?—Yes.

I do not quite gather by what means you are going to give access from the low-level to the high-level streets. Is it by inclined roads?—Yes. [Witness here entered into a lengthy explanation of a large number of plans.]

You consider 160ft. the minimum width for the two main avenues?—Yes. In Paris the boulevards have a maximum width of 240ft. and an average width of 140ft.

How would the lower road be lighted?—There would have to be artificial lighting except at the points where the upper deck joined with the lower. At these points there would be natural lighting.

Continuing, Witness said that all the shop fronts would be on the upper deck, and along the sides of the lower deck there would be basements and cellars.

Sir JOHN WOLFE BARRY: What occurs to me is that if the lower deck would not be worth anything commercially, except for warehouses, what is the advantage of raising the road instead of lowering it. Is it a matter of expense. Why not lower the road and have a street, say, 16ft. below the present level, having, as the upper deck, the existing roadway?—Then your through traffic would have to go on the lower level. The object is to take all through traffic over the top of the other roads. Then, again, in sinking the roads you have to deal with the river, and on the south side there would be difficulties because the ground is below the high-water level. We have made several attempts and think this is the best result.

My idea was to sink the roads rather than sacrifice the present frontage?—You are not sacrificing the frontage. You get an additional frontage with warehouse accommodation below.

May I ask you if you have estimated the cost of works very fully?—I have taken the Parliamentary estimates.

And the land?—Speaking generally, the estimate is taken more or less *en bloc* street by street, and not house by house.

Then with regard to the upper railway, where is that accommodated?—It would be in the middle of the upper road over the motor road, and on either side of the latter there would be electric tramways.

Continuing, Witness said that the cost per mile of the double-deck avenue would be £605,000, and for the single-deck streets £180,000. The net cost of the property and works (allowing for recoupment) upon the north and south avenue was £4,574,000, and upon the west to east route £16,737,000, a total of £21,311,000.

Mr. WALTER BEER, who has co-operated with Mr. Meik in devising the scheme above referred to, said it was estimated that with suspended railways, the capital would be repaid in 49¼ years, and with shallow subway tramways in 85½ years, but if tube railways were adopted there would be an annual deficit of £36,477. This was estimating interest at 3½ per cent.

Mr. RALPH LOW, who had estimated the value of the lands and buildings and the recoupment from the sale of surplus lands, corroborated the figures put forward by the two previous witnesses.

Evidence was then heard on behalf of the Cab Drivers' Union and the London Cab Drivers' Union.

The Commission adjourned.

CORRESPONDENCE.

M. BLONDLOT'S N-RAY EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Since the date of my last letter on this subject, published in your columns on January 22nd, I have made further numerous endeavours to confirm M. Blondlot's experiments. It is by no means difficult to obtain some of the effects that M. Blondlot describes, but so far as my observations go, these effects, when obtained, are in every case due simply to heat.

The luminosity of calcium sulphide is considerably affected by minute differences in temperature. For instance, a coin taken from one's pocket and held at the back of a calcium sulphide screen will, in a few seconds, show through the screen as a disc of increased luminosity; or again, when two small calcium sulphide screens are placed upon two pieces of similar metal differing in temperature by only about 2° F., it is easy to discover which of the two pieces of metal is the warmer by the superior luminosity of the screen placed upon it. This, I think, is the explanation of the experiment described in your contemporary *Nature* for the 18th inst., where it is stated that "if one of these screens be laid on the floor when it is very feebly fluorescing it will be invisible, but its light will increase when it is placed on the top of the foot and the muscles put into action."

I have repeated this experiment with home-made screens with entire success, my method being to use two screens, each about 16mm. by 2mm. in size, of normally equal luminosity.

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When one is placed on the foot it brightens up considerably as compared with the other. This experiment is at first sight most convincing, but unfortunately for the N-ray theory, I find no necessity for the presence of the foot at all. A boot newly taken off and still retaining some warmth, or any other warm object, acts equally well; while if one screen be placed on the foot and the other upon a can of water heated to the same temperature as the foot, no difference between the luminosity of the two screens can be detected. Again, the foot experiment does not succeed if a good thickness of paper or cardboard is placed between the foot and the screen so as to prevent the transference of warmth to the latter.

According to another experiment that I have tried, a large calcium sulphide screen was exposed to a large Nernst lamp, one-half being shaded with lead and the other with several thicknesses of black paper, so that only half was exposed to the N rays. Visually no difference could be detected in the brightness of the two halves of the screen, but on exposing a gelatino-bromide photographic film in contact with the screen for some three minutes it was found on development that the portion of the photographic film that was in contact with the half of the screen that was shaded by the paper only was considerably more fogged than the other half. Here again, however, the result was clearly due to heat, the black paper being perceptibly warm to the touch, as when, in place of paper, a thin aluminium sheet was employed and the experiment repeated, no difference at all could be noted between the two halves of the developed photographic film.

Since making this experiment I have, when using two very small separate screens, one shaded only by very thin aluminium and the other by thick lead, succeeded in observing some slight excess in brightness in the former over the latter, but this has been discernible only when the aluminium had become appreciably warmed by the heat radiated from the lamp, so that the difference in temperature would, in light of my other experiments, entirely account for the effect. It is indeed very difficult altogether to eliminate the heat coming either from a Nernst lamp or an Auer burner except by using materials such as, for instance, alum water, which, according to M. Blondlot, are opaque to the N rays. This in itself is instructive, as is also the point noted by M. Blondlot that the brightening of the screen under the influence of the N rays is not instantaneous but is gradual, as also are most thermic effects.

During the past fortnight there have been published in your columns and elsewhere details of some new investigations made by M. Gutton and communicated by Prof. Poincaré to the French Academy of Sciences, according to which the luminosity of calcium sulphide screens is increased by their being placed in a non-uniform magnetic field. It is stated by M. Gutton that only a weak field is necessary and that the effect is very sensitive. Having spent considerable time in endeavouring to confirm this observation without the slightest success, it would interest me to know whether anyone else has tried it, and with what result.

As everyone who has experimented on similar lines is aware, investigations of these descriptions are full of pitfalls, and it is very easy to see what one expects. For instance, if two or more faintly, but equally luminous, calcium sulphide screens of small dimensions, placed 2in. or 3in. apart, are observed, one will occasionally become dim, and it is quite easy with a little practice, while looking directly at the screens, to make any one of them actually disappear at will, this being due to certain portions of the retina being much less sensitive to these weak radiations than other portions. However, one can scarcely suppose that a scientist of M. Blondlot's antecedents and experiences can have deceived himself, or have been deceived by others, in regard to the numerous positive results that he has obtained; and those who have unsuccessfully tried the experiments can only imagine that, assuming that the phenomena observed are really objective, they are only visible to certain individuals. Whether the persons who can, or those who cannot, see these effects have abnormal sight further investigations alone can show.—Yours, &c., A. A. CAMPBELL SWINTON.

London, Feb. 23.

THE INHERENT REGULATION OF ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. H. S. Meyer, in his Paper on "Voltage Regulation in Alternating-current Systems," commenced in your last issue, says that the method of specifying the inherent regulation by the *full* in voltage from no load to full load should be abandoned in favour of the method which limits the *rise* in voltage between full load and no load. I, in common with a great number of engineers, both in this country and in America, do not agree with him, and it is well to put forward at this time the arguments which favour our view of the matter.

Are we to look to the interests of the user of the alternator, or are we to look to the interests of the manufacturer who wishes to make a cheap generator perform a showy feat? If we look to the interests of the user we will ask for a test of the regulation which will insure good operation under the actual conditions of use.

Now, the most common case for an alternator to show its good or bad behaviour is when the load is coming on suddenly. The machine begins lightly loaded at normal voltage. Demands for power are made suddenly, and before the attendant can bring up the voltage further demands are made. With a bad regulating machine, the voltage falls below normal and jumps up and down with the variations of the rheostat and the state of load. A machine with saturated poles showing good regulation only from full load to no load, and not from no load to full load, behaves badly just when good behaviour is needed. A machine which shows good regulation from no load to full load always behaves better still under the opposite conditions, so that the test that Mr. Meyer would abandon is just the one the user should try.

The rise in voltage when the load is thrown off can always be made small by saturating the iron. But saturation of the iron in an ordinary alternator is, from the user's point of view, a bad thing. It limits the overload capacity of the machine. It prevents the maintenance of the voltage at low power factors, or causes excessive heating of the field coils. It prevents the adjustment of the voltage of the machine between limits which the user may find convenient.

The manufacturer of inexpensive alternators may wish to abandon the crucial test of performance, but the user and his consulting engineer, both in this country and in America, will continue to call for it.

There are several points in Mr. Meyer's excellent Paper to which exception should be raised, but these I will leave for another occasion.—Yours, &c., MILES WALKER.

Manchester, Feb. 24.

EDDY CURRENTS IN DYNAMO MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is possible to decide the question of eddy-current distribution once for all by comparing the efficiences of two machines, one with solid poles and yokes the other laminated. It would be better still to use the same armature and bearings, and to change the field magnet system, all dimensions and flux densities being the same in the two cases. An improvement of 1 or 2 per cent. in the latter case would place the question beyond doubt. The most convenient size for such a test would be about 5kw. The second armature tested, quoted in the appendix to the Paper, should read 0·5kw., not 5kw.

Mr. Press has suggested that the unlocalised loss might occur in the core teeth. The loss there depending on B^2 is no doubt greater, but my experiments were made on smooth core armatures. Assuming that the friction and windage loss increases as the 1·5 power of the speed, and that the top of the Kapp diagram is straight, the following will enable the eddy-current index x to be found.

Correcting for the slight heating of the armature winding, the power supplied to a motor running light may we written

$$w = an + bn^{1.5} + cn^x,$$

or

$$w/n = a + b\sqrt{n} + cn^{x-1}.$$

This is the curve which is found by experiment to be a straight line, so that we may write

$$b\sqrt{n} + cn^{x-1} = kn.$$

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The coefficient b is determined by driving the machine with fields unexcited from another motor at various speeds; k is the tangent the above straight line makes with the speed axis.

From this $$\left(\frac{n_1}{n_2}\right)^{x-1} = \frac{kn_1 - b\sqrt{n_1}}{kn_2 - b\sqrt{n_2}},$$

and $$x = \frac{\log\left(\frac{kn_1 - b\sqrt{n_1}}{kn_2 - b\sqrt{n_2}}\right)}{\log\left(\frac{n_1}{n_2}\right)} - 1.$$

To find x it is only necessary to run the machine, first as a motor, light, at two speeds, n_1 and n_2; secondly, from another machine at the same speeds, but with unexcited fields. The eddy-current loss so found is for the whole machine, and if the 1·5 law holds x must be less than 2.

I sincerely thank Mr. Field for the trouble he has taken with my Paper, and hope that it will soon be possible to make the tests here suggested.—Yours, &c.,

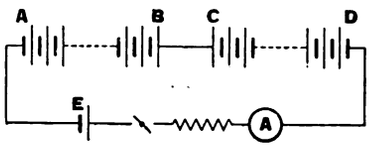
Newcastle-on-Tyne, Feb. 22. W. M. THORNTON.

MEASURING THE RESISTANCE OF SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN

SIR: Can any of your readers suggest any better method of measuring the internal ohmic resistance of a battery of 54 storage cells, as distinct from the polarisation effect always produced when any discharge is taken or charge given, than the one described below?

As will be seen, the question of accuracy turns on whether the polarisation produced when a storage cell is discharging is the same as when the cell is being charged with the same current, although, of course, in the two cases the direction is opposite:—



AD is the battery of 54 cells split up into two halves of 27, AB and CD, joined in opposition to each other. The E.M.F. across AD is measured by an electrostatic voltmeter and an auxiliary cell, E, is then joined to the terminals through an ammeter and adjustable resistance, so that AB is charging and CD discharging.

The volts across AD are again measured with the current passing, from which the internal resistance can be found, $(E_1 - E_2)/C$. The test is repeated, but with E connected in the opposite direction to before, when the same result should be obtained. Both the ammeter and voltmeter readings would be corrected by potentiometer to ensure absolute accuracy.

If the polarisation effects exactly neutralise each other in the two halves the result apparently gives the true resistance without the disturbing effects which polarisation otherwise introduces.—Yours, &c., SECONDARY.

London, Feb. 20.

PARLIAMENTARY INTELLIGENCE.

Petitions have been presented against the following bills since our last issue:—Belfast Corporation Tramways, by the Great Northern Railway Co. of Ireland and the Belfast and County Down Railway Co.; Bristol Tramways (Extensions), by the Midland Railway Co.; Chesterfield Corporation Tramways, by the Midland Railway Co. and the Derbyshire County Council; Holywood Tramways, by Belfast Corporation and the Belfast and County Down Railway Co.; Lothians Electric Power, by the North British Railway Co., Edinburgh and Leith Corporation Gas Commissioners, Caledonian Railway Co., Lanarkshire County Council, Midlothian County Council, Pioneer Electric Supply Co., Edinburgh Corporation, Edinburgh District Water Trustees and the Leith Water Purifier and Sewage Commissioners; Manchester Corporation Tramways, by Stretford Urban District Council, Sale Urban District Council, London and North-Western Railway and the Manchester and South Junction and Altrincham Railway Companies; Mid-Cheshire Tramways, by Stockport and Hazel Grove Carriage and Tramway Co. and London and North-Western Railway Co.; Newcastle-upon-Tyne Tramways, by the Durham County Council, Tyneside Tramways and Tramroads Co., Newcastle-upon-Tyne Electric Supply Co. and the Tynemouth Improvement Commissioners; North Wales Electric Power, by Flintshire County Council and the Llandudno Urban District Council; Portmadoc, Beddgelert and South Snowdon Railway, by the Carnarvon Harbour Commissioners; Preston and Blackburn Tramways, by the Lancashire and Yorkshire Railway Co.; Preston-Lytham Tramways and Tramroads, by the Lancashire and Cheshire Coal Association and the Mining Association of Great Britain; Preston, Chorley and Horwich Tramways, by the Liverpool Corporation and the Lancashire and Yorkshire Railway Co.; Stretford Urban District Council, by Stretford Gas Co., Trafford Park Estates, West Manchester Light Railways Co., British Westinghouse Electric and Mfg. Co. and the Manchester and South Junction and Altrincham Railway Co.; Ulster Electric Power, by the Belfast Corporation and the Great Northern Railway Co. of Ireland; West Riding Tramways, by the Midland Railway Co., West Lancashire Coal Owners Association and the Lancashire and Yorkshire Railway Co.

The London and North-Western Railway Co. has withdrawn its petition against the London County Council (Tramways and Improvements) Bill.

Standing Orders of the House of Lords have been complied with by the following Bills:—Southport and Lytham Tramroad, Clyde Valley Electric Power and the North Wales Electric Power.

Standing Orders of the House of Commons have been complied with by the following Bills:—Charing Cross Euston and Hampstead Railway, Great Northern and City Railway (Extension of Time), and the Baker Street and Waterloo Railway, Watford and District Tramways (Extension of Time), Preston and Lytham Tramways, and the Saddleworth and Springhead Tramways (Abandonment).

In the House of Commons on Thursday last week, the Torquay Tramways Bill was read a second time. On Monday the North-Western Electricity and Gas Power Bill and London, Camberwell and Dulwich Tramways Bill were read a second time. On Tuesday the Rotherham Corporation Bill was read a second time. On Wednesday the Baker Street and Waterloo Railway, Charing Cross, Euston and Hampstead Railway, Great Northern and City Railway (Extension of Time) Bills were read a second time. The London County Council Tramways and Improvements Bill was ordered for second reading.

In the House of Lords on Thursday last week, the Portmadoc Beddgelert and South Snowdon Railway Bill was read a second time. On Friday the Ilford Urban District Council, Lothians Electric Power and the Stretford Urban District Council Bills were read a second time. On Monday the following were read a second time:—Isle of Thanet Tramways, Derbyshire and Notts. Electric Power, Leicestershire and Warwickshire Electric Power, Metropolitan District Railway, Preston, Chorley and Horwich Tramways, Govan Burgh Electricity, Southport and Lytham Tramroad (Extension of Time) and the Belfast and North-East Ireland Electricity and Power Gas.

The Standing Orders Committee of the House of Commons had before it on Tuesday the London United Tramways (Railways) Bill, which, as reported in our last issue, was reported by the examiners of private bills as not having complied with standing orders. The Committee decided that the standing orders had not been complied with, and that the bill could not, therefore, proceed.

When the St. Marylebone Electric Lighting bill came up for second reading in the House of Commons on Tuesday, Mr. Horner, who had a motion on the paper to move the rejection of the measure, did not avail himself of it, and the bill was accordingly read a second time without discussion.

Mr. Goddard has since put a notice on the paper that next Tuesday he will move the following:—That it be an instruction to the Committee to which the St. Marylebone Electric Lighting Bill is referred to insert the following clause:—"The Council shall once in every year, after the first year's working of the electric lighting undertaking, cause to be laid before them a statement and balance-sheet of the accounts of the electric lighting undertaking, drawn up in accordance with the form of accounts prescribed by the Board of Trade for a local authority under the Electric Lighting Acts of 1882 and 1888, and the Council shall thereupon fix annually the charges to be made for the supply of electrical energy in the then ensuing year at such rates (not exceeding the maximum rates specified in the order of 1898) so that as far as it is reasonably practicable the revenue for that year shall not be less than the estimated amount of the expenditure and the charges for interest and sinking fund for that year."

The Electric Lighting (London) Bill was reported in the House of Commons on Monday for second reading. Yesterday it was read a second time and referred to Committee.

The Victoria University (Manchester) Bill will be read a second time in the House of Lords on Thursday next, March 3.

THE METRIC SYSTEM.

In the House of Lords on Tuesday Lord BELHAVEN, in moving the second reading of the bill for rendering compulsory the adoption of the metric system of weights and measures, said the Government apparently held the view that public opinion was not yet formed sufficiently in favour of the metric system to make it compulsory. He thought, however, that the commercial classes especially were strongly in favour of this bill. In 1895 a Select Committee of the House of Commons had dealt with the subject, and the evidence taken showed that the unsatisfactory condition of our weights and measures seriously interfered with our commerce, especially our foreign trade. The Select Committee made three recommendations—(1) that the metrical system be at once legalised for all purposes; (2) after a lapse of two years it should be made compulsory by Act of Parliament; (3) that the system be taught in all public elemen-

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tary schools. The results in the schools, however, had not been satisfactory. The only countries in which the metric system had not yet been adopted were Great Britain and her dependencies, the United States and Russia. A bill was, however, before Congress to introduce the system, and Russia had already taken some steps in the same direction. The adoption of the metric system would not only be of enormous advantage to trade, but the educational advantage would also be great. The present system was incomprehensible to foreign nations using the metric system, and they, therefore, preferred to pay more for an article elsewhere than to come here for it. If this bill were to become law, and our Colonies were to follow our example, 85 per cent. of our trade would be exported to countries in which the metric system was used, and doubtless the system would then soon become universal. He had that day presented to the House petitions in favour of the bill from 30 town and city councils, and 40 chambers of commerce, from retailers and trade unions representing 289,000 workers, and from teachers' associations, inspectors of weights and measures, and others. He hoped in a week's time to present nearly as large a number of supplementary petitions. It was objected that the change might upset and irritate the uneducated, but the experience of other countries proved that if after the passing of such a measure a due interval were allowed for the people to become familiar with the new standards the system was received favourably, and there was no desire to revert to the old system. A third objection to the present proposal was the cost to which traders, and especially small traders, would be put to provide new weights. The advantages which would follow from the adoption of the metric system, however, would soon recompense them for this expenditure. He agreed with a fourth objection, that most of the benefit of the metric system would be lost if a decimal coinage were not introduced; but even so the change would lead to a great improvement in the conduct of business affairs, and he did not think the one should wait upon the other. The bill provided that the metric system should become compulsory on April 5, 1906, or at such later date as might be directed. It was, therefore, left to the discretion of the Government to fix the date for inaugurating the compulsory adoption of the system.

Lord COLCHESTER doubted whether the time had come for making the system absolutely compulsory.

Lord KELVIN said we had had nine years' of permission to use the metric system and had lost enormously by not taking advantage of that permission. He did not attach the smallest weight to any one of the objections raised against the definite and compulsory introduction of the system. We should lose much by a single year more of waiting. He believed that whatever difficulty might be caused in factories, great or small, would in a month's time be far more than compensated for by the diminution of labour which the change would produce. The decimal system originated in England. In 1783, James Watt suggested a plan which was in every respect the system adopted by the French philosophers seven years later. Curiously enough, he anticipated Herbert Spencer's objection to the metric system, which was that it ought to be duodecimal. If each of our hands had six fingers, then duodecimal subdivision might be convenient, but decimal arithmetic was absolutely settled, and no complicated sub-divisions should be permitted. Some time ago, while experimenting with a rifle, he was misled by the resemblance in the tables of weights of different dimensions, and, as a result, put into the rifle too large a charge, If he had not discovered his mistake in time he might have been blown up. He hoped that the bill would be allowed to pass the second reading, and that it would not be referred to a Select Committee. It should be sent forward with full pressure to the other House, because its final passing into law would be an enormous gain to the British people.

Lord WOLVERTON, speaking for himself, and not on behalf of the Government, said that he was in favour of the bill, but the Government thought that it should be referred to a Select Committee of the House of Lords. At present there were 80 different denominations represented by 155 different kinds of weights and measures, but the bill proposed to reduce these to 30 denominations represented by 53 different kinds of weights and measures. With reference to clauses 7 and 8 of the bill, which dealt with the constructions of Acts of Parliament, bye-laws and deeds as to weights and measures, these clauses might lead to some curious results, citing railway rates, sales of land, the price of gas and legislation relating to the gallon. Some provision would have to be made to call in the old weights and measures, otherwise the bill might be ineffective. Another point was the difficult nomenclature which needed simplification. These were points which should be examined by a Select Committee; but, on behalf of the Government, he offered no opposition to the second reading.

Earl SPENCER was strongly of opinion that the bill should go forward, but he did not think that it should be referred to a Select Committee. The question had been sufficiently reported on in a blue book of a committee, presided over by Sir Henry Roscoe, which sat in 1895.

The Marquis of LANSDOWNE said that the existing system was distracting to learners and obstructive to trade, home and foreign. He was tempted to cap the story told by the noble and erudite lord on the back benches. Some time ago a friend of his was travelling on the Continent, and being indisposed he sent an English prescription to be made up by a local practitioner. In due time a box of pills, each the size of a small marble, was delivered, and being so intimidated by their appearance his friend decided not to adopt the remedy. It appeared subsequently that the chemist's assistant who had made up the pills did not know the difference between a grain and a drachm, with the result that each of those torpedoes contained about 30 grains of calomel. The report of the Select Committee of 1895 was a very short one, and was a perfunctory treatment of a difficult subject. If the bill were sent to a Select Committee no undue delay would occur, and it would stand a greater chance of success.

The Earl of ROSEBERY was of opinion that the bill should not be referred to a Select Committee, as all that needed to be inquired into was contained in the 1895 report. When it was remembered that nearly two centuries ago the country faced the difficulty of adopting a totally new calendar, he did not think there would be any trouble experienced in the change in weights and measures. He thought the change would be of infinitely more advantage to the commerce of the country than all the fiscal remedies proposed by the members of the Government.

The Earl of SELBORNE said the Select Committee of 1895 considered a policy, not a bill, whereas the Select Committee in the present instance would pursue the opposite course. The bill, after second reading, should go to a Select Committee, as that would be the most convenient way of passing it through that House.

The Duke of RUTLAND agreed if the bill was referred to the Committee, but not if the subject as well as the bill were referred to them.

Lord TWEEDMOUTH suggested that after the bill had passed the House of Lords it should be made a Government bill in the House of Commons

The bill was then read a second time, and on the motion of Lord WOLVERTON it was referred to a Select Committee.

The following are among the petitions which have been deposited in the House of Lords in favour of the bill:—Corporations of Folkestone, Stockport, Chatham, Inverness and Brighton, the Chambers of Commerce of Sheffield, Liverpool and Wolverhampton, the London Association for the Protection of Trade and a large number of town and county councils.

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

When the bill comes up for second reading in the House of Commons next week, Sir Frederick Banbury will move that it be an instruction to the Committee to omit tramway No. 2—*i.e.*, the line along the Embankment.

Yesterday the Standing Orders Committee of the House of Lords decided that Standing Order No. 22 (consent of local authority) with regard to tramway No. 1 (along Tottenham Court-road) could be dispensed with. The measure was referred back by the Examiners owing to the consent of the Holborn Borough Council not having been obtained. The bill will therefore now proceed to the committee stage.

LONDON COUNTY COUNCIL TRAMWAY RAIL CONTRACTS.

In the House of Commons on Monday, Sir THOMAS DEWAR asked the President of the Board of Trade what were the number and value of contracts for rails and railway material placed by the London County Council with foreign makers during the past five years, and what percentage of these orders were secured by German firms.

Mr. GERALD BALFOUR replied that the information asked for did not come within the knowledge of the Board of Trade in the ordinary course, but from a statement supplied him by the London County Council it was shown that the total value of all contracts let by the London County Council for tramway works was about £2 000,000, of which amount £150,000, or 7½ per cent., represented foreign work. The Council began by restricting the tenders for this work to British firms, but owing to the limited number of tenders and high prices it adopted open competition, and, as the result, all materials were now being obtained in this country and at much lower prices. Altogether the Council estimated that it had saved in rails alone about £40,000 by its policy of open competition. No contracts had been sent to Germany.

TELEGRAPHIC ADDRESSES.

LORD STANLEY in a printed reply to Sir R. Hermon-Hodge in the House of Commons on Friday last week stated that Henley-on-Thames is accepted as one word in a telegram under the rule which stated "all names of towns and villages in the United Kingdom are counted as one word." Goring-on-Thames did not come under this rule because it was not the name of a town or village. The name of the village near Reading was Goring.

ROYAL COLLEGE OF SCIENCE.

In a printed reply to Mr. Allhusen in the House of Commons on Monday, Sir WILLIAM ANSON said that no proposal was at present before the Board of Education for the transfer of the Royal College of Science to the University of London.

THE POST OFFICE TELEPHONE SYSTEM.

In the House of Commons yesterday (Thursday), Mr. JOHN CAMPBELL asked the Postmaster-General whether he could state the amount expended on the new telephone system, whether that system was now completed, and, if not, would he explain why hundreds of men, many with a record of long service, had been discharged.

Lord STANLEY: The expenditure on the London telephone exchange system amounted to £1,495,602 on Dec. 31 last. The system is not yet complete. The extension is dependent on further funds by Parliament, and I hope shortly to move a resolution for leave to introduce a bill to provide additional capital for this purpose. It has been necessary to restrict the expenditure on telephone work in London and to reduce the number of workmen employed, in order to avoid exceeding the expenditure authorised by Parliament. If, as I hope, further expenditure is authorised at an early date, the works will be pressed forward as rapidly as possible,

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LEGAL INTELLIGENCE.

Parker v. London County Council.

This case came before Mr. Justice Channell on Monday on an order of a Master in Chambers for the determination of a point of law raised by defendants. The London County Council, who, by virtue of Acts of Parliament, had acquired the tramways of the London Tramways Co., and at the time of the accident were working the tramways with funds provided out of the rates, were sued for damages for injuries alleged to have been caused by their negligence. On June 16, 1902, plaintiff, whilst a passenger on one of defendants' tramcars, sustained injuries in an accident which occurred to the car on which he was being carried, through the alleged negligence of defendants' servant, the driver of the car. On Jan. 12, 1903, plaintiff issued a writ claiming damages for the injuries, but defendants contended that they, in carrying on the working of the tramcars, were protected by the provisions of the Public Authorities Protection Act, 1893, and that, inasmuch as the plaintiff had not commenced proceedings within six months of the negligent act complained of, the action was barred by the limitation provided by sec. 1 (*a*) of that statute. The question for decision was whether or not this contention was in law a good defence to the action.

Mr. Justice CHANNELL said that he had come to the conclusion that the matter was concluded by authority and that he must give judgment for the defendants. The London County Council, by the combined operation of several Acts of Parliament, had acquired certain tramways and had been empowered to work those tramways. The question was whether or not the accident in question was one to which the Public Authorities Protection Act applied. The complaint against defendants was that of negligence in working the trams. If the matter had been open to him, he would have been inclined to say that on the true construction of the section defendants would have been protected from the consequences of negligence in the course of the construction of the tramways, but that they would not be protected from the consequences of their servants' negligence in carrying on the work in relation to the working of the trams after the construction was completed. The case was covered by the authorities, however, and in particular by the case of "The Ydun," in which a municipal corporation had become a harbour authority with powers to take tolls from ships entering the harbour. The harbour master was negligent. In an action to recover damages from the corporation for the consequences of that negligence, it was held that the corporation, in carrying on their duties in respect of the harbour, were protected by the provisions of the Public Authorities Protection Act. He therefore gave judgment for defendants, with costs.

Rhos Gas Co. v. British Electric Traction Co.

At Wrexham County Court last week, Sir Horatio Lloyd delivered judgment in an action brought for the recovery of £23. 3s. 3d., cost of re-arranging plaintiff company's mains. It appeared that in May last defendants were arranging for the extension of the electric tramways from Johnstown to Rhos, when negotiations took place as to the plotting out of the gas mains. Plaintiffs alleged that it was agreed they should move the mains where necessary, and that defendants should be charged only the actual cost of the work. Defendants submitted that his Honour had no jurisdiction, and that, if he had, they were not liable.

His HONOUR said the only question to consider was whether there was an agreement between the parties. The whole tenor of the correspondence, he considered, showed that there was an underlying agreement that whatever work was necessary should be done, and that defendants were to pay for it. Judgment would be for plaintiffs for the full amount claimed, with costs.

Marshall v. Lock.

In the King's Bench Division yesterday, before Mr. Justice Darling and a common jury, an action was commenced in which Mr. Alfred William Marshall sued Mr. J. H. Lock, of 78, Temple-chambers, Bouverie-street, London, E.C., to recover £70 paid as premium and other moneys paid to defendant for binding plaintiff's son as an apprentice to electrical engineering and motor and general engineering. Plaintiff alleged that defendant had fraudulently held himself out, and by verbal and written misstatements represented himself as being capable of taking plaintiff's son as an apprentice on the basis of an advertisement appearing in a number of journals, when, in fact, he was not in a position to do so.

A report of the action, which not concluded when the Court rose, will appear in our next issue.

National Electric Traction Co. (Ltd.).

Mr. Justice Byrne on Tuesday made a compulsory order winding up this company.

Wireless Telegraphy on the Amazon.—*Engineering News* of New York states that wireless telegraph communication is to be attempted between Para, Brazil and Manaos, 1,000 miles up the Amazon. A land-line telegraph between these points is impossible and the submarine cable recently laid in the bed of the river to connect them is said to be frequently out of order. From Manaos the service may be extended to Iquitos and other centres of the rubber trade on the upper Amazon.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Council of the Institution of Electrical Engineers desire to receive applications for the position of secretary vacant by the death of Mr. W. G. McMillan. Commencing salary £500 per annum. Applications to the chairman of the Secretaryship committee, Institution of Electrical Engineers, 92, Victoria-street, Westminster, London, S.W, by March 7. See also announcement in our advertising columns.

The Council of the University of Liverpool invite applications for the Chair of Physical Chemistry. The emoluments are derived from a fixed salary and a share of fees, the total guaranteed to be not less than £600 a year. Further particulars from the registrar, to whom applications by April 1. See also advertisement.

Bridlington Corporation require a clerk of works for their electricity supply scheme. Salary £4 per week. Applications to town clerk (Mr. A. E. Matthewman), Town Hall, Bridlington, by noon March 8. See advertisement.

Manchester Tramways committee require a superintendent of their parcels department. Applications by March 12.

Mr. Philip Williams, of Bangor, has been appointed, out of 150 applicants, resident electrical engineer at Holyhead at a commencing salary of £140 per annum.

Bradford Electricity committee recommend the appointment of Mr. T. Roles, of Poplar, as assistant electrical engineer at £250 per annum.

Acton.—A special meeting of the Council was held on Friday last to consider the proposed agreement with the Metropolitan Electric Supply Co. by which the company are to supply electricity in bulk for 27 years. The Council have the right to acquire the Acton undertaking at nine or 18 years.

The Council's consulting electrical engineer (Mr. W. H. TRENTHAM) recommended the insertion of a clause that the agreement should only take effect subject to the consent of the Local Government Board to the borrowing by the Council of the necessary capital.

The CHAIRMAN did not favour the suggestion, as he considered it "almost impossible" for the Board to refuse.

The agreement was approved and ordered to be sealed.

Argentina.—Messrs. E. E. Clerice & Co. have obtained a concession for constructing a mechanically-operated street railway from Bahia de San Blas to Carmen de Patagones; and a French syndicate has been formed in Buenos Ayres having for its object the construction and equipment of a network of street railways in the provinces of Cordoba, Buenos Ayres and Santa Fé.

Barnstaple.—The results of the first year's working of the electricity department to Jan. 28 show working expenses £1,487, including coal (£453), water (£156), engineer's salary and wages (£523); receipts were £2,163 (including £1,384 from supply to private consumers at 6d. per unit and £740 from public lighting), showing £676 gross profit. Interest absorbed £591, leaving £85 towards sinking fund charges. The number of private consumers has increased to 168. Supply would shortly be given in Newport.

On Monday the Council decided, on the recommendation of the Electric Lighting committee, to reduce the price of current to private consumers from 6d. to 5d. per unit.

Bath.—At last week's meeting the Council discussed the proposal of the Tramways company to lay electric tramways from the Great Western Railway station to the Guildhall. The matter was, however, referred back to the Tramway committee. The recommendation of the Electric Light committee not to proceed with the suggested extensions of the electricity works (estimated to cost £16,000) was adopted.

Batley.—The borough surveyor (Mr. O. J. Kirby) has been granted an honorarium of £50 for services in connection with the construction of the electric tramways.

Battersea (London).—The Council on Wednesday informed the Incorporated Municipal Electrical Association that they will sign the petition to be presented to the Local Government Board asking that Metropolitan Borough Councils be authorised to contribute to the funds as members of the association.

Belfast.—The city electrical engineer (Mr. Victor A. H. M'Cowen) reports that for the year ended Dec. 31 the total number of units of current sold was 2,081,938, compared with 1,491,841 for the previous year, an increase of 590,097 units, or 39½ per cent. The increase in revenue was £5,826. 18s. 6d., equal to 28 per cent.

Bonnyrigg (N.B.).—A petition from ratepayers complained of the quality of the gas supplied and asked, in view of the early introduction of electricity into Dalkeith, that steps be taken by the Council for securing an extension of the mains to Bonnyrigg.

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Bradford.—The income of the electricity department for the past year was £75,739, working expenses £35,672, gross profit £40,067. Sinking fund and interest absorbed £31,144, and there were set aside for depreciation £8,436, leaving a net surplus of £587.

Bredbury and Romiley.—As a preliminary to carrying out the provisions of their electric lighting order, 1900, the Council are ascertaining the probable number of consumers in the compulsory area.

Canada.—A recent census puts the number of generating stations in the Dominion at 324, supplying current to 1,780 arcs and 1,212,861 incandescents, an increase of over 21 per cent. in the number of lamps compared with the preceding 12 months.

Chesterfield.—In the estimate prepared by the engineer (Mr. R. L. Acland) the cost of the proposed tramways and other improvements, for which sanction is sought in the Corporation's bill, is estimated at £127,642, of which the tramways will require an expenditure of £95,021, and £8,980 is to be spent upon machinery for the electric lighting undertaking.

Cleckheaton.—Application has been made for sanction to a loan of £4,000 for electricity extensions.

Companies to be Struck off Register.—The following are to be removed from the register of joint-stock companies, unless cause is shown to the contrary:—Barrow-in-Furness Tramways Co., Railways Electric Supply Synd., Round's Accumulator Co.

Copper Output in 1903.—According to authentic figures relating to the production of copper in 1903, the total output was the largest on record. The following figures give the totals (in long tons) for 1901, 1902 and 1903:—

	1903.	1902.	1901.
United States	318,861	303,446	272,609
Spain and Portugal	51,000	49,790	53,621
Mexico	48,000	35,785	23,795
Chili	30,000	28,930	30,780
Japan	31,000	29,775	27,475
Australasia	29,000	28,640	30,875
Canada	22,500	17,485	18,800
Germany	22,000	21,605	21,720
Other countries	37,000	35,860	36,317
Totals	589,361	551,316	515,992

Crediton.—The Council are considering a scheme submitted by Mr. Frank Christy (Christy Bros. and Middleton) for obtaining a provisional order, and for erecting electricity works. It is proposed to form a local company to erect and maintain the works.

Croydon.—The Corporation have referred back a report recommending application for sanction to a loan of £2,450 for erecting 44 additional arc lamps.

Cuba.—A company with $4,000,000 capital has obtained a concession for the construction of an electric railway from Palmira to Las Cruces, with a branch running through sugar plantations to Manicaragua Valley. Water power will be used for generating electric energy.

Derby.—Sanction to a loan of £29,900 for electric lighting has been obtained by the Corporation.

Dumfries.—The Council have submitted the proposals of Messrs. Crompton & Co. and of the India Rubber, Gutta Percha and Telegraph Works Co. for the erection of electricity works to their consulting engineers (Messrs. Matthew Buchan and Hogarth) for report.

Dundee-Broughty Ferry Tramway Scheme.—The Caledonian and North British Railway Companies have lodged petitions in opposition to this scheme on the ground of competition.

Dunfermline.—Fife Electric Power Co. are negotiating for acquiring a site of 6 acres of Corporation land for a generating station.

East Ham.—The District Council have received sanction to a loan of £14,430 for additional electric lighting plant.

Edinburgh.—Since the beginning of 1904 applications for current represent 88,246 8 c.p. lamps, an increase of about 30,000 over the corresponding period last year.

Edmonton.—The District Council have definitely engaged Mr. R. Hammond to carry out his electricity supply scheme, Mr. Hammond's remuneration to be 5 per cent. on the estimated cost (£44,000), 1 per cent. to be paid on the preparation of the specifications, 1 per cent. on the acceptance of the tenders, 2 per cent. as the work is carried out and 1 per cent. on completion.

Egyptian Trade.—A return has recently been made of the trade of Egypt for the years 1900-1902, in which it is shown that our chief competitor in manufactured iron and steel, copper and brass, machinery and parts of machines, and rolling stock is Belgium, but it is satisfactory to find that the United Kingdom still occupies an easy first place in regard to each item, excepting rolling stock. The United States, Belgium and Austria-Hungary compete keenly for this branch of trade. The report concludes with the remark that, "as regards manufactured goods the United Kingdom, competing in this neutral market under equal conditions with other countries, more than maintains its position of supremacy."

Electrical Equipment of a New Battleship.—The new battleship "New Zealand," which was recently launched at Portsmouth, is provided with a wireless telegraph installation, and the other electrical arrangements, it is said, will be most complete. According to a provincial contemporary, the generating plant will consist of four dynamos, each capable of supplying 600 amperes at 100 volts when running at 400 revs. per min. In addition to lighting every part of the ship, electrical power is to be utilised for driving the numerous fans for the ventilation of the ship, as well as for motors for ammunition hoist winches, coal hoist winches and the after capstan. A complete installation of electric bells, voice pipes and telephones will be fitted with loud-speaking navyphones at important positions.

Engineering Employers' Federation.—The British Westinghouse Electric and Mfg. Co. (Ltd.) have notified their intention to join this Federation, and to abide by the working terms agreed upon by the Federation and the representatives of the trades unions.

Epsom.—The expenditure (£596. 10s. 5d.) of the electricity department during the past quarter exceeded receipts by £119. 19s. 5d. The demand for current is increasing in a satisfactory manner.

Farnworth.—During the quarter ended December last the Council's electricity works supplied 185,352 units of electric energy, an increase of 41,884 units over 1902. The receipts for the quarter were £1,421. 9s. 9d. expenditure (including interest and sinking fund charges) £1,150. 17s. 9d., leaving net profit £270. 12s. The equivalent of 18,234 8 c.p. lamps is connected.

Frome.—Sanction to a loan of £8,500 for electricity supply has been obtained by the Council.

Glasgow.—The Corporation have concluded agreements with the County Council of Renfrew and the Upper District committee of the county with regard to the extension of the tramways to Giffnock and Thornlie Bank.

Greenwich (London).—On Wednesday the Council decided to petition against the East London and Lower Thames Electric Power Bill, in order to obtain protective clauses.

Hackney.—The Finance committee recommend application to be made to the London County Council for sanction to a loan of £3,996 for laying additional distributing mains.

Halifax.—The Tramways committee are considering the advisability of adopting "one man" cars as an experiment on the Post Office-Railway Station electric tramway route.

The Halifax-Brighouse tramway extension has been officially inspected and will be opened for traffic to-day (Friday).

On Thursday last a new Pollit and Wigzell-E.C.C. generating set was started at the Foundry-street electricity works by the chairman of the Tramways committee, Alderman T. Hey, who said the plant, with foundations, cost about £8,000. The capital expended on the electricity and tramway undertakings is about £570,000. The revenue of the electricity department would reach £33,500 for the current year. The cost of generation had been reduced to 1·08d. per unit.

Hammersmith (London).—The Council have refused the request of the Guardians to allow the borough electrical engineer, Mr. G. G. Bell, to supervise the installation at the new workhouse and infirmary buildings.

It has been decided to light Shepherds Bush Green electrically and the Electricity committee has been instructed to prepare a scheme.

Hales Owen.—The Council have sealed the agreement for the transfer of their provisional electric lighting and light railway orders to the Empire Electric Light and Power Co. The company have agreed to undertake the public electric lighting at a cost not exceeding the present price of gas, and to supply current for lighting the municipal buildings at 5d. per unit and to private consumers at 7d.

Hampstead (London).—The Borough Council have decided to purchase six new transformers and lay additional cables at an estimated cost of £2,347 to provide for next winter's demands. Last quarter's revenue of the electricity department was £16,916, an increase of £2,474 over the corresponding period of 1902.

Heckmondwike.—If the Co-operative Society take current from the municipal electricity works, the charge will be reduced to 4d. per unit. Electric lighting is to be adopted in 19 additional thoroughfares.

Hospital Lighting.—The Metropolitan Asylums Board have received permission to expend £4,350 on electric lighting at Fountain Hospital.

House of Commons.—Many attempts have been made to improve the ventilation of the Houses of Parliament, in spite of which

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efforts it cannot be said that hitherto a satisfactory result has been obtained. It has, we understand, been decided to thoroughly overhaul the ventilating arrangements and to instal new plant. The work has been entrusted to Messrs. Matthews and Yates, who expect to have the plant in operation by the commencement of next session. In previous years this firm have supplied between 60 and 70 fans for the ventilation of committee rooms, division lobbies, lavatories, &c.

Huddersfield.—The profit on the past year's working of the Electricity department was £3,915 1s. 11d.

The income was £26,005. 12s. 9d., of which £23,784. 16s. 10d. was for electricity sold, compared with £23,159. 15s. 1d. and £21,347. 3s. 7d. in the previous year. Expenditure was £12,627. 7s. 9d., compared with £10,404. 6s. Of the balance (£13,378. 5s.), £4,680. 1s. 10d. is required for interest, £3,492. 9s. 11d. for redemption of debt, £1,290. 11s. 4d. was repaid to Public Works Board, leaving £3,915. 1s. 11d. This is transferred to the depreciation and contingencies account, which now stands at £11,853. 11s. 7d. The number of consumers for February was 1,898, and the equivalent 8 c.p. lamps connected 132,910.

Hull.—The estimates of the tramways department for the ensuing year puts the gross income at £100,634, working expenses £62,601, interest and sinking fund £18,764, balance £19,269. The Works committee recommend that of this balance £11,500 be carried to city fund and the remainder to reserve for depreciation and other contingencies.

Ince.—The question of putting into force the Council's electric lighting order 1901 has been deferred for three months. In the meantime the probable demand for current will be ascertained.

Italy.—In a report upon the trade of Southern Italy for 1903 (which is published with commendable promptitude by the Foreign Office), Mr. Consul-General Neville-Rolfe makes an interesting review of the progress of the Naples district. He refers to the project of a new line to run from Rome across the Pontine Marshes to Terracina, thence to Forimo on to Naples, following more or less the line of the coast. Water power for this line will be obtained from the Tiber and the Volturno, especially the latter. Reference is also made to the electric railway opened in 1903 to Vesuvius. This line will soon run from the city of Naples to the base of the funicular railway which has carried passengers up to the cone of the mountain for many years. Pugliano, the present starting point of the railway, is an hour's drive from Naples. The electrical system adopted on the Vesuvius line is the Stur, the same as is used on the Jungfrau line.

A new company recently registered at Naples is concerned with the construction of an electric tramway from Castellamare to Sorrento, a distance of about 11 miles. Owing to the hilly character of the journey, 1½ hours is taken in covering the distance by horse carriage. The power station is to be steam-driven, as there is no water power available in this district. Naples, in fact, has no river, and there is a scheme under consideration to bring water-power into the district from the River Volturno.

Leicester.—The chairman of the Tramways committee (Councillor Flint) explained at the Corporation meeting last week that the receipts had fallen off during the past year owing to interruption caused by conversion of the tramways to electric traction. The gross profit (£9,149) was not sufficient to meet interest and sinking fund, and £1,300 would be required from reserve. Mr. Lucas had been appointed as secretary and traffic manager at £350, and Mr. T. R. Smith as resident electrical engineer at £250 per annum, increasing by annual increments of £25 to £350. He (Mr. Flint) anticipated the electric tramways would be opened for traffic before Whitsuntide.

Leigh (Lancs.).—The Corporation is engaging a consulting engineer to inquire into and report upon the present position of the electricity undertaking.

The Tramways committee have been authorised to ascertain upon what terms the South Lancashire Tramways Co. would be prepared to take a lease of the lines authorised by the Corporation's 1903 Act.

Light Railways.—A public meeting was held recently to consider a scheme for a light electric railway from Cinderford to Lydney, 12 miles. It is proposed to lay a three-rail track, the narrow gauge for passenger and the broad gauge for minerals. It was stated that the carriages and trucks can be run by gravitation from Cinderford to the river and that electric energy for the upward journey and for taking back the empties can be generated by a turbine in the river worked by the tides. The meeting appointed a committee to confer with the promoters.

The Commissioners will hold an inquiry on March 9 into the application of Cheltenham and District Light Railway Co. for an extension order.

Lampeter Council will support and contribute to the preliminary expenses of the Lampeter-Llandilo light railway project.

Llangollen.—The Llangollen Electric Light and Power Co. notify that they will be able to complete their contract for the purchase of the Council's provisional electric lighting order next month.

London County Council.—At Tuesday's meeting the Highways committee recommended that the underground conduit system of electric traction, approved by the Council on Dec. 1, for the reconstruction of the first section, about 2½ miles in length, of the Council's northern tramways, be adopted for the reconstruction, as double lines, of the tramways in Goswell-road.—Carried.

Motor Vehicle Registration.—Up to Feb. 17 the clerk had registered 2,356 motor cars and 1,358 motor cycles. Identification marks of motor cars had been assigned to 209 manufacturers or dealers.

Tramways.—Mr. Benn stated that the receipts per car-mile from the electric trams were 12·21d., against their estimate of 12d.

Borrowings by Local Bodies.—Lord Welby, replying to a question, said the debt of the Council on account of loans for metropolitan bodies, in 1903, was £9,941,000, an increase of £3,879,594 since 1899. The Finance committee of the Council had sent out a letter to the metropolitan local authorities pointing out the present position of the money market, and suggesting that borrowings should be limited. So far the committee had never refused a loan to a borough council on the ground of its existing indebtedness. The Council's commitment in regard to the new Holborn to Strand improvement scheme up to Dec. 31, 1903, was £4,010,952. They had recouped out of this amount £185,866, leaving the net expenditure to the date mentioned £3,825,086 without reckoning interest. Up to March 31 the expenditure would amount to £4,423,000, and of this £443,000 would have to be provided in the financial year 1904-5. The average rate of interest the Council was paying was 3⅛ per cent. Against this was to be set the ground rents receivable, amounting approximately to £146,528.

London County Council Tramways.—The General Purposes committee of Holborn Council, who reported upon the County Council's proposals to adopt the conduit system of traction on the tramways in the borough, have come to the conclusion that "on the grounds of economy, efficiency in working and the saving of enormous interruption of traffic and business of the ratepayers in the borough the overhead trolley system of tramways is far preferable to the conduit system." The report will be discussed a the next meeting of the Borough Council.

Mexico.—The imports into Mexico in 1902 included electric batteries to the value of £17,409, and incandescent electric lamps £15,387. These goods came chiefly from the United States, the balance from Germany.

The use of the telephone has increased very much in Mexico in late years, and there were at Dec. 31, 1902, 21,958 miles of telephone lines in the country. The bulk of these lines, however, belong to the Government. The longest line is between Mexico City and Toluca, about 50 miles. There were about 10,000 telephone instruments in use in Mexico at the end of 1902.

Milan-Varese-Porto Ceresio Electric Railway.—According to the *Zeitschrift für Elektrotechnik* the traffic on this line is steadily increasing, and during the winter 1902-1903 the number of trains running in each direction was increased to 24 per day. Excepting minor failures to the small motors used for compressing air, disturbances due to the electrical equipment were rare. Thanks to a suitable arrangement for clearing the third rail from snow, no trouble was experienced on that account. Between Dec. 1, 1901, and Aug. 31, 1902, the receipts were 1,000,000fr., against 666,000fr. for the same period in the preceding year, when the line was worked by steam.

Musselburgh.—The promoters of the local electric tramways have acquired site for a power station.

Natal.—The Government's telephone service is being added to by a new exchange at Dundee, just constructed and to be opened early in February instant. There is in contemplation the erection of a telephone exchange at Newcastle.

New Zealand.—Under the new Preferential and Reciprocal Trade Act, 1903, which came into force in November last, a preferential tariff applies to rails for tramways and railways imported from Great Britain, or from any part of the British dominions, into New Zealand before March 31, 1906, for use in the construction of any tramway or railway for which plans and specifications had been completed, or were in course of preparation at the time of the passing of the act. The same preference applies to gas and oil engines, pumps and other apparatus for raising water.

Mr. Hancock, the American engineer employed by the Government to report upon the potentialities of the water power, &c., of the colony and its employment in the generation of electric energy, has completed his survey of the islands and his report is expected almost at once.

Newcastle-on-Tyne.—All the schools in this district are to be wired for the electric light.

Paraguay.—A street railway concession has been granted to La Cia. Edificadora for the construction of a line nearly 2 miles in length in Asuncion.

Patent Law in British Central Africa.—An ordinance has been issued dated Dec. 4, 1903, providing that in all cases relating to patents, designs and trade marks, the law in force in England shall prevail in the British Central African Protectorate.

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Pembroke (Dublin).—The Roads committee recommend the Council to carry out the electric lighting extension scheme prepared by their consulting engineer (Mr. Robert Hammond), and estimated to cost £25,000.

Poplar (London).—The borough electrical engineer (Mr. Percy N. Hooper) has reported that, while the plant and mains are in a satisfactory condition, two of the sets are small and necessarily inefficient.

The plant was run at some risk during the winter, and certain applications for current were refused, and others granted upon condition that supply was not taken for six weeks on either side of the shortest day in the year. A diagram prepared by Mr. Hooper shows that applications have, up to a comparatively recent date, been well sustained, and, so far as the winter load was concerned, at one time the safety line was actually passed, so that if an accident had happened to one of the 500kw. sets supply over a large area would have failed. It is, consequently, necessary to at once consider the question of providing for next winter's demand. It is recommended that the two small sets referred to be disposed of, and two new generators, each of 1,000kw. capacity, be provided. This arrangement would increase the capacity of the station by 1,800kw. and one of the sets would be available during the next winter, the other being a reserve unit. The high-tension alternating-current three-phase system is intended to be adopted in connection with the new machinery, and the scheme will involve a capital expenditure of £65,500, made up as follows:—Generating station £20,000, mains in south district £25,500, north district £14,000, dock crossing subways £6,000. For the present it is only necessary to provide for two generators, with foundations, condensing plant and switch gear, at an estimated cost of £16,000.

The committee recommend, in view of the decision in "Colwell and others *v.* St. Pancas Borough Council," that authorities owning electric lighting undertakings should combine and approach the Board of Trade with a view to the abolition of the nuisance clause in provisional orders and the substitution of a clause giving powers to undertakers to acquire property compulsorily.

Post Office Telegraphs.—A return has been issued showing the gross amount received and expended on account of the telegraph service for the year ended March 31, 1903. Net receipts in respect of telegrams, private wire rentals, special wire rentals, &c., were £3,631,745. 6s. 4¼d., in addition to the value of telegraph services performed for other public departments without remuneration (£92,121). The total expenditure was £4,325,577. 14s. 7d., showing a deficit of £601,711. 8s. 2¼d.

Prince Albert (Saskatchewan, Canada).—The municipality of this town (with 2,000 inhabitants) has established electricity supply. Part of the plant is already in operation, and the remainder is expected to be running in April. Overhead cables are used.

Provisional Order Transfer.—Prestwich District Council intend to transfer their electric lighting orders, 1900 and 1903, to Salford Corporation, but reserve the right to purchase the undertaking in 21 years or at the end of any subsequent five years. The charges for current in Prestwich are not to exceed those in Salford by more than ½d. per unit.

Railway and Tramway Competition.—At the meeting of the London and South-Western Railway Co. last week, the chairman (Lieut.-Col. the Hon. H. W. Campbell) said they had suffered from increased tramway competition in the London suburbs and in several provincial towns to the extent of about £10,000. But satisfactory increases were shown in goods, minerals and other traffic. The receipts on the Waterloo and City Railway showed a small decrease of £297, and that was the first time they had had a decline in the receipts on that line.

The chairman of the Great Central Railway Co. (Sir A. Henderson, M.P.) also complained of tramway competition at the meeting last week. He said they had felt very keenly the competition of tramways in both Manchester and Sheffield. During the corresponding half of last year that competition accounted for the loss of 330,000 passengers, and this half-year he had to record a further diminution of 424,000; so that, taking the two half-years together, they had lost no less than 750,000 passengers. Fortunately the money received for the short journeys was small.

To meet the competition of the London United Tramways the Great Western Railway are issuing books of 25 "family" tickets for all three classes between London and Southall and intermediate stations at a reduced rate.

At the meeting on Friday of the London and North Western Railway Company, the chairman (Lord Stalbridge) stated that their shorter distance traffic continued to suffer in many districts owing to the competition of the tramways, but not to such an extent as in past half-years.

The chairman of the Midland Railway Co. (Sir Ernest Paget, Bart.) complained of the effect of tramway competition upon their receipts at the meeting on Friday last. There had been a decrease of 477,000 in the number of passengers in the suburban districts where electric tramway competition existed. He did not, however, think electric tramway competition was going to be a very serious matter.

Ravensthorpe (Yorks.)—The Yorkshire Electric Power Co offer the Council supply of electricity in bulk at prices ranging from ½d. to 1¼d. per unit.

Rotherham.—An inquiry was held here on Tuesday into the application of the Corporation for permission to borrow £14,670 for extensions of the electricity undertaking.

The Town Clerk (Mr. H. Hampton Copnall) gave statistics as to population, rateable value, &c., and explained that £1,280 of the loan was, required for two Lancashire boilers, £4,300 for engines and dynamos £500 for injectors, &c., £350 for switchboard extensions, £200 for boiler fittings, £150 for foundations, £560 for contingencies and engineering charges, total £7,340, required for present requirements. For future extensions the estimate was for £460 motor-balancer and switchboard, £950 for consumers' services, £600 for meters £1,200 for feeder cable, £1,500 for distributor cable, £2,500 for traction battery, and £120 contingencies. Considerable progress had been made by the electric lighting and power department since the commencement of supply on May 23, 1901. At the end of March, 1903, when there were 203 consumers with an equivalent of 13,126 8 c.p. lamps connected, a total of 5,600yds. of feeder and 12,833yds. of distributing mains had heen laid, the station was capable of supplying 10,850 8 c.p. lamps.

Technical particulars were supplied by the borough electrical engineer (Mr. E. Cross),

Shildon.—Some time ago the Council issued a writ against the Northern Counties Electricity Supply Co. for damages for breach of agreement in regard to electricity supply. Terms have now been arranged, and the company guarantee to erect a generating station by Aug. 1, 1904, and a refuse destructor by Jan. 1906.

Southend-on-Sea.—The Corporation have authorised the expenditure of £21,000 in relaying the tramway track, £3,000 in providing new cars and £2,500 on additional machinery, &c.

Southwark (London).—Mr. J. W. Thompson, held a Local Government Board inquiry last week into the application of the Council to formulate a scheme providing that the expenses of the Newington electric lighting undertaking should be chargeable to the whole borough.

It was stated that Newington had rather more than half the population and more than half the area of the Borough of Southwark, but rather less than half the rateable value. In 1897, Newington obtained an electric lighting order, and on September 8, 1899, supply was first given. Up to March 31, 1900, there was a deficiency on trading of £822, and after adding interest (£1,328) the net deficiency was £2,150. In the second year the trading profit was £1,758, but interest absorbed £1,796, leaving a net deficiency of £38. The trading profit of the third year was £1,304, and interest came to £2,328, leaving a deficiency of £1,024; and for the year ended March 31, 1903, the trading profit was £3,608, but interest charges came to £2,738 and sinking fund (which became due for the first time) amounted to £1,599, leaving a deficiency of £729, making a total deficiency of £3,941, of which £3,148 had been paid by Newington parish. It was now sought to make the balance (£793) chargeable to the whole borough.

Counsel for the Council stated that it had been sought to extend the area of supply over the whole of Southwark, but the application was refused by the Board of Trade. For every part of the borough electric lighting powers were held by either two companies or by the local authority, and a company, and in some cases two, were in actual competition. Counsel contended that unless the scheme asked for was granted Newington would have to pay deficiencies on the electricity undertaking, whereas if there was a surplus it would go to the benefit of the whole borough.

Counsel for opposing ratepayers said his clients were willing to let Newington have the benefit of any surplus, while for the Council it was said that an arrangement of that kind could not be made, as when the loans were paid off the undertaking would be the property of the whole borough. It was submitted by the parishes of St. George the Martyr and the district of St. Saviour's Board of Works that it would be unfair to charge them with the losses of an undertaking initiated by Newington, and the area of supply of which was restricted to Newington.

Stockport.—The results of the third year's working of the electric tramways show a small surplus after paying annual expenses, interest and sinking fund. Last year there was a deficiency of £563, and in the first year of £800. The Cheadle tramway route has been opened, and extensions to Gatley are being constructed.

Stoke-on-Trent.—The Corporation invite loans of from £10 to £100 from ratepayers at 3 per cent. interest, to provide moneys (about £31,000) for electric lighting and other works.

Sudbury.—The Council have agreed with the Empire Electric Light and Power Co. for a transfer of the Council's order. The company will erect electricity works and supply current at a maximum price of 7d. per unit for lighting and 4d. for power.

Sunderland.—The estimates of the Tramways committee for the year ending March 31 show estimated income £63,061, expenditure £35,240. The gross profit of £27,820 will be applied as follows:—Compensation reserve fund £500, contribution to Channel Squadron visit and regatta funds £111, Municipal Electrical Association and St. John Ambulance Association £83, interest £8,670, depreciation and renewal fund, including sinking fund, £13,690; net profit £4,765, against £5,000 in previous year.

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Sydney (N.S.W.)—The Government Tramways Department are to erect a battery sub-station at Botany, where current will be received from the Ultimo power station for working the Botany tramways. A new car shed has been erected at Rozelle for cars used on the Balmain and neighbouring lines. The shed accommodates 105 cars.

Telephony in Australia.—New regulations have been issued by the Commonwealth Government under which any subscriber paying the business rate may permit his telephone to be used by the public upon payment of 3d. per call, 1d. of which is paid to the subscriber by the Government's collector.

Topsham (Devon).—The Topsham Electric Lighting Co. are putting down electric lighting plant capable of supplying current to about 2,000 8 c.p. lamps, and expect to be able to supply current by May.

Torquay.—Last week the Council resumed discussion on the proposal to establish new electricity and destructor works at a cost of about £42,500:—

The electric Lighting committee recommended the substitution of the site originally proposed instead of Upton Valley, and that a sub-committee be appointed to report upon plans, &c.

The Mayor said that, although reverting to the original site would save £3,000 or more, it would render the Corporation more liable to charges of causing a nuisance with the destructor, and the delay occasioned by the preparation of new plans might also render them liable to a claim for compensation for delay in providing energy under their agreement with the Dolter Electric Traction Co.

The recommendation was adopted.

Tottenham.—The Council have decided not to proceed further with the electricity supply scheme drawn up by Messrs. Hawtayne and Zeden.

"Trade Marks of the British Empire."—A Paper with the above title was read before the Chartered Institute of Patent Agents on Feb. 10 by Mr. G. B. Ellis (Messrs. Mewburn, Ellis and Pryor). In this Paper Mr. Ellis first dealt briefly with the position of the colonies in relation to the patent laws of the mother country, and again in respect to their joint relation as members of the empire. So far as the Merchandise Marks Act, 1887, is concerned, it may be regarded in part as a criminal act and in part as a customs act, and in regard to the former aspect of the measure Mr. Ellis referred to the fact that the 1862 Merchandise Marks Act imposed a penalty on persons imitating trade marks, and in this way clearly recognised the proprietary of trade marks long before registration came into effect. Mr. Ellis has a good word to say for the Indian laws respecting merchandise marks. While there is no trade mark registration in India, there is to be found in the Indian code the main provisions of the penal part of the British Merchandise Marks Act, 1887. Mr. Ellis concludes by suggesting that many who give the matter consideration may be disposed to consider it advisable to have an Imperial trade mark to be granted to British subjects to cover the whole of the dominions of the King. It was not long ago that British patent laws covered Great Britain and the colonies, and even now a patent granted in France and Spain covers the colonies of these nations respectively, and a trade mark registered in Holland covers the many colonies owned by that country. In an appendix to the Paper Mr. Ellis gives in alphabetical order the trade marks registration regulations of all British possessions.

Victoria (Australia).—In a recent issue the "Australian Mining Standard" strongly condemns the action of the Legislature in refusing to sanction the proposed electric tramway and electricity supply scheme for Flemington and Essenden, and points out that the proposed tramways would probably become feeders rather than competitors of the State railway.

Walthamstow (London).—At the Council meeting on Tuesday, several electricity consumers complained that lamps had been sold to them by dealers which were not of the voltage of the Council's supply. It was resolved to issue a notice that incandescent lamps of good quality and suitable for the Council's supply pressure could be obtained at the municipal electricity works at following prices:—8 or 16 c.p., 1s. each; 32 c.p., 1s. 3d.

The National Boiler and General Insurance Co. offer to insure for £10,195 the gas engines, dynamos, switchboards, boosters, balancers, motors, gas plant, and motors and fittings on consumers' premises, against breakdown, and to make good any faults due to defective design or inferior workmanship for an annual premium of £268. Quotations from three other insurance companies are to be obtained.

The Electrical Engineer (Mr. F. A. Wilkinson) reported, with reference to the experiments in street lighting by incandescent electric lamps, that the lighting posts are fitted with two 16 c.p. glow lamps, which consume 0·128 unit per hour, and as the average number of lighting hours in one year is 3,631, the consumption of the two lamps is 464 units per annum. At 3d per unit (including current, repairs, interest, sinking fund, &c.) this is equivalent to £5. 16s. per annum. It was decided to obtain from Mr. Wilkinson and the lighting foreman details of the comparative cost of incandescent electric and incandescent gas lighting.

Cables are to be laid on the Forest Estate, and sanction to a loan for £6,054 has been applied for.

The Council have been authorised to borrow £1,091 for lamp columns for electric lighting. The engineer and surveyor (Mr. Holmes) was directed to proceed with the preparation of plans for the extension of the generating station, and upon the recommendation of the Electric Traction committee a motion was passed calling the attention of the Lighting committee to the necessity for providing arc lamps in the roads along which the trams will run.

Watford.—The report of the Electric Light committee presented to the Council last week stated that no progress had been made with the suggested negotiations with the North Metropolitan Electric Power Supply Co. for the sale of the electricity undertaking, and, therefore, the committee recommended the discontinuance of negotiations. This was approved by the Council.

Major Cardew has been engaged to report upon the efficiency of the present plant at the electricity station and to give evidence in support of the Council's application for a provisional order to extend their area of supply.

Application has been made to the Local Government Board to sanction a loan of £26,000 for electric lighting extensions.

Willesden (London).—At Tuesday's meeting of the Council the solicitor reported that the sale of the electricity undertaking had been completed and that £8,633. 8s. 2d. had been paid in connection therewith. The balance was secured by mortgage, in respect to the site, £2,458. 7s. 8d., repayable in 55 half-yearly instalments, and in respect to the buildings, machinery, &c., £61,556. 16s. 3d., repayable by 48 half-yearly payments.

Wireless Telegraph Working in Orange River Colony.—An ordinance has been published providing that no person shall establish or use any apparatus or installation for the transmission of messages or other communications by means of electrical energy without the aid of wires without having previously obtained a licence, and for this licence £100 shall be paid. The licence may be revoked at any time by the Lieutenant-Governor. Licences will be granted upon such terms and conditions as the Lieutenant-Governor may from time to time prescribe by proclamation in the "Government Gazette." Penalties are fixed for contravention of the ordinance.

Wisbech.—The Council recently discussed the report on electric lighting prepared by Messrs. R. Hammond & Son, and decided to enter into negotiations with companies for the erection and maintenance of electricity works in the district.

Wolverhampton.—Sanction to a loan of £16,514 for electric tramways has been received by the Corporation.

Electro-Harmonic Society.—The next concert (ladies' night) will be given at the Holborn Restaurant, London, W.C., this (Friday) evening at 8 o'clock, with Lord Claud Hamilton in the chair.

Dinner.—The first annual dinner of the Manchester branch of the National Electrical Contractors' Association was held on Thursday last:—

The president of the Section, Mr. J. M'Dermott, presided, and the guests included Mr. W. R. Rawlings, president of the National Association, who, in responding to the toast of "The Association," referred to the progress which had been made, and the possibilities of future development. The work in which they were engaged was becoming known throughout the country, and the benefits were such that there was every prospect of a large increase of membership. Already about 500 contractors were connected with the Association, 200 of these being in London and the remainder in different parts of the country.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1904 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date, and the Directorial Division of the new volume has been corrected up to February 11th, 1904. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates over 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. A number of large sheet Tables, Maps, &c., are included in the issue.

TENDERS INVITED.

Ilford District Council invite tenders for the supply and erection of one 1,000kw. steam dynamo (vertical engine coupled direct to multipolar dynamo); extensions to main switchboard and cable

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connections; works distributing switchboard; condensing plant, comprising surface condenser, water driven pumps, water cooling tower and pipe work; feeder and pilot cables, feeder pillar and joint boxes. Specifications after 29th inst. Plans may be inspected and further information obtained at the offices of the chief electrical engineer (Mr. Arthur H. Shaw, M.I.E.E.), Electricity Works, Ley-street, Ilford. Tenders, addressed to Chairman of Council, Town Hall, Ilford, by noon March 22. See advertisement.

Ilford District Council also invite tenders for the supply of materials and stores for their electricity department for the year ending March 31, 1905. Specifications, &c., from the chief electrical engineer (Mr. Arthur H. Shaw), Electricity Works, Ley-street, Ilford. Tenders, addressed to Chairman of Council, Town Hall, Ilford, by 4 p.m. March 8. See also advertisement.

Ilford District Council also invite tenders by March 7 for 12 months' supply of stores for tramways department.

Hackney (London) Guardians invite tenders for providing and fixing electric lighting fittings in connection with the lighting of the casual wards and other buildings in course of erection at Gainsborough-road, Hackney Wick. Specifications, &c., from the architect (Mr. W. A. Finch), 78, Finsbury-pavement, London, E.C. Tenders to the clerk, Mr. Frank R. Coles, Sidney-road, Homerton, N.E., by 2 p.m. March 9. See also advertisement.

The Electrical committee of *Stepney* (London) Council invite tenders for supply and erection of one 1,000kw. steam turbine-driven double-current generator, four water-tube Babcock-Wilcox boilers, economisers, induced-draught apparatus, steam and other pipework, motor-driven feed pump and accessories. Specifications from the offices of electricity department, 27, Osborn-street, Whitechapel, E. Tenders (addressed chairman of Electrical committee) by noon March 14. An advertisement contains further particulars.

Manchester Tramways committee invite tenders for the supply of general stores, including timber, oils and paints, pinion and gear wheels, fuses and switches, copper wire, incandescent lamps, cells, trolley heads, brackets for tramway poles, armature repairing material, rubber goloshes, gloves, &c., handcarts, barrows, &c., belting, metal polishing liquid and paste, truck springs, electrical accessories, trolley standards and booms, cable, tape, insulating material, bells, carbon brushes and carbons, galvanised steel span wire, bolts, nuts, &c. Specifications, &c., from the general manager (Mr. J. M. McElroy), 55, Piccadilly, Manchester. Tenders to chairman by 10 a.m. March 7. See also advertisement.

Loughborough Gas and Electric Lighting committee invite tenders for supply and erection of two dry-back boilers, one surface condenser with electrically-driven air and centrifugal pumps and piping and one battery of 260 cells with Planté-formed positive plates. Specifications, &c., from the consulting engineer (Mr. C. H. Gadsby), 20, Victoria-street, Westminster, S.W., after March 2. Tenders to town clerk (Mr. Harry Perkins) by noon March 12. See also advertisement.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring the installations set out in an advertisement for direct connection with the fire brigades at Greenock and Edinburgh. Tenders close March 2. Particulars from managing director, 49, Queen-street, Glasgow.

Belfast Gas and Electric committee invite tenders for electric motors, insulated cables, stoneware conduits, troughs, &c., cast-iron pipes, troughs, street boxes, &c., and bitumen. Specifications from the city electrical engineer, Mr. Victor A. M'Cowen. Tenders to the town clerk (Sir Samuel Black), Town Hall, Belfast, by noon of Friday, March 11. See also advertisement.

Londonderry Corporation invite tenders for the supply of carbons, meters and demand indicators for one year from March 31, 1904. Forms of tender, &c., from the borough electrical engineer (Mr. R. V. Macrory), Strand-road, Londonderry. See advertisement.

Kilmarnock Corporation invite tenders for the supply and erection of pipe-work, feed-pump, economiser, jet-condensing plant, &c.; arc and incandescent lamps, posts and gear; lighting and traction feeders, mains, switch pillars and road-work, and electricity meters. Tenders to the town clerk (Mr. W. Middlemas), for arc lamps, &c., by Feb. 29 and for pipe work, &c., by March 14.

The *Great Central Railway Co.* invite tenders for the supply (during the 12 months ending April 30, 1905) of stores and materials, including telegraph and electric light materials, wire, asbestos, &c., packing, glass, iron, indiarubber, oil, screws, signalling materials, &c. Tenders to the secretary (Mr. Oliver S. Holt), London-road Station, Manchester, by March 1.

Wimbledon District Council invite tenders for various stores required during the year ending March 31, 1905, including engine-room stores, cables, joint boxes and jointing materials, transformers, meters, lubricating oils, incandescent lamps and carbons. Tenders to Mr. R. H. S. Butterworth, Council offices, Wimbledon, S.W., by noon March 18.

The Council of the Metropolitan Borough of *Bermondsey* invite tenders for wiring buildings and supply and erection of fittings and materials for the installation of electric light at the generating station, Bermondsey. Tenders to the town clerk (Mr. Frederick Ryall), Spa-road, Bermondsey, London, S.E., by noon March 1.

The Council of the Metropolitan Borough of *Shoreditch* invite tenders for the supply of stores for their electricity works department, &c., for the year ending March 31, 1905. Tenders to the town clerk (Dr. H. Mansfield Robinson), Town Hall, Old-street, London, E.C., by 3 p.m. March 8.

Weymouth and Melcombe Regis Corporation invite tenders for the lighting of their generating station and the supply of electricity meters. Tenders to the town clerk (Sir Richard N. Howard, J.P.) by March 7.

Gainsborough Council invite tenders by March 16 for supply and erection of telephone instruments, fire alarms and connecting overhead wires.

Wallasey District Council require alternating-current transformers for the next two years. Tenders to Public Offices, Egremont, by March 16.

Edinburgh Corporation invite tenders by March 14 for stores for the electricity department for the year ending May 15, 1905. including arc lamp carbons, road box frames and covers, &c.

Wrexham Council invite tenders by March 10 for electrical stores.

Metropolitan Asylums Board invite tenders by March 8 for fire alarms at Caterham Asylum.

Croydon Corporation require tenders by March 1 for coal for 12 months

Torquay Electric Light committee invite tenders by March 1 for steam coal.

Leeds Corporation invite tenders by noon March 3 for coal.

The Department of Posts and Telegraphs, 10, Carretas, *Madrid*, require tenders by March 20 for the supply of 32,000 zinc cylinders for Callaud piles. The upset price is 1,890 pesetas per 1,000 (about £53). The "Madrid Gazette" of Feb. 21 contains additional particulars.

The "Madrid Gazette" of Feb. 20 contains particulars of a quantity of telegraph posts required by the Telegraph Department of the Spanish Government. Tenders to 10, Carretas, Madrid, by March 22.

The "Madrid Gazette" of Feb. 20 also contains particulars of tenders required for lighting the towns of Solana and Membrella for 20 years.

The "Madrid Gazette" of Feb. 21 contains a notice directing a fresh competition to be held for the construction and working of a telephone line from Gijon to Pola de Siero, as no tenders were received when invited on a former occasion. Tenders have to be in by March 20.

TENDERS RECEIVED AND ACCEPTED.

Glasgow Electricity committee have recommended for acceptance the offer of Dick, Kerr & Co. to provide and erect at Port Dundas electricity station two turbine-generators of 3,000kw. each, the turbines to be made by Messrs. Willans and Robinson, at £29,145. The offer of the same firm to provide and erect at Pollokshaws-road station one 1,400kw. steam turbine of their own make, with condensing plant and two continuous-current dynamos by Messrs. Siemens Brothers & Co., at £8,950, has also been recommended for acceptance.

The following contracts have recently been placed with Belliss and Morcom:—

Four engines (through Dick, Kerr & Co.) for direct coupling to English Electric dynamos for Kilmarnock.

Two engines (through Siemens Brothers & Co.) for direct coupling to Siemens dynamos for the English Process Co. (Birkenhead).

One 580 H.P. engine for direct coupling to a 400kw. Westinghouse generator for Chesterfield.

Contracts in connection with the electric lighting of Enniscorthy District Lunatic Asylum have been secured by Thomas Parker (Ltd.) (dynamo), at £699); British Westinghouse Company (engine), £347; Pfluger Accumulator Co. (accumulators), £243; Porte & Co. (wiring), £309); and British Insulated and Helsby (cables), £636.

Glasgow Electricity committee have accepted the tender of the Electrical Co. for the supply and erection of six motor-generators in sub-stations at £9,958.

The Admiralty have placed an order with Babcock and Wilcox for water-tube boilers for the first-class battleships "Britannia," "Hibernia," and "Africa." Each vessel will have 18 boilers.

Babcock and Wilcox have also received an order for boilers for the Italian first-class battleship "Napoli," which will be fitted with 22 boilers.

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London County Council have accepted the tender of F. Hodgson & Son for wiring the Deptford fire station at £185. 17s. and the Old Kent-road station at £157. There were 13 tenders in each case, the amounts varying for Deptford from the accepted to £293. 19s. 6d. and for Old Kent-road from the accepted to £278. 2s. 6d.

London County Council were recommended on Tuesday by the Highways committee to accept the tender of Wm. Griffiths & Co., for the reconstruction for electric traction of the cable tramways between Kennington and Streatham and for the construction of tramways in Tooting High-street and Defoe-road (about 8 miles of single-track) at £86,623. 19s. 11d. There were 10 tenders, varying from the accepted to £128,587. 11s. 3d. The chief engineer's covering estimate was £93,926. The tenders were, however, withdrawn by the chairman.

For the supply of boiler feed pumps for Greenwich power station of the London County Council, tenders were received from 33 firms, some of whom submitted alternative tenders as follows :—

John Cochrane & Co. (*accepted*)	£3,618	Pratchitt Bros.	£4,381
Mather and Platt	8,484	Andrew Bartelay, Sons & Co. (2 tenders)	£4,357 and 4,488
Baker's Patent Appliances Co.	6,735	British Westinghouse Co. (7 tenders)	£4,256 to 5,792
Electrical Mining Co.	6,692	Hunter and English	4,174
Crow, Harvey & Co. (2 tenders)	£6,681 and 6,981	Lancashire Dynamo & Motor Co. (4 tenders)	£4,158 to 4,978
Rhodes Electrical Mfg. Co.	6,580	Johnson and Phillips (4 tenders)	£3,978 to 4,125
R. W. Blackwell & Co, (3 tenders)	£5,312 to 5,470	Frank Pearn & Co.	3,958
Worthington Pump Co.	5,162	Blake & Knowles Steam Pump Wrks (3 tenders)	£3,936 to 5,172
Worth, McKenzie & Co.	5,156	Campbell Gas Engine Co. (2	£3,751 and 4,406
Henry Berry & Co.	5,022	Bruce Peebles & Co.	3,751
Arthur Koppel	5,018	Phœnix Dynamo Mfg. Co. (3 tenders)	£3,711 to 3,876
Ernest Scott and Mountain (2 tenders)	£4,789 and 5,089	Bever, Dorling & Co.	3,659
W. H. Bailey & Co. (2 tenders)	£4,732 and 4,887	J. G. Moore	3,550
Mirrlees-Watson Co. (2 tenders)	£4,635 and 4,745	C. A. Musker	3,545
Coalbrookdale Co.	4,581	Lowmoor Iron Co.	3,410
Goodfellow Engineering Co.	4,459	J. C. Lyell & Co. (incomplete)	3,030
British Thomson-Houston Co. (2 tenders)	£4,453 and 4,456		

Messrs. Cochrane & Co. were allowed to sublet to Bruce Peebles & Co. (or such other person or firm as approved by Council's engineer) the motors and accessories.

For the supply of five additional fuel economisers for Greenwich power station, the following submitted tenders :—

E. Green & Son (*accepted*)	£3,071 6	Arthur Lowcock (Ltd.)	£3,060 0
Goodbrand & Co.	3,165 0	James Carter & Sons (not to specification)	2,518 0
Clay Cross Co.	3,151 0		

Permission was granted to Green & Son to sub-let to the British Thomson-Houston Co. the motors, to the Sturtevant Engineering Co. the starting switches and to R. Wagner the pyrometers.

For the supply and erection of seven railway turntables for Greenwich station the following tenders were submitted :—

Ransomes and Rapier (*accepted*)	£805	T. Larmouth & Co.	£910
J. Musgrave & Sons	2,149	Heenan and Froude	875
R. Hudson	1,253 & 1,393	Isca Foundry Co.	858
Coalbrookdale Co.	1,239	Dick, Kerr & Co.	854
Whessoe Foundry Co.	1,050	Hurst, Nelson & Co.	840
J. and F. Howard	1,050	Cowans, Sheldon & Co.	809
J. Hitchen & Son	1,019	Patent Shaft & Axletree Co.	791
Alex. Penney & Co.	910	Graham, Morton & Co. (not to specification)	721

The Paterson Engineering Co. have received an order from the British Westinghouse Co. for a Paterson combined feed-water softener and grease eliminator for the Northampton tramway power station.

The Anderston Foundry Co have obtained the order for cast-iron yokes, road boxes, &c., required for the reconstruction of the Kennington-Streatham cable tramways of the London County Council.

Lowestoft Town Council have accepted the tender of the Ingersoll-Sargent Drill Co. for electrically-driven plant at the pumping station at £726. There were five tenders varying from the accepted to £1,114.

Bradford Corporation have placed a repeat order with the British Westinghouse Co. for a 1,000kw. direct-current traction generator, which will be vertically divided and run normally at 550 volts, 85 revs per min.

Cardiff Corporation have accepted the tender of Bolckow, Vaughan & Co. for the supply of steel tramway rails (105lb. to 111lb.) at £5. 11s. per ton, and for fishplates, &c.

Swindon Corporation have accepted the tender of J. G. White & Co. for the supply and erection of steel poles, overhead lines, section boxes, arc lamps and accessories at £4,164. 8s. 7d.

Manchester Tramways committee recommend for acceptance the tender of the British Westinghouse Co. for electrical equipment of additional electric tramcars.

Kingston-on-Thames guardians have accepted the tender of Chas. Oldridge & Sons for wiring and fitting up the infirmary for the electric light at £2,074. 10s.

Battersea (London) Borough Council have accepted the tender of C. A. Parsons & Co. for a 750kw. steam turbo-generator at £4,890.

Preston Corporation have accepted the tender of Messrs. Dick, Kerr & Co. for steam and feed piping at £890. 13s. 3d.

The A.B.P. Accumulator Co. have just completed a second order for cells for Sir Thomas Lipton's yacht "Erin."

LIQUIDATIONS, BANKRUPTCIES, &c.

S. H. and J. E. Thompson, electricians, 6, East-street, Plymouth, have been adjudicated bankrupt.

In the bankruptcy of Charles Wallis, electrical engineer, 121, Cleethorpe-road, Great Grimsby, the first meeting of creditors will take place on 27th inst. at 15, Osborne-street, and the public examination on March 3 at the Town Hall, Great Grimsby.

A receiving order has been made against E. E. Clarke, lately electrical engineer, 11, Claypit-street, Camp-road, Leeds. First meeting of creditors 29th inst. at 22, Park-row, Leeds. Public examination March 8 at the County Court House, Leeds.

The first meeting of creditors of Frank Moore, trading as an electrical engineer at 12, St. Paul's-street, Leeds, under the style of Frank Moore & Co., but now of Shipley and out of business, took place at Leeds last week. Liabilities estimated at £65. 19s. 9d., assets 19s. 6d.

Claims against W. H. Hooley and J. W. Talbot, electrical engineers, Regent-street, Rugby, must be in by March 3. Mr. E. T. Peirson, 17, Hertford-street, Coventry, is trustee.

The trustee (Mr. F. Stone, 47, Full-street, Derby) has been released in the bankruptcy of David Roberts, electrical engineer, formerly of Derby.

A meeting of the Electric Resistance and Heating Co. (Ltd.) will be held on March 25 at 130, Dashwood House, London, E.C., to receive an account of the winding up.

Ferranti Limited.—It is announced that a meeting of the creditors of this company will be held at Winchester House, Old Broad-street, London, E.C., at 2.30 p.m. on March 2. The committee of creditors appointed in November last will present a report to this meeting.

Sales by Auction.—Messrs. Wheatley Kirk, Price & Co. have received instructions from the liquidator (Mr. J. P. Garnett) of Heaton and Smith (Ltd.) to sell by auction on March 3 and 4, at 11 a.m. each day, on the premises, Salford Switch Works, Frederick-road, Salford, Lancs., the entire stock-in-trade, work in progress, loose tools and utensils, office furniture and other effects. The catalogue comprises a large number of enclosed motors, switch-boards, distribution boards, electroliers, wall and other brackets, pendants and a variety of fittings, switches, &c. Further particulars are given in an advertisement. Catalogues from Messrs. David Smith, Garnett & Co., C.A., 22, Booth-street, Manchester; Messrs. Parkinson, Slack and Needham, solicitors, 10, York-street, Manchester; or from the auctioneers, Albert-chambers, Albert-square, Manchester, and 46, Watling-street, London, E.C.

Messrs. Percy Huddleston & Co. (acting for the receiver for the debenture holders of the Stewart Electrical Synd., Ltd., in liquidation) will sell by auction in lots on the premises, 57, New Compton-street, London, W.C., on March 1, at 11 a.m., the stock of an electric supply stores, comprising alternating and continuous-current motors, motor fans, rheostats, starters and dimmers, switches, voltmeters, ammeters, current indicators, testing sets, cable and wire, arc and incandescent lamps, carbons, &c., also the goodwill of the business. Particulars and catalogues from Messrs. Bolton, Pitt and Breden, accountants, 140, Leadenhall-street, E.C., from Messrs. H. H. Wells & Sons, solicitors, 16, Paternoster-row, E.C., of the auctioneers, 72, Finsbury-pavement, London, E.C.; or on the premises three days previous to sale. See also advertisement.

Plant for Sale.—The Corporation of Launceston (Tasmania) have for sale alternate-current plant and direct-current arc lighting plant. Some particulars are given in an advertisement. Further information from the city electrical engineer, Town Hall, Launceston, Tasmania.

Electric Lighting Plant Wanted.—Messrs. R. H. Longbotham & Co., Ings Foundry, Wakefield, require electric lighting plant capable of giving 200 amperes at 100 volts. See advertisement.

Electric Lighting at the Automobile Show.—The electric lighting at the recent automobile show was carried out by Electric Lighting Boards (Ltd.). Over 10,000 8 c.p. lamps were installed on upwards of 150 exhibitors' stands, in addition to a large number of motors for driving exhibits. Current was supplied by the company, who put down at short notice a complete electric lighting plant in the Palace grounds, including the necessary building for the power house.

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The plant consisted of one 80 H.P. portable engine belt-coupled to a Crompton 250-ampere 220-volt dynamo, one 35 H.P. vertical open-type engine belt-coupled to a Crompton generator, two compound open-type vertical engines direct-coupled to Johnson and Phillips 35kw. shunt-wound generators, two simple engines direct-coupled to Johnson and Phillips dynamos, and three 40 H.P. gas engines driving generators by belt. Steam was supplied at 100lb. per square inch by three locomotive type boilers, and flexible steam piping was used from boilers to engines. Cables were taken from the generators to a switchboard attached to the main switchboard in the Egyptian Court, and supplied by Messrs. Nalder Bros. and Thompson. This switchboard was of white marble and consisted of nine dynamo panels, each having a shunt regulating switch, double-pole switch and fuses, and ammeter and voltmeter. The distribution panels carried 13 100-ampere ways, each of which was provided with double-pole switch and fuses, and an ammeter. All nine generators were running in parallel, and, despite the variety of plant which was employed, little difficulty in regulation was experienced. Cables were carried from the board to distribution points under the floor of the Palace. From each distribution point cables were taken to the various stands, the looping system being adopted in case of the smaller stands. The distribution cables were of the E.L.B. type and every stand in the show was wired on the E.L.B. system. The plant and apparatus was erected in three weeks from the opening of the show.

The Paris automobile show and the New York automobile show were illuminated on the E.L.B. system, which is also being employed at the St. Louis Exhibition, 1904.

British Aluminium Co.—This company state that it has been again found necessary to increase the capacity of the Foyers works by the erection of two more series of aluminium furnaces.

Ferro-bleach.—We have received from Mr. W. Tylar, 41, High-street, Aston, Birmingham, a sample bottle of a compound known as "Ferro-bleach," for writing on blue prints. When used with an ordinary pen, the result is clean white writing, which, it is said, does not rot the paper. The preparation is already mixed, and this is, perhaps, its chief advantage over a solution of common washing soda, which, as a rule, is found to answer most practical purposes.

Directories, &c.—The 1904 issue of Garcke's "Manual of Electrical Undertakings" is just issued, and is replete with maps and statistical data and information of electric supply and tramway undertakings. Some of the information contained in this work is not to be obtained elsewhere. This especially applies to financial information given. Much of this information is, unfortunately, somewhat stale, from the fact that both company and municipal accounts are made up to periods long anterior to their actual publication, although they are the latest figures available, the financial status of the undertakings to which they refer may, by capital commitments, debenture, or other issues, &c., be materially modified. The get-up of the book is all that can be desired. The published price is 15s. nett, and copies can be obtained at Mowbray House, Norfolk-street, London, W.C.

We have also to acknowledge the edition for 1904 of the Directory of Electric Lighting and Traction, edited by Mr. C. S. Vesey Brown and published by Messrs. Hazell, Watson & Viney, price 10s. 6d. net. Like all publications designed for meeting the requirements of the electrical industries, this work becomes each year of increased bulk. The book is admirably arranged and is well printed.

Amongst the welcome annuals which come to hand with unfailing regularity we may mention "Who's Who," published by Messrs. A. and C. Black at 7s. 6d. net. In spite of the fact that a large tabular section has been removed from the book this year and is published separately, "Who's Who" for 1904 has increased in size and contains personal particulars of nearly every name of note within the British Empire. In a mass of matter of this character there must occur inaccuracies, but taken as a whole, we have found the biographical sketches very readable and accurate.

Messrs. A. & C. Black do not confine their attention to the male sex, and have published what we feel sure is an excellent and useful work for the ladies. The 24th annual issue of "The Englishwoman's Yearbook and Directory" gives evidence of careful compilation.

Catalogues, &c.—The General Electric Co., who have for many years supplied the E.C.C. dry cell, write us:—

We have frequently been asked for a dry cell which could be kept in stock for an indefinite period without deterioration. After a series of exhaustive experiments we are now placing on the market such a battery, which we term the extra sec E.C.C. cell. This contains all the necessary ingredients for satisfactory working with the exception of the exciting fluid, and it is only necessary to pour a saturated solution of salammoniac into the opening provided for the purpose to excite the battery and render it ready for use. In one form the salammoniac solution is received by an absorbent material which prevents its escape even though the cell be upset. In another type this absorbent material is absent, and consequently, if the cell is required to be put out of action for some considerable time, the salammoniac solution can be poured out, to be replaced when the cell is again required for use. The output obtained from the battery is large, each cell being capable of giving continuously a current of ¼ amp. for 380 to 400 hours. The electrodes are so arranged as to be extremely close to each other; at the same time the construction of the cell renders damage from short-circuit impossible, and the arrangement is such that the supply of the salammoniac solution between the electrodes is well maintained when once it is excited. These two facts reduce the internal resistance to a minimum. The battery is specially serviceable for use in hot climates and for export purposes generally.

The General Electric Co. have also ready a new pamphlet dealing with "Geeko" fire alarms. Concise and full particulars for the proper installation of a complete fire alarm system are given. The apparatus shown includes some of the latest and best ideas put forward by the company for this class of work. For an automatic fire alarm which is illustrated in the list the company obtained a gold medal at the recent International Fire Exhibition at Earl's Court. Other lists issued by the General Electric Co. include the "Progress Sheet" for February, which illustrates a new type of switch, the "Quadrant," and some new designs of glass ware.

Messrs. C. J. Thursfield & Co., Clement-st, Birmingham, have ready a new catalogue and price list of artistic fittings for electric lighting, including an extensive variety of high-class brackets, pendants, lanterns, electroliers, &c. Some very choice designs are shown, many of the hand-wrought ceiling fittings, electroliers and lanterns being particularly effective. A sheet of repoussé switch covers is included.

Messrs. Pinching, Johnson & Co., of 23, Billiter-street, London, E.C., have ready a catalogue of insulating varnishes.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Feb. 17 to 23, with the ports of destination:—

Africa—Alexandria, £40 and 78 loads telegraph poles; Cape Town, £835 (including £139 telegraph material); Durban, £2,898 (including £686 telegraph material); East London, £1,487; Port Elizabeth, £52. *Argentina*—Buenos Ayres, £109. *Australasia*—Auckland, £95; Fremantle, £50; Hobart, £100; Melbourne, £117; Sydney, £2,781 (including £2,450 telegraph material); Wellington, £1,754 (including £1,744 telegraph material). *Belgium*—Antwerp, £222; Ostend, £20. *Canada*—Halifax, £55. *Ceylon*—Colombo, £180 (including £110 telegraph material). *Channel Islands*, £13. *China*—Shanghai, £526. *France*—Paris, £64. *Germany*—Hamburg, £360. *Gibraltar*, £20. *Holland*—Amsterdam, £32. *Hong Kong*, £304. *India*—Bombay, £59; Calcutta, £2,602 (including £1,762 telegraph material). *Malta*, £39. *Japan*—Yokohama, £2,284. *Portugal*—Lisbon, £31. *Russia*—Reval, £127; St. Petersburg, £1,312 (telegraph cable) and 131 cwt. telegraph paper. *Straits Settlements*—Singapore, £130. Total £16,698, against £19,394 in the corresponding week last year (Feb. 18 to 24).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Testing of Electromagnetic Machinery, and other Apparatus." By B. V. Swenson and B. Frankenfield. Vol. I. Direct Currents. (London: Macmillan & Co.) 12s. 6d.

"The Law Relating to the Telegraph, the Telephone and the Submarine Cable." By Evelyn G. M. Carmichael. (London: Knight & Co.) 10. 6d. net.

"O'Gorman's Motor Pocket-Book." By Mervyn O'Gorman. (London: Archibald Constable & Co.) 7s. 6d.

"Table of Multiplication, Division and Proportion for the Ready Calculation of Quantities and Costs, Estimates, Invoice Prices, Interests and Discounts, Weights and Strengths, Wages and Wage Premiums." By Robert H. Smith. (London: Archibald Constable & Co.) 6s.

"Entropy; or Thermodynamics from an Engineer's Standpoint, and the Reversibility of Thermodynamics." By James Swinburne. (London: Archibald Constable & Co.) 4s. 6d.

"Proceedings of the Royal Society." No. 482, Vol. LXXIII. (London: Harrison & Sons.) 2s.

"The Tariff Dictionary: A Compendious Handbook to the Fiscal Question." (London: Simpkin, Marshall, Hamilton, Kent & Co.) 2s. 6d.

"Hie Europa! Hie Amerika!" By Jul. H. West. (Berlin: Franz Siemenroth). 1m.

"Graphs and Imaginaries." By J. G. Hamilton and F. Kettle. (London: Edward Arnold.) 1s. 6d.

"The Common Sense of Municipal Trading" By Bernard Shaw. (London: Archibald Constable & Co.) 2s 6d.

"Les Cables Sous-Marins Travaux en Mer." By Alfred Gay. (Paris: Gauthier-Villars.) 2fr. 50c.

"Circulating Tables and Collection of Frequently Used Numerals." By Dr. H. Zimmermann. (Berlin: Wilhelm Ernst & Son.) 6s.

"Wireless Telegraphy: its Origins, Development, Inventions and Apparatus." By C. Henry Sewall. (London: Crosby Lockwood & Son.) 10s. 6d.

"Simple Experiments in Static Electricity." By Percival G. Bull. (London: Percival Marshall & Co.) 6d.

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PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parenthesis are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December 23, 1903.

28,252 L. SUNDERLAND. Electric lighting batten and preventing confusion of colours by lamps therein.
28,268 F. DERRY. Construction of galvanic elements for medico-electric generating apparatus.
28,290 R. A. FESSENDEN. Wave telegraphy.*
28,291 R. A. FESSENDEN. Receivers for electromagnetic waves. (Date applied for April 9, 1903, date of application in U.S.)*

December 24, 1903.

28,324 C. J. SIMEON, T. S. J. B. PARNALL and W. E. HIPKINS. Birmingham. Automatic weigher for coal or other flowing materials elec rically controlled.
28,334 H. H WILSON. Trolleys.
28,349 F. O. V. DE KASTEELE. Voltmeters.
28,355 C. B. ROBERTSON. Trolley catchers.*
28,399 F. T. SNYDER. Magnetic ore separator.*
28,400 F. F. HUNT. Production of hydroxides and oxides of metals by electrolysis.*
28,401 C. PERDRISAT. Arc lamps.

December 28, 1903.

6,899A C. L. WALKER. Thermostats. (Date applied for, March 25, 1903).
28,417 E. WEINTRAUB. Electric vapour lamps. (Date applied for Dec. 26, 1902, date of application in U.S.)*
28,422 S. W. QUICK. Blackpool. Electric door-handle alarm.
28,445 F. BARRITT and W. A. FRASER. Manchester. Trolley pulleys.
28,453 J. CROWTHER and W. HORSFALL. Withington. Electrical motor starting switch.
28,494 E. SPEYER. Indicating devices for use with telephones, &c.
28,503 A. G. BLONAM. (Société anonyme d'Etudes Electro Chimiques, Switzerland.) Electrolytic extraction of zinc from its ores, and apparatus therefor.
28,514 G. KAMM. Electric stand lamp.
28,520 R. H. FLETCHER. Socket for making temporary electrical connections.

December 29, 1903.

28,545 W. G. HEYS. For covering wire with insulation. (Walter E. Ammon, U.S.)* Manchester.
28,553 A. ECKSTEIN and A. E. ANGOLD. Manchester. Construction of arc lamps.
28,557 E. T. GOLDBURGH. Terminal connection protector.
28,568 J. HONEY. Section insulators for electric tramways.
28,574 H. S. SOUTTAR and T. HAMILTON-ADAMS. A combined switch and fuse.
28,580 G. E. GAIFFE. Transformers employed in high frequency circuits.
28,601 G. B. BOWELL and PEARSON FIRE ALARM. Automatic fire alarm systems.
28,607 F. G. BAILY. Edinburgh. Fuse holders, fuse boxes and the like.

December 30, 1903.

28,623 H. S. MARTIN. Liverpool. Joint box for conductors.
28,632. L. M. WATERHOUSE and SIMPLEX STEEL CONDUIT CO. Liverpool. Metallic conduits.

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

23,262 BLONDEL Manufacture of electrodes for arc lamps.
27,850 HALL. Electric lighting of vehicles.
23,071 RIEDER. Alternating-current systems and switches therefor.
28,588 THOMSON, Baron KELVIN, and KELVIN AND JAMES WHITE (LTD). Magnetic brake and damper of vibrations.
28,857 PIEPER. Switches.
28,932 HILL. Safety apparatus for overhead electric tramways.
28,950 MACKENZIE (Miller, Stiles and Kelloway). Electric signalling apparatus.

1903.

25 HALL. Trolley electric tramways.
117 HEYLAND. Commutators for polyphase currents.
143 CHAMBERLAIN AND HOOKHAM and WATTS. Electrical measuring instruments.
165 FISCHER and SCHNEIDER. Machines for making couplers for wires.
174 RICHMOND and CAREY. Electric control of lifts, hoists, &c.
175 WILLIAMS. Promoting electric discharges across a dielectric gap.
414 HALL. Thermostats.
541 POULSEN. Storing and reproducing audible messages and signals.
702 B.T.-H. Co. and HOLDEN. Electric measuring instruments.
870 MADIGIN. Storage or secondary batteries.
1,068 CAROLAN (G.E. Co., U.S.). Generating and distributing alternating current.
1,077 BOULT (Hoffmann). Couplings for wires.
1,259 LOGAN. Electrical motors, dynamos and the like.
1,676 MEYGRET. Electrodes for accumulators.
1,540 ELECTRIC AND ORDNANCE ACCESSORIES Co. and ARON. Metering and registering electrical energy to be charged for under varying conditions of supply.
1,776 HUNTER and HULME. Switches.
2,212 ROSS. Supporting standards and trolley arms.
2,273 B.T.-H. Co. and HOLDEN. Electrical measuring instruments.
2,284 HALL. Starting and regulating gear for electric motors.
2,429 WATSON. Make-and-break mechanism of induction coils.
2,512 LAYBOURN. Incandescent lamps.
2,541 RAY. Signalling apparatus for automatic reply telegraphs.
2,609 LEWIS. Arc lamps.
2,746 CRAIG. Electric service main and other switches.
2,805 JENATZY. Magnetic clutches.
2,930 MUNRO. Couplings for conduits for conductors.
3,080 BRANDER. Combined telephone transmitter and automatic switch.
3,444 LE TALL (Cooper Hewitt Electric Co.). Luminous gas or vapour lamps.
3,572 GROVES. Electrical measuring instrument.
3,783 JOHNSON and BIRCHAM. Electric light safety relay.
3,705 CROMPTON & Co. and GOLDSCHMIDT. Single-phase alternate-current motors.
3,825 HEYWOOD and HEYWOOD. Switches.
3,957 WOODYER and MAYNER. Electric fittings.
4,089 DOBRZANSKI and HUSCHAK. Electric block signalling or brake operating device.
4,388 PAUL. Resistances.
4,390 STEVENSON. Chain and pulley utilised for raising and lowering weights at any part of a curve and protecting conductors from the moving rope.
4,557 LEWIS. Arc lamps.
4,618 BEST. Electric lighting of miners' safety lamps.
4,727 MECHWART, COLTRI & Co. Resistance regulators and starting switches for shunt motors. (Date applied for Aug. 29, 1902.)
4,973 COLLET and SOMERVILLE. Collapsible electric light fitting or bracket.
5,169 CAROLAN (G.E. Co., U.S.) Rheostats.
5,204. VICKERS and ANDREWS. Brakes for electric tramcars.
5,291 CAROLAN (G.E. Co., U.S.). Dynamo-electric machines.
5,449 CAROLAN (G.E. Co., U.S.). Oscillating fans.
5,480 BOULT (Electric Contract Co.) Electric gas lighters.
5,572 RATHBONE and SMITH. Arc lamps.
5,845 JOEL. Construction of electrodes for storage batteries.
5,873 HAMILTON-ADAMS. Arc lamps.
6,102 ZIEGENBERG. Electricity meter.
6,145 FENNELL and PERRY. Storage batteries.
6,180 BOULT (Societa Romana Solgati). Treating aluminium ores to obtain alumina and other products.
7,027 BLONAM (Soc. Electro-Métallurgique Française). Production of iron and steel.
7,335 CHAMBERS. Electric collector shoes for insulated third rail.
7,955 DAUNCEY. Electric couplings.
9,571 FELDKAMP. Storage batteries.
10,395 EVERED & Co. and EVERED. Incandescent lamp holders.
10,772 BINKO. Electric heaters and stoves.
10,814 EDWARDS (Mallet and Parent). Electric mining safety lamps with portable accumulators and charging devices.
11,316 SIEMENS BROTHERS & Co. and FERREIRA. Electrically controlled semaphore signals.
11,323 BOULT (Electric Storage Battery Co.) Switches for batteries.
12,101 ANGOLD, HILL and SIR HIRAM MAXIM ELECTRICAL AND ENGINEERING Co. Arc lamps.
12,521 OTTO. Medical ozoniser.
13,547 BLONDEL. Exciting and regulating alternating current motors and alternators having collectors. (Date applied for June, 17, 1902.)
14,994 BOULT (Koch). Obtaining direct-current impulses from a high tension alternating current source, particularly for use with Röntgen and similar tubes.
15,821 HIBBERT. Magnetic balance and galvanometer.
16,190 LAKE (Compagnie de l'Industrie Electrique et Mécanique). Prevention of electric shocks in systems of electric distribution.
18,416 KERN. Insulated ferrules and tips. (Date applied for, August 26, 1902).
18,934 PRATT and VINCE. Storage batteries.
21,216 EAVER. Electric railways.
21,306 BURKE. Electric lamps.
21,405 SIEMENS BROTHERS & Co. (Siemens and Halske A.-G.). Electric energy meters.
21,653 CLARK and THOS. E. CLARK (Wireless Telegraph-Telephone Co.). Coherers for wireless signalling.
22,456 BOWELL and PEARSON FIRE ALARM. Fire alarm apparatus.
22,532 GIRDLESTONE and THORKELIN. Arc lamps.
22,538 EASTERFORD. Automatic fire alarm.
22,680 DORMAN. Coherers for wireless telegraphic systems.
23,121 PAGE (Weber Railway Joint Mfg. Co.). Rail joints for electric railways.
23,226 GORHST. Electrically illuminated signs.
23,260 NEWTON. (Eltypic Mfg. Co.) Receiving instruments of printing telegraphs.
23,482 ROSSAT. Secondary batteries. (Patent applied for, Nov. 24, 1902.)
23,557 STECKEL. Electric clutch and brake mechanism.
23,647 MCLAUGHLIN. Arc lamps.
23,854 IMRAY. (Siemens-Schuckert Werke. G.m.b.H. method of effecting a phase-shift of 90deg. or more between pressure and field in shunt circuit of alternating current meters.
24,914 REUTER. Engaging devices and magnetic lifting contrivances for cranes.

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25,026 WARNER AND WARNER. Magnetic tachometers.
25,028 GALWORTHY and LONDON ELECTRICAL FITTINGS Co. Adjustable electric light pendants or fittings.
25,053 MILNE. Electric lighting and power systems.
25 150 HONOLD. Generators for electric ignition of explosion engines.
25,451 HADDAN (trading as Samuel Zielenziger). Arc lamps.
25,677 PEARSON, CUTCHEON and WILLIAMSON. Protecting electrical windings from static strains.
25 814 WILLENBUCHER. Trolley heads for electric tramcars.
25,885 WOLFENDEN. Securing shades, &c., to incandescent lamps.
26,043 CÉSAR and GUARINI. Railway signalling by means of a line circuit.
26,248 RANDALL. Telephone transmitters.
26,380 JOHNSON (Elektricitäts A.-G. vorm. W. Lahmeyer & Co.). Safety fuses for electric circuits.
26,792 WILSON. Electric sanitary closets.
27,196 HUNTER. Switches.

COMPANIES' MEETINGS AND REPORTS.

Westminster Electric Supply Corporation (Ltd.).

The ordinary general meeting was held on Wednesday, Lord SUFFIELD presiding.

The SECRETARY (Mr. Frank Iago) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: I am pleased to be able to again congratulate you on the satisfactory progress of the company's business, and on the fact that the directors are in a position to recommend the payment of an increased dividend and to carry forward a satisfactory balance. The equivalent of 59,153 lamps of 8 c.p. have been added to the circuits during the 12 months ending Dec. 31, and applications continue to be received at a satisfactory rate. A feature of the year has been the increasing demand for current for power for business purposes, such as motors, passenger lifts, builders' hoists and the charging of batteries for motor cars; and this demand is a most promising field for the extension of the business in addition to the ordinary demand for lighting, which continues to grow. The sales of current since the beginning of the new year show that the usual rate of increase in profits is well maintained. The rate of charge per unit fixed for the current to be taken from the Central Company this year will show a substantial saving over last, and as the load increases at the station in St. John's Wood, we are advised the cost will eventually be considerably reduced. In order to meet the growing demand for electric energy, the Board have acquired a long lease from the Duke of Westminster of an excellent site for an underground station in Mayfair, and in close proximity to our generating station in Davies-street, for the purpose of transforming the current received from the Central Company's station. The work is proceeding satisfactorily, and the station will be ready for work in time for the heavy load of next winter. With regard to the public lighting in the City of Westminster, we are now supplying and maintaining 952 arc and 202 incandescent lamps, which continue to give every satisfaction. He concluded by moving the adoption of the report and accounts.

This was carried unanimously, as was also a resolution approving the dividend at the rate of 14 per cent. per annum.

Mr. ERNEST LAW asked whether the directors anticipated that in future the corporation would make further sound and good profits out of the business of supplying energy. This was a branch of electric supply which in some cases in the North, and also in certain parts of London, he believed, was proving every day more remunerative. He would also like to know whether the corporation reduced the charge for current supplied for lighting purposes below the level of the ground floor. He understood that the St. James' Company did so, and that they did a large and growing business in that respect for the basements of large warehouses, shops, restaurants, and so on.

The CHAIRMAN said every attention was being given to the points raised, and to other points as well.

Prof. A. B. W. KENNEDY (Engineer-in-Chief) said, in reply to Mr. Law's first point, that the amount of current sold for energy had increased very largely during the last two years, and especially during the last year. The corporation had been charging a lower rate, which made it worth the while of those who required power for lifts and builders' purposes, and many other purposes, to take it. But, of course, it must be recognised that Westminster was not an industrial part of London, and never would be unless the nature of the buildings was altered very much. They could not, therefore, expect so large a demand as in districts where there were a great many factories. Nevertheless, that part of the business had increased in a gratifying manner during the past year or two.

In reply to a question, the chairman said the directors had no increase in the company's capital in contemplation.

The retiring directors were then re-elected, and a hearty vote of thanks to the chairman and directors, and to the engineer-in-chief and the staff, for their able services terminated the proceedings.

BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)—The directors' report for the year ended Dec. 31 states that the credit balance, with £2,909. 14s. 5d. from previous year, is £13,950. 16s. 3d. After deducting interest and interim preference dividend there remains £8,001. 4s. 1d. It is proposed to pay the balance preference dividend, put £1,250 to depreciation, and carry £5,219. 19s. 1d. forward. The equivalent of 8 c.p. lamps connected at the end of the year was 60,540, an increase of 15,624, and consumers show an increase of 500. Gross revenue was £19,450. 1s. 10d., expenditure £8,409, increases of £5,115. 16s. 8d. and £1,430. 6s. 2d. respectively. In virtue of the company's Act of 1903 the undertaking of the Lewisham and District Electric Supply Co. was transferred to the company as from Sept. 30. The directors have entered into a provisional agreement for the purchase of the undertaking of the Crystal Palace District Electric Supply Co., whose area of supply connects the separated areas in Lewisham and Penge acquired from the Lewisham Company.

BROCKIE-PELL ARC LAMP (LTD.)—Sir Frederick Dixon-Hartland, M.P., presided at the adjourned meeting on Thursday last week, and said he was sorry the report was not so good as on the previous occasion. Their company was not alone in that respect, many competitors being in the same position. The cause of their failure to earn a dividend was that it had not had so much work to do as in previous seasons. This falling off was not the fault of the company. Three years ago there were only three or four tenderers for any contract, but now there were 18 to 20, and in some cases the prices given were actually less than cost of manufacture. Competition was the sole cause of the company being unable to make a profit. He thought it would be advisable for the company to have a managing director appointed to the board who would give the whole of his time to the company, and be responsible for the whole of the work being carried on in the most efficient way. The directors had before them the names of men, and hoped to be able to appoint one shortly. He never pretended to be well up in the electrical portion of the business, but only attended to the monetary portion. He held 1,000 shares, and had never parted with any of them. The directors had the interests of the company at heart, and would look carefully into any suggestions of a practical nature that were proposed. The directors' report and accounts were, after some discussion, adopted. The chairman proposed that a committee of three shareholders (with power to add) be appointed to confer with the directors as to the position of the company, and this was adopted.

CROSSLEY BROS. (LTD.)—The report for 1903 states that the amount at the disposal of the directors is £118,681, out of which the preference dividend has been paid, and a dividend on the ordinary shares at the rate of 10 per cent. per annum, leaving £80,081. It is now proposed to pay the balance preference dividend and at the rate of 12 per cent. per annum on the ordinary (making 11 per cent. for year), leaving £35,777. As this balance is unusually large and a shrinkage in the value of investments has been taking place for some years (amounting to £17,000 on the £130,000 invested), the directors recommend that the invested funds be written down by this amount, and that £18,777 be carried forward.

ENGINE, BOILER AND EMPLOYERS' LIABILITY INSURANCE CO. (LTD.)—The chairman (Mr. M. Longridge), at the meeting last week, congratulated the shareholders upon the steady progress made. No boiler insured by the company had exploded during the year, and no fatal accident had occurred or even a case of personal injury from such accidents as were covered by the company. The directors were glad that six years ago they decided to steer clear of workmen's compensation and third party risks and to confine their operations to the technical branches for which they were specially equipped. The claims for damage to steam and gas engines and also to electrical machines had again been numerous, but their number and seriousness had doubtless been minimised by periodical inspections, which were the principal feature of the company's work, and caused a higher percentage of expenditure than in any other class of insurance. A dividend at the rate of 3s. per share was declared for the half-year ended Dec. 31, £6,000 was added to reserve, the special reserve for current risks was increased by £1,000 and £500 was written off furniture and instruments, in addition to the usual depreciation, leaving £3,060 to be carried forward.

HART ACCUMULATOR CO. (LTD.)—The directors' report to Dec. 31, 1903, states that the profit for the year is £5,860. 5s. 2d., and with balance from last year (£4,877. 5s. 6d.) the sum of £10,737. 10s. 8d. is available, out of which the directors recommend payment of a dividend of 12½ per cent. per annum on the ordinary shares, absorbing £5,000 and leaving £5,737. 10s. 8d. to be carried forward. The buildings, plant, tools, &c., have been augmented by £1,790. 7s. 3d., charged to capital, and due depreciation on same has been made. The maintenance of works, plant, &c., has been well kept up at a cost of £724. 5s. 8d., which has been paid out of revenue.

An extraordinary meeting of shareholders will be held after the ordinary meeting on March 2 to authorise an increase in the capital from £40,000 to £60,000 by the creation of 20,000 new £1 preference shares.

LONDON UNITED TRAMWAYS (1901) (LTD.)—Mr. S. White presided at the meeting on Monday (in the absence through illness of Mr. C. T. Yerkes). Mr. White said their traffic income for the year had increased by £280,241, and the expenses by £56,000 to £176,000, the net profit amounting to £108,107. After payment of interest and preference dividend, as well as the interim dividend on the ordinary shares at the rate of 8 per cent., they were enabled to devote the remaining balance to the payment of a dividend of 8 per cent., making 8 per cent. for the year. The act obtained by the company last year would effect the conversion to double track of a number of inconvenient short lengths of single-line, as they could acquire by compulsion a number of properties on the existing route.

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METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—At the meeting on Wednesday the chairman (Mr. E. Garcke) gave details of the various undertakings of the company. (Some of these ventures were set out in our last issue.) Referring to the question of the system of electric traction to be adopted on the lines of the North Metropolitan Tramways, on which point they were in correspondence with the London County Council, Mr. Garcke said before they committed themselves to the conduit system they were entitled to know what had been the cost of construction and of working, and he did not think the County Council knew at present what was the cost of working on that system on the southern tramways. Until that was known it would be more prudent, if the convenience of the public were to be studied, that the overhead system, the conditions of which were thoroughly well understood, should receive preference. They had made an agreement with the Middlesex County Council by which the Council approved of the company obtaining from the North Metropolitan Electric Power Supply Co. the current required for working the 11½ miles of light railways which were to be leased by the Council to the company, and the price to be charged for current was one which would leave a fair return on the capital invested in the plant and undertaking of the Power Company. Two acts had been obtained by the Power Company, giving a right to supply electricity in bulk over an area of something over 300 sq. miles in Middlesex, Hertfordshire and Essex, the rights being held in perpetuity. The Power Company had been engaged in erecting an extensive power house at Brimsdown, near Enfield, and had purchased a large power house from Willesden Council. He had no doubts as to the highly successful and prosperous character of the undertaking.

NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)—The chairman (Mr. F. H. Thornton) at the meeting on Thursday last congratulated the shareholders upon another prosperous year. The income had been temporarily affected by the reduction in the price of current. The mains had been largely extended with the object of opening up important manufacturing and residential districts. A few months since they received an intimation from the City Council to re-open negotiations for the purchase of the company's undertaking, and if matters proceeded further the directors would call together the shareholders. It was proposed to pay the balance preference dividends, a dividend on the ordinary shares at 4½ per cent., and to carry forward £209. 12s. He congratulated his chief engineer and staff on the efficiency and smartness with which the additional works carried out during the year had been conducted, and said the company was the first in England to have their accounts ready for the official auditor. They had 251 H.P. at work in motors, against 150 in 1902, and the number of consumers had increased from 580 to 704. They might have paid another ½ per cent., but it was thought bestto pursue a steady policy in view of what they had to do. He also drew attention to the great reduction in working expenses, the coal bill had been reduced 12 per cent., and he compared favourably with any station of their size in England.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—The annual report of the directors to Dec. 21, states that expenditure on capital account has been increased during the past year by £6,077. 7s., bringing it up to £216,335. 3s. 1d. £2,125. 15s. 3d. was for new mains and £2,297. 9s. 8d. for a new 500 H.P. motor generator at Bulmer-place station, and £710. 9s. 5d. for converting the leasehold property in Lancaster-road into freehold. Debentures for £5,000 were issued to meet this expenditure. The number of consumers is now 2,052, representing an equivalent of 116,360 8 c.p. lamps connected (against 99,497 in 1902), 97 per cent. are supplied at 200 volts. The gross revenue showed an increase of £605 and the net profit an increase of £408. The net profit would have been larger by about £5,100 had the charge for current been the same as that for 1902. The directors were under agreement with the local authority to reduce the charge for current from 6d. to 5d., and the result was that practically the whole of the profit arising from fresh business was absorbed. The reduction promises, however, to result in an increase of business. There has been transferred out of profits to depreciation, renewal, and reserve accounts £1,250, and £1,030. 11s. 6d. has been paid to the trustees of the cumulative sinking fund of the Joint Debenture stock. From the net profit remaining is to be deducted interest (£2,155. 14s. 4d.), and (£1,966. 16s. 3d.), leaving £8,606 15s. 4d. available for dividend. The directors recommend payment of the usual dividend of 6 per cent. on the ordinary shares and 6 per cent. on the preference shares (already paid). This absorbs £8,310, and the balance is to be divided, one-half to founders' shares undivided profit account and one-half to other classes of shares. The directors also recommend a dividend of 5s. per share on the founders' shares.

OXFORD ELECTRIC CO. (LTD.)—The directors' report for 1903 states that the profit (including £276. 3s. 1d. from last year) was £10,545. 3s. 1d. After providing £2,040. 17s. 2d. for interest and writing off £623. 15s. 3d. on account of hire-purchase installations, the available balance is £7,880. 10s. 8d., which it is proposed to appropriate in payment of a dividend at the rate of 6½ per cent. per annum (2½ per cent. was paid in September), absorbing £4,550, in adding £2,500 to reserve and renewal of plant account, the balance (£830. 10s. 8d.) being carried forward. The equivalent of over 55,000 8 c.p. lamps were connected to the mains on Dec. 31, and the number of units sold was 12 per cent. more than in 1902. The capacity of the generating plant has been increased by 375kw., and three additional sub-stations have been installed. Extensive additions to the mains have also been made.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)—The fortieth annual report of the directors states that the accounts for the year show a net profit of £108,738. 2s. 4d. after charging interest on debentures. To this sum is added £101,385. 14s. 11d. brought forward, making a total of £210,123. 17s. 3d. From this amount is deducted the interim dividend of 5 per cent., paid in July last, amounting to £22,410, leaving £187,713. 17s. 3d. to be dealt with. The directors now propose to distribute a dividend of £1. 4s. per share, together with a bonus of 12s. per share, absorbing £67,230 (being at the rate of 15 per cent., and making the total dividend and bonus for the year £2. 8s. per share, or 20 per cent., tax free), leaving £120,483. 17s. 3d. to be carried forward. The company's factories at East Greenwich and Wharf-road have been actively engaged during the year in the manufacture of submarine telegraph cables and of insulated wire for landlines. The company's steamships have been employed in cable-laying operations as well as in the carrying out of repairs of submarine cables. The company's factories and steamships have been efficiently maintained and are in excellent order and repair.

The shareholders will be asked at the forthcoming meeting to approve a form of trust deed constituting a pension fund for the benefit of the company's staff and their dependents, and to saction the payment to trustees, to be appointed under the deed, of £67,085. 3s. 6d. appearing in the balance-sheet as set apart for that purpose.

The transfer books will be closed from 22nd inst. to March 1 inclusive, preparatory to payment of the above-mentioned dividend.

YORKSHIRE ELECTRIC POWER CO.—At the meeting on Tuesday the chairman (Mr. A. G. Lupton) said that they had acquired a site for their Thornhill station. The cost of obtaining their act and of the issue of capital had also been paid, amounting to £47,746. The balance in hand in December (£17,585) had enabled the directors to delay making the next call on the shareholders. In the next few months, however, they would have considerable payments to make for buildings and machinery, and further calls would be made. The wet weather had caused difficulty to the contractors and some delay, but the work was proceeding to the satisfaction of their consulting engineer. They had entered upon negotiations with several local authorities for the supply of electricity in bulk, and were being met in a very friendly spirit In some half-dozen cases powers were being sought by local authorities to supply electricity outside their own areas. They would be in direct competition with the company, and therefore the directors had felt it necessary to oppose them. Some were asking for exceedingly extended powers, not only in their own districts, but enabling them practically to go all over the kingdom. He believed that many of the clauses had been put into the bills by Parliamentary agents, probably without the knowledge and certainly without the full appreciation of the authorities concerned. The opposition of the company was confined to the point of supplying outside municipal areas. The company had no objection to, indeed, they would do all in their power to assist local authorities who wished to distribute power in their own areas. They would be prepared to undertake contracts for the supply of current by December next. He could not prophesy a dividend at the next meeting, but he hoped they would be able to show definite results in the way of customers on the books, current sold, and work done.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26 1/16d. per oz. (Feb. 25). Consols 86 5/16—86 5/16 for money, 86 5/16—86 5/16 for account; 2½ per cent. annuities 86—86½ (Feb. 25). Consols Pay Day, March 1; Stocks and Shares Continuation Days, March 8 and 26; Ticket Days, March 9 and 27; Pay Day, March 10; Mining Share Carry-over Days, March 7 and 25.

BELFAST STREET TRAMWAYS CO.—A dividend of 5½ per cent. has been declared. The Corporation have lodged their bill empowering them to take compulsory possession of the company's undertaking on Jan. 1 next, instead of waiting, as provided in their agreement, until after Aug. 10, 1907. The company are opposing the bill.

ELECTRICAL ENGINEERING AMALGAMATION IN GERMANY.—The Allgemeine Electricitäts Gesellschaft, of Berlin, have acquired a large financial interest in the firm of Brown, Boveri & Co., of Baden, Switzerland, and Mannheim, Germany, and it is proposed to increase the capital of the Allgemeine Co. by 3,500,000 marks for this purpose.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—The directors recommend a dividend of 3 per cent. per annum for the past year.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—The report for 1903 states that an interim dividend of 2½ per cent. has been paid, and a further distribution of 4½ per cent. is proposed, making 7 per cent. for the year. £11,030 was expended on capital account during the year. The number of consumers increased from 785 to 830, and the total revenue had been £11,232, against £10,273. An agreement has been entered into with Scarborough Electric Tramway Co. for the supply of power for their tramway service.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to allow the further issue of £68,533 4½ per cent. first mortgage debenture redeemable stock of *Edmundson's Electricity Corp. (Ltd.)* to be quoted in the official list.

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IMPERIAL TRAMWAYS CO.—The chairman (Mr. Geo. White) stated, at the meeting on Saturday, that the company had had another satisfactory year, and he considered the current year's results would not be worse. They were paying a 9 per cent. dividend. The Middlesbrough line showed progress, and they were promoting a bill for extension to Ormesby, South Bank and Eston and for doubling the existing lines in the neighbourhood of Stockton racecourse. The proposed doubling of lines and additional facilities to Middlesbrough had been dropped owing to the attitude of the Corporation.

NORTH LONDON RAILWAY CO.—The chairman (Lord Rathmore) stated at the meeting last week that, in view of the opening of the Great Northern and City Tube Railway, the company had decided that the fares on that part of the line which was in competition with the new tube should be reduced for third-class passengers to the tube rate, and they had decided also to issue third-class season tickets at the tube rate. He feared they would lose a certain number of passengers, but he thought it would ultimately turn out that there was room enough for both lines.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend (payable March 25) of 3s. per share (at the rate of 6 per cent. per annum), tax free, for the quarter ended Dec. 31. The transfer books will be closed from March 18 to 24 inclusive.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

APPLEGARTH AND OSTLERE (LTD.)—Reg. Feb. 16, capital £4,000 in £1 shares, to acquire business of R. Applegarth and Simplex Appliance Synd., and to carry on the business of submarine, mechanical and electrical engineers, manufacturers and patentees of and dealers in smoke-preventing appliances, &c. First directors are R. Applegarth and A. Ostlere (both permanent). Reg. office, 11, Queen Victoria-st., London, E.C.

CASUALTY INSURANCE CO. (LTD.)—Reg. Feb. 18, capital £60,000 in £5 shares, to carry on the business of an accident, fire, employers' liability, burglary, fidelity, boiler, marine and general insurance, indemnity and guarantee company, life assurance business excepted. First directors are R. J. Price, M.P., F. Temple, V. Bennett, J. W. Carn, M. Guthrie and F. J. Lea-Smith.

DULVERTON ELECTRIC LIGHTING CO. (LTD.)—Reg. Feb. 17, capital £3,000 in £1 shares, to adopt agreements with Mr. G. B. Fisher and with Messrs. Edwards and Armstrong, and to carry on at Dulverton or elsewhere in Somerset the business of an electric lighting company. First directors are B. Bayley, G. B. Fisher, F. M. Lock, J. A. Moyle, W. B. Woodbury, J. Moore and F. W. Wills. Reg. office, High-street, Dulverton, Somerset.

STATUTORY RETURNS.

BRITISH ELECTRIC LIGHT WIRING CO. (LTD.)—The return to Dec. 10 gives capital as £10,000 in £1 shares, 156 of which have been taken up. 10s. per share has been called up on seven and £1 per share on 149 shares, and £152. 10s. has been received. No mortgages or charges.

ELECTRIC SIGN AND GENERAL ADVERTISING CO. (LTD.)—In return to Jan. 19 the capital is given as £5,000 in £1 shares, of which 2,000 have been taken up. £1 per share has been called up and paid on 1,000 shares, and the remaining 1,000 are considered fully paid. No mortgages or charges.

GREAT WESTERN ELECTRIC LIGHT AND POWER CO. (LTD.)—According to return to Dec. 25 the capital is £1,000 in £10 shares, seven of which have been taken up. No calls have been made. No mortgages or charges.

POROUS ACCUMULATOR CO. (LTD.)—This company's return to Dec. 23 gives the capital as £3,000 in £1 shares, all of which have been taken up. £1 per share has been called up and paid on 1,007 shares, and 1,993 are considered as fully paid. Mortgages and charges, £16,000.

NATIONAL ELECTRIC ENGINEERING CO. (LTD.)—In return to Dec. 31 the capital is £5,000 in £1 shares, of which 2,659 have been taken up. £1 per share has been called up and paid on 654 shares, and 2,005 are considered as fully paid. Mortgages and charges, nil.

NERNST ELECTRIC LIGHT CO. (LTD.)—The return to Dec. 29 gives the capital as £320,000 in 140,000 preference and 180,000 ordinary shares of £1 each, of which 139,480 preference and 180,000 ordinary have been taken up. £1 per share has been called up on 114,480 shares, and £114,480 has been received, in addition to £238. 15s. paid on 520 forfeited shares. Mortgages and charges, nil.

PYKE, HARRIS & CO. (LTD.)—The return to Jan. 14 gives the capital as £30,000 in 1,400 A and 4,600 B shares of £5 each, of which 1,218 A and 1,440 B have been taken up. £5 per share has been called up on the A shares, and £6,090 has been received. £7,200 is considered as paid on the B shares. Mortgages and charges, nil.

ROUNDHAY AND DISTRICT ELECTRIC LIGHTING CO. (LTD.)—According to return to Dec. 24 the capital is £20,000 in £10 shares, of which 777 shares have been taken up. £7 per share has been called up. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

ADAMS-RANDALL TELEPHONE PATENTS CO. (LTD.)—Issue on Feb. 5 of £50 debenture, part of series created April 22, 1899, to secure £10,000, charged on company's patents, patent rights and leasehold premises. Trustee, E. Davies. Previously issued of same series, £9,950.

JULIUS SAX & CO. (LTD.)—Issue on Feb. 11 of £1,200 debentures, part of series created Jan. 30, 1904, to secure £1,600, charged on undertaking and property, present and future. No trustees. No previous issue of same series.

SUNBEAM LAMP CO. (LTD.)—Issue on Feb. 12 of £8,200 debentures, part of series created Jan. 28, 1904, to secure £10,000, charged on company's undertaking and property, present and future, except uncalled capital. No trustees. No previous issue of same series.

E. C. THEEDAM (LTD.)—Lien reg. Feb. 10, for £2,000 5 per cent. debentures; no trustees; charged on undertaking and all property, including uncalled capital.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
*Aberdeen Corporation	Feb. 20	1,044	+ 211	38	46,261	+ 9,057
Airdrie	,, 12	127	...	...	127	...
Ayr Corporation	...	...	...	...	...	...
Barnsley	,, 12	154	- 21	6	893	- 72
Barrow	,, 12	170	+ 110	1	170	+ 110
Bexley District Council	,, 19	128	...	20	3,007	...
Birkenhead	,, 21	950	- 8	...	...	...
Birmingham Corporation	,, 20	290	...	...	...	...
*Birmingham Tramways Co.	,, 20	5,151	+ 296	7	35,903	+ 2,553
*Blackburn Corporation	,, 19	716	+ 67	§47	39,534	+ 1,934
Blackpool Corporation	,, 18	282	- 43	§16	89,924	- 276
Blackpool and Fleetwood	,, 20	179	- 22	8	1,866	- 38
Blackp'l, St. Anne's & Lytham	,, 18	146	+ 146	†16	2,354	+ 1,775
Bolton Corporation	,, 21	1,622	+ 118	47	85,201	+ 9,035
Bournemouth Corporation	,, 17	858	...	7	5,940	...
*Bradford Corporation	,, 21	3,548	+ 369	45	175,135	+ 22,633
Brighton Corporation	,, 21	711	- 5	46	42,057	+ 2,629
Brisbane Tramways	Jan. 6	2,056	- 82	1	2,056	- 82
*Bristol Trams & Carriage	Feb. 19	4,242	- 171	13	58,609	+ 2,467
*Buenos Ayres & Belgrano	Jan. 24	3,041	+ 458	14	47,589	+ 2,696
Burnley Corporation	Feb. 20	867	+ 200	47	46,044	+ 8,816
Burton Corporation	,, 21	291	...	28	10,003	...
Calcutta Tramways Co.	,, 20	R37,380	+ R7,232	8	R276,077	+ R55,601
Camborne-Redruth	,, 22	98	...	16	1,809	...
Cardiff Corporation	,, 20	1,804	+ 234	47	91,560	+ 22,772
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 20	7,096	+ 164	8	55,979	+ 406
Chatham & Dist. Lt. Rys.	,, 18	512	+ 135	7	3,532	+ 801
City & South London Rly.	,, 21	3,177	+ 109	8	25,763	- 617
Cork Electric Trams Co.	,, 18	381	- 14	7	2,750	+ 17
Darwen Corporation	,, 19	200	+ 8	47	10,580	- 214
Devonport & Dist. Trams	,, 12	457	+ 81	6	2,816	+ 464
Dover Corporation	,, 20	162	- 8	†47	10,341	+ 40
Dublin & Lucan Railway	,, 21	25	+ 2	8	696	+ 38
Dublin Southern District	,, 19	660	- 127	¶7	31,040	+ 539
Dublin United	,, 19	5,536	- 180			
Dudley—Stourbridge	,, 12	732	+ 16	6	4,355	+ 185
Dundee Corporation	,, 17	773	- 27	39	33,339	+ 2,038
East Ham Council	,, 20	600	+ 101	†47	30,867	+ 8,473
Gateshead & Dist. Trams	,, 12	864	+ 36	6	5,288	+ 269
Glasgow Corporation	,, 20	12,918	+ 422	38	517,499	+ 52,527
Gravesend—Northfleet	,, 12	216	+ 32	6	1,249	+ 191
Gt. Northern & City Rly.	,, 20	852	...	1	852	...
Greenock & Port Glasgow	,, 12	448	+ 71	6	2,879	+ 440
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 12	241	+ 20	6	1,501	+ 197
Hudder-field	,, 13	1,078	+ 34	...	...	...
Hull Corporation	,, 20	1,987	+ 323	†47	89,687	+ 7,087
Ilkeston Corporation	,, 17	118	...	14	1,671	...
Ipswich Corporation	,, 20	314	...	7	3,871	...
Isle of Thanet Co.	,, 21	233	- 18	...	...	...
Kidderminster & District	,, 19	92	- 8	6	553	- 49
Kirkcaldy Corporation	,, 17	191	...	51	9,235	...
Lanarkshire Trams Co.	,, 18	527	...	7	4,078	...
Leeds Corporation	,, 20	4,956	+ 293	48	255,055	+ 15,545
Liverpool Corporation	,, 18	9,471	+ 59	7	66,858	+ 2,742
*Liverpool Overhead Rly.	,, 21	1,472	+ 4	8	12,217	+ 358
*London County Council	,, 13	9,661	+ 1,122	†46	449,017	+ 78,978
Lowestoft	,, 20	132	...	¶30	6,569	...
Manchester Corporation	,, 20	10,572	+ 2,450	85	414,154	+ 186,658
Mersey Railway	,, 20	1,482	+ 297	7	10,067	+ 2,545
Merthyr	,, 12	192	+ 15	6	1,137	+ 116
Middleton	,, 12	247	+ 21	6	1,473	+ 89
Newcastle-on-Tyne Corp.	,, 20	3,432	+ 421	7	24,347	+ 3,734
Newport (Mon.)	,, 20	438	+ 227	21	9,731	+ 4,787
Oldham, Ashton & Hyde	,, 12	489	- 30	6	2,983	- 192
Perth (W. A.) Elec. Trams.	,, 19	1,323	+ 163	7	9,933	+ 1,318
Peterborough	,, 12	118	- 30	6	668	- 145
Poole and District	,, 12	211	- 23	6	1,319	- 52
Portsmouth Corporation	,, 20	1,342	+ 114	†47	80,702	+ 5,449
*Potteries	,, 12	1,692	+ 240	6	9,798	+ 651
Reading Corporation	,, 11	572	...	...	...	...
Rotherham	,, 12	39	+ 2	6	271	+ 15
Salford Corporation	,, 22	3,668	+ 827	47	178,844	+ 49,666
Sheerness	,, 10	47	...	6	269	...
Sheffield Corporation	,, 21	4,288	+ 332	†48	214,506	+ 17,838
*Southampton Corporat'n	,, 18	871	+ 55	7	5,968	+ 281
Southend Corporation	,, 17	218	+ 33	46	14,397	+ 2,214
Southport Tramways	,, 12	219	+ 1	6	1,444	+ 146
S. Staffordshire Trams.	,, 12	767	+ 36	6	4,416	+ 297
Sunderland Corporation	,, 21	1,061	+ 94	47	56,504	+ 2,701
*Swansea Trams	,, 12	510	+ 74	6	2,831	+ 113
Taunton Trams	,, 12	48	+ 1	6	287	- 8
Tynemouth and District	,, 12	210	- 9	6	1,248	- 1
Tyneside Trams Co.	,, 17	283	+ 45	7	1,884	+ 406
Wallasey District Council	,, 20	569	+ 50	†47	31,866	+ 3,840
Weston-super-Mare	,, 10	21	- 4	6	134	- 7
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 12	333	- 9	6	1,964	- 64
Worcester	,, 12	282	+ 140	1	282	+ 140
Wrexham	,, 12	97	...	6	589	...
Yorkshire Woollen District	,, 12	490	...	6	3,005	...

(a) These comparisons are with the corresponding period last year.

*Partly electrical. † Minus 5 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days. ** 5 days.

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME	Price Wed., Feb. 24	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS WEEK TO FEB. 21 Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅜—4¾	5 2 6	April, Oct	4⅛	4⅜
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
St.	3 4 2	Auckland Elec. Trams 5% Deb. (red.)	93 —100	..	..	99½	..
10	10	Barcelona Tramways Ord.	7 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 17 8	..	100	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	..	..
10	8%	†Bristol Tramways and Carriage Ord.	19½—20	4 10 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼—10½	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	82 —85	3 11 5	..	..	..
St.	5%	Do. Pref. Ord. Stock	93 —96	5 5 6	..	94	..
10	5/0	Do. 5% Cum. Perp. Pref.	10 —10½	4 15 3	..	10⅜	..
4	4½%	Do. 4½ per Cent 1st Mort. Debs.	103⅝—105⅞	4 7 0	..	..	..
100	4½	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9¼—10¼	7 12 5	..	10⅜	9⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	10¼—11½	5 5 4	Feb, Aug	11⅜	10⅛
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	122½	121½
5	..	Buenos Ayres and Belgrano Ord.	2⅝—3⅛	..	..	..	..
5	3 0	Do 6 per Cent. "A" Cum Pref.	5¼—5⅜	5 4 0	..	5⅜	..
5	3/0	Do. "B"	4¾—5⅛	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs	98 —101	4 19 6	..	..	..
St.	..	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 —100	5 0 3	..	..	..
5	2 6	Calcutta Tramways	6½—7	4 12 10	..	6⅜	6⅛
100	4½%	Do 4½% 1st Deb. Stock (red.)	104 —107	4 4 2	..	106½	105
1	1/0	Cape Electric Tramways Shares	1⅞—2	8 10 0	..	1⅞	..
St.	4%	Central London Ordinary Stock	91 —94	4 5 1	June, Dec	94	92
St.	4%	Do. 4 per Cent. Pref. Stock	96 —99	4 0 10	..	99	..
St.	4%	Do. Deferred Stock	86 —89	4 9 11	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 —115	3 9 9	..	..	..
5	2/6	City of Birmingham Trams 5% Cm. Prf.	4¾—5¼	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2%	City and South London Rly. Con Ord	49 —52	4 11 4	Feb, Aug	50⅜	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	3 19 4	Feb, Aug	..	..
St.	5%	Do. (1893)	119 —122	4 2 0	..	..	..
St.	5%	Do. (1901)	118 —121	4 2 8	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	111	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(red.)	102 —105	4 16 5	..	..	..
10	3 0	Dublin United Trams. (1896) Ltd., Ord.	12½ -13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 - 16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf	3 —4	7 10 0	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. 4%	7 —8	3 15 0	..	7⅜	..
10	3 4	Gt. Northern, Piccadilly & Brompton Ord., Spever Bros. Scrip Certs.	9 —10	..	..	..	..
10	9%	†Imperial Tramways Ord	19½ -20½	4 7 10	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	11%	†Liverpool Overhead Railway Ord.	4⅛—4⅜	2 16 5	Feb, Aug	..	..
1	5%	† Do. 5 per Cent. Pref.	9¾—10¼	4 17 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98½—100⅜	3 19 10	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11¼—11¾	4 5 1	..	11⅛	11⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	102 —104	3 17 4	..	103⅛	102
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	..	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	..	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	1⅜—1½	4 8 11	..	1⅜	..
100	4½%	Do. Sterling 4½% Debs.(1922)	103 —105	4 17 1	..	..	..
5	..	New General Traction Ord.	104 —106	4 4 11	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅛	..	..	..	..
St.	5%	Perth (W.A.)Elec. Trams. 1st Mt. Db. Stk.	1½—2½	..	May	..	..
10	10/0	Potteries Electric Traction Ord.	99 —102	4 18 0	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	8½ 9½	5 5 3	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	8¾—9¼	5 5 3	Feb, Aug	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	103 —106	4 5 11	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	..	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	April, Oct	..	..
St.	3½%	Waterloo and City Ord.	91 —94	3 9 8	Jan, July	..	..
					June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	15/0	Anglo-American	50 —53	6 0 9	F,My,Ag,N	50	..
St.	30/0	Do. Preferred	94 —96	6 7 7	F,My,Ag,N	95	94½
St.	1/0	Do. Deferred	7¼—7⅜	0 13 6	F,My,Ag,N	7⅜	..
100	32	Commercial Cable Capital Stock	180 —190	4 4 5	Ju,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 —91	4 8 3	Jn Ap,Jy,O	91	89½
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2¼—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—8½	5 17 8	April Oct	..	..
50	4¼	Do. 4½ per Cent. Deb.	98⅞—101⅞	4 9 1	Jan, July	..	..
20	3/0	Direct United States Cable	9⅜—10¼	6 6 10	Ja,Ap,Jy,O	10⅛	9⅛
100	4½	Direct West India Cable 4½%Rg.Db.(rd.)	98 —101	4 9 1	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	119 —124	5 12 11	Ja,Ap,Jy,O	121½	119⅜
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 17 10	Ja Ap,Jy,O	..	..
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	..	..
10	2/6	Eastern Extension	10⅜—11½	6 4 5	Ja,Ap,Jy,O	11	10¾
St.	4%	Do. 4 per Cent. Deb. Stock	104 —107	3 14 9	Feb, Aug	104	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	98 —101	4 0 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 11	May, Nov	..	..
10	5.0	Great Northern of Copenhagen	23 —24	5 4 2	Jan, July	..	..
100	4½	Halifax & Bermuda4½%1stMt.Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	12 6	Indo-European	38 —41	6 1 11	May, Nov	39⅜	..
100	6%	London Platino-Brazil. 6% Debs., 1904	100 —103	5 19 5	Mar, Sept	..	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..
2½	..	West Coast of America	¼—¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	⅜	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
*	5%	Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	11⅜—12½	5 14 8	Mr,Jn,O,D	11⅜	11⅜
100	5%	* Do. 5% Debs. (2nd Series, 1906)	99 —102	4 18 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 3	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8¼—8¾	4 11 5	Ja Ap Jy O	8⅛	8¼
10	3/0	Do. 6 per Cent. Pref.	12 —12½	4 16 0	Ja Ap,Jy,O	12⅜	12⅛
8	4/0	Reuter's	6¾—7¼	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	117 —122	5 0 0	April, Oct	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Feb. 24	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE	BUSINESS WEEK TO FEB 21. Highest.	Lowest.
		TELEPHONES.					
5	8/0	Chili Telephone (fully paid)	4¾—5¼	5 14 3	August	5	..
St.	6%	National Co. Pref. Stock	103 —105	5 17 7	..	104	102
St.	5%	Do. Def. Stock	78 —81	6 1 2	..	79½	78
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13½—14½	4 2 9	Feb, Aug	14⅛	14
10	6/0	Do. 6 per Cent Cum. 2nd Pref.	14 —15	4 0 0	Feb, Aug	14½	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5⅝	4 13 0	Feb, Aug	..	..
St.	3½%	* Do. Stock 3½ per Cent. (red.)	95 —97	3 12 2	June, Dec	95½	95½
St.	4%	Do 4 per Cent. Deb. Stock (red.)	100 —102	3 18 5	..	101½	101½
1	0/7½	Oriental	¾—1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
5	3 0	United River Plate	5½—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 —105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Greenwich. Dist. Ord.(f.p.)	¾—1	..	..	..	..
1	..	Do. 7% Cum. Pref.	1⅛—1⅜	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	115 —118	3 17 4	..	115	114½
10	16.0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¼—10¼	4 5 9	..	9⅜	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10 —10½	4 15 3	..	..	..
1	3/6	Do. 7 per Cent. Pref.	9⅜—10½	3 8 4	Mar, Sept	..	..
5	3 0	Calcutta Electric Supply Ord. ex rights	6 —7	4 12 10	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 — 109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7⅜—8⅜	4 17 0	Feb, Aug	7⅜	..
5	2/3	Do. 4½ per Cent. Pref.	5½—5⅝	4 5 9	Feb, Aug	5⅜	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅜—5	4 10 0	..	4⅜	..
5	1.7	Do. Do. (1903)	4⅜—5	..	..	4⅜	..
St	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 8	..	102	..
5	2 0	Chelsea Electric Supply Ord.	5⅜—6⅛	4 8 0	March	5⅛	5⅜
St	4½%	* Do. 4½ per Cent. Deb Stock (red.)	106 —109	4 3 1	Jn, Dec	..	..
1	5/0	City of London Electric Lighting Ord.	10¾—11½	6 13 4	Feb, Aug	11	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	103½	..
10	4/0	County of London & Brush Prov. Ord.	8 —9	4 8 11	..	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Mar, Sept	11⅝	11⅜
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	105 —109	4 2 11	..	108	107½
St.	27 6†	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	100⅜	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5¾—6¼	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 3	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	⅜—½	..	..	..	..
5	5/0	Kensington & Knightsbridge Ord.	11 —12	4 3 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station; 4% Deb. Stck. (red.)	103 —106	3 16 2	..	..	..
1	..	London Electric Supply Ord.	1⅞—2⅛	..	..	..	..
5	2/0	Do. 6 per Cent Pref.	5½—6	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 1	Mr,Jn,S,D	..	..
10	8 0	Metropolitan Electric Sup. Ord.	17½—18½	4 3 9	April, Oct	18⅛	17⅞
5	..	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	..	..	5⅜	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	97 —100	3 10 6	..	..	..
100	..	Midland Elec. Corp. for P. & D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
1	6 0	Notting Hill Electric Ord.	13 —14	4 5 9	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5½—6	4 11 8	March	..	..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 3	..	..	..
1		Rand Electric	⅞—1	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
1	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅜	14½
1	3 6	Do. 7 per Cent. Pref.	8 —9	8 17 9	Feb, Aug	..	..
St	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
1	2/6	Smithfield Markets Electric Sup. Ord.	3½—3⅝	3 6 8	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
1	1/0	South London Electric Supply Ord.	3⅜—4¼	4 2 4	..	..	..
5	2/6	Urban Electric Supply Ord.	4⅜ 5	5 0 0	..	..	..
5	2 6	Do. 5% Cum. Pref.	4½—5⅛	4 17 7	..	4⅝	4⅛
5	6/6	Westminster Electric Supply Ord.	12½—13¾	4 16 4	Mar, Sept	13⅛	13⅛
1	/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6⅛	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—½	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅜—⅝	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	6½	..
5	3 0	Do. 6 per Cent. Pref.	5½—5⅞	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	103 —105	4 5 8	..	..	..
5	3/0	British Westinghouse 6% Pref.	3⅝—4⅛	7 1 2	..	4⅜	3⅞
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 3 4	..	94⅜	..
2	..	Brush Electrical Engineering	¾—1½	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 —1½	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	98 —101	4 11 2	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	75 —80	5 12 8	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	5⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 8	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
1	0,7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½ —2	7 10 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8 —8½	..	..	..	..
5	..	Do. 6% Cum. Pref.	5¼—5⅝	..	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
5	..	Edison & Swan United("A"Sh.)(£8 pd.)	¾—1	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5¾—6¼	5 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5¾—6¼	4 16 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 4 11	..	104½	..
2	1/2½	Electric Construction Co.	1½—1⅝	6 7 1 2	Jan, July	1⅝	..
2	2 9⅜	Do. 7 per Cent. Cum. Pref.	2⅝—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅛—¼	..	..	..	..
1	7½	Do. 7 per Cent. Cum. Pref.	⅛—¼	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¼—9¾	5 2 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 —98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	12 —13	7 13 10	Feb, Aug	13	12⅝
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	5⅛	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	108 —112	4 0 9	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	18⅛	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 17 4	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¾—11½	4 8 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33 —36	6 13 4	Mar, July	35	33⅜
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	101⅛	..
5	3/0	Willans and Robinson Ord.	4 —5	6 10 0	Apr, Oct	4½	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5½—6	5 0 0	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 5	May, Nov	..	..

allowance has been made for accrued interest, but not for redemption.

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NOTES.

THE report of the "Electricity in Mines" Committee and the rules which are recommended to regulate the use of electricity in mines are causing some dissatisfaction in mining circles. Although, as we have already pointed out, the report and rules cover generally what would be required to meet the demands of good modern practice, there are some matters of detail which will have to be altered before the code of regulations is adopted by the Home Office. A letter by Mr. W. B. WOODHOUSE this week refers to some of these details, but there are some more important ones that require attention. The Committee has not confined its attention to the employment of electricity below the surface, but has also issued recommendations with regard to the generating stations. Among the rules for these is one specifying that no bare metal charged at a higher pressure than 250 volts shall be placed on the front of the switchboard within 8ft. of the platform. We cannot but think that Mr. G. S. RAM (the Electrical Inspector of Factories), who drafted the rules for the Committee, and Mr. W. H. PATCHELL, chief engineer to the Charing Cross and Strand Electricity Corporation, who was a member of the Committee, must both have protested against this regulation, which is quite contrary to established practice—in fact, the majority of the generating stations of those mines which have adopted electricity do not conform with it. There is a note at the end of the rules exempting existing installations from their provisions "unless an inspector shall otherwise direct"; but as, in the body of the report, this question of bare metal is insisted upon, an inspector might possibly think that this rule was so vital that the old installations must be altered in accordance with it.

THE "personal" question as to inspectors is also an important one. If certain things are to be left to the discretion of the inspectors—and their duties cannot conceivably be merely mechanical—gentlemen occupying these positions should have good technical knowledge of electrical matters. This would disqualify the majority of the existing inspectors of mines, and thus it will be necessary for a small staff of electrical inspectors to be appointed under the guidance of a chief electrical inspector (perhaps Mr. RAM, who is already attached to the Home Office in the capacity of Electrical Inspector of Factories).

THERE is another point in the proposed rules to which our attention has been called. One of these is a rule to the effect that "unless fixed in sight and out of reach of injury, all conductors other than lead-covered armoured cables must further be protected by a strong covering, and this in damp situations must consist of water-tight metal tubes . . ." It is customary in many cases to employ vulcanised bitumen cables, armoured but not lead-covered, to run down the shafts, and this rule, if enforced, would make it necessary that these cables should be lead-covered as well. This would be absolutely unnecessary, and, moreover, would greatly increase the weight of the shaft cables, which is an important consideration in view of the difficulty of supporting them. A recommendation that oil-break switches should be employed is also open to comment, as a sharp break under oil might be injurious to long cables designed for low pressures, owing to the momentary rise of pressure at the break. This last, however, is a minor point.

THE rules exist at present only in the form of recommended regulations. We should therefore advise all the mine-owners concerned, and their electrical engineers, to bring such matters as

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we have alluded to under the notice of the Home Office and their electrical inspector of factories, Mr. RAM, as soon as possible. When the rules are "made by the Home Office," it will be a far more difficult and lengthy process to bring about any alteration in them.

THE abstract of an article by Dr. WALSH, on the treatment of cancerous throat with the assistance of radium, which appears in another column, is particularly interesting, for it is a careful and authoritative statement of what has actually been accomplished. The author shows that it is possible to place capsules containing the radium directly in contact with the affected part, a feat hitherto considered beyond the range of medical skill. Moreover, it appears that the application was successful. While expressing confidence that radium will play no small part in future medical and surgical practice, Dr. WALSH is careful to refrain from rash prophecies, and in this he is well advised. It is to be hoped that the scarcity and consequent high price of radium compounds will effectually prevent the establishment of large numbers of quacks, who would find no difficulty in catching public attention by the use of the magic word "radium."

IT was almost unanimously agreed in the discussion on Dr. WALMSLEY'S Paper, "Transatlantic Engineering Schools and Engineering," which took place at the Institution of Electrical Engineers on February 25th, that English technical education—or "technological instruction," as Mr. TROTTER prefers to call it—is not really so far behind that in America as certain critics would have us believe. Even the eminent teachers who joined in the discussion deprecated the lavish equipment of laboratories which is now so fashionable on the other side of the Atlantic, and it may be gathered that the true value of the college workshop is at last being recognised. Unquestionably, there is only one place in which a man can gain real workshop experience, and that is in actual commercial works; the college shops are only a sort of preliminary training ground and an auxiliary to the classes, lectures and laboratory practice.

WHILE discussing this matter of education it is interesting to turn from suggestions of action to action itself. Under the Education (London) Act of 1903, the London County Council has to appoint a Committee which will provide for primary, secondary and technical education in the metropolis. A draft scheme was approved by the Council on January 24, 1904, and from this it appears that the Committee is to consist of 43 members, including the chairman, vice-chairman and deputy chairman of the Council, 35 members of the Council, and five women; these will include, as far as possible, persons possessing experience in educational matters. But as the constitution of the Committee will thus be practically restricted to members of the Council, it is, therefore, not surprising that a memorial, signed by the leading science teachers and authorities in technical education in London, has been sent to the Board of Education, urging the desirability of amending the scheme, so that the Education Committee may include educational experts and men of science who would be universally recognised as authorities on the needs of the University, the Technical Institutes, and the Elementary and Secondary schools.

WE publish in this issue the rules framed by the Board of Trade in respect to applications under the Railways Electrical Power Act of 1903. The Act will be found in "The Electrician" Directory and Handbook for 1904, and is substantially in the terms of the Bill which we printed in our issue of May 1, 1903. It will be remembered that the object of the Act is to facilitate the substitution of electrical power for other methods of propulsion upon railways without obtaining special Acts of Parliament for the purpose. The Board of Trade is now able to confer such powers by Provisional Order, subject, however, to the confirmation of Parliament, if the Order provides for the acquisition of lands otherwise than by agreement.

THE rules now issued bear a general resemblance to those in force under the Light Railways Act and under the Standing Orders of the Houses of Parliament; but there are some important modifications which make for economy of time and simplicity. No particular time of year is laid down for applications and notices; therefore, any application may be made at the time most convenient to the company. This should be an assistance to engineers, solicitors and others, who sometimes find the rush of work, due to the strictly limited time within which notices and deposits have to be given and made, rather irksome. An objection which might be taken to this is, that persons affected might overlook advertisements appearing at times at which they are not accustomed to examine the columns of the *Gazette* or local newspapers, but this objection appears to be fully met by the provision in the rules that notices are to be sent to landowners and others affected within three weeks after the first advertisement of the notice. There are also more specific requirements as to publication in districts affected than is the case under the Light Railway and Tramway Rules, the Standing Orders of Parliament having been more nearly adopted in this case. Railway companies having running powers over the railway to which the Order applied for relates must also have specific notice within the same time. The deposits with local authorities and Government departments follow the established practice set out in Standing Orders.

OBJECTIONS to an application must be made within three months of the first advertisement, simultaneously to the Board of Trade and to the promoters. This enforcement of a liberal time limit is an improvement upon the unlimited time allowed in the case of light railway applications, and a similar improvement, adopted from Parliamentary Standing Orders, tending to define the opposition to be expected, is afforded by the notice to landowners, which has to bear an inquiry whether the person served assents or dissents to the taking of lands and requesting him to state his objections. Under the Act, the Board of Trade decides, upon consideration of the application and any objections which may be made to it, whether or not it will hold a local inquiry, and it may either

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reject or accede to the application without such inquiry at its discretion. It appears that these rules are in correspondence with the purpose of the Act, providing a comparatively speedy and simple procedure for bringing it into force in each case.

N-Rays.—In the *Electrical World* of New York, Dr. J. B. Whitehead says that Prof. Wood, of the John Hopkins University, has attempted to repeat many of Blondlot's experiments without success.

The Royal Society.—Among the Papers down for reading yesterday was one by Dr. C. Chree, F.R.S., on "An Enquiry into the Nature of the Relationship between Sunspot Frequency and Terrestrial Magnetism."

Charing Cross and Strand Company's Bohemian Concert.—A Bohemian concert was given by the Charing Cross and Strand Electricity Supply Corporation at the Freemasons' Tavern on Tuesday evening. Mr. J. M. Gatti was in the chair and the attendance was extremely large. Many well-known artistes contributed to the enjoyment of the evening and the function was continued until a late hour.

Radio-active Bath Waters.—At a meeting of the Bath Town Council on Tuesday, the mayor, Major Simpson, stated that he had received a note from the chairman of the Baths committee stating that the Hon. R. J. Strutt had now come to a definite conclusion that there were traces of radium in the Bath thermal waters. Two gallons had been sent him for examination. It will be remembered that Mr. Strutt had previously found that traces of radium existed in the deposits.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903
Tarifa—Tangier	Jan. 18, 1904
Oran—Tangier	Feb. 3, 1904

Electrical Engineers (R.E.) Volunteers' Ball.—The first annual regimental ball of the Electrical Engineers Volunteers was held at the Kensington Town Hall on February 26th. Dancing commenced at 9 p.m. and continued until about 3 a.m. The rooms presented a very animated appearance, which was considerably enhanced by the scarlet and other coloured uniforms. Altogether about 130 ladies and gentlemen were present, including Col. and Mrs. Crompton, Major and Mrs. Erskine and Mr. and Mrs. Wallis-Jones.

Royal Society Candidates.—The Council of the Royal Society has recommended 15 candidates for election as Fellows, and among the names are the following :—

Dr. A. C. Dixon, Professor of Mathematics at Queen's College, Belfast, author of numerous Papers on difficult questions in pure mathematics.

Prof. C. J. Joly, Royal Astronomer of Ireland and Professor of Astronomy in the University of Dublin, author of Papers on quaternions, screws, the properties of curves and corresponding subjects in analytical geometry.

Dr. A. Muirhead, for his submarine cable telegraph work, and as an original investigator in practical questions connected with this subject.

Dr. M. W. Travers, Professor of University College, Bristol, and formerly assistant to Prof. Sir W. Ramsay at University College, London, with whom he was associated in researches at low temperatures and in the discovery of new constituents in the atmosphere, besides independent investigations on similar subjects.

Mr. G. T. Walker, Meteorological Reporter to the Indian Government, and author of Papers on aberration and the magnetic field (the Adams Prize Essay, Cambridge) and other electrical subjects, besides a study of boomerangs and a mechanical top.

Manchester Students' Section.—In the chairman's address to the Manchester Local Section of the Institution of Electrical Engineers last November, he referred to the fact that a students' section was projected. This section has now been formed, and meetings will be held at the School of Technology, on Friday evenings at 7:30 p.m. A short programme of meetings and visits has been arranged for 1904. On Friday next, Mr. J. W. Bell will read a Paper on "Switch Gear for Traction and Transmission," and Mr. E. W. Cowan, chairman of the local section, will take the chair. To-morrow, Saturday, a visit will be paid to the Stuart-street Generating Station of the Manchester Corporation. Papers have also been arranged for on the following dates:—March 25th, "Photometer Testing," by D. Levingston Sands; April 8th, "Direct-Current Controllers," by H. N. Dutton. On Saturday, April 9th, Messrs. W. T. Glover & Co.'s cable works at Trafford Park will be visited. Mr. J. Roberts, junior, has been appointed hon. secretary, and his address is 23, Derby-street, C.-on-M., Manchester.

Paddington Technical Institute.—On Saturday afternoon Sir A. W. Rücker, Principal of the London University, opened the Paddington Technical Institute of the London County Council. A large gathering was present, including Lord Monkswell, chairman of the London County Council, and several members of the Technical Education Board. Sir A. W. Rücker said the Institute incorporated the technical education work of the Westbourne Park Chapel, Queen's Park Congregational Church and the Kilburn Anglican Sisterhood. The premises had been acquired from the latter for £15,000. What was being done there must be done on a larger scale elsewhere, so as to bring the schools into closer contact with the university, for until this combination of forces was effected it would not be possible to carry out the union of all teaching forces. Co-operation must be the note of education in the future. It was stated that the ultimate intention is to erect a power house and an engineering laboratory at the Institute and to carry on a motor car school. After the usual votes of thanks the Institute was thrown open to public inspection. From an examination of the buildings, however, it appears that there is no immediate intention of giving engineering instruction of a very high standard. No electrical engineering laboratory has been provided, and the mechanics, physics and chemical laboratories are obviously more suited to secondary school scholars and purely trade classes than for professional teaching. This impression gathers weight when it is known that instruction will be given in domestic economy, the necessary kitchen, laundry, &c., having already been equipped.

Wireless Telegraph Notes.—The *Electrical World* of New York states that wireless telegraphy has been unsuccessful between Nome and St. Michael, owing to the distance being too great for transmission during winter weather. It is suggested that the Government should establish two more stations in order to accomplish the desired result. Stations have already been established at Port Safety, near Nome, and St. Michael, at a cost to the Government of $6,000. The distance across Norton Sound, between the two existing stations, is about 125 miles.

H.M.S. "Hercules" has now been equipped as the new signal school of the navy in place of the "Victory." A wireless telegraph installation has been fitted, as well as a system of electric lamps for night signalling.

The statement that the dispatches from Chemulpo with regard to the warlike operations of the Japanese, appearing in Monday's *Times*, were sent by the de Forest wireless telegraphy was incorrect. The message was sent by *The Times* special dispatch steamer running between Chemulpo and Wei-hai-wei.

An official announcement has been issued by the committee of Lloyd's to the effect that the signalling of vessels at the Fastnet Lighthouse will commence on April 1st. Vessels that make their signals to the Fastnet Rock Lighthouse will be reported by the Marconi system of wireless telegraphy to Brow Head Signal Station, whence the reports will be telegraphed to the required destinations in the usual manner. It is added that signalling cannot be carried on at any time when the explosive fog signal at the lighthouse is in operation.

Theatre Lighting.—The Theatres committee of the London County Council have submitted a revised list of rules to be observed by theatre licensees to minimise the danger of fire. The following deal with the electric lighting of theatres:—

19. Where there is an electrical installation a properly qualified man must be in charge of such installation.

20. In all cases in which it is desired to instal temporary lighting, notice must be given to the Clerk of the Council, in writing, as long as possible before it is desired to commence the work. Wires and cables must be adequately and firmly fixed, and must be similar to the wires specified in the Council's regulations, and in all cases where the wires are within reach of the public they must be cased. All joints must be soldered and taped if used for more than one week, and if used less than a week the wire must be soldered if larger than 7/20 S.W.G. or

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its equivalent. In either case the joints must be taped. The circuits must be subdivided as much as possible, no sub-circuit exceeding 10 amperes. All temporary work must be immediately removed when no longer required for the purpose for which it was installed. In the case of temporary work on the stage, all connections to the permanent installation must be removed immediately after each performance in which they are used unless permission be obtained to the contrary. Such special conditions as may be requisite in each case will be attached to the consent of the Council to the use of temporary electrical work.

21. All main switches, fuses, &c., which are the property of the electric supply company shall be distinguished by being coloured red with a white band.

22. At least one pair of indiarubber gloves must be provided for the use of the electricians in connection with the electric lighting arrangements as a precaution in the event of high voltage occurring. The gloves must be kept on the stage switchboard and be kept in good order.

23. At least one bucket, filled with dry sand, must be kept in some accessible position on the stage in readiness for use in dealing with an electric fire, and one must also be kept in each of the intake rooms.

The rules were adopted by the Council at their meeting on Tuesday.

Opening of the West Ham Corporation Tramways.—On Saturday last the first section of the municipal electric tramways at West Ham was opened. The local authority obtained a provisional order under the Tramways Act of 1870, authorising 10⅛ miles of double track and 2⅝ miles of single track. The lines just opened form a portion of the first sections which are under construction, and which total 6½ miles of double track and 2⅞ miles of single. The gauge is 4ft. 8½in., the track rails being of the girder type, weighing 100lbs. to the yard. The overhead trolley system has been adopted, the conductor being of 0000 S.W.G. copper. The line feeders are British Insulated and Helsby Co.'s paper-insulated lead-covered, laid under the footpaths in Sykes earthenware conduits fitted with Stanford joints. The return is by the rail and two feeders There are 50 double-deck cars, each weighing 8 tons, and having a seating capacity of 56 passengers. Hand and electric brakes are fitted. Current is supplied from the Corporation electricity works. Mr. J. K. Bock is the borough electrical engineer and Mr. H. E. Blain the tramway manager. When the West Ham Corporation tramways are all completed as well as those to the neighbouring boroughs, a very complete system of electric traction will be available to the east of London. Sooner or later the London County Council intends to reconstruct the line to Bow Bridge from Aldgate. West Ham's system will continue from that point to Manor Park, whence the East Ham Corporation's cars continue the journey to Ilford. Thence the local authority runs to the next district of Romford, in which a company has powers to construct tramways, and which is a distance of 14 miles from London.

Electric Railways.—On Friday, February 26th, Mr. Alexander Siemens delivered an evening discourse on "New Developments in Electric Railways," illustrating his lecture before the crowded audience of the Royal Institution by a series of excellent lantern slides. Starting with the small railway built in 1879 by Messrs. Siemens and Halske at the Berlin exhibition, Mr. Siemens gave a brief historical sketch of the earlier developments and then dealt more fully with present attainments. He specially pointed out the continued changes and improvements which had taken place in the method of conducting current to the trains. In 1892, Werner von Siemens had commenced traction experiments with three-phase currents and had an experimental track built in Grosslichterfelde. Soon afterwards similar trials with polyphase currents were undertaken by other firms also, and the outcome was several three-phase railways, notably in Italy and Switzerland. A great impetus was given to the question of electric traction on main railway lines by the work of the German "Studiengesellschaft," to whom credit was due for the excellent results achieved in the recent high-speed trials on the experimental line Berlin-Zossen. Three-phase working had one great disadvantage in that it necessitated at least two overhead conductors for conveying the energy to the moving trains, and it was therefore not surprising that efforts were being made in various quarters to adopt single-phase motors for traction work. One way of achieving this end was suggested by Messrs. Mordey and Jenkin some time ago, and consisted in equipping the locomotive with a single-phase continuous current converting plant. This system was known as the Ward-Leonard system, and it had been experimented with by the Oerlikon Company in Switzerland. The Union Company of Berlin had developed a single-phase traction system pure and simple and was carrying out experiments on an experimental track near Berlin.

National Electrical Manufacturers' Association.—The annual general meeting of this Association was held at the Hotel Cecil on Tuesday afternoon. In the report of the committee for the year 1903 it is stated that although the Association has only been in existence for two years, its formation has been fully justified by the various schemes inaugurated and carried out, as well as by the large accession of members. The membership during the year under review increased from 34 to 57. The negotiations with the China Furniture Manufacturers' Association have proved abortive, but the terms on which such material may now be obtained by electrical manufacturers are much more favourable than they were formerly. The reference book, by means of which the credit of doubtful firms can be investigated, has proved extremely valuable. No arrangements regarding an agreement with the plant and cable associations have been arrived at, but there is now a definite understanding between the manufacturers' and contractors' associations, and a joint committee has been formed before which disputes between members of the respective associations will be brought. After paying all liabilities, the Association has a credit balance of £83. 19s. at the bank. The committee for the ensuing year is composed of the following:—Messrs. Bevis, Oppenheimer, Northcote, Smith, Grainger, Lundberg, Nalder and Patersen. The adoption of the report was moved by Mr. Davenport, and in seconding it, Mr. Max. Byng said he would be glad if the Association could devise some way of finding out the financial position of small limited liability companies before members opened accounts with such firms. He called particular attention to the fact that his own company had frequently suffered by giving credit to others having perhaps seven shares and 2,000 debentures. Mr. Oppenheimer agreed with Mr. Byng and suggested that enquiries emanating from the Association would be less likely to cause offence than those set on foot by a single individual or firm. The report and financial statement were adopted.

The Metric System and the Colonies.—As an outcome of the Conference of Colonial Premiers in London in the summer of 1902, Mr. Joseph Chamberlain, who was then Colonial Secretary, addressed on September 9, 1902, a letter to the Governors of the Crown Colonies and self-governing Colonies enclosing a copy of the resolution passed at the Conference and referring to the adoption of the metric system. In this letter, a request was made for an indication of the views of each particular Colony, and the replies have now been published as a Parliamentary Paper. The resolution was as follows:—

That it is advisable to adopt the metric system of weights and measures for use within the Empire and the Prime Ministers urge the Governments represented at this Conference to give consideration to the question of its early adoption.

The replies to Mr. Chamberlain's note of September 9, 1902, may be summarised as follows:—

The metric system is already used in Mauritius and Seychelles. The following are favourable to the adoption of the metric system:—Australia, New Zealand, Cape of Good Hope, Transvaal, Orange River Colony, Southern Rhodesia, Gambia, Northern Nigeria, Gibraltar, British Guiana, Trinidad, Leeward Islands and the Windward Islands. The following are favourable provided that it is adopted in the United Kingdom or in the Empire generally:—Sierra Leone, Southern Nigeria, Ceylon and the Falklands. Hong Kong would take common action with the other Colonies. The States of New South Wales, Victoria and Western Australia are favourable, but, together with South Australia and Tasmania, they consider that the matter is one for the Commonwealth Government. Fiji is doubtful, but says it must follow Australia and New Zealand, as also would British New Guinea. Jamaica and British Honduras require the adoption of the system in the United States; the Straits Settlements and Labuan would follow India in the matter, and the Bechuanaland Protectorate would be guided by the rest of South Africa. The following are on the whole unfavourable:—St. Helena, Cyprus, Lagos, Wei-hai-wei, Barbados and Bahamas. The Gold Coast Colony and the State of Queensland, whilst prepared to adopt the metric system, consider that inconvenience would occur thereby. Natal will not consider the matter until some general lines of legislation have been agreed upon by His Majesty's Government. No definite reply has been received from Newfoundland, Malta or Bermuda, and Canada has not yet replied.

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Northampton Institute.—On Friday and Saturday last week the annual conversazione of the Northampton Institute took place. Lord Kelvin distributed the prizes on Friday evening, and Mr. L. B. Sebastian, chairman of the governing body of the Institute, presided. A large audience was present at the prize distribution, and it included Dr. R. T. Glazebrook, F.R.S., Prof. S. P. Thompson, F.R.S., Prof. Unwin, F.R.S., Mr. J. Gavey and Sir A. W. Rücker. Dr. Walmsley, the principal, in his report summed up the work of the students during 1902-3 (the year for which the prizes were being distributed) as 95,000 student-hours. He said the electrical engineering department was still the premier department of the Institute as regards numbers, and that the need for increased accommodation was being keenly felt, students being turned away in great numbers. Lord Kelvin, having been introduced by the chairman, said he regarded the Northampton Institute as a splendid example of the truth that good deeds were everlasting, as its upkeep was in part the result of benefactions made 500 or 600 years ago through the City Parochial Foundation. From this the Northampton Institute received £4,000 or £5,000 annually. Referring to the coming abolition of the Technical Education Board of the London County Council, he said he hoped the Northampton Institute would not suffer by the change, and, speaking generally, he trusted the new education authority would be courageous and do what was right, and not fear to demand rates when it was convinced that the payment of these rates would be for the benefit of the ratepayers. As to the great advantages accruing from scientific education, he said the scientific aspects of such work were more interesting than he could find words to express. Tremendous advance had been made during the past 50 years, and discoveries were now being constantly made. It was true that many of them were in the realm of pure science, with no immediate prospect of practical application. But what was to be thought of the investigator who only looked for an immediate practical application? The electrical discoveries of Faraday and Henry would never have been made if they had asked *cui bono*. Lord Kelvin afterwards distributed the prizes and inspected the buildings and laboratories.

Electrical Methods of Measuring Temperature.—Prof. H. L. Callendar, F.R.S., delivered the first of three lectures on the above subject at the Royal Institution on Thursday last week. The electrical methods were, said the speaker, more accurate, speedy and generally convenient than the other methods yet known, and were at the present time used almost exclusively in research work. There were two kinds of electrical methods for determining temperatures, the one based on the property of electrical conductors to change their resistance with the temperature, and the other based on the observation that a P.D. is produced at the junction of two different metals when it is heated. The first method was more accurate, as a rule, than the second, especially for low temperatures, and it possessed the further advantage of giving readings almost instantaneously; it was also very convenient for measuring mean temperatures. On the other hand, the second method, employing the thermo-couple, was valuable for determining the temperature at a particular point. Prof. Callendar then discussed briefly the methods for determining resistances, pointing out the great accuracy of the zero methods, and drew special attention to the proper way of connecting up the wire resistance of the thermometer—which generally consists of very fine platinum wire—to the Post Office pattern of resistance box. The proper way to do this was to make the connections so that the current passing through the resistance wire of the thermometer had also to pass through the resistance in the third arm of the bridge. The current passing through the wire was thus small, and the error due to its heating the wire was reduced to a minimum. The lecturer then went on to describe the practical arrangement of the resistance construction of electrical thermometers on this principle, and discussed the formulæ of various investigators connecting the resistance with the temperature. Subsequently Prof. Callendar explained by means of exhibits the construction and peculiarities of the thermo-couple, and proved in an experiment how suitable such thermo-couples were for the measurement of temperatures at particular points. Turning, then, to the practical applications of these temperature-measuring methods, Prof. Callendar drew particular attention to their usefulness for meteorological purposes, and he showed and explained a temperature recorder of his own design which might be used for various purposes—for instance, for recording the duration and intensity of sunshine. How very more sensitive—besides being superior in other ways—this electric recorder was than the burning-glass method, which is generally used, was forcibly brought home to the audience by comparative charts.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 4th.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "Some Notes on Electric Storage Batteries," by G. C. Allingham.

SATURDAY, March 5th.

INSTITUTION OF ELECTRICAL ENGINEERS (STUDENTS' SECTION).

9:30 a.m. Visit to the Works of Messrs. J. I. Thornycroft & Co. (Ltd.), Chiswick.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

2:15 p.m. Students' Visit to the Stuart-street Generating Station of the Manchester Corporation.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture III., by the Right Hon. Lord Rayleigh, F.R.S., on "The Life and Work of Stokes."

MONDAY, March 7th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture I.: "Recent Advances in Electro-Chemistry," by B. Blount.

TUESDAY, March 8th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Meeting at 207, Bath-street. Paper to be read: "Electrical Coal-Cutting Machinery," by S. Mavor, and adjourned discussion on Mr. M. Georgi's Paper, "New Methods of Electrical Winding-Gear for Collieries and Allied Purposes."

WEDNESDAY, March 9th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. Meeting at the Literary and Philosophical Society, Westgate-road. Included in the business of the evening will be the discussion on Mr. B. C. Laws' Paper, "Technical Education."

THURSDAY, March 10th.

ROYAL INSTITUTION.

5 p.m. Afternoon Lecture III.: on "Electrical Methods of Measuring Temperature," by Prof. H. L. Callendar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS: LEEDS LOCAL SECTION.

7:30 p.m. Meeting at the Yorkshire College. Paper to be read: "Description of the Electrical Equipment of an Engine Works," by H. O. Wraith.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Papers to be read: (1) "The Railway Electrification Problem and its Probable Cost for England and Wales," by F. F. Bennett. (2) "The Rated Speed of Electric Motors as affecting the Type to be Employed," by H. M. Hobart.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Meeting in the Royal College of Science. Paper to be read: "The Supply of Electricity to Small Irish Towns," by T. Tomlinson.

FRIDAY, March 11th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7:30 p.m. Students' Meeting in the School of Technology. Paper to be read: "Switch Gear for Traction and Transmission," by J. W. Bell.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, Westminster. Paper to be read: "The Premium System of Payment for Labour," by W. G. Banister.

PHYSICAL SOCIETY OF LONDON.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "The Whirling and Transverse Vibrations of Shafts," by Dr. C. Chree, F.R.S. (2) "Notes on Non-homocentric Pencils, and the Shadows Produced by them. Part. II.: Shadows Produced by Axially Symmetrical Pencils possessing Spherical Aberration," by W. Bennett. (3) Exhibition of Apparatus by Messrs. Pye & Co., Cambridge.

SATURDAY, March 12th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture IV., on "The Life and Work of Stokes," by the Right Hon. Lord Rayleigh, F.R.S.

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RULES UNDER THE RAILWAYS (ELECTRICAL POWER) ACT.

The Board of Trade has now framed the following rules with respect to applications under the Railways (Electrical Power) Act, 1903 :—

NOTICE OF PROPOSED APPLICATION.

1. *Notice by Advertisement.*—Notice (hereinafter referred to as "the notice") of intention to apply to the Board of Trade for an order under the Railways (Electrical Power) Act, 1903 (hereinafter referred to as "the Act"), must be published by advertisement, in each of two consecutive weeks,

(*a*) in the *London, Edinburgh* or *Dublin Gazette*, according as the general offices of the railway company applying for the order (hereinafter called "the promoters") are situate in England, Scotland or Ireland, respectively;

(*b*) in at least one local newspaper circulating in every county or borough or urban district in which is situate any part of that portion of the railway to which the order applied for relates; and

(*c*) If it is proposed to take lands or to construct works in any county or borough or urban district other than the foregoing then in at least one local newspaper circulating in that county, borough or urban district.

A copy of each of the gazettes or newspapers containing these advertisements must be sent, when published, to the Board of Trade.

2. *Contents of Notice.*—The notice must be subscribed with the name and address of the promoters or their responsible agents, and must

(*a*) State generally the objects of the intended application;

(*b*) If it be intended to modify any working agreement, specify the company or person with whom such agreement subsists;

(*c*) If it is proposed to take any land under the order applied for, describe the land proposed to be taken, stating the quantity thereof and the purpose for which it is proposed to take it;

(*d*) Name (1) a place where copies of the draft order will be obtainable on payment of not exceeding 1s. per copy, and where (if it is proposed to take any lands) a plan of the lands to be taken and a book of reference to the plan made in accordance with these rules and in these rules referred to as the plan and book of reference will be deposited for inspection, and (2) a date, not later than three weeks after the first advertisement of the notice, after which copies of the draft order will be so obtainable, and the plan and book of reference will be so on deposit for inspection;

(*e*) State that any objections must be made in writing to the Board of Trade in accordance with these rules, and a copy thereof sent to the promoters.

3. *Deposits with Local Authorities.*—Copies of the draft order (and if lands are proposed to be taken, of the plan and book of reference) must be deposited by the promoters within three weeks after the first advertisement of the notice, with the clerk of the council of any county, borough or urban district in which any part of that portion of the railway to which the order applied for relates, or any works proposed to be constructed or any lands proposed to be taken are situate.

4. *Deposits with Government Departments.*—A copy of the draft order and of the notice must be deposited by the promoters within three weeks after the first advertisement of the notice with the Treasury, the Postmaster-General, the Commissioners of Works, and the Commissioners of Inland Revenue, and, in any case in which lands are proposed to be taken within 300yds. of land belonging to the Crown or to the Duchies of Cornwall or Lancaster, at the offices of the Commissioners of Woods, the Duchy of Cornwall or the Duchy of Lancaster as the case may be. A copy of the plan and book of reference, if any, must at the same time be deposited with the Commissioners of Works.

In the case of railways in Scotland, a copy of the draft order and of the notice must also be deposited with the Secretary for Scotland, and, in the case of railways in Ireland, with the Chief Secretary to the Lord Lieutenant and with the Commissioners of Public Works, Ireland, at their respective offices in Dublin.

5. *Notice to Railway Companies having Running Powers.*—If any other railway company has running powers over that portion of the railway to which the order applied for relates, a copy of the draft order and of the notice must be sent to each such company within three weeks after the first advertisement of the notice.

6. *Mode of Making Objection.*—Any objection to an application to the Board of Trade for an order under the act must be made in writing to the Assistant Secretary, Railway Department, Board of Trade, within three months after the first advertisement of the notice, and a copy must at the same time be sent to the promoters or their solicitors or agents.

7. *Notice as to Commons.*—If the promoters propose to take under the order any part of a common as defined by sec. 21 of the Light Railways Act, 1896, or any easement over or affecting any such common, they must send intimation in writing within three weeks after the first advertisement of the notice to the Board of Agriculture and Fisheries, describing the common affected and the mode in which it is affected.

8. *Deposit of Plans, &c.*—If lands are proposed to be taken, the plan and book of reference referred to in the notice must be deposited by the promoters within three weeks after the first advertisement of the notice at the place named in the notice, and shall be open to inspection at all reasonable times.

The promoters shall supply copies of the draft order on payment of not exceeding 1s. per copy at the place and after the date named for that purpose in the notice.

PLANS AND BOOK OF REFERENCE.

9. *Plans.*—Every plan made for the purpose of these rules must be drawn to a scale of not less than 4in. to the mile, and must describe the lands intended to be taken, and unless the whole of such plan shall be upon a scale of not less than ¼in. to every 100ft. an enlarged plan shall be added of any building, yard, courtyard or land within the curtilage of any building, or of any ground cultivated as a garden, proposed to be taken, on a scale of not less than ¼in. to every 100ft.

10. *Book of Reference.*—The book of reference made for the purpose of these rules shall contain the names of the owners and reputed owners, lessees or reputed lessees, and occupiers of all lands and houses proposed to be taken, and shall describe such land and houses respectively.

NOTICE TO OWNERS, LESSEES AND OTHERS.

11. *Service of Notices on Landowners and others.*—Within three weeks after the first advertisement of the notice the promoters must serve a notice on the owners or reputed owners, lessees or reputed lessees, and occupiers of all lands intended to be taken, describing in each case the particular lands intended to be taken, and inquiring whether the person so served assents to or dissents from the taking of such lands, and requesting him to state any objections he may have to such lands being taken.

Every such notice shall be in the form set out in the schedule to these rules, or in a form to the like effect.

APPLICATION TO THE BOARD OF TRADE.

12. *Documents to accompany Application.*—Every application to the Board of Trade for an order must be made within a month after the first advertisement of the notice, and must be under the seal of the railway company applying for the order, and must be accompanied by—

(*a*) Three copies of the draft order and notice, and, if it is proposed to take land under the order, of the plan and book of reference; and

(*b*) If it is proposed to raise additional capital, an estimate of the expenses to be incurred for the purposes of the order, including the expense of acquiring land, and of the incidental expenses; and

(*c*) A list, with their postal addresses of the owners or reputed owners, lessees or reputed lessees, and occupiers on whom notices have been served; and

(*d*) A list of the councils with whom copies of the draft order have been deposited under these rules.

13. *Documents to accompany or follow Applications.*—(*a*) A statement, so far as can be made, whether the owners or reputed owners, lessees or reputed lessees, and occupiers on whom notices have been served in each case assent, dissent or are neuter, must be deposited with the Board of Trade on or before the last day of the month after the month in which application was made;

(*b*) Such proofs must be furnished as the Board of Trade may require of compliance with these rules before they take the application into consideration;

(*c*) A certificate that the members of the railway company applying for the order have assented to the application by such a resolution as is required by the Standing Orders of Parliament in the case of an application to Parliament by such company must be deposited with the Board of Trade before an order will be granted.

14. *Service of Notices.*—Notices and any other documents required or authorised to be served under these rules may be served by delivering the same to or at the residence of the person to whom they are respectively addressed, or, where addressed to the owner or occupier of the premises, by delivering the same or a true copy thereof to some person on the premises; or, if there is no person on the premises who can be so served, then by fixing the same on some conspicuous part of the premises; they may also be served by post by a prepaid letter.

Any notice by these rules required to be given to the owner or occupier of any premises may be addressed by the description of the "owner" or "occupier" of the premises (naming them) in respect of which the notice is given without further name or description.

FEES.

15. *Fees Payable to Board of Trade.*—On or before lodging any application the under-mentioned fee, which has been fixed by the Treasury, on the recommendation of the Board of Trade, must be paid by the promoters to the Board of Trade by cheque in favour of an assistant secretary of the Board of Trade, viz.:—

For each application—the sum of £50.

GENERAL.

16. All communications to the Board of Trade should be on foolscap paper and written on one side only, and should be addressed to—

The Assistant Secretary,
Railway Department, Board of Trade, S.W.

17. The Interpretation Act, 1889, applies for the purpose of the interpretation of these rules as it applies for the purpose of the interpretation of an Act of Parliament.

FRANCIS J. S. HOPWOOD, Secretary.

Board of Trade, 7, Whitehall Gardens, S.W.,
February 17, 1904.

SCHEDULE.—FORM OF NOTICE TO LANDOWNERS AND OTHERS.

SIR: We beg to inform you that application is intended to be made to the Board of Trade on behalf of the.....Railway Company for an order under the Railways (Electrical Power) Act, 1903, and that the property mentioned in the annexed schedule or some part thereof, in which we understand you are interested as therein stated, will or may be required for the purposes of the said order.

We also beg to inform you that a plan relating to the said application and a book of reference thereto have been or will be deposited with the

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clerks of the [*specify county and other councils as the case may be*] on or before [*state the date*] for public inspection, on which plan your property is designated by the numbers set forth in the annexed schedule.

As we are required to report whether you assent to or dissent from the proposed undertaking, you will oblige us by writing your answer of assent or dissent in the form left herewith, and by stating any objections you may have to your property being taken and returning the same to us with your signature on or before the.....day of.....next; and if there should be any error or misdescription in the annexed schedule, we shall feel obliged by your informing us thereof at your earliest convenience, that we may correct the same without delay.

We are, &c.,

Schedule referred to in the foregoing Notice describing the Property therein alluded to.

Parish, township, townland or extra parochial place.	Number on plans.	Description.	Owner.	Lessees	Occupier.

I, the undersigned, $\frac{\text{assent to}}{\text{dissent from}}$ my property being taken for the proposed work (*and my objections are that*).....

THE EQUIPMENT OF AN ENGINE TEST HOUSE.*

BY R. K. MORCOM.

The days of broad guarantees of coal consumption of a plant per month or per annum have now passed, and the era of specialised testing has been inaugurated by modern competition. Nowadays boilers, engines, generators and motors must all be proved to fulfil the specification as to efficiency and reliability, and it is on the closeness with which the results obtained approach the guaranteed figures that the justification of an enterprise often depends. The value of the experience gained by tests is so great that all progressive manufacturers lay down more or less extensive testing plants for their own use, and so it is only natural that their test houses should also be used to demonstrate guarantees, and to ensure that time shall not be wasted on site, and to avoid the inconvenience to a station engineer of having his station turned into an experimental department. A brief account of the evolution of a plant for testing combined sets for electricity stations, and of some of the more interesting results obtained, is the object of this Paper.

In getting the necessary apparatus the following requirements had to be met:—The units to be tested ranged in size from 75 H.P. to 1,250 H.P., running condensing or non-condensing, with steam pressures from 80lb. to 250lb., and degrees of superheat up to 350°F. above saturation point. The voltage might be anything from 60 to 6,000, and the current anything from 10 to 2,000 amperes, either in direct current or in single or polyphase alternating current of various frequencies. The sets might have to run at full load, light loads, and varying loads. Regulation tests of the dynamo and governing tests of the engine would also be generally required. Add to this the fact that only a limited space would be allotted, and as rapid changes from one set to another were necessary, the complication of the problem is obvious.

A testing plant had to be evolved to meet the above requirements which should be accurate without being too costly, and which should be satisfactory to the expert, and yet easy to explain to the inexperienced. In the following is given an account of a modern engine test-house intended to meet the above requirements satisfactorily, without neglecting the important question of cheap working costs.

Steam is raised by four water-tube boilers, capable of producing 20,000lb. of steam per hour. It is carried either direct to the engine or through a separately-fired superheater. Steam dryers are fitted in the flues of two of the boilers. Analyses of gases and fuel consumptions are taken periodically, and everything possible is done to keep the steam-raising costs low. The range is designed to supply eight testing berths. It is divided into two sections, each of which can be isolated with one or more boilers in case tests at different pressures are run simultaneously. Reducing valves have been avoided, owing to the fact that the very trying conditions of varying pressure and temperature would probably render them a source of trouble.

The test plates are of the usual grid type on solid concrete foundations, and pits are arranged to accommodate big generators. The engines are coupled to the range by means of steel bends and matching pieces, each standard engine having its own series of piping. Flexible piping and other similar devices have been found unsuitable for test-house wear and tear. Difficulty has been found in providing lagging for the temporary pipes; the most satisfactory so far has been a large diameter asbestos rope, with which considerable lengths can be expeditiously lagged.

Temperature Tests.—A thermometer is fitted into the steam pipe leading to each engine, and the temperature of the steam is adjusted to meet the requirements of the inspecting engineer. The first arrangement used for measuring this temperature was a steel tube or cup, closed at one end, and arranged to screw into the steam pipe at any convenient place close to the engine. The cup was filled with mercury, and an ordinary high-reading glass thermometer dropped into the mercury. As the lower portion of the cup extended well down into the steam space, the thermometer gave a fairly close approximation to the actual temperature of the steam. This method is adopted by a good many makers who supply thermometers for reading steam temperatures, the only difference being that the glass thermometer is secured in the cup, and generally provided with a metal cover to protect the glass from injury. This method, however, is not sufficiently accurate, as the thermometer always gives a reading lower than the actual temperature, owing to a certain amount of heat being lost by conduction from the cup to the comparatively cool steam pipe.

Another way of indicating the steam temperature is by means of a mercury steel pyrometer, which indicates the temperature by a pointer on a dial face, and has much the same appearance as an ordinary pressure gauge. It is actuated by the expansion of mercury in a steel tube reacting on a spring. This type of instrument need not itself be attached directly to the steam pipes; it may be fixed in any position in the engine room, and connected by a fine steel tube containing any convenient medium to transmit the pressure to the spring. It is useful as an indicator to the engine attendant, but it is troublesome to calibrate, and requires frequent correction.

Prof. Burstall suggested a platinum-wire pyrometer, but this was frequently broken by the rush of steam, and was too delicate for a works test house. The present arrangement is a thin steel tube, screwed well into the steam pipe through a stuffing box, so that an asbestos packing may insulate it from the steam pipe. Oil is used in the tube instead of mercury, as it is found slightly more accurate; the mercury also boils away at high temperatures.

Exhaust.—Exhaust steam is passed into a range connected to three surface condensers, separated by middling valves. The back pressure is adjusted to the specified amount from the lowest the plant can register up to any specified amount. The exhaust range has to be extremely adaptable, as engines are often running round unloaded for one cause or another, while water consumptions are being taken on others on load. Accordingly, every branch is three-wayed—going to the engine, an atmospheric main, and to the condenser main. At every point where water may collect a drain has been fitted, as water returning from the exhaust has occasionally been found troublesome. The larger engines are coupled up by large cast-iron pipes, the smaller ones with flexible piping. The air-pump discharge is passed into tanks attached to Avery balances, on which the amount of water delivered in any given interval is weighed and announced by electric bell to any suitable point. Open-ended flushing valves are provided to these tanks in order that any leakage can be immediately detected or rectified.

The actual taking of the water consumptions varies in different test houses, so a brief description of the method adopted in the one under consideration may not be out of place. Before attempting to take a measurement under certain fixed conditions of load and steam, the engine should be run under those conditions for a sufficient time to ensure its having reached its proper temperature throughout. The time varies from a quarter of an hour to an hour. If this point is neglected, anomalous results are apt to be obtained. This also has a bearing on what may be called traction-load results with a varying load. It has been found that short measurements taken at different loads dropping from full load by steps down to no load at, say, 10 minutes' intervals, always gives better results than when taken on an up-grade. It is possible to conceive that with the same mean load on the same size engine certain load curves will for this reason give better results than others.

All cylinder drains should be closed, and the ends of the drain pipes should be inspected for leakage, unless they are coupled into the engine exhaust pipe. The valve from the condensed water weigh tank should be shut, and the sliding weight of the balance set at a fixed point on the arm. As soon as the weight is balanced, the arm on its upward swing makes an electric bell circuit, and the man at the load-board carefully notes the time and load. The slide weight is then moved on sufficiently to give a two minutes' interval before the next ring, when the process is repeated. A complete log of steam pressure, temperature, &c., is taken, say, every third reading. In this way over a half-hour's tank results can be obtained with quite as great accuracy as would be obtained by an arduous six hours' water consumption. The idea that a lengthy measurement of condensed water is necessary is really due to the fact that a confusion exists in some people's minds between measurements of feed water and condensed water.

Brake Test.—Tests are often run on the water brake if the dynamo is not to hand. A series of brakes is kept to suit different

* Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on February 17th.

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sizes, the Heenan and Froude, pattern being the one adopted. The beauty of this brake, from the inspecting engineer's standpoint, is that, whatever else it may be doing, the engine is certainly lifting a certain weight at a certain radius. The type is too well known to require any description here.

As a check on the readings, either brake or electrical, and also when comparing brake horse-power with electrical horse-power the indicator is always used. But too much reliance on the readings of this instrument may lead to trouble, especially in high-speed work. Cards taken on the same load by experienced and inexperienced operators often vary as much as 5 per cent. The efficiency of a well-constructed quick-revolution engine is so high, that unless practically the whole indicated horse-power is registered absurd results are recorded, whereas a similar fault on a less efficient engine would be unnoticed. For this reason separate indicators are used, both top and bottom, with full bore fittings right into the cylinders. The indicators are continually calibrated under steam, and all cards are taken by an expert operator. In this way the highest accuracy is ensured, and the indicator becomes a useful check on other figures. An interesting point in high-speed engine indicating has been demonstrated—viz., that the oscillations always associated with the cards are actually present in the steam, and are not due to indicator inertia.

After trials of all manner of instruments and consideration of objections raised by grumblers thereat, the following equipment for testing the electrical side of the plant has been arranged :—

Ammeters.—For direct-current shunted instruments of the Weston and solenoid types are used. For alternating-current double-range hot-wire ammeters are adopted, except for very high voltages, when suspended coil dynamometers have proved more serviceable. The instruments here detailed for alternating current are, of course, available for direct current also. As a calibrating instrument, a large Siemens dynamometer with reversing switch is found reliable.

Voltmeters.—For direct current the Weston type has also been chosen, being fitted with a volt-reducing box to give a very big range. For alternating work, vertical scale static instruments are used. For calibration a wide-ranged horizontal scale Kelvin instrument has been adopted.

Wattmeters.—The hardest instrument to come to a decision about is undoubtedly a wattmeter for alternating current. Every engineer seems to have his own views on the matter, and an instrument that has much to recommend it to the practical man is often condemned for some theoretical defect. The instruments finally adopted in the test house under consideration are of the suspended coil type, both direct and zero reading. The current range is capable of alteration by putting the current coils in series or parallel, and the volt range is also variable by means of resistances.

Potentiometers.—In experimenting with a potentiometer, the fact that the works' foundations were of a light character rendered the mirror galvanometer too delicate an instrument, as the vibration of the cranes made the spot very elusive. This difficulty might have been overcome by the use of felt pads or some form of vibration damper, but another reason put this highly adaptable and accurate instrument out of court. This reason was an appreciation of the value of simplicity in inspiring confidence in the tests. It was thought best to contrive so that anyone could follow and check every figure, even the most inexperienced assistant whom it might be convenient for a chief engineer to send down ; and from a manufacturer's point of view, also, so much must be taken on trust where time is important that a careless assistant may vitiate a whole series of results when working with an instrument which does not give readings without manipulation.

Water Resistance.—After considerable trouble and expense in connection with wire resistances, both in wooden and iron frames, a form of water resistance for taking up the load has been devised. The poles are of iron, arranged in wooden tanks. Water from a neighbouring canal is passed continually through the tanks by a bye-pass on the condenser circulating pump, and flows out over a weir. The poles are connected to a load-adjusting switchboard, and can be coupled into the load in many combinations. Three tanks are used for different ranges of voltages, and these ranges are further divided by adjustments of the outflow from the tank. Specially subdivided tanks are used for polyphase work.

The first experience when using a water resistance was not very satisfactory. The apparatus consisted of an iron tank about 3ft. wide and 6ft. long, with two large iron plates for the electrodes. This tank did not last very long, for the current, as well as passing from plate to plate, found a shorter passage by way of the sides and bottom of the tank. An improvement of this arrangement was a large wooden tank, 4ft. wide by 10ft. long, and about 4ft. deep. Into this were fitted four hollow cone-shaped castings, large end upwards. Inside each of these cones was a smaller one, suspended from above on a screwed spindle and hand-wheel. The outer cone was coupled to one terminal of the dynamo on test, and the inner through a flexible lead to the other terminal. Load could then be varied by raising or lowering the inner cone on the screwed spindle. It was necessary to keep the water-level a little higher than the top edge of the outer cone, so that the heated water in the space between the cones might rise naturally and flow away. This arrangement gave very satisfactory results ; in fact, some cones are still in use which were fitted about 18 months ago.

For higher voltages it was proposed to use a metal rod dipping into the water at the centre of the cone, but the conducting area of water to the outer cone was too large and the length of water resistance too small for many machines. Accordingly, a wooden trough of small cross section and great length was designed for high-voltage work. The use of wooden troughs did away with the need for conical poles, and it is now found more useful to substitute iron plates fixed at the top to flexible terminals and movable on insulated rollers along wooden runners. The load can thus be varied by sliding the plates along so that the cross-section between them is varied. By using a considerable number of smallish plates a very flexible load is obtained, and if care be taken with the circulating arrangements a very steady load results.

Switchboards.—These are of two types. Those of the one type are purely load boards, and are placed close against the load tanks. They are arranged to give any required fraction of the load by cutting out sections of the poles of the water resistance. The other boards are instrument boards, and are portable. They each contain a complete equipment of instruments and switches suited to the class of machine for which they are used. Special boards are provided for continuous current and high and low-voltage alternating current ; these latter are made suitable for three-phase work. A description of the three-phase low-voltage board will be characteristic.

The board is made of a stout wooden frame with an ample base, which is arranged for bolting down if necessary. The instruments and switches are mounted on the front and side faces on slate slabs. In the space contained by the wings of the board at the back are arranged all the required connections and terminals. There are three hot-wire ammeters, one static voltmeter, with three-way switch, and one large three-phase switch for the main circuit. On a shelf projecting below the ammeters are placed two wattmeters of the suspended coil type. Lamps lit by the machine on test are arranged over each instrument. They serve not only to light up the dials, but afford information to a distance. The auxiliary instruments for the exciting circuit are fitted on the wings. The whole board with instruments and connections can be lifted by a crane.

The cables are being laid in troughs, with a junction box to each test-berth, all being connected to the load boards.

Besides the supply of low-reading ammeters for shunt and exciting, circuit-reading portable rheostats are kept, as it is generally inconvenient to run a generator with its own regulating resistance. These have two sliding contacts on the top for coarse or fine adjustment, and the coils are contained in stout angle-iron frames, shielded with perforated sheet steel. They are stronger and have a larger range than those usually supplied with the machines.

After the various trials, which can be run light, and which by deduction based on previous records can be made to give most of the information required about the engine, the dynamo is coupled up to the load. The portable switchboard is placed in front of the engine and connected to the dynamo and junction-box. The proper arrangements of the load board are then made, the machine excited and loaded up and all the required preliminary trials made. After any defects discovered by these runs have been put right, the set is ready for its official tests.

The usual course is a six hours' run at full load, after which dynamo temperatures, &c., are taken. Then the governor is tested, and then any light load or special trials are made. Water consumptions are taken periodically. In recording these great care must be taken to have all readings taken that are necessary for accuracy. Steam pressure and temperature, vacuum, revolutions and load must be carefully recorded over the interval during which the condensed water is being weighed. Indicator cards should be taken during each consumption test as a check on the load-measuring instruments. Simultaneous all-round reading should be arranged by signal, in order to give the right efficiency, whenever a set of cards is taken. After the official trial further small details are rectified and re-tested, and the set is ready for overhaul and despatch.

Preliminary and official trials are often utilised to give information on small points of design, such as packing, governors, oil service details and other matters. New gauges, instruments, jointing materials and lagging are also frequently under test. When it is impossible or inadmissible to run such experiments on preliminary or official trials, special trials have to be run for the purpose. These points are of course of great importance to the designers of engines, but though the results may be appreciated by the users, the experiments leading up to the improvements are not of the same interest. The special tests which excite most interest are those which bear on engine performance, and a brief account of some recent trials will serve to show the type of results obtained in a modern test house.

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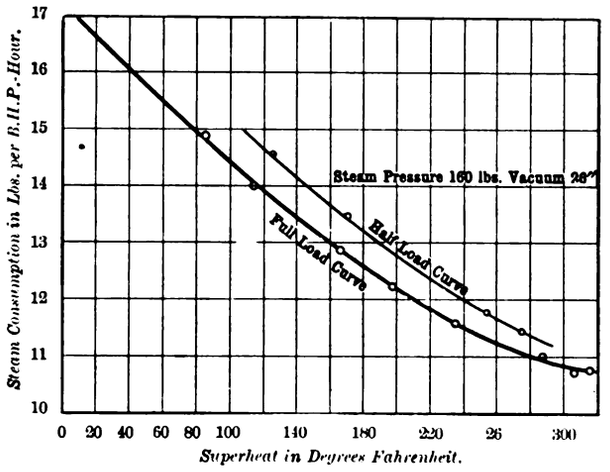
Superheating.—The benefit due to superheating has long been recognised, but what that benefit amounts to in practice still seems very doubtful to many. On an engine properly designed to run under superheated steam conditions full advantage is taken of the improved economy with but little extra trouble in running. It is only in using superheat on an engine quite unsuited for the purpose that those troubles are experienced which in so many cases prejudice engineers against elevated temperatures.

Another point is sometimes brought forward that, as clearance for expansion must be allowed in the pistons and valves of an engine designed f r superheat, so if the superheat fall the engine will be very extravagant of fuel. Experiments have been run which prove that this is a mistaken notion. An engine designed to run with 250deg. superheat has been tested with dry steam at saturation temperature, and the result shows that with these valves and pistons the engine is only 2·1 per cent. less economical than when fitted with valves and pistons designed for ordinary conditions.

Superheat water consumption curves are given in the diagram from a three-cylinder triple engine of 200kw. capacity. Results are given at full and half loads. The trials were run on the brake at 160lbs. steam pressure and 26in. of vacuum. It will be seen that the percentage of improvement for any given rise in temperature is approximately the same at full and half loads. The gain due to 200deg. of superheat is here seen to be 41 per cent. On a given type of engine the curves obtained are very similar for both large and small sizes.



The actual gain due to superheat is, of course, less than this, as extra lubrication and increased fuel consumption are required. The increased cost of oil for cylinder lubrication amounts to about 0·04d. per 100 H.P.-hour, and is, therefore, a very small item. Fuel consumption trials run on a 522 B.H.P. triple expansion engine with 160lbs. pressure and 26in. vacuum gave the following figures :—

Trial (1).	Fuel per hour with saturated steam ...	1,193lbs.
,, (2).	,, in boilers with superheat	833 ,,
	,, in superheater to give a temperature of 600deg.	173 ,,

Accordingly the gain in fuel is 19 per cent. The fuel was slack of poor evaporative value.

It may be mentioned that the superheater was very lightly loaded, and that the lagging of the steam pipe was not so good as it might have been. Allowing for these points, it seems that a saving of, say, 25 per cent. might be expected by superheating to 600deg.

Another interesting trial taken on a 120 B.H.P. compound engine at 450 revs. per min. was on the influence of forced lubrication on the indicated horse-power at light loads. The engine was run free, and friction cards taken with oil pressure of 30lb., 5lb. and 0lb. The I.H.P.s in each case were 2·128, 2·409 and 3·333 respectively. This is interesting as showing that a great increase in oil pressure will not bring a correspondingly big advantage.

Trials on such points as the effect of by-passing the steam, on variable expansion governing, and many other points of the sort might be quoted, but the results are not of sufficient general interest or originality to warrant their inclusion here.

A testing department is always accumulating results, and every result is entered up in careful history books; anomalous figures are remarked on and, if possible, explained, and curves illustrating various points are frequently made. This mass of information is necessarily largely unpublished, and the public only hear of the work of those numerous well-equipped laboratories when some improvement is put before them in a fully-fledged condition. Probably much of the information is not used to the full, and doubtless there are many experiments made in engineering colleges and institutions to elucidate mysteries when all the time the solution is lying clear to see in some manufacturer's record book.

The following is an abstract of the discussion which took place in connection with the Paper :—

Mr. HENRY LEA (vice-chairman) referring to the section on temperature tests, suggested that Mr. Morcom's ill-success with platinum wire pyrometers was owing to his having exposed the bare platinum wire to the rush of steam. If Mr. Morcom had exposed the bulbs of his mercurial thermometers in a similar way to the rush of steam, they would, he suggested, have been blown off one after another. The platinum wire should have been enclosed in a protecting tube having only one or two very small holes in it to allow the steam to obtain access to the wire. His own experience was that mercurial thermometers immersed in cups did not register correctly the full temp rature of the steam, and a platinum wire thermometer properly protected from mechanical injury would be far superior. Mr. Morcom had said that half-hour tank results could be obtained with as great accuracy as by means of an arduous six hours' water consumption test. This was perfectly correct, but the objects of a six or eight or ten hours' test were not confined to the measurement of condensed water, but related generally to the behaviour of the dynamo and its capability of working at full load or a specified overload within the specified limits of rise of temperature. If a prolonged test were necessary from this point of view, there was no particular reason why the consumption of steam should not be ascertained by weighings of condensed water extending over an equal length of time. The older he got, the less he felt disposed to place much reliance on indicator cards. He once saw a list drawn up by an expert of the number of different ways in which an indicator card could be caused to show what was not going on in the engine, and, if he remembered rightly, there were 200 different reasons why an indicator should give false results. And when these 200 reasons had been eliminated there remained the fact that the diagram itself was drawn with a pointed wire which makes a line that might easily be $\frac{1}{60}$in. thick, representing a possible error of 3 per cent. in the area of the diagram. Indicator diagrams were invaluable for valve setting and as methods of measurements of power when no other methods were available, but for testing steam dynamos he should be quite content to ignore the indicator diagram altogether, and take the result in pounds of water per kilowatt. He had great admiration for the potentiometer, and Mr. Morcom's views were worth consideration, but when tests were being carried out of electric generating plants costing large sums of money, a really experienced assistant should be sent down who would appreciate so accurate and reliable an instrument as a potentiometer. With regard to water resistances, he asked at what voltage and rate of current the wooden tank, 4ft. wide 4ft. deep and 10ft. long, could be used. Finally, he was surprised at Mr. Morcom's curve showing symmetrical improvement in steam consumption from about 10deg. of superheat up to 320deg. He (Mr. Lea) had found in the course of some laboratory tests that the first 40°F. or 50°F. of superheat accounted for an enormous reduction in steam consumption where the valves and pistons of the engine were at all leaky. In some tests 40°F. of superheat at a pressure of 60lb. per square inch reduced the amount of leakage by 45 per cent., and this was not materially further reduced by any increase in superheat up to 100°F. The beneficial effect of superheated steam might, he concluded, be divided into two parts—first, the effect of reducing the amount of steam passing through leaky valves or pistons, and, second, the more economical behaviour of the superheated steam in the engine, irrespective of the amount of leakage. All engines would be benefited by about 50°F. of superheat, the more leaky ones to an extent which was almost incredible, as he had proved in the case of a high-speed 200 H.P. set, the electrical output of which went up exactly 100 per cent. in relation to the weight of coal consumed when the steam at the engine was superheated only from 20°F. to 30°F.

Mr. HOLDING had never found more than one or two Weston instruments of the standard horizontal type that could be trusted for a week without recalibration. He should like to know if there were any precautions which could be taken to maintain their efficiency. With regard to wattmeters, he found the Kelvin balance very good, and generally trusted by inspectors. Both the Kelvin and Swinburne instruments suffered to some extent from the fact that they were not direct-reading. It was possible to make enormous mistakes with potentiometers, and his experience of inspectors sent by consulting engineers corresponded with that of Mr. Morcom.

Mr. REYNOLDS said that at the test house of which he had most experience (Messrs. Willans and Robinson's) they had very much the same sort of apparatus for connecting up the steam ranges as Mr. Morcom had described. They had found, as he had, that flexible pipes would not stand the wear of a test house. The way they connected up differed slightly from Mr. Morcom's method in that their instruments were fixed. There were permanent leads coming down to pillars near every machine, so that the only thing they had to do when a machine came on the bed was to connect up the leads to the pillars, and the instruments were then ready. In the same way they had permanent leads for the load. With regard to the condensers they had found there was a large loss of vacuum whenever they had a bend or an angle in the pipe. With condensers fixed it seemed to him they must have rather a low vacuum as the ordinary working vacuum in the engine, and, if so, what allowance did they make to get the guarantees of 28in. and 27in. in vacuum? As to the indicating, if the operator was experienced and the indicators were kept with all their joints in working order, he thought the indicated horse power was well within ½ per cent. of what it ought to be. He had found that putting a Weston instrument between two machines or near two machines the readings altered, but that the Siemens dynamometer was not a really reliable calibrating instrument. He agreed with what had been said about the engineers who came down to inspect sets. In the works of which he had experience they found water resistance did not keep the load so steady as their ordinary resistance, They had coils of wire and also ordinary gal.

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vanised lattice wire, which they found a very good steady resistance. With regard to superheat in engines, they had found the engines did not require to be designed for superheat at all. They put superheat on their standard type of engines, and they had never had any difficulty with wear or anything, and when they went back to the saturated steam they did not find any increase in the steam consumption. He should like to know the method Mr. Morcom employed to measure the superheat.

Mr. MORCOM said they took the temperature of the steam pressure gauge.

Mr. REYNOLDS said they had found no extra lubrication was required with superheat. That very afternoon he was running an engine at about 200deg. superheat, and somebody suddenly discovered that the sight feed lubricator had not been working for about a couple of hours, but the engine had not seized up. They had found a very similar curve to that shown by Mr. Morcom in their trials at Rugby.

Mr. WALSH endorsed what had been said as to the trouble with platinum-wire pyrometers. They put a perforated plate round the arrangement that carried the wires, but it did not seem to help matters much. They might have succeeded better with one or two very small holes, but he thought this might affect the correctness of the reading. There was also a possibility of error in connection with the leads running from the pyrometer to the Wheatstone bridge which formed part of the pyrometer set. As had been emphasised, an inspector must take the instruments for granted. Weston ammeters were calibrated from an independent source, and were generally supplied sealed up with their shunts. If there was any question at all about the accuracy of the readings, the instruments could be taken away and calibrated by the Board of Trade. Then the weighing tanks might be inaccurate, but they were very easily checked by standard weights. They had a series of standard weights at Messrs. Belliss and Morcom's works, so that inspectors who chose to do so might check the arrangement at the beginning and end of the run. Of course, the indicator could be made to read almost anything, and might give a very thick line, but that was one of the points where the expert came in—he sharpened his pencil. You could get a line very much narrower than the 100th part of an inch. He was present at the test mentioned in the Paper, regarding the effect of forced lubrication, and the results mentioned represented the average obtained for a dozen sets of cards, and they did not vary except on the third.

Mr. ASHLYN said his experience had been that it was very difficult to get two ammeters even of the Weston type to read alike, though they might be on the same circuit with the same current passing through them. He should like to ask whether Mr. Morcom found the shunts themselves varied in actual use. They knew alloys crystallised at a certain temperature, and he knew himself that the alloys of which the shunts were made varied very much, and it was a question whether they should not come back to the fairly frequent recalibrating of those instruments to get anything like a standard reading at all. If they worked water consumption out to decimal points, they needed to be equally careful in their steam readings and their electrical readings. He should like further particulars than those given in the Paper as to the actual net gain due to superheat under different conditions.

Mr. MORCOM, replying to the discussion, said his point was that it was unnecessary to waste the time of the staff in lengthy measurements of water consumption. He was afraid he had been too hard on the assistants sent down by consulting engineers, for he must confess some of the trouble with the potentiometers was due to the works assistants. The tank 4ft. wide by 10ft. long and 4ft. deep took 500 volts and 2,000 amperes with a steady flow of canal water, which had a very high conductivity. With regard to the gain due to superheat, he did not think the excessive gains over the early ranges which were mentioned would be found with engines having carefully designed piston and valve rings which were of such a nature as to fulfil an Admiralty trial for steam pipes. Weston ammeters were not only very convenient in having a nice wide scale and a good range, but they had found them extremely accurate and permanent. They had their own ammeters constantly calibrated, but there was never anything to be put right. One of the speakers had said that in the test house with which he was connected they had fixed instruments with permanent connections. They had had the same arrangement at Belliss and Morcom's works once, but gave it up because they found it so much more convenient to have the instruments reasonably close up to the engines under test. As to loss of vacuum, no doubt they did lose a certain amount; but they did not need to make any allowance for it, as they gave their guarantees without it. The Siemens dynamometer which they used was large, and enclosed in glass, and its readings had shown great accuracy, well within 1 per cent., over a long period. He had no doubt it was the case that certain engines were specially suited to superheat, as had been suggested. The figure he had given as to fuel gain was taken fairly recently on a trial, and they had had a check on it which bore out the estimate of 20 per cent. However, as they had to test at the rate of about an engine and a-half a day, they had not much time for full trials.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Science Abstracts." February. Section A, Physics; Section B, Electrical Engineering. (London: E. and F. N. Spon.) 1s. 6d. each.

"Die Elektrometallurgie der Alkalimetalle." By H. Becker. (Halle-a-S.: Wilhelm Knapp). 6m.

"The Indian Electricity Act, 1903: Act III. of 1903." By J. W. Meares. (Calcutta and London: Thacker, Spink & Co.) 10s. 6d.

VOLTAGE REGULATION IN ALTERNATING-CURRENT SYSTEMS*

BY H. S. MEYER.

(Concluded from page 744.)

C.—AUTOMATIC VOLTAGE REGULATION AND COMPOUNDING.

According to their action the methods commercially introduced for compounding alternating-current generators may be divided into four classes:—

1. Mechanical influence on the exciter rheostat.
2. Use of a pulsating excitation in the exciter field.
3. Influence on the armature reaction of the exciter.
4. Self-excitation by means of rectified or low periodicity alternating currents.

1. *Mechanical Influence on the Exciter Rheostat.*

Fig. 8 gives a general illustration of this method. A represents the alternator, N the exciter, R is the rheostat in the exciter field. Its handle is worked by means of a worm gearing from a magnetic clutch, K, which is controlled by the relay L. The latter device is shown as a solenoid acting against a spring. In accordance with a lower or higher supply voltage either the spring or the solenoid will be more powerful, thereby closing the energising circuit of M_1 respectively M_2, thus increasing or reducing the resistance R. By adding a second coil, L_2, wound in opposition to L_1 and controlled from the secondary of a current transformer, V, the primary of which is in series with one of the main lines, over-compounding with increasing current can be obtained. The above scheme has been successfully

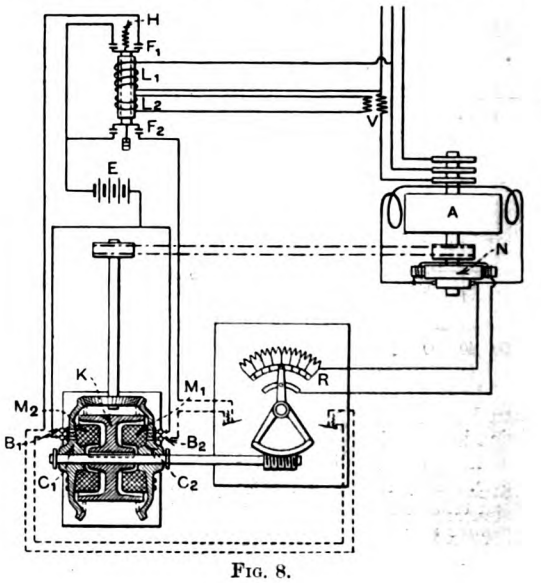

FIG. 8.

used in a number of plants where the nature of the load introduces only very gradual changes in load. For all other purposes it cannot be recommended, since the time lag between action and reaction is too large to allow a satisfactory regulation of the voltage.

2. *Use of a Pulsating Excitation in the Exciter Field.*

Somewhat similar in its general arrangement is the device invented by A. A. Tirril of the General Electric Co. of America. The main distinguishing feature of this regulator is the control of voltage by rapidly opening and closing a shunt circuit across the exciter field rheostat, thus giving the exciting current of the exciter a more or less pulsating character. The frequency of the make and break of this circuit is controlled by the voltage, and, if desired, also by the current of the generator, and varies from about 1 to 20 per second. The smallest drop from the desired voltage will cause the rheostat to remain short-circuiting for a longer period, thereby raising at once the voltage of the exciter and of the main generator. To avoid sparking at the contacts, a condenser is shunted across the breaking points. Fig. 9 gives the diagram of connections of the regulator as actually built.

The rheostat shunt circuit is opened and closed by a differentially-wound relay. The current for operating this relay is taken from the exciter 'bus bars, and is controlled by the floating main contacts. The current for operating the direct-current control magnet is also taken from the exciter' bus bars. The relay and the direct-current control magnet constitute the direct-current portion of the regulator, and maintain, not a constant, but a steady exciter voltage. The alternating current portion of the regulator consists of a magnet having a potential winding connected, by means of a potential transformer,

* Abstract of a Paper read before the Liverpool Engineering Society on January 20th.

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to the 'bus bars or the circuit to be regulated. This magnet also has an adjustable compensating winding which is connected in series with the secondary of a current transformer usually inserted in the principal lighting circuit. The core of this magnet is attached to a pivoted lever carrying a counterweight which is balanced by the attractions of the magnet. If a load is thrown on the generator the voltage will tend to drop, the alternating-magnet current will weaken and destroy the balance of the core and lever and cause the main contacts to close; this, in turn, will close the relay contacts and entirely short-circuit the exciter field rheostat, thus increasing the exciter voltage until the original balance of the alternating-current magnet core and lever is restored and the alternating-current voltage maintained at the required value.

Once the regulator is adjusted to maintain a desired voltage, it will maintain it under all ordinary conditions of load or speed without further adjustment, and since the moving parts of this regulator are very light and move only a short distance (about $\frac{1}{16}$in.) they can act instantly without any chance of hunting.

The regulator may be put in and out of service at any time without interfering with the voltage, and any number of alternators can be run in parallel—using the same regulator—provided the exciters are also run in parallel. If the generators are in parallel and the exciters are not, it would require a regulator for each of the exciters, which have to run at the same time. The base on which it is mounted is 15in. by 20½in., and therefore the complete apparatus can also be placed on a standard switchboard panel. The capacity of the plant which is to be regulated only affects the condenser capacity, which must be shunted across the contact points. Thus it has been found that for every 15kw. of exciter capacity, corresponding to about 1,000kw. generator capacity, one condenser section of about 2½mfd. is required.

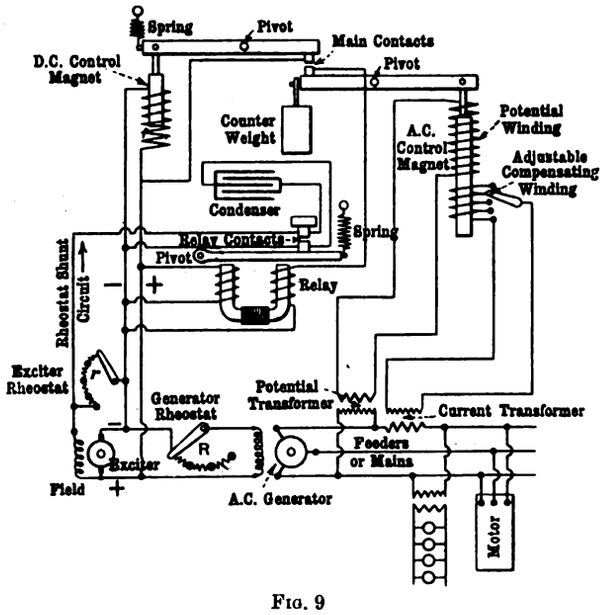


FIG. 9

In Figs. 10 and 11 some charts are given illustrating the working of this device on a standard 75kw. generator with direct-connected exciter and a normal speed of 900 revs. per min. The generator was driven by a shunt motor, and the normal variations of speed shown in chart 1 were due to changes of load on the generator and changes of voltage on the motor supply circuit. The 5 per cent. speed changes were made purposely to show the effect on the voltage. The motor was allowed to run with practically no attempt to regulate its speed.

The second chart gives the load in amperes on the generator, showing at times about three-quarters full load.

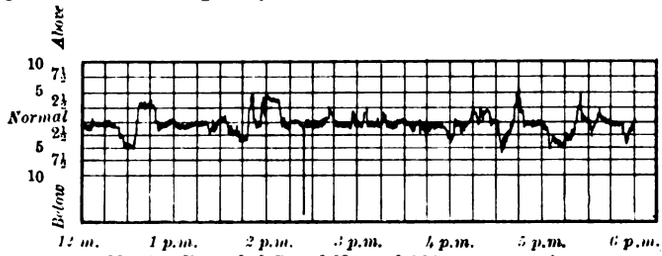
The third chart shows the voltage which was not regulated after once set at 115 volts. This chart shows that with a direct-connected exciter a speed change of 8 per cent. may cause a variation of about 32 per cent. in the voltage of the alternator, giving a ratio of about 14·1.

The next set of charts, 4, 5 and 6, were taken on the same generator, under more severe conditions, but using the regulator to maintain constant voltage. Chart 4 shows that the speed changes were greater with the regulator than without, as on chart 1 the extreme speed variation was only about 10 per cent., while on chart 4 the speed change was about 20 per cent. A load having various power-factors was frequently changed, as may be seen on chart 5, and notwithstanding these severe conditions the regulator maintained a voltage within ½ volt, as will be seen by the practically perfect chart 6,

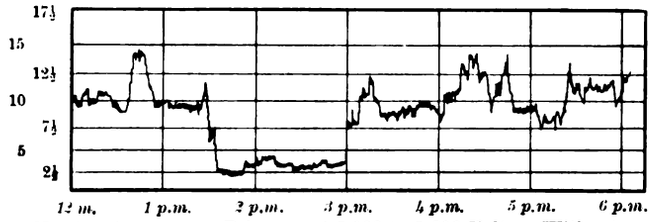
It may be added that more than 100 of these regulators have been installed in the States within the last 18 months.

3.—*Influence on the Armature Reaction of the Exciter.*

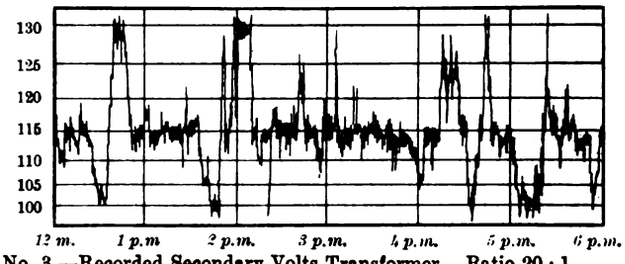
Here we have to mention, in the first place, the compensated generator as developed by the General Electric Co. of America, of



No. 1.—Recorded Speed Normal 900 revs. per min.
Per cent. variation from normal speed. Without Voltage Regulator.

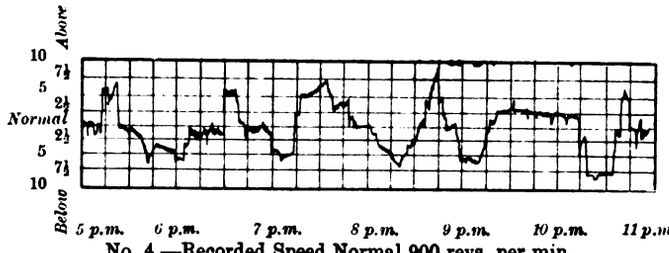


No. 2.—Amperes on Primary, at 2,000 to 2,600 Volts. Without Voltage Regulator.

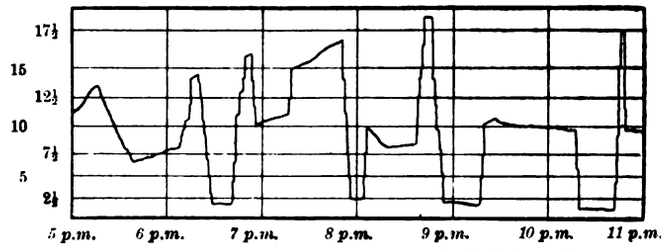


No. 3.—Recorded Secondary Volts Transformer. Ratio 20 : 1.
Without Voltage Regulator.

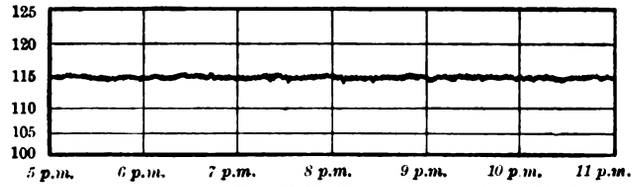
FIG. 10.



No. 4.—Recorded Speed Normal 900 revs. per min.
Per cent. variation from normal speed. With Voltage Regulator.



No. 5.—Amperes on Primary, at 2,300 Volts. With Voltage Regulator.



No. 6.—Recorded Secondary Volts Transformer. Ratio 20 : 1.
With Voltage Regulator.

FIG. 11.

which about 30,000kw. are in successful use in the States in sizes from 50kw. to 500kw. The general arrangement is illustrated by Fig. 12. The main point is to obtain a current in the exciter armature of the same periodicity as the generator current; therefore the

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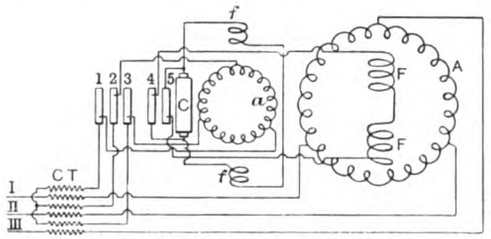
exciter which is built into the generator frame has to have the same number of poles as the generator, except where gearing instead of direct connection is chosen. By means of the series transformer CT and the collector rings 1, 2, 3, the generator current is made to react magnetically on the exciter field in proportion to the strength and phase relation of this current. Consequently the resultant magnetic field, and, hence, the voltage of the exciter is due to the combined effect of the shunt field current and the magnetisation of the alternating current flowing in the armature. This automatically gives the necessary rise in the exciter voltage for all loads, non-inductive and inductive. To be able to vary the degree of compounding, the position of the exciter field in respect to the armature winding of the alternator can be altered by turning the field structure of the exciter through a certain angle. The exciter must work on the straight part of the saturation curve, so as to obtain the voltage proportional to the ampere-turns.

The special nature of the exciter limits this type of generator to sizes mentioned above and to machines of a moderate number of poles.



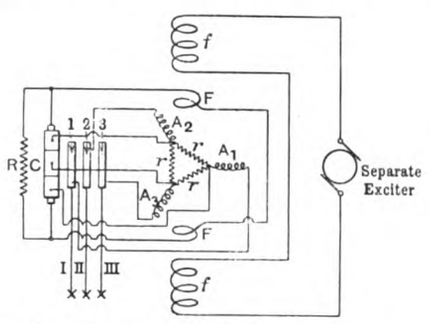
GENERATOR.—A, arm. winding; F, rev. field.
EXCITER.—*a*, arm. winding; *f*, field winding; *c*, commutator.
1, 2, 3, slip-rings for A.C.; 4, 5, slip-rings for D.C.; CT, current transformer.

FIG. 12.

Before leaving the subject of compounding by means of specially-arranged exciters, one ought to mention the scheme devised by M. Leblanc, the working of which was demonstrated at the Paris Exhibition. However, the complications inherent to this arrangement have apparently prevented its commercial introduction, and, therefore, a further description falls outside the scope of this Paper.

4.—*Compounding by Means of Rectified or Low Periodicity Alternating Currents.*

The earliest and the latest attempt to solve the question of automatic compounding with the load fall under this heading. The General Electric Co. and the Westinghouse Company in America, further, Ganz & Co. on the Continent, have built, since the early days of our art, alternators which were provided with a commutator and a series winding on the field in a similar manner as compound-wound direct-current generators. Fig. 13 shows the arrangement



A_1, A_2, A_3, three-phase armature winding; *r*, rotating shunt; R, stationary shunt; C, rectifying commutator; F, series field winding; *f*, separately excited winding.

FIG. 13.

as used by the first-named firm. A three-part commutator each with as many segments as there are pairs of poles rectifies the current from the three phases. The rotating shunt reserves as neutral point for the winding, and at the same time prevents its being opened in case of a break in contact at the commutator. The stationary shunt R is adjustable so as to be able to vary the compounding for loads with different power-factors. Both shunts also serve to reduce the sparking at the commutator. These machines were built with a separate shunt excitation, so as to keep the commutator as small as possible. By the introduction of revolving field machines, and the more advanced schemes of compounding as described under (2) and (3), this type of machine has been superseded.

Quite recently some new arrangements have been brought out by M. Latour and by A. Heyland, which both revive the idea of using a commutator for exciting and compounding of alternating-current generators. These inventors use the commutator for converting the high-frequency stator currents into rotor currents of such a frequency as to obtain an inducing magnetic field which is constant both in magnitude and direction. In machines built according to this principle the armature reaction on non-inductive load will be completely compensated for by the induced currents, and, therefore, the fall in terminal pressure under these conditions will be due only to the ohmic and inductive drop of the windings. To compensate also for these and for the wattless load currents, the same commutator in conjunction with current transformers is used for introducing the compound excitation. In this manner, even over-compounding can be obtained if desired. For further details of these schemes, the author has to refer to some recent publications, which fully cover the ground.*

In concluding, the author wishes to express his thanks to his assistant, Mr. F. H. Clough, for the help given in preparing this Paper.

TRANSATLANTIC ENGINEERING SCHOOLS AND ENGINEERING.

The following is an abstract of the conclusion of the discussion which took place on Thursday, February 25th, in connection with Dr. R. Mullineux Walmsley's Paper on the above subject, which was read before the Institution of Electrical Engineers on Thursday, February 11th. An abstract of the Paper and opening of the discussion was published in our issue of February 19th.

Major-Gen. C. E. WEBBER referred to a conference which was held in December, 1903, at the Westminster Palace Hotel, between a consultative committee of representatives of various scientific and commercial institutions. The following institutions were represented:—General Medical Council, Institute of Actuaries, Institute of Bankers, Institute of Chemistry, Institution of Civil Engineers, Institution of Electrical Engineers, Institution of Mechanical Engineers, Pharmaceutical Society, Royal Institute of British Architects and the Society of Accountants. The conference was held under the Education Board, and was opened by Lord Londonderry, president. The object was to devise a system of "leaving" certificates, or certificates of general education and culture at the close of the course of secondary education. The idea was, if possible, to get all educational centres to accept one "leaving" examination, and everyone present had concurred generally in the view that the proposal of having one standard of "leaving" certificate was sound and likely to prove useful. In the course of discussion, however, it came out that the consultative committee was opposed to examinations by means of papers sent over the whole of the country, but favoured a standard examination of a character satisfactory to some educational centre with which the schools should be affiliated, and which should be ample evidence that the boy had passed a satisfactory course of secondary education. It was thought that the examination should be confined to a smaller number of subjects than usual. He thought the whole subject was of interest in connection with the general discussion on technical education because the foundation of what had been described in the Paper was based upon the efficiency of secondary education in the United States. The Institution of Electrical Engineers had no examination for its students. They simply specified that the students should have been, or were, under training at electrical colleges, thus leaving a very wide door of entrance. In late years the Institution of Civil Engineers had narrowed this door by establishing examinations for students. It therefore seemed to him that the suggestion that there should be a culture examination, which should be accepted outside the examinations now conducted by the Institution of Civil Engineers, was one worthy of discussion. The system of conducting examinations by the Institution was an expensive one.

Mr. H. D. SYMONS, chairman of the Students' Section of the Institution, said he could not help thinking, after reading the Paper, how many more opportunities an American student had of obtaining knowledge than an English student. Not only were their laboratories more modern there, but the libraries were much finer, and a good library was a very great help to a student. At the Massachusetts Institute there were arrangements by which the lectures could be illustrated on an engineering scale. In England the students often had to troop to the laboratory to see some little point which the lecturer had to explain. The system of short lectures on special subjects by eminent men was also a good one, as it gave the student the advantage of knowing such eminent men. With regard to college education, there was one thing which a college could not do: it could not give the student knowledge. The acquisition of knowledge depended upon the student's own energy in obtaining it, and this was why a small class of students in America, who could not give themselves college education in their early years became such excellent students later on by reason of very hard work. They corresponded to the evening class students in England. Dr. Walmsley seemed to question whether a student could get through the vast amount of work expected of him in his fourth year, but if a student had done his work conscientiously up to the end of the third year, he ought, in the fourth year, to romp through a great amount of work because he had not theh

* *The Electrician*, July 3 and 10, 1903. Eborall on "Induction Machines and a New Type of Polyphase Generators." *The Electrician*, October 2, 1903. Heyland on "The Compensation and Compounding of Alternating-current Generators." *Transactions* of the American I.E.E., June and July, 1903. Garfield, Latour: "The Compounding of Self-excited Alternating-current Generators."

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to think of what all the technical terms meant, as in the first year. With regard to the endeavour in America to give the students works training as well as theoretical training, he said the students here felt that they could not learn at a college what they could learn at a works, and, above all, they could not learn tact or organisation, which was a very essential point in an engineer's training. There was no mention in the Paper as to whether American students formed engineering societies amongst themselves. In almost every college in England there were both mechanical and electrical engineering societies, and the advantages of them could not be too strongly emphasised. With regard to the attitude of employers in America, he said that the only thing which seemed to gain a man a position there was his knowledge, but here there still seemed to be a sort of lingering affection for the student who had some influence in a works, and who was given a preference over a man who had higher technical qualifications but less influence.

Prof. W. C. UNWIN said the general bearing of the Paper was that we were very much behind America; in fact, looking at statistics we were enormously behind. But he was not quite sure that the general effect of the Paper was not a somewhat exaggerated one. First of all it should be remembered that the population of the United States was double that of this country and that the area was 30 times greater than that of Great Britain. From these two conditions it had resulted that there had been a most enormously rapid development of engineering work in the States and an enormously large demand for young men with some technical qualifications. No doubt the facilities for the higher technical education were very much greater than here, and through the generosity of private individuals a very much larger expenditure had been incurred upon the equipment of technical colleges. But he was not quite sure that we were as far behind as the mere look of figures would make it appear. He had a friend who owned a shipyard on the Clyde and another in the States. In the latter all his employés had technical training, whereas on the Clyde this was not so. But he preferred the Clyde workmen. There were ways of getting technical education which were not represented by the figures of the numbers of students at college. In this connection he would like to draw attention to the figures given in the Paper purporting to give the number of students in technical colleges in this country. The first year students were given at 347. But at the Central Technical College there were 100, and in other London colleges there must be another 100, which only left 147 for Manchester, Liverpool, Edinburgh, Glasgow, Aberdeen, and the other colleges in the provinces and Ireland, so that it would not appear that this figure was an accurate one. A very difficult thing was the entrance examination. At the Central Technical College they had one which was limited very strictly to the subjects which it was felt were necessary for the students who were taking up the courses there, and he did not think it compared very badly with the American courses, as defined in the Paper. His own experience was that our students were better prepared than those in America, although he would like to have seen Dr. Walmsley carry out a more detailed and critical examination of one or two colleges instead of so many, and the conditions previous to entering college, during college life, and after leaving, pursued for a year or two. With regard to the fourth year training in America he felt sure that English students were more advanced at the end of the third year than Americans were at the same time, and the next step we should have to take would be the adoption of a fourth year, for it was not until the fourth year that it was possible to properly specialise. This fourth year could be utilised for specialised subjects for a limited number of students, and it would be conforming with the rule that an engineer should know something of everything and one thing extremely well. On the question of college workshops, after 20 years' experience, during which he had changed his opinions on this matter once or twice, he would now not be without a college workshop. It in no way took the place of factory workshop training, but it gave the students a great insight into the handling of tools and metals. No one pretended that a student after such a course was a good mechanic. At the end of his three years' training, however, the student went to the works not wholly a novice. Personally, however, he would like a year's workshop training in between the second and third year, and another year at the end of the third college year. A good deal had been said about a student earning a living wage when he left college, and in America that was accomplished to a certain extent. But he was not quite sure that it was desirable—except in special cases—that a student who wished to be something better than a foreman or a manager, and to be in any sense a professional engineer, should be encouraged to enter the engineering profession if he could not support himself for five years.

Mr. A P. TROTTER said he was a member of the Board of Studies of the University of London, but how he got there or why they kept him there he could not quite understand. He did not like the expression "technical education." He did not think it was education. Education ought to come first, and then a man ought to study science, and the principles of electrical engineering were to be found in physics. If a man got as much as he possibly could of these, he got the foundations of electrical engineering as well as the principles. These would always last, but if they began by teaching design this was not much good as knowledge, although it was very interesting as examples. There were some things in which the teaching was abominable. For instance, dynamics. All the text books on dynamics were hopeless things. When an engineer had been at work for some 20 years, and his algebra was a bit rusted, he had to turn to books of reference. He had wanted to see how to work out the acceleration of a train by the swing of a pendulum, but not one of his books helped him, although there was a lot of talk about g and a lot of stuff which was no good. These things ought to be instinctive in engineers, and if they could get the principles thoroughly in their heads, the details and applications would come afterwards. He agreed with Prof. Unwin with regard to the college workshop, but it had been overdone in many cases, and, as the author said, the engineering laboratory gave the student an opportunity of seeing work done which he would not see in the workshop. The Paper stated that when the Finsbury and Central Technical Colleges were opened they were far in advance of anything in America, but that now some of the United States colleges far surpassed anything here. Well, he had not been to America, and did not know much about technical colleges. But he thought we had something here which had not been approached in America. Prof. Thompson, for instance, Prof. Ayrton, Prof. Perry and Prof. Unwin all had a tremendous enthusiasm, which, perhaps, was not heard enough of. The question of the demand for third-year students in this country by the manufacturer was an important one. Was the manufacturer to blame? Was it his fault that he did not appreciate what the colleges turned out for him, or was it that the colleges were not turning out just the right kind of man for him? But he would not occupy their time discussing it. It was rather interesting to see that the matriculation standard was so high in America, and in this connection he said he did like to see a distinction made between a university and a technical college. There was a very distinct difference to be made and it had been lost in this country. He was very sorry to see the London University losing a little bit of the high standard which it once had, and coming down to a point which could hardly be called university. There was an immense scope and field for the technical college, but when one saw the endeavours which were being made to instruct the student with all the details of the trade he did not think it was educational, and it was very questionable how much of it was going to remain good for six or eight years or by the time that the student was in full swing with his work. He had been making enquiries on the question of design and considered there was a good deal too much of this in the technical colleges at present. He had asked manufacturers if they would put a third or fourth year student who had passed all the best examinations on dynamo design straight on to this work. The answer was no, because there was a good deal to be learned before a dynamo designer could get into the commercial side. No American manufacturer would dream of such an action. In fact, there was more specialising in America and on the Continent than in England. For example, a man who could design tramway motors would never design lift motors in the States. He was told it was a very common practice to have an electrician who said what he wanted designed, these requirements were handed over to a mathematician who got them out and handed them back again to the electrician. Then the matter was passed on to a mechanical engineer who got out the drawings and designed the machine, and then the head of the firm would look over the whole thing. He had asked what would happen supposing the mechanical engineer was ill or away, and the answer had been that no one else could be trusted to carry out his work. Specialisation was carried on in this way, and it was a thing which could not be taught in a college. The whole point of the thing was that the present technical college training was called technical education. He preferred to call it technological instruction.

Prof. CORMACK said that at present technical schools did not realise that engineering was one of the learned professions. In this connection one very often heard nowadays of the formation of technical classes in the secondary schools, together with a workshop. This was all very well in its way, but its place was a very secondary one in secondary school training, and if any time were to be devoted to it, it should be a very limited amount of time. The possession of an engineering workshop in a school was not a guarantee that a suitable preliminary training was being given, and it would be well if parents could be made to realise that, because a boy was handy with his hands, it did not follow that he would make a good engineer. It did not seem to be understood by parents that an engineer was not a man who worked with his hands but with his head. In comparing our college course with the American the first striking difference was the fourth year, but if they looked at the syllabus it would be found that this could readily be accounted for. In America they gave a large amount of time to languages and elementary subjects generally, and also a very considerable portion of the time to workshop training. If the college training were to precede the works training he thought something might be said for workshops in colleges. It certainly did give the student some idea of tools and machines, but if the better system of training was the "sandwich" system, or some modification, then there was no necessity at all for the college workshop, and the engineering laboratory would be quite sufficient. In that case, with a sufficiently high standard of training before the technical training, there was no reason why, in the third year, students should not be produced who had a thorough grounding in the principles. In this respect he agreed with Mr. Trotter. Another important feature in America was their splendidly equipped laboratories, although the author stated that they were not made full use of. In this connection we were distinctly ahead of America, for the experimental side was always looked after here throughout the three years. At the same time, he thought we could do very much better here if more money were spent on equipment of laboratories. Three things had to be looked to in order to improve our college training. First of all we must look to the employer, and to find out the kind of men he required. Then we must look to the employers for guidance as to what in their opinion was the most suitable scheme for the training of an engineer, and he hoped that the committee which had been appointed by the Institution of Civil Engineers would be able to arrive at some general decision as to what it considered the best course. When the colleges had before them a scheme which had been approved by engineers and lecturers there was no doubt they would at once endeavour to put themselves in a line with it, and the only thing which would be wanting would be money. Perhaps there was some hope of getting this in London. In the provinces they had been getting a considerable amount of money lately for engineering work. In Glasgow £20,000 had been spent, in Manchester several hundred thousands had

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also been spent, and in Liverpool it was considerably over £100,000. Altogether, it seemed that we were on the eve of awakening, and that the money would be forthcoming if the colleges showed themselves inclined to do as the employers wished.

Dr. R. T. GLAZEBROOK said he had no very serious difference with Dr. Walmsly's conclusions. With regard to lack of support on the part of the manufacturers there was a good deal to be said, and he could only hope that the inquiry which was now going on at the instance of the Institution of Civil Engineers would lead to some definite result. When one saw the large amount of money which had been spent on this question in America, it no doubt created a little jealousy, but at the same time it raised a very important question. Admitting for the moment that we were really very far behind America in this work, was it necessary for us to spend sums comparable with these in order to overtake the Americans and to put ourselves in a position to enable young men to profit by the education which could be offered them? Was it necessary that our technical colleges should be fitted in the elaborate manner described in the Paper? It often appeared to him that such completely-fitted laboratories had a tendency to become museums. For his part, he would prefer to see students taught by somewhat simpler methods and simpler apparatus. In this connection his memory took him back to the early days in the Cavendish Laboratory, where the teaching was not specially organised, but where there was a professor of immense power and undoubted enthusiasm, who would set a problem and leave the students pretty much to themselves to work it out, but ready to render help whenever necessary. He had had a very interesting conversation during the summer with an eminent American meteorologist, who had compared, much to our disadvantage, the sums which the Government here found for the most important work of the Meteorological Office and those given under similar circumstances in America. There, on several occasions, the estimates had been put back because Congress did not think sufficient had been provided for certain work. But this eminent authority went on to say that, in spite of all this, the real discoveries in meteorology would not come from America, but from England, because of our superior methods of teaching. At the same time, the discoveries would be used and adopted in America before we did so in England. Therefore, he was inclined to think there was still some hope for us in the same way on the engineering side, even though it might not be possible to spend the immense sums of money mentioned in the Paper. But he could not help regretting that the author had not taken a more sanguine view of what it was possible for us to do in England.

Mr. HUGH E. HARRISON thought Dr. Walmsley had made out England's case as bad as he possibly could in order to stimulate us to great efforts. Apparently we could do very little unless we had about £20,000,000, and that very quickly. But in making these estimates the author had overlooked the endowed schools. The idea that parents of those who were about to be engineers wished somebody to pay for their training was a fallacy, and therefore there was no necessity for the £10,000,000 said to be needed for endowments. The equipment of the colleges was a very different matter. They could ask a parent to pay for his son's education, but they could not ask him to pay for the necessary college equipment. His opinion was that simple apparatus should be provided at first, after which a student should pass on to plant used for manufacturing purposes. This latter plant need not be in the training institutions. Suitable arrangements should be entered into with the bigger firms by which a student after having passed through his college course was enabled to put into practice what he had learned. Indiscriminate endowment was just as bad as indiscriminate charity. If outside assistance was to be obtained it should be applied in the form of scholarships and exhibitions, which should be awarded to students by examination, or if they were not very brilliant but otherwise industrious and capable, by nomination.

Mr. W. R. COOPER thought the Paper raised two main questions: first, was the product of the schools a good one? and second, should we follow the school teaching of America? At present it appeared that in England the employer did not appreciate technical training, but this was largely due to students thinking that their training was complete when they left the technical college. He was sorry to see that the employers were not taking part in the discussion. College training seemed to have to suit a man to enter any one of the many branches of engineering after a course of general instruction through all of them. Students ought to be followed up more during their first year of practical work after leaving college and a good idea obtained as to how they were getting on. The conditions were not the same in England as in America, and he did not agree with giving so much time to the college workshop as was done in the States. It was a rather doubtful advantage to extend the college course to four years.

Mr. C. A. BUCKMASTER, of the Board of Education, after remarking upon the fact that we still did not seem to understand each other's terminology, as was evidenced by Mr. Trotter's remarks, said the technical colleges in this country had been led away, in some instances, into trying to make a more or less inferior copy of some university. This was not necessarily good for the training of the engineer because, as English universities were organised, they lacked entirely that elasticity which was so marked in Germany by which a student who had obtained a certain amount of preliminary training could specialise in any part of the whole science to which he felt particularly called. For a man to be able to specialise in a technical college the college should be run more or less by the employers and should have at its command the finest talent it was possible to secure. He feared the addition of a "leaving" examination to the already long list. The standard of attainment should be sufficiently high to be suitably described as a thoroughly efficient secondary education. Technical colleges in this country had to deal with such very imperfect material, and they really performed the functions of half a dozen different institutions. With reference to the remark made by Prof. Unwin, he said it was the rarest possible thing to find on the Clyde a man who had not been for many sessions at the evening classes in Glasgow, and this was of interest in view of the remark made by Mr. Symons as to the good work done by evening class students.

Dr. J. A. FLEMING thought the whole question really turned upon how we stood nationally with regard to this matter compared with America and the Continent. With regard to the provinces he felt pretty confident that we could hold our own. But London was a very vast place and Londoners suffered from what might be called a want of local patriotism. In the provinces, people were proud of living in Birmingham or Liverpool or Manchester, and would do great things for their town, but no one would, from this point of view, do anything for St. Pancras or Finsbury or the Strand. There were 12 institutions in London possessing fairly well equipped laboratories in which 1,200 or 1,300 engineering students were being regularly taught during the daytime. The evening class students numbered about 5,000. As regards day classes we did not compare unfavourably with the Continent. But what we lacked was coherence and specialisation in the teaching. Whatever was done in the way of organisation should be left to the teachers and not to outside politicians.

Mr. LINEHAM said that England had been a pioneer of education, but she had, without doubt, been distanced firstly in Europe, and then in America, on lines which she had herself laid out to begin with. This was not the fault of the schools themselves, but of those whose duty it was to support them. The country that did not spend every possible penny of its public and private funds upon education, either slept or deteriorated. The most important matter was that there should be an expenditure hitherto undreamt of, and which should be given without stint to education, especially to that most useful and applied form of it known as technical education. Employers had, for too long, looked severely askance at the efforts of engineering teachers, and had been too apt to condemn rather than assist. No one with a grain of educational sense would put an examination result down as a true test of education; but a testing by their fruits was all that any good school demanded; it was the rejection of school work without a fair trial that roused our sense of injustice. He was surprised to find that such high fees were demanded of American students, and that the entrance age was such that the pupil emerged from college at 22 without having had a scrap of commercial practice or a particle of earned money. The first polytechnics of Switzerland, and many others on the Continent, took students at merely nominal fees. The question of men for the college staff was of the most intense and urgent importance in all countries, and if it was an unsolved question in America, it was none the less so here. Only that in England commercial salaries were lower, and the comparisons between England and America were not so much to the disadvantage of the former as would at first sight appear. Nevertheless, the salaries of technical teachers in England were not such as to attract men who are at once successful practical engineers and thoroughly able teachers. Success in practice by no means implied the successful teacher; for successful teaching must have its training and its long experience every bit as much as engineering practice. On the other hand, that engineering teachers should be compelled to practice was a self-evident requirement if their teaching was to have its true value, but over-consultation should be guarded against much more keenly than it had hitherto been. When in the past the employer had treated the school work with scant courtesy, the apprentice had been only too ready to take his cue accordingly, and the result had very often been a lack of training which was deplorable when viewed in connection with Continental and Transatlantic methods; but if the firms would show their apprentices that a technical training was now considered by them to be a necessity, a very great change of front would be apparent in the ranks. Scholarships were not a real aid to knowledge among the many. Those of the smaller kind were often obtained by a species of fluke, and our daily experience of that class of scholar was that he was extremely troublesome and disinclined to work, through the false belief that he had already achieved his success. Neither was such smaller assistance really required in view of the very moderate fees demanded in the technical schools of England; the best way to assist a student was to make him feel that there would be a recognition in everyday life of his apparent sacrifice of time and labour in the pursuit of technical knowledge. The higher scholarships, such as those of the late Sir Joseph Whitworth, stood in a different plane, but although Whitworth scholarships had done excellent service in the past, they did not meet modern engineering requirements; and a thorough revision of them was required, within the term of the bequest. England's technical education had certainly advanced, but other countries had begun their advance first, and a stern chase was always slow.

Prof. R. SMITH did not believe that mere magnitude of establishment and lavishness of expenditure were necessary in England.

Dr. WALMSLEY said he would make the greater bulk of his reply to the *Journal*. In reply to Mr. Symons, students' engineering societies existed very numerously indeed. They published Papers, and had their journals. An incident in relation to this was that a few years ago the Westinghouse people took over to Pittsburg some Englishmen to prepare them for their Trafford Park works. There were 60 of them, and they formed a club. That club still existed in Pittsburg although the Englishmen had all come home again. With regard to Prof. Unwin's remarks that America was larger than England and the population practically double, and that, therefore, there would be a greater demand for engineers, he would like to remind the Institution that England was not the British Empire, and that in Greater Britain we had a territory which far exceeded that of the United States. He quite agreed with Prof. Unwin that at the Central Technical College the students were as well prepared as any in America, but this was not the case all over the country. Mr. Trotter had spoken about enthusiastic teachers. But there were also some enthusiastic teachers in

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America. He entirely disapproved of engineering courses in secondary schools. He did not consider it necessary to spend money on the same scale as that spent in America, but we did certainly require to spend upon a larger scale than hitherto. As for every parent paying the full value of the engineering education of his sons, he would ask Mr. Harrison to remember that brains did not always go with money, and that if we were to get the brains of the country into the engineering profession we must rise to the same position as had been the case in America, and recognise that it was for the good of the community that education of this character should be paid for at the cost of the community. In the Western universities on the prairies the fees were very low.

The PRESIDENT then proposed a vote of thanks to the author, which was given with acclamation.

THE DE LAVAL STEAM TURBINE.*

BY T. C. PORTE.

Since the time of Hero of Alexandria, in the second century before Christ, inventors have revived from time to time the idea of the steam turbine, and have tried to improve upon its original design. Nothing of value, however, was done until De Laval invented, in 1882, his first turbine. It was originally intended for the direct driving of milk separators and was constructed much on the same principle as Hero's. The driving-wheel consisted of a pipe bent in the shape of a S, to which steam was admitted through a stuffing box in the centre, where the shaft also was fixed. On account of its high speed, large steam consumption and the attention it required, small sizes only were manufactured. At present the De Laval turbine is designed on quite a different principle and has been built in sizes up to 500 H.P. It is founded on the action or impulse principle, the steam flowing through diverging nozzles (Fig. 1) and gaining in speed until it impinges upon the one row of vanes fixed around the periphery of the wheel. After giving up its kinetic energy to the vanes, the steam is exhausted either to atmosphere or the condenser. Fig. 2 represents a nozzle which is intended for an initial pressure of 200lb. per square inch and a vacuum of 28in. In passing through it, the steam is expanded down from 215lb. per square inch absolute to 0·93lb. per square inch absolute. Calculations, which were proved to be correct by actual experiments, show that—if the steam be expanded adiabatically in the nozzle, and that practically is the case—all the potential energy of the steam is converted into kinetic energy, and the energy of this steam is absolutely the same as if the steam were expanded in the same proportion in the cylinder of an engine with the same initial and end pressures. With the pressures mentioned and the ratio between the largest and smallest section equal to 27·23, the following figures with regard to pressure, velocity, &c., at various sections of the nozzle of Fig. 2 hold good :—

At point.	Pressure of steam in lbs. abs.	Velocity of steam. Ft. per sec.	Per cent. of moisture in steam.	Specific quantity of steam.	Specific vol. of steam in cub. ft. per lb.
A	215	..	0	1·00	2·11
B	125	1,500	4	0·96	3·50
C	0·93	4,127	24	0·76	256·8

The amount of steam that will pass through a certain size of nozzle is now so well known that it is often used to determine the steam consumed by the turbine. In this particular nozzle, exactly 479lb. of steam will pass per hour in the conditions mentioned. In the following table will be found the velocities of outflow and the kinetic energies of dry saturated steam in various conditions when expanded adiabatically in properly constructed nozzles. From the well-known formula $v^2/2g = x$ B.Th.U. × 778 ft. lb., in which v = velocity of steam, g = acceleration due to gravity, and 778ft.-lbs. = Joules' equivalent of heat, we get $v = \sqrt{(2g)(x\text{B.Th.U.})(778)}$, and this formula was used to calculate the velocity given in the table.

* Abstract of a Paper on "Steam Turbines" read before the Dublin Local Section of the Institution of Electrical Engineers on February 11th.

The value of a good vacuum is well brought out in the table. In the turbine represented by Fig. 1 the nozzle is placed at an angle of 20deg. with the plane of rotation, the clearance between nozzle and vanes being $\frac{1}{16}$in. With this angle the most efficient speed of the vanes is 47 per cent. of that of the impinging steam. The steam then leaves the buckets at 34 per cent. of the initial velocity, and, since the energy given up by the steam is proportional to the square of the velocities, we obtain for the theoretical efficiency the expression $(v^2 - v_f^2)/v_i^2 = 1 - 0{\cdot}34^2 = 88$ per cent. For the turbine alluded to

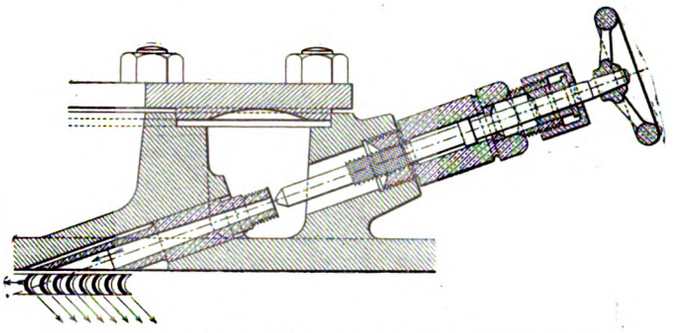

FIG. 1.—ARRANGEMENT OF NOZZLE AND SHUTTING-OFF VALVE.

above, the most efficient speed of the vanes would be 0·47 × 4,127 = 1,920ft. per second. This, however, is impracticable at present, the highest speed yet used in the De Laval turbine being 1,380ft. per second in the 300 H.P. type. Some of the speeds employed in the various sizes of turbines are :—

	Diameter of wheel.	Revs. per min.	Peripheral speed. Ft. per sec.
5 H.P. size	4in.	30,000	515
30 ,, ,,	8$\frac{7}{8}$in.	20,000	774
100 ,, ,,	19$\frac{3}{4}$in.	13,000	1,115
300 ,, ,,	30in.	10,600	1,378

Against increasing the size of the wheel, in order to obtain a slower rotating turbine, two chief objections may be raised :—The one concerns the tensile stresses of the material used for the wheel and the other applies to the skin friction of the wheel in the medium

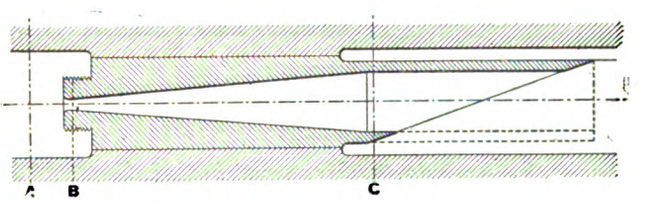

FIG. 2.—SECTION OF STEAM NOZZLE.

in which it rotates. The latter is of considerable magnitude and increases more rapidly with the diameter of the wheel than with the number of revolutions. Some idea of the magnitude of the strains due to centrifugal forces will be obtained when it is considered that the centrifugal force caused by each vane of the 300 H.P. turbine, when this is running at normal speed, is 15cwt., the vane weighing 250 grains. Fig. 3 represents graphically the radial and tangential stresses obtaining in the 50 H.P. type of turbine. As will be seen, the tangential stresses increase towards the bore, and, in order to avoid this, the larger sizes are made solid without the hole through the centre. In order to meet the centrifugal strains the wheel is made of a solid disc, each vane being separately made and dovetailed into it. In Figs.

Initial steam pressure Lbs. per sq. in.	Counter pressure 1 atmosphere.			Counter pressure 2·4lb. per square inch absolute, corresponding to 25in. vacuum.			Counter pressure 0·93lb. per square inch absolute, corresponding to 28in. vacuum.		
	Velocity of outflow of steam. Ft. per sec.	Kinetic energy. Ft.-lb. per sec.	H.P. of 550 ft.-lb. per sec.	Velocity of outflow of steam. Ft. per sec.	Kinetic energy. Ft.-lb. per sec.	H.P. of 550 ft.-lb. per sec.	Velocity of outflow of steam. Ft. per sec.	Kinetic energy. Ft.-lb. per sec.	H.P. of 550 ft.-lb. per sec.
		Per lb. of steam per hour.			Per lb. of steam per hour.			Per lb. of steam per hour.	
60	2,421	25·29	0·046	3,320	47·57	0·087	3,680	58·44	0·106
80	2,595	29·06	0·053	3,423	50·56	0·092	3,793	62·08	0·113
100	2,717	31·86	0·058	3,520	53·47	0·097	3,871	64·66	0·118
120	2,822	34·37	0·062	3,596	55·80	0·101	3,940	66·99	0·122
140	2,913	36·62	0·066	3,661	57·84	0·105	3,999	69·01	0·125
160	2,992	38·63	0·070	3,718	59·65	0·108	4,045	70·61	0·128
180	3,058	40·35	0·073	3,764	61·14	0·111	4,091	72·22	0·131
200	3,115	41·87	0·076	3,810	62·64	0·114	4,127	73·50	0·134
220	3,166	43·26	0·079	3,852	64·03	0·116	4,159	74·64	0·136
280	3,294	46·83	0·085	3,962	67·74	0·123	4,229	77·18	0·140

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4 and 5, representing the wheel construction for small and large turbines, it will be noticed that a recess has been turned in the wheel-disc near to the vanes. If now a wheel should burst from an excess of speed, it would give way at this recess, the vanes would become detached, and, since they are so light, no damage would occur. No matter how carefully the disc is balanced in a state of rest, its centre of gravity does not exactly coincide with its geometrical centre, and at high speeds such severe vibrations would be set up that no bearings would be able to withstand them. This difficulty,

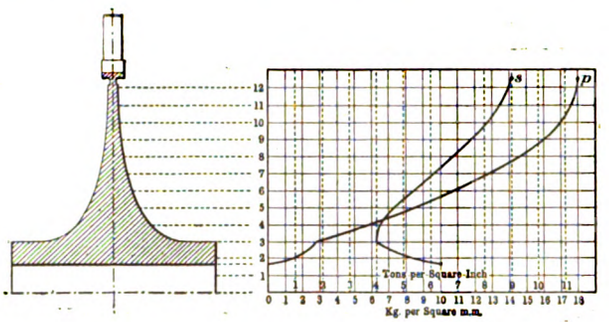

FIG. 3.—DIAGRAM OF STRESSES IN A 50H.P. WHEEL.
p=Radial ; s=Tangential.

as is now well known, was overcome by using a flexible shaft. Vibrations, however, will occur with this arrangement up to a certain speed, called the critical speed of the wheel, but at this point the vibrations suddenly disappear and the wheel settles down and runs perfectly smoothly in its bearings. The explanation is that at lower speeds the wheel rotates round its geometrical centre, but when it reaches the critical speed the shaft is sprung out of centre and the wheel begins to rotate around its centre of gravity. This critical

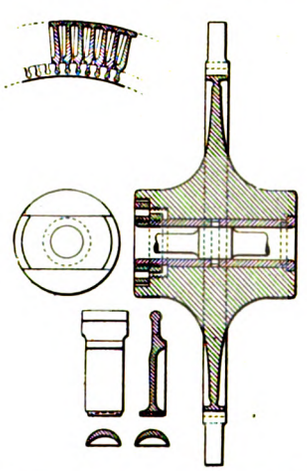

FIG. 4.—SECTION OF SMALL WHEELS.

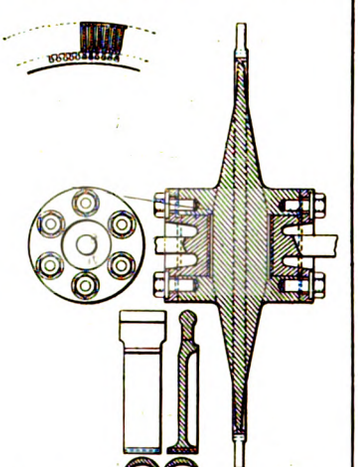

FIG. 5.—SECTION OF LARGE WHEELS.

speed is from one-sixth to one-eighth of the running speed. The speed of the turbines is reduced by a double helical gearing, the pinion being made of very hard steel, the teeth of the large wheel consisting of softer steel. In the larger sizes there are two gear wheels, one on either side of the pinion, with, of course, two low-speed shafts. By this arrangement excessive side pressures on the high-speed shaft are avoided. This gearing, made as a rule for reducing the speed to one-tenth of its original value, works satisfactorily, but it is, in the larger sizes, accompanied by a singing or hissing

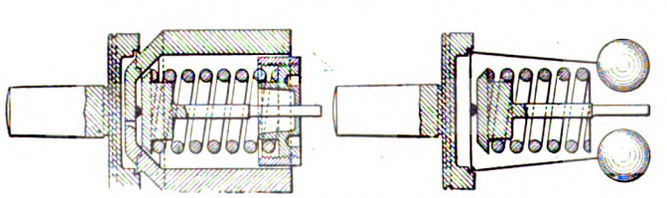

FIG. 6.—SECTION OF CENTRIFUGAL GOVERNOR.

noise, to which, however, there is little objection. With regard to wear, the author could not, after four to five years' regular working, detect signs of wear in the turbines under his charge. All high-speed bearings are lubricated by sight-feed lubricators, the low-speed shafts being lubricated by oil rings.

While very small turbines are fitted with one steam nozzle only, the larger sizes have many. Each nozzle has its own stop valve, and at variable loads the nozzles are shut down in such numbers that the remaining nozzles work at their best efficiencies. Fig. 6 represents diagrammatically the centrifugal governor. Its two expanding parts swivel on knife-edges, and force out—when acting—the central pin, which presses on a lever actuating the governor valve. Some records showing the variation of the turbine speed with fluctuating loads are given in Fig. 7. All the turbines will work with any steam pressure between 50lb. and 200lb. per square inch, exhausting either to atmosphere or to the condenser, the only change for various pressures being in connection with the nozzles, which are shaped differently for different pressures, and are interchangeable. Sometimes turbines are fitted with two sets of nozzles, one set for exhausting to atmosphere the other set for use with condensers.

When the turbine is employed for driving electric generators, it is usual practice, at least with the larger sizes, always to use two armatures on the same shaft. Some tests, made with a 30 H.P. non-condensing turbine, working at a pressure of 88lb. per sq. in. abs., are recorded below. They show in a marked degree the effect of superheat upon the steam consumption.

Load H.P.	21 ..	21 ..	30 ..	30
Steam per B.H.P.-hour	48·3 ..	31·5 ..	39·6 ..	25·7
Temperature of steam °F. ..	327 ..	530 ..	327 ..	600

The following tables refer to a 300 H.P. turbine, working with steam at a pressure of 197lb. per square inch, and to a high-lift turbine pump, consisting of a centrifugal pump directly coupled to the high-speed shaft of the turbine and a slow-speed pump which is driven from the high-speed shaft through gearing. The slow-speed pump lifts the water up and passes it on to the high-speed pump.

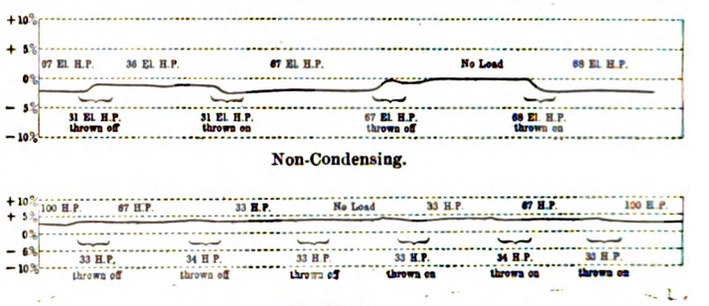

FIG. 7.—DIAGRAM OF SPEED VARIATIONS.

A good vacuum is essential for the efficient working of a steam turbine for several reasons, not the least being the great reduction in skin friction for a rapidly-rotating wheel in a good vacuum. This is clearly shown by the following test:—It took 35 H.P. to rotate a 150 H.P. De Laval turbine wheel at normal speed in steam at atmospheric pressure, but only 2·33 H.P. to run the same wheel at the same speed in a vacuum of 28in. It is not quite so easy to see why superheating effects such a marked increase in the efficiency of the steam turbine, which is greater than can be accounted for by thermo-dynamic reasons. In the tests of both De Laval and Parsons turbines the average gain in efficiency for moderate superheat works out at about 1 per cent. for every 8deg. of superheat. Part of this gain is due to the reduction in the amount of initial condensation in the steam, thus leaving a larger amount of steam to expand and to do work. But a considerable portion of the gain must be due to the reduction in the friction of the rotating parts.

Tests of 300 H.P. *De Laval Steam Turbine.*

Nozzles open.	Loads. B.H.P.	Relative loads. Per cent.	Steam in lbs. per B.H.P.-hour.	Increase for diminishing loads referred to maximum load.	Amount of superheat.
8	352	100	13·94	..	84°F.
7	298	85	14·35	2·9%	64°F.
5	196	56	15·53	11·4%	..
8	333	100	15·17	..	Saturated steam
7	285	86	15·56	2·6%	
5	195	59	16·54	9·0%	
3	119	36	16·40	8·1%	

Tests of a 75 H.P. *Turbo-pump.*

——	Height of delivery. Ft.	Gallons of water delivered per min.	Water-H.P.	Pounds of steam per water-H.P.-hour.	Remarks.
1st trial	312	529	56·0	34·2	
2nd trial	443	629	84·4	29·0	Work for condensing is included
3rd trial	509	529	81·6	31·3	
4th trial	467½	640	90·7	30·6	
		530	75·0	32·2	
		430	60·9	35·1	
		286	40·5	43·1	

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The following is an abstract of the discussion which took place after the reading of the Paper:—

Mr. WHITING (in a written communication) thought that the small space occupied by turbines would be an important factor in the advantages over reciprocating engines in most cases, but where power houses were being built on the outskirts of towns for supplying power in bulk, as was done now in a number of cases, land was not so expensive, and the amount of space occupied by engines would not be a matter of much importance. Regarding attendance, he failed to see that any saving could be effected, except possibly in comparison with some marine, type of cross-compound engines, since one man could well look after a fair number of engines. In cases he knew of, one driver looked after as many as six and more high-speed reciprocating engines. A good vacuum —such as 28in.—on which the high efficiency of turbines so much depended, might be very expensive to maintain. It involved increased capital expenditure in condensers and pumps, and required a good deal of care and attention to maintain. Again, bringing steam down to the temperature necessary for this vacuum meant using a large quantity of water at a low temperature which was not always easily obtained. If the condensed discharge was required again for feeding boilers its temperature was necessarily very low, as compared with the temperature of water from a vacuum of, say, 23in. to 25in., and consequently the loss involved in heating it up again for the boilers counted against the extra advantage of 2in. or 3in. of vacuum. He would like to ask Mr. Porte if he could tell him why the Blackpool Corporation were having reciprocating engines installed after they had been using turbines.

Mr. RUDDLE said he had formed no opinion as to the relative advantages of turbines and reciprocating engines, but he was not at all satisfied that the turbine is yet reliable. Much was made of the installation of turbines by the Metropolitan Company, but this had been a matter of compulsion on account of vibration troubles with the reciprocating plant. He had visited the station twice in one week, and had found the turbines opened for repairs.

Mr. TATLOW made the suggestion that it might be a useful idea to make use of the exhaust steam of non-condensing engines for turbines. He thought that a theoretical explanation of the economy attained by superheat in turbines might perhaps be found in the increased kinetic energy of the steam arising from its increased velocity due to increase of head and reduction of density. The solidity of the turbine foundations was of importance, and, in support of this view, he referred to a turbine at the Glasgow Exhibition which could not be run owing to the foundation having been broken.

Mr. OLSSON said he was rather surprised at the claims for economy through superheat in turbines, as he thought it had been the general opinion that superheat did turbines less good than reciprocating engines. He drew attention to performances of reciprocating engines worked with the Schmidt system of superheat, and mentioned the case of a 300 I.H.P. engine built by Messrs. Easton at Manningtree, and tested by Prof. Ewing. A consumption of 9lb. of steam per indicated horse power-hour was attained, and this compared very favourably with the figures for the 5,000kw. Curtis turbine with 15·4lb. of steam per kilowatt-hour. He could not agree with Mr. Porte's statement that a great deal of power was wasted in moving reciprocating parts, for it was well known that a well-constructed steam engine of modern design was a very efficient machine, and a mechanical efficiency of 95 per cent. was said on very good authority to be obtainable.

Mr. PORTE, in reply to a question put to him by the chairman, Prof. Thrift, said that the expansion and contractions of the casing and of the blades took place simultaneously, and that the loss of efficiency with varying degrees of superheat was, therefore, not great. With regard to the question of increase of efficiency with increased vacuum, he mentioned the case of a turbine in which an increase of 4 per cent. in the vacuum had given rise to an increase in power of 10 per cent.

RADIUM AND CANCEROUS THROAT.

An interesting article entitled "The Applicability of Radium in the Treatment of a Cancerous Throat," by David Walsh, M.D. (Senior Physician at the Western Skin Hospital, London), appeared recently in the *Medical Press and Circular*. Dr. Walsh is evidently convinced that radium may be applied to cancerous growths with considerable success, and although it is not yet possible to speak with certainty as to its exact therapeutic value, yet he is confident that by means of radium it is possible to modify profoundly, and in some cases apparently to cure, surface rodent ulcers and epitheliomata. He proceeds to quote cases brought before the Medical Society of Vienna in 1903, the first being that of a man aged 37, who had undergone an operation for melano-sarcoma of the humerus three years previously. For eight months he suffered from small subcutaneous nodules near the seat of the operation. Radium was applied to these nodules, which varied in size from $\frac{1}{8}$in. to $\frac{3}{4}$in. in diameter.

The method of application was to enclose the radium in a small indiarubber capsule with a mica window. The capsule was then fixed to the skin by means of a strip of adhesive plaster, exactly over the nodule, with which it was kept in contact from a quarter of an hour up to 25 minutes. In from two to 48 hours a dermatitis followed, resembling the X-ray or focus tube dermatitis. Where the application had lasted less than 15 minutes no change was found in the nodule at the end of a fortnight. On the other hand, in those nodules which had been treated for a quarter of an hour or more (up to 25 minutes) there was either a marked diminution or disappearance of the nodules. New nodules developed on the shoulders, breast and left upper arm, but disappeared beneath the influence of the radium, their former site being marked by a flat depressed cicatrix.

Dr. Walsh then calls attention to the brilliant results which have been obtained in the United Kingdom by Mr. Mackenzie Davidson, M.B., the inventor of an exact system of X-ray localisation. His first case was one of rodent ulcer on the right side of the nose in a woman. The ulcer, which measured 1in. by $\frac{3}{4}$in., had resisted treatment, both by the Finsen light and by the X-rays. Treatment by radium began on May 21st, and on June 11th, after four applications, "the ulcer was practically healed." Five months later there had been no recurrence. The most important of Mr. Davidson's cases was an extensive rodent ulcer of the right side of the face. It would be more correct, apparently, to describe the condition as cancerous, inasmuch as the surgeons who saw the patient in the early stages stated that it was an undoubted case of epithelioma. The disease, according to Mr. Davidson, "has been arrested," and a complete cure may reasonably be expected.

The author continues to the effect that radium is most conveniently used in the form of the bromide, and should be of good quality. The small glass tube containing the salt must be placed directly in contact with the ulcerating surface. It apparently is of no use if applied to the unbroken skin surface. The action of the radium is strongest at the immediate point of contact, and lessens in power according to the distance from that point of contact. The radium may be applied for a quarter of an hour or more, up to 30 or 40 minutes, but the length of application should be most carefully regulated by individual results. A reaction occurs usually on the eighth day of treatment. If it be moderate the temperature runs up to about 100°F., and the patient suffers little general disturbance. On the other hand, if the exposure has been unduly prolonged, the temperature may run up to 104°F. or even higher, and the patient be attacked by vomiting and other distressing symptoms. The suggestion of Mr. Davidson that the reaction may be due to the formation of an antitoxin is of great interest.

It will be at once apparent that the necessity of direct application of the radium to the tissues involved in the malignant process must for the present limit the field of applicability of radium. Still, much may be achieved by the exercise of a little patience and ingenuity on the part of the operator. In the case of an epithelioma inside the cheek there would obviously be little difficulty in maintaining contact of the radium tubes with the diseased surface for any required length of time. It is far otherwise, however, when one has to deal with a malignant invasion of the palate and fauces, when the structures are in a state of constant watchfulness to respond to and resent reflexly almost all kinds of direct stimulation. To keep one or more small glass tubes in contact with various parts of the reflexly sensitive and excitable soft palate and fauces might seem *a priori* to be an almost hopeless task.

A patient came under Dr. Walsh's care suffering from early but rapid malignant invasion of the upper throat. At first he tried the application of the high-frequency current of the X-ray tube, the latter especially to the glands at the angle of the left jaw, which were slightly enlarged and tender. At the same time he devised an apparatus whereby the rays from the focus-tube could be projected directly on to the back of the throat by means of a flattened vulcanite speculum. Some improvement followed this course of treatment, but not long after its commencement he made some inquiries as to radium, and determined to try that agent. Four sealed tubes, each containing 5mm. of radium bromide, were fastened at the end of a curved holder and inclosed in a covering of indiarubber extemporised from a finger stall. The throat was then cocainised and a gag inserted between the teeth. A light thrown into the mouth by a mirror enabled the doctor to pass in the radium and press it with precision on the desired part. At first the patient showed the greatest intolerance of contact with the foreign body, but, by dint of perseverance, it was found possible to push the application sufficiently to give from a quarter of an hour to half an hour, or sometimes 40 minutes, distributed on various parts of the palate, fauces and pharynx. As a matter of fact, the patient sometimes could not bear the contact for more than a few seconds, while at other times he could tolerate the pressure for one minute, two, and occasionally three or four minutes together. In estimating the time of application, allowance had to be made for the continual stoppages, while the radium holder, and in many instances the gag also, were removed from the mouth.

Dr. Walsh considers the case is of importance, inasmuch as it appears to be the first in which radium has been applied to a cancerous throat. The ordinary process of that terrible condition, epithelioma of the upper throat and fauces, has been profoundly modified, if not, as he hopes, even arrested. Meanwhile, he has thought it his duty to lose no time in publishing the fact that it is possible to apply radium to the soft palate, the tonsils and the posterior pharynx. Henceforth, medical men who have cases of malignant disease of the upper throat and fauces will know that it is possible to apply radium to the seat of the disease. Further, in fairly early cases there appears to be a prospect of cure.

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LOCOMOTION IN LONDON.

In spite of the fact that so much has been written and said during the past few years concerning London locomotion, it is a subject which possesses a peculiar interest, and for many obvious reasons. Matters were allowed to drift along very much as they pleased until the possibilities of electric traction began to reveal themselves, but while in the provinces and abroad advantage was quickly taken of the new motive power, progress in London has taken place by such easy stages that at present, in an area of 121 square miles and having a population of 4½ millions, there are, to-day, only 25 route-miles of electric tramway and 17 route-miles of tube railway in operation. We have horse tramways and an omnibus service radiating to the suburbs from the edge of the City, whilst into the latter, omnibuses only are allowed to penetrate. In searching to fix the responsibility for this condition of affairs, it cannot be overlooked that Parliament itself is largely at fault in making no effort to amend legislation in order to render it more easily applicable to the change of conditions brought about by the introduction of electric traction. This aspect of the question, of course, does not concern London alone, but a far more serious want of foresight on the part of the Government is the policy of delay which has characterised its actions in relation to London. It is true that a Royal Commission is now conducting an exhaustive inquiry into all forms of communication in the metropolis, but the history preceding this belated tribunal is worthy of recapitulation.

With the growth of the population and business of London during the past 10 or 15 years, the need for means of quicker transit from place to place and better through communication between the various main lines of traffic became patent to everybody, yet no action was taken in the matter until 1901. In March, of that year, Mr. J. W. LOWTHER Chairman of Ways and Means in the House of Commons, moved a resolution for the appointment of a Joint Committee of the two Houses to consider 14 tube Bills which had been deposited, stating that he hoped conclusions would be arrived at on broad principles which would enable the promoters to proceed with their proposals on clear lines in the following year. At the time we stigmatised the appointment of the Joint Committee as an unnecessary waste of time. However, so far as tube railways were concerned, nothing was done for that

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Session; and the Committee in due time reported both generally and with regard to specific routes. In the following Session the promoters, having adopted the suggestions of the Joint Committee, again introduced their bills for the tube railways above referred to. The bills came in due course before a Committee of the House of Lords, but, largely owing to a disagreement between the promoters, only a few extensions to existing lines were finally sanctioned. Thus for two years after the appointment of the Joint Committee nothing further was done to provide the much-needed additional transit facilities in London. By 1903 this investigation and report of the Joint Committee had apparently been forgotten, and a Royal Commission was appointed, with the widest possible terms of reference, to consider the whole question of London traffic facilities.

Whilst not entirely disagreeing with the wisdom of conducting a general inquiry into the condition of locomotion in London, we repeat what we have expressed more than once—viz., that any further addition, either in the form of tramways or tubes should not be delayed by reason of the existence of the Royal Commission of 1903. The result of its appointment has been, however, that the London County Council has not sought powers for any new main routes of tramways, and promotions of tube railways have had to be abandoned for two more Sessions, so that virtually nothing has been done in the way of sanctioning important new lines of communication since 1900. In addition, judging by the protracted proceedings of the Commission, there is just the possibility that a fifth and even a sixth year's delay will be occasioned, for no tube Bills have been introduced this year, and the report of the Royal Commission may not be issued in time for the preparation of Bills for next Session, these having to be deposited before December 1, 1904.

Turning now to the proceedings before the Royal Commission of 1903, which have been reported each week in our columns, we cannot refrain from thinking that too much time has been devoted to the consideration of what might be called fads. A general feeling has prevailed amongst the majority of witnesses that a comprehensive scheme of communication in London should be drawn up by a traffic board or some specially-constituted authority, which shall include tramways, railways, tube railways, shallow tramways and roads, to say nothing of the re-arrangement of the omnibus routes, and so forth. But except in a very few instances, no one seems to have realised that every account must be taken of what already exists, and that any comprehensive scheme can only be drawn up as a continuation or extension of the lines of communication now serving the public. At this advanced period in the history of London, existing interests cannot be swept aside in so perfunctory a manner as many of the "experts" suggest. On the other hand, propositions have been made that a department should be created whose work shall consist of a general supervision of the whole of the communications of London, and more especially the examination of new schemes, so that by consultation with the promoters these may be brought into line with the means of transit already existing. Before any work of this nature could be effective, however, even supposing a suitable body of men could be found to constitute such an authority, the ground will have to be cleared by means of important modifications in legislation. Here, possibly, will be found the key to the solution of the whole problem of London traffic. Private enterprise has been too much restricted. In respect of tramways, the London County Council has exercised its veto with a severity which has resulted in private promoters simply abandoning London as a field for their efforts. That there is a serious side to this aspect of municipal trading cannot well be denied, and what has happened outside the metropolis can very well take place within it. A recent decision of the West Ham Corporation indicates the possibilities of the future in this connection. So extensive are its commitments in respect of municipal expenditure that the West Ham Corporation finds itself unable to proceed with the "electrification" of its horse tramway lines which it has just acquired from the North Metropolitan Tramways Company. Then there is also the oft-discussed purchase clause of the Tramways Act, which has been largely responsible for the delay in the conversion of the horse lines in the north of London to electric traction; and as, moreover, in several cases the London County Council, the Borough Councils and the Tramway Company to which the lines are leased, have all more or less different opinions as to the terms upon which the conversion should take place, it would be no surprise to us if electric traction on the northern lines in the county of London was postponed until the expiry of the Company's lease.

Let us now consider the means of communication which are available in London. There are the tube railways, more or less isolated at present, it is true. But a considerable mileage of additional lines—viz., the Baker Street and Waterloo Railway, the Charing Cross, Euston, and Hampstead Railway, and the Great Northern, Piccadilly and Brompton Railway—is well on the way towards completion, and the scheme of intercommunication which is contemplated between these lines, the existing tube railways, and the "electrified" Metropolitan and Metropolitan District systems, would seem to us to cover London in a fairly comprehensive manner from the railway point of view. There are, however, a few directions in which additional accommodation of this description would be needed, notably a route from the west to the north and north-east, and increased communication between the north and south, but these could very well be left to private promoters to project in view of the definite recommendations of the Joint Committee of 1901. Then as to tramways. Remove the condition attaching to Standing Order 22, and modify the Tramways Act of 1870, and much will have been accomplished. Hitherto the Light Railways Act has not been applied to London for the reason that the London County Council, deeming itself the one authority for the construction and working of tramways in London, would oppose on the ground that it would itself carry out the lines promoted, and so get the preference. Had the legislative restrictions above referred to not existed, it is quite possible that both the northern and southern tramway lines of London would ere this have been working electrically, but even at this late period much good would accrue by allowing private promoters to submit schemes and to have them considered on their merits either by Parliament or a special tribunal, if the Royal Commission thinks this latter desirable.

The question of street widenings and street improvements so as to accommodate the surface traffic to better advantage is a wider question into which we do not propose to enter deeply. Suffice it to say that if, as has been almost suggested by more than one witness, a considerable portion of London were to be pulled down and rebuilt for this purpose, the completion of this process would take so long as to bring us to the time when electric tramways will have been superseded by a still more modern and convenient means of locomotion. Undoubtedly the least difficult and most expeditious method of dealing with this matter of locomotion in London, therefore, is to make the most of the conditions and circumstances in which we are placed by giving private enterprise greater freedom, and at the same time insisting that all new schemes be so developed that they may work in harmony with those already existing.

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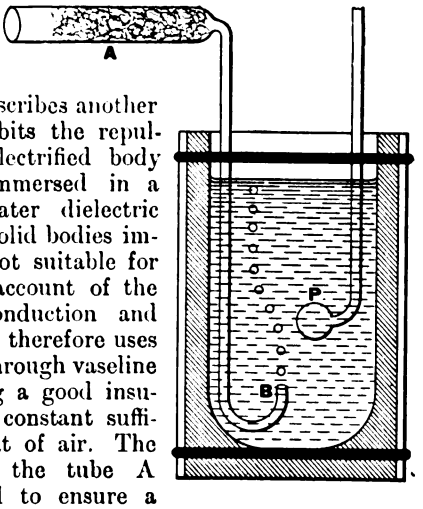
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Mercury Arc Lamp.—H. Siedentopf has designed a new form of mercury arc lamp in which, contrary to the practice adopted by Gumlich, Lummer, Paschen, Straubel and others, the light utilised comes from the mercury crater, and not from the flame arc. Since the crater is formed in a liquid, it is, of course, necessary to reflect the beam into a horizontal direction by means of a mirror. But this disadvantage is amply compensated by the circumstances that the luminosity of the flame arc is thus added to that of the crater, and that the tendency to condense mercury drops on the glass walls is counteracted by the heat given out by the upward radiation. To make quite sure that this does not take place, the author lets the cover of the tube consist of a glass ball which is hollow, and is evacuated before sealing up. The mercury electrodes are contained in concentric cylinders. Of these there are three, the inner and outer ones being positive, while the middle one is negative. The outer and inner ones communicate with each other and with a reservoir of mercury, so as to delay the exhaustion of the positive electrode by distillation. The lamp requires 18 volts, and burns well with 8 amperes. It will burn for about a quarter of an hour without special cooling, and for about an hour if simply immersed in water. If it is to burn longer continuously, it is necessary to cool it with running water, and then it can be kept burning for several hours without interruption. As in all mercury lamps, the life is limited by the absorption of alkaline constituents from the glass into the mercury, but it amounts to several hundred hours. The lamp is well adapted to monochromatic projections.

[H. SIEDENTOPF, *Zeitschr. Instrumentenk.*, January, 1904.]

An Electric Analogue to Diamagnetism.—The attraction exerted by an electrified body upon another body immersed in a medium of lesser dielectric capacity than itself is the well-known parallel to paramagnetism. L. Puccianti describes another experiment which exhibits the repulsion exerted by an electrified body upon another body immersed in a medium having a greater dielectric capacity than itself. Solid bodies immersed in liquids are not suitable for this demonstration on account of the disturbing effect of conduction and convection. The author therefore uses air bubbles ascending through vaseline oil, which, besides being a good insulator, has a dielectric constant sufficiently in excess of that of air. The latter is pumped into the tube A filled with cotton wool to ensure a uniform train of bubbles, and the bubbles ascend from the orifice B past the metallic sphere P. On charging the latter the train of bubbles is deflected as shown. If the bubbles are small and follow in quick succession a good lecture experiment is obtained.



[L. PUCCIANTI, *Phys. Zeitschr.*, February 15, 1904.]

Theory of Phosphorescence.—A. Dahms attempts to give a connected account of the phenomena of phosphorescence and fluorescence hitherto investigated, and to formulate a working theory as a guide to future research. In general, a phosphorescent body consists of a substance capable of existing in two modifications, A and B. The modification A is transformed into the modification B by exposure to rays of short wave-length. The retransformation is accompanied by a luminosity which is called fluorescence, and which appears as soon as any of the B modification has been produced, and while the original rays are still acting. If the retransformation takes place in an unmeasurably short time, there is no luminosity after the original radiation has ceased, and it is a case of pure fluorescence. If the retransformation is gradual we have the luminous effect known as phosphorescence. Sometimes the process of retransformation is arrested before its completion. It can then usually be completed by the addition of heat, and then we get the phenomena of thermo-luminescence. That some forms of radiation have the effect of extinguishing the phosphorescence may be explained by supposing that they allow the process of retransformation to complete itself in another manner which is not accompanied by luminosity. Both heat and infra-red rays apparently overcome some molecular resistance which opposes the retransformation. Where such a resistance does not exist, as in the case of fluorescent bodies, no effect is produced by those forms of energy. Nothing definite is known concerning the luminous energy of the retransformation. In zinc sulphide, at all events, the luminous energy of the substance, when excited to bright phosphorescence and then left to itself, is much greater than the energy emitted when it is excited to the same extent and then exposed to infra-red rays.

[A. DAHMS, *Ann. der Physik.*, No. 3, 1904.]

Actinium Emanation.—A. Debierne has found that the activating and ionising effects of the emanation of actinium follow different laws. While the ionising energy of the emanation diminishes regularly from the moment of its disengagement by the actinium, the activating energy increases rapidly at first, passes through a maximum, and only diminishes regularly after a certain time. That regular diminution then takes place at the same rate as the diminution of the ionising energy, half value being reached in 3·9 seconds. The emanation probably consists of two kinds of energy centres, one of which produces ionisation of the gas, while the other induces radio-activity on solid bodies. The author supposes that the first kind is transformed into the second kind. Thus the concentration of activating centres would be zero at the instant at which the ionising centres are evolved, and both kinds of centres would be finally transformed into induced radio-activity. Since the activating centres are destroyed more rapidly than the ionising centres, the law of decrease would, after a short time, become the same for both kinds. The rate of decrease is much more rapid than that of the radium emanation, which requires as many days to fall to half its value as the actinium emanation requires seconds. In the experiments the actinium salt was placed between two plugs of glass wool. Air was drawn through the tube, and passed between the armatures of a cylindrical condenser placed at a variable distance from the preparation. The induced radio-activity was measured by expelling the ionised air by means of a current of ordinary air and then sending a current through between the armatures at various intervals of time.

[A. DEBIERNE, *Comptes Rendus*, February 15, 1904.]

Transmission of N-Ray Fluorescence.—A. Charpentier has found that the transmission of N-rays can be accomplished not only by conducting substances, but also by bad conductors, such as glass and wood, though to a somewhat lesser extent. He has, in conjunction with M. Blondlot, even succeeded in transmitting the fluorescence across an air-gap between two condenser plates. If one end of a wire is covered with fluorescent sulphide, a similar patch of sulphide at the other end shines out when the former does. If the wire is cut and one of the cut ends is bent aside, the transmission ceases, but not if parallel plates are attached to the ends, as in a condenser. The equilibrium between the two fluorescent patches establishes itself after several oscillations. Transmission may be accomplished over a distance of 10 metres. Another transmitting instrument is a piece of twine impregnated with a collodion emulsion of fluorescent sulphide. The sulphide shines out along its entire length when one of its ends is near a source of N-rays, and sometimes shows waves of light going both ways. The author has used the secondary or conducted N-rays with success for further researches. He exposes a screen of calcium sulphide 18cm. by 24cm. to the sun, and covers it with coarse wire netting attached to a wire which leads into a dark room. The other end of the wire emits strong N-rays, and gives a number of foci when transmitted across an aluminium lens, as in Blondlot's experiments. A wire, one end of which is immersed in a fluorescent solution, may also be used.

[A. CHARPENTIER, *Comptes Rendus*, February 15, 1904.]

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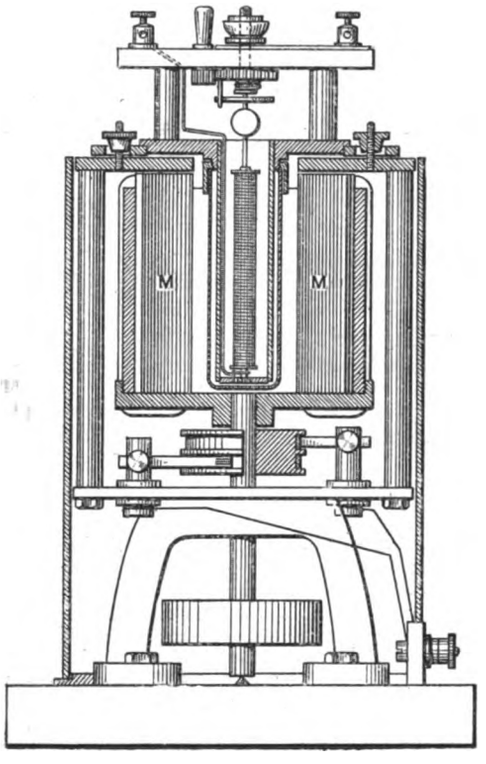
A NEW METHOD OF DETECTING ELECTRICAL OSCILLATIONS.*

BY J. A. EWING, LL.D., F.R.S., AND L. H. WALTER, M.A.

The magnetic detector of Rutherford,† though now well known, appears to have created little interest until attention was directed to the subject by Marconi's adaptation of the method to his telephonic detector. Marconi's apparatus employs the change of hysteresis, which is produced in iron by the influence of electric oscillations, when these are caused to pass through a coil surrounding the iron, the change being made manifest by means of a telephone. In his view the electric oscillations act by reducing the hysteresis.‡ It occurred to us to exhibit the alteration in hysteresis by a different method—namely, by applying the principle which is used in an instrument invented some years ago by one of us for the mechanical measurement of hysteresis. In that instrument§ the hysteresis is measured by the mechanical couple between a magnetic field and the iron, when either the iron or the magnet providing the field is caused to revolve. Thus, if the field revolves, the iron tends to be dragged after it, as a consequence of hysteresis in the reversals of its magnetism, and if the motion is prevented by a spring or other control it assumes a deflected position. Suppose, now, the electric oscillations to act on it, any change of the hysteresis caused by them will be exhibited by a corresponding change in the deflection. We anticipated, in accordance with the generally accepted view that hysteresis is reduced by the oscillations, that their presence would be detected by a fall in the deflection.



With this expectation an experimental apparatus was arranged, consisting of an electromagnet capable of being rotated on a vertical axis by an electric motor. The magnet poles were bored out circular, and between them was suspended, by a phosphor-bronze strip, a ring made up of three thin, flat annuli of soft iron, clamped together, and provided at the foot with an axial pivot. The ring was free to turn inside of two bobbins wound with fine copper wire, the windings being at right angles to the plane of the ring. Through these copper windings electrical oscillations, produced in the usual manner by means of a distinct spark-gap, were passed.

The first experiments resulted in a very small deflection from the position due to normal hysteresis, indicating, as was expected, a decrease of hysteresis when the oscillations arrived. The apparatus was also tested with an alternating current of about 100 periods per second in place of the oscillations, with the effect that the normal hysteresis deflection was almost entirely wiped out.

Various other forms were also tried with indifferent results, when it occurred to us that there would be advantages in passing the oscillations through the magnetic material itself, making it of magnetic wire. A small bobbin was therefore wound with insulated soft iron wire, and the ends soldered to the upper and lower halves of the spindle, which was itself divided at the centre, the upper half bearing the controlling spring, and the lower dipping into mercury, from which a connection led to the other terminal. On passing oscillations through this winding, a remarkable and unexpected result was obtained. The change of deflection was much more marked than in the former experiments, and was in the opposite sense, indicating an increase of hysteresis while oscillations were present. Afterwards, hard steel wire was substituted for the soft iron, and a very great increase in the effect was observed, still in the same direction—that of increase of hysteresis.

Owing to these encouraging results, it was decided to continue the experiments in this direction, abandoning the older form, in which a decrease of hysteresis was dealt with. The first bobbin constructed was about $\frac{5}{16}$in. in external diameter, and had a vertical wire space of $\frac{1}{2}$in. The winding was a single No. 32 gauge iron wire, double cotton-covered, wound straight round from beginning to end. Later, No. 40 and No. 46 steel wires were employed, of which the latter gave the best results. It was soon noticed that any method of increasing the oscillatory current in the wires, as by winding the bobbin with two wires having a slightly unequal number of turns, was of advantage in giving a larger deflection. Later, a fine copper wire secondary, wound on the bobbin parallel to the magnetic wire, was tried, first with the ends insulated, and then with the ends soldered together. A marked increase in deflection was observed when the secondary was closed, showing that the magnetic nature of the wire itself was influential. Accordingly, a bobbin was then wound with insulated steel wire, doubled back on itself. This non-inductive winding gave by far the best results hitherto attained, and is now used, except when special results are required.

The instrument, though described as a detector of electrical oscillations, may be said to measure rather than detect, giving quantitative as well as qualitative results, and being capable of regulation from a sensibility of the same order as that of an average coherer down to practical insensibility to powerful sparks in the same room.

In the instrument, as shown in the figure, the electromagnet takes the form of a ring capable of moving round a vertical axis, and is provided on the interior with two long wedge-shaped pole-pieces, M, M, the current to the winding being supplied through brushes bearing against insulated rings below. The magnet is made to revolve by an electromotor, the best speed being about 5 to 8 revs. per sec., but the electromagnet may be replaced by a permanent magnet system giving a similar field. A structure is built up, external to the magnet, to support the vessel containing the pivoted bobbin and its centreing arrangements. The bobbin itself is made of bone, and is about 2in. long. It is provided with a steel spindle at each end bearing in a jewel hole, the two halves of the spindle being insulated from one another. The winding, which is, as far as possible, non-inductive, consists of about 500 turns of No. 46 gauge, hard-drawn steel wire, insulated with silk. The bobbin is immersed in petroleum or a mixture of petroleum with thicker mineral oil, which serves the double purpose of fortifying the insulation and giving the damping effect necessary to steady the deflection due to the drag of the revolving magnet. Readings are taken by means of a spot of light, as with speaking-mirror galvanometers, but a siphon-recording attachment has been fitted, and any form of contact for working a relay could be employed.

The detector, as before mentioned, gives quantitative readings, and, in some cases, the deflection may be too large to be easily read by the scale. For this purpose a variable shunt is provided, by which the deflection can be regulated. For the purpose of wireless telegraphy, the instrument has the advantage of giving metrical effects. The benefit of this in facilitating tuning, and in other respects, need not be insisted upon.

From the physical point of view, the augmentation of hysteresis is interesting and unlooked for. It is probably to be ascribed to this, that the oscillatory circular magnetisation facilitates the longitudinal magnetising process, enabling the steel to take up a much larger magnetisation at each reversal than it would otherwise take, and thus indirectly augmenting the hysteresis to such an extent that the direct influence of the oscillations in reducing it is overpowered. The net result appears to be dependent on two antagonistic influences, and, in fine steel wire, under the conditions of our experiments, the influence making for increased hysteresis, as a result of the increased range of magnetic induction, is much the more powerful.

* Paper read before the Royal Society, February 11, 1904.
† *Phil. Trans.*, A., Vol. CLXXXIX., p. 1, 1897.
‡ Roy. Soc. *Proc.*, Vol. LXX., pp. 341—344, 1902.
§ *Journal* Institution of Electrical Engineers, Vol. XXIV., pp. 398—430, 1895.

Novel Method of Stopping a Leak.—The *Electrical World* of New York gives details of an interesting piece of engineering which was recently carried out in St. Louis. A leak occurred in one of the cofferdams being used in the construction of the foundations for the new plant of the Union Electric Co. on the river front. Water poured in rapidly, but the engineer of a refrigerating plant laid ammonia pipes to the point, and the breach was soon closed with solid ice. The water was then pumped out and work resumed.

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ALTERNATORS IN PARALLEL.*

BY H. BOHLE.

Although a great deal has been said and written on this subject, there are many problems yet on which opinions differ. Some engineers think it is impossible to tell beforehand whether alternators, when running in parallel, will cause trouble or not, others do not agree with this opinion. It will certainly be very complicated, although not impossible, to predetermine "all" the oscillations, in regard to their origin and cause, which are produced when two machines work upon the same network. Some of them are very irregular; for instance, those due to changes in the steam pressure or the chemical composition of the gas, and they may cause all the trouble in machines which might otherwise run in parallel without the least hitch. It has been said the coefficient of speed variation is "the" all-important factor for parallel alternators, and coefficients as low as $\frac{1}{500}$ have been asked for. We shall see later on that this factor has certainly a very important bearing upon good parallel working. Nevertheless, sets with coefficients larger than even $\frac{1}{100}$ have been found to work smoothly together. A coefficient of $\frac{1}{50}$ should certainly satisfy any engineer, and the author holds that for single-crank engines the factor may be considerably larger. This will reduce the price of the machines. According to Prof. Friese, a coefficient of $\frac{1}{6}$ produces light which is unbearable, and he says that the sensibility of persons increases with increasing intelligence; $\frac{1}{100}$ will therefore be about the limit, regarded from this point of view.

The Paper which is brought before you to-night is a treatise of the whole subject. In order to give a clear picture of the most important problems, it will be necessary in the first place to treat parallel direct-current machines, to see to what extent we can apply the knowledge thus obtained to alternators. Machines are joined in parallel to supply energy to the same network. Two such machines are shown in Fig. 1. Suppose, now, that from any cause

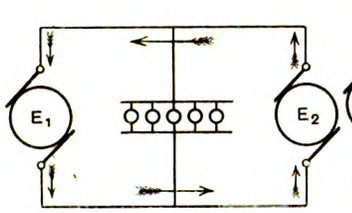

Fig. 1.

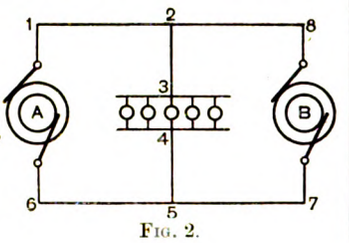

Fig. 2.

whatever the E.M.F. of one machine drops, a current will be caused to flow from the machine with the higher E.M.F. to that with the lower E,M.F., whose value is given by

$$C = \frac{E_2 - E_1}{2R} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

E_1 and E_2 are the E.M.F.s of the two machines and 2R their resistances, including connections. This current will cause a drop in the armature with E.M.F. E_2, so that the terminal pressure of this machine $E_{T2} = E_2 - CR$. In the other machine CR is *a motor* drop, hence $E_{T1} = E_1 + CR$. From equation (1) it follows: $C \times 2R = E_2 - E_1$ or $CR + CR = E_2 - E_1$

or $$E_2 - CR = E_1 + CR = E_{T2} = E_{T1} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The current C keeps, therefore, the terminal pressures constant, and is thus an "equalising current." Let us assume now that machine E_2 has just been joined in parallel to E_1, but that E_1 is doing all the work. Machine E_2 is intended to take one half of the load off E_1. To each output corresponds a definite input, be it steam, or gas, or water, the amount of which is checked by the regulator. If now the machine E_2 is excited more fully than would be necessary for simple parallel running, the E.M.F. will be raised and current will be supplied to the network, the amount depending upon the rise of the E.M.F. above the value which is required for simple paralleling. The regulator of the prime mover will allow at the same time more steam or water to pass, as the speed of the machine has dropped on account of the increase of work done by the generator, at the instant the excitation was raised, bringing thus the number of revolutions back to its normal value. The field regulator provides us therefore with a means of loading and also of unloading its corresponding machine.

From the preceding remarks it will be seen that we require simply equal E.M.F.s for the parallel running of direct current generators. In alternators the case is complicated by the fact that, in addition to equal E.M.F.s, we require equal periodicities and phase equality. Let us consider the frequency first:—If p_1 be the number of pairs of poles, n the frequency and n_1 the number of revolutions per minute, then

$$n = p_1 n_1 / 60 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

* Paper presented at the Leeds Local Section of the Institution of Electrical Engineers, Jan. 21st. (See *The Electrician* of Jan 22nd, p. 511.)

For simplicity sake, let us assume that all the machines have the same number of poles; the same frequency means then the same number of revolutions. To join an alternator, B, in parallel with an alternator, A, B must be raised to the frequency of A or brought into "step." With the above assumption of an equal number of poles, B must be raised to the same number of revolutions. This is simple enough, but it may happen that when this happy state has been arrived at, a fluctuation in the load of A takes place, which, unless the regulator of the primer mover of A is very sensitive, might upset all our calculations. If once the machines are working properly they keep themselves in step, as will be seen later on, so that a very sensitive regulator would be of great disadvantage. Thus during the paralleling, the regulator should be very sensitive, whilst afterwards it should act as if it possessed a dashpot.

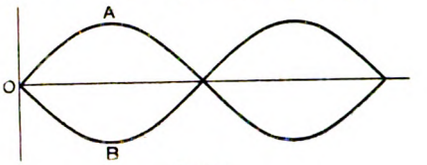

Fig. 3.

As regards "Equality of Phase," all alternators should produce currents which have at any time the same direction. Fig. 2 shows two alternators in parallel. The various circuits are: (1) 1, 2, 3, 4, 5, 6; (2) 8, 2, 3, 4, 5, 7; (3) 1, 2, 8, 7, 5, 6. The first two circuits are in parallel; the currents of the latter, if any, in opposition.

Considering circuit 1, 2, 8, 7, 5, 6, we must have currents as represented by the curves in Fig. 3 to have equality of phase. This state may be seen by means of phase lamps or phase meters, joined up as shown in Fig. 4. Suppose alternator A feeds properly on the 'bus bars, and that machine B is running but has not yet been excited. A current will then circulate in the circuit 1, 2, 8, 7, 5, 6, causing the lamps to glow. If we excite now the fields of B, an

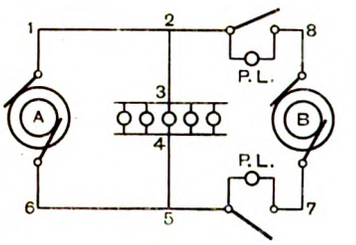

Fig. 4.

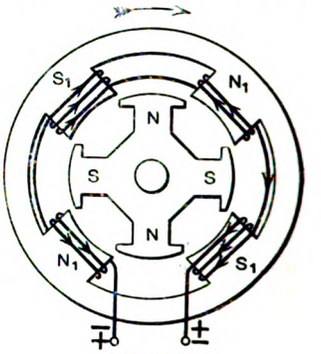

Fig. 5.

opposing E.M.F. is set up. It will be evident that, as long as the machines are not in phase, the lamps will show various states of incandescence, but ultimately, when both machines are brought into step, the E.M.F.s of machines A and B will directly oppose each other, considering, of course, only circuit 1, 2, 8, 7, 5, 6, so that the lamps will be dark. The switches may then be inserted.

The third condition—viz., equal E.M.F.s—is also of importance. Assume machine B is driven by a turbine, and that the quantity of water is just sufficient to keep B in step with A without sending energy into the network. Let us increase now the field excitation, then we naturally conclude that the pressure is raised. This would, however, mean more work for the turbine, which it cannot give, as

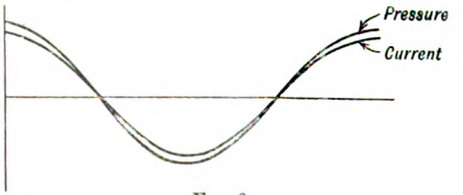

Fig. 6.

the water is only sufficient to run the alternator light. What will happen is the setting up of a wattless current, which neutralises the disturbing action and corrects the fields. Let us see how this state is obtained. In Fig. 5 the induction of the stator winding is a maximum, and let further the current be in phase with the pressure; then fields are set up by the stator winding, which are at right angles (electrical degrees) to the dynamo fields N, S. As both sets of fields are perfectly symmetrical in regard to each other, we have here the greatest turning moment, such that S_1 tends to place itself opposite N. In other words, we require here the greatest force to turn the rotor in the direction of the arrow, and the dynamo field is neither weakened nor strengthened.

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The curves of the pressure and current are shown in Fig. 6. Let us suppose now that the rotor is moved so that the stator and rotor poles are exactly opposite, then with the above assumption of phase equality between pressure and current the E.M.F. and current would be nil. Assume now that while the E.M.F. is zero, the current has a maximum value in this position, lagging, therefore, by 90deg., so that the stator fields N_1, S_1 are produced (see Fig. 7). Both sets of fields are, as will be seen, in opposition, so that the dynamo fields N, S are weakened. Conclusion: Lagging currents decrease the dynamo field.

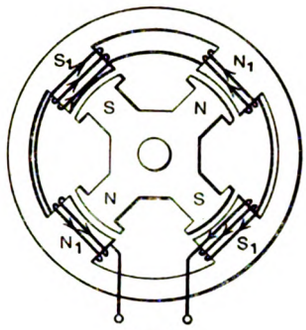

Fig. 7.

In the same way we should have found that, if the current obtained its maximum value 90deg. before the pressure, the dynamo fields would have experienced an increase. Thus we see that currents in phase with the pressure have no influence upon the dynamo field; lagging currents decrease and leading currents increase the dynamo field. Let us return now to our parallel alternators. When the excitation of B is increased, an instantaneous increase of

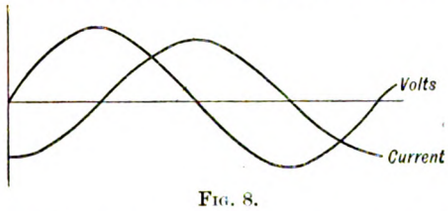

Fig. 8.

its E.M.F. will take place, producing a difference, $E_2 - E_1$, between the E.M.F.s of the two alternators. As, however, the current set up by $E_2 - E_1$ works upon an almost pure inductive resistance, this current will be lagging by nearly 90deg. in regard to $E_2 - E_1$, decreasing thus its own field. The result is, therefore, not an increase in the pressure, but a wattless current in circuit 1, 2, 8, 7, 5, 6 (see Fig. 9). If B is to supply energy into the network,

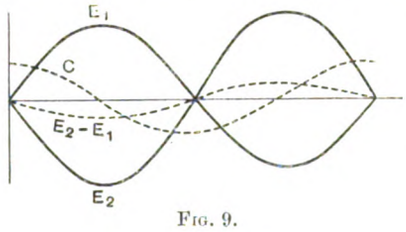

Fig. 9.

it is necessary to open the valve of the prime mover more fully. Similarly, if we intend reducing the work done by alternator B we must shut part of the water or steam off. The above-explained field-correction current is, of course, not perfectly wattless, as the resistance of an armature cannot be nil. Its watt component is C^2R, its E.M.F. of inductance $E_s = 2\pi nLC$, where L is the coefficient of self-induction.

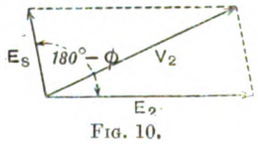

Fig. 10.

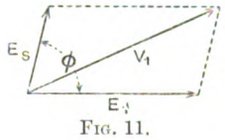

Fig. 11.

The correcting effect of the field-correction current may be seen from the accompanying vector diagrams. In Fig. 10 we have the machine with the strongest excitation, the E.M.F. of inductance opposing E_2, so that the angle of lag ϕ must be drawn in as 180deg. $- \phi$. In Fig. 11 we have the less excited alternator A, with E.M.F. E_1, in regard to which the correction current leads, so that here E_s aids E_1. The terminal pressures remain, therefore, equal. Suppose now machine B is running properly in parallel with A, but that it has not as yet taken up any of the load. When now the valve is opened, so that more steam or water can pass, the prime mover has a tendency to run faster, as a short time will elapse between the opening of the valve and the taking up of the load. The result will be that the relative positions of the rotating fields of the two alternators will differ. Hence the E.M.F. E_2 of the faster running alternator B will lead in regard to E_1 (see Fig. 12), setting up a resultant E.M.F. equal to E_d. As the circuit of the current set up by E_d is almost purely inductive, the current will lag by nearly 90deg. in regard to its own pressure E_d.

But from Fig. 13 it will be seen that this current C_1 is practically in phase with the E.M.F.s E_2 and E_1, being, therefore, a watt current. Now C_1 is on the same side of the X axis as E_2, being thus a generator current in regard to E_2, and causing machine B to retard its speed. In regard to E_1 C_1 is a motor current causing machine A to accelerate. In other words, current C_1 tends to decrease the divergence between the relative inductor positions of the two alternators. This current is, therefore, doing actual work besides heating its own circuit, as it corrects the phases, keeping the machines in synchronism. Hence the name "Synchronising force." We have thus the presence of two correction currents. One, C, which keeps the pressures constant, being wattless, and C_1, which keeps the machines in synchronism, and which is a watt current. In loading or unloading a direct-current machine, all we had to do was to alter the position of the field regulator. In the case of alternators the loading and unloading depends entirely upon the supply to the prime mover, as the alteration of the position of the field regulator produces only a wattless current.

Let us see now what is further due to the synchronising force. When B is accelerated, due to the larger supply of steam, the mass of its rotating system will obtain an increased momentum, forcing the inductor* past a position which it would take up on account of the larger supply only. This is, however, succeeded by a greater synchronising force, which pulls the rotating system back. On its backward course the mass of the inductor stores a momentum in an

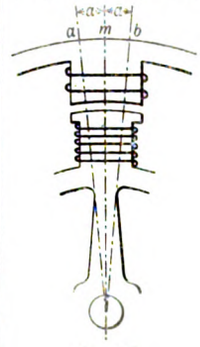

Fig. 12.

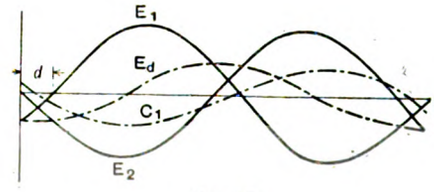

Fig. 13.

opposite direction, forcing it past the synchronising position. The result will be oscillations of the inductor of B round the synchronising position, of gradually decreasing amplitudes, dying finally out. Similar oscillations are produced by fluctuations in the load, but all these oscillations are quite harmless and will not cause any trouble, as long as they do not knock the alternator out of step, in the first instant, and provided no other oscillations interfere with them. The oscillations due to the synchronising force will be free oscillations, and may be compared with those of a ring, which is connected by means of a clock spring to a fixed centre. If we rotate the ring by any force, F, out of its position of equilibrium and let it go, it will oscillate, the amplitude of the oscillations becoming smaller and smaller, dying finally out. Let I be the moment of inertia of the ring, F_m moment which could act if the ring were rotated from its position of equilibrium through unit of angle; the time of a complete oscillation will be given by:

$$t_r = 2\pi \sqrt{I / F_m}. \quad \ldots\ldots\ldots \quad (4)$$

In our alternator the tension of the clock spring is replaced by the synchronising force, the ring by the rotating inductor and F_m by S_1, where S_1 is the moment of that synchronising force which acts at the instant the machine drops out of step. We have, therefore, the time of a free oscillation given by:

$$t_a = 2\pi \sqrt{I / S_1}, \quad \ldots\ldots\ldots \quad (5)$$

where I is the moment of inertia of the moving parts. Now the time of an oscillation will be constant for the same system, but the amplitude will vary proportionately to the synchronising force, and, as the latter is produced by fluctuations in the load, these oscillations will be due to the latter. Where free oscillations are the only ones, no trouble will be experienced by running alternators in parallel. This is proved by the fact that turbo-driven alternators give excellent results when working upon the same network. This is due to the uniform speed of the turbines, but the case is vastly different with reciprocating engines.

(To be continued.)

[* By "inductor" we presume the author means the field-magnet system.—Ed. *E.*]

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DISTRIBUTION OF ELECTRICITY IN SHIPYARDS AND ENGINE WORKS.

The following is an abstract of the adjourned discussion on Mr. J. A. Anderson's Paper on the above subject, which took place at the Newcastle Local Section of the Institution of Electrical Engineers on February 29th. The Paper was published, together with the first part of the discussion, in *The Electrician* of February 19th.

Mr. BIGLAND questioned the accuracy of the author's figures.

Mr. TURNBULL said that he was more than ever convinced of the superiority of electricity as a motive power in shipyards.

Mr. J. C. SNELL mentioned that from tests made in Sunderland with a 50 H.P. motor, driving shafting, it had been found that 22 per cent. was lost in the shafting alone, and he thought that in this case several motors should be installed and the shafting considerably reduced. A gas engine as prime mover driving a generator was generating at a cost of 1·33d. per unit, and in another case at 1·8d. per unit. After running some time, the efficiency of gas engines materially decreased, and there was no doubt that in a shipyard with large isolated machines electric motors were the thing.

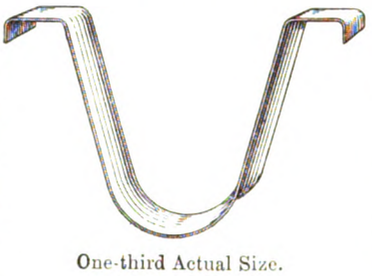
Mr. VARDY said that in shipyards some arrangement was wanted to control and operate hydraulic pumps and air compressers in such a way that the whole apparatus would be efficient at low speeds. Three-motor cranes of high travelling speed were desirable for long shops, but this speed should not exceed walking pace; for small runs, single-motor cranes with friction clutches worked quite satisfactorily. In his opinion, three-phase motors were a greater success in shipyards than continuous-current machines, chiefly on account of their reliability and simplicity of starting.

Mr. STONEY advanced the usual arguments in favour of alternating current, whether it were single, two or three-phase, and against commutated current.

Mr. ANDERSON, in reply, stated that he had experienced no difficulty with the small clearance of three-phase machines. He regretted that the figures given in some cases were not complete, but they were taken in the ordinary course of working, and were not at the time intended for publication. Motors should be rated for a standard temperature rise of, say, 60°F. above atmospheric temperature. Variable-speed motors would, in some cases, be an advantage, but in no case would it be worth the extra expense.

A NEW BRIDGE-PIECE FOR CABLES ON THE "SOLID" SYSTEM.

The British Insulated and Helsby Cables (Ltd.) are introducing a new bridge-piece for supporting cables laid in troughs on the "solid" system. This extremely simple device, which has been designed by Mr. E. T. Ruthven-Murray, electrical engineer to the Willesden Urban District Council, and is protected by a provisional patent, consists of a U-shaped piece, illustrated below, which is stiffened by the arching of the bottom and sides. The flange of the bridge-piece rests on the top of the trough, and holds the cable in the centre in such a way that, whether the troughs are of iron, earthenware or wood, the hot bitumen or pitch can flow right round the cable without there being a danger of cavities being left, as sometimes happens with the wooden or stone-ware bridge-piece usually employed. In some cases, we believe, the wooden bridges which have been employed have rotted and damaged the lead sheathing, and, of course, damage of this nature cannot possibly occur with these metal suspension pieces. The company inform us that the bridge-pieces are not more expensive than wooden ones, and that during the six weeks which they have taken them up they have obtained permission to use nearly 70,000 of them.

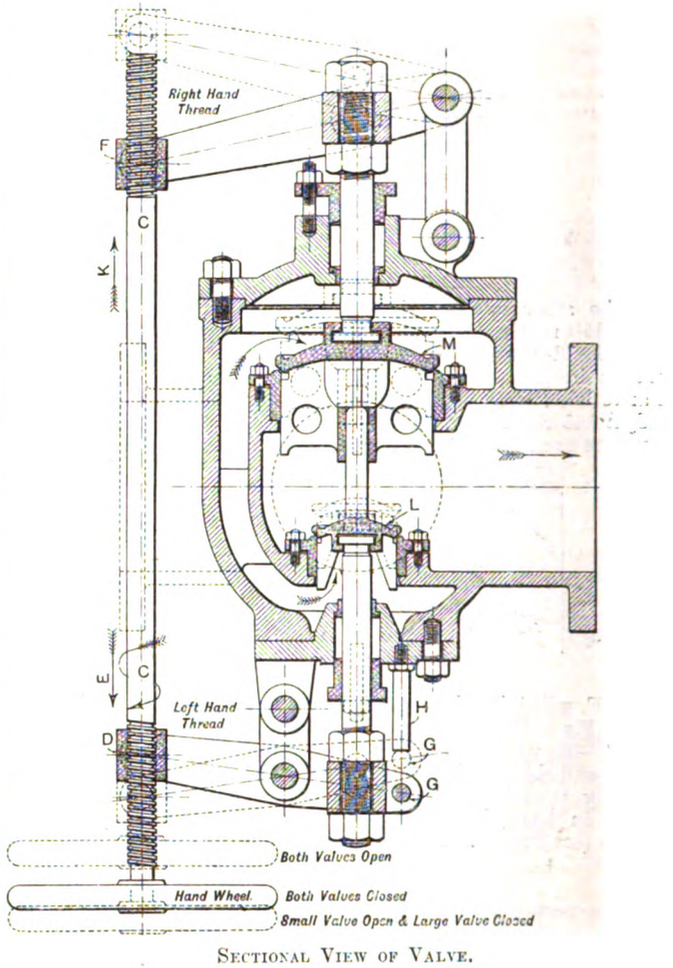


One-third Actual Size.

A NEW BALANCED STOP-VALVE.

In order to overcome the difficulty of leakage and want of easy control experienced with single-seat and double-beat valves of the ordinary type, Messrs. Holden and Brooke of Manchester have introduced a new balanced stop-valve, the design of which will clearly be understood by reference to the illustration below. The two valves are to a certain extent independent in their movement on one another. The smaller valve L has the pressure on its under side, the admission steam pressing on the larger valve M from above. It is evident that, when opening the valve, the small valve L will be the first to open and will continue to do so until the pin G comes into contact with the stop H. By this time the pressure has become equal on both sides of the larger valve, and, if the turning of the handwheel be continued, the large valve will now be lifted. The spindle C has a left and a right-hand thread.

Although each valve is closed positively and independently, no force is required to open them, since the opening movement is assisted by the steam pressure on the under side of the small valve. It is said that the time required to open or close the valve is very short, only 12 turns of the handwheel being required, for example, to fully open or shut the 10in. size of valve.



SECTIONAL VIEW OF VALVE.

In the standard pattern, the valves and seatings are made of phosphor bronze, the bodies being of cast-iron, steel or gunmetal according to steam pressures. If required, the valve can be made to operate by direct lever action instead of by screw.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, February 25.

Mr. J. W. LOWTHER, M.P., for the Penrith Division of Cumberland, and Deputy Speaker in the House of Commons, said he did not think Parliament would ever consent to hand over to an entirely independent tribunal the control and decision of such important matters as the routes, rates and conditions of the tube railways. He did not think that either public companies, capitalists or public bodies would be satisfied with anything less than a Parliamentary decision. If any tribunal, therefore, were to be established, it must be subordinate to Parliament. But he did not think that any other tribunal was necessary. With regard to locomotion, the present system of legislation had worked well, and he was not aware that if there had been any other tribunal the lines now working and sanctioned would have been refused or diverted. In considering the disadvantages, of the present system, he agreed it was a drawback that when a scheme was proposed it could not be extended or curtailed, but it was possible to overcome this defect by the promoters promising to promote additional lines in the next Session. Then there was the inability of Parliamentary Committees to take a general survey and carry out a consistent plan, but in connection with this he agreed very largely with the evidence of Sir Ralph Littler that it was altogether too late to seek to form any general scheme for laying out railways, tubes, tramways and subways in London. If this was ever to have been done it should have taken place when tramways first came into London or when

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tube railways were first thought of. There were several objections to any tribunal, department, Board or Commission or body laying down a general scheme. Such a scheme laid down in 1904 or 1905 might, in 10 or 15 years time, be obsolete, insufficient or unnecessary. A scheme of this description would probably have all the parts interdependent; but if promoters only took up some parts and left others, the general object of the scheme would be frustrated. The assent of Parliament could not be obtained to the scheme as a whole. The work of evolving a scheme, which was to be reasonably permanent and to take into consideration all the interests and overcome all the difficulties, was beyond the powers of any tribunal. If, however, it was deemed desirable to establish a tribunal for all matters affecting London traffic, he thought the following would meet the case:—Promoters should deposit draft provisional orders at the Board of Trade similar to the Scottish Private Bill Procedure Act. Petitions should also be lodged with the Board of Trade against these provisional orders. After the Board of Trade was satisfied that the provisional order had complied with general orders, they should be referred to the permanent tribunal, which would decide all questions of *locus standi*, &c., and the Board of Trade should subsequently introduce provisional order confirmation bills. These latter would go forward in the ordinary course, but in the event of opposition the bill should be referred to a joint committee. With regard to Standing Order 22, which stipulates that the consent of the local authority should be obtained, he was of the opinion that this should be abolished. On the other hand, he would give all local authorities the right to appear against all tramway schemes. He thought, however, that there would be considerable difficulty of convincing the House of Commons on this matter.

Mr. J. L. POUND, director of the London General Omnibus Co., said his evidence represented the views of all the London omnibus proprietors. He said the utmost endeavour was being used to provide a means of mechanical traction, and numerous types of vehicles were constantly being inspected. These had been given most careful trials, and at the present time the principal companies had contracts pending for the production of specimen motor omnibuses. The advice of the electrical and motor experts was that it would only be a short time before a satisfactory motor omnibus would be produced, and in support of this statement he quoted the Paper by Colonel Crompton before the Mechanical Science Section of the British Association at Glasgow in 1901. With regard to the congestion of traffic in the streets, apart from the congestion caused by the vehicles and pedestrians, he said there was a constant interference by gas, water and electric lighting companies. Amongst his suggestions for remedying this state of affairs was the construction of deep level railways operating in conjunction with omnibuses. He disagreed with the policy of construction of shallow tramways except in existing streets, but admitted they might be tried in new thoroughfares. He said the omnibus proprietors had considered with great care the question of a tribunal. In their opinion the ordinary procedure by Parliamentary Committees was cumbersome, but the Light Railway Commission semed to afford an almost ideal tribunal for the consideration of traffic questions. In establishing a tribunal on these lines, he thought it should consist of three, or preferably five members appointed for a term of years absolutely independent of promotors and opponents of traffic schemes. As in the case of the Light Railway Commission, one member should be an engineer, one a lawyer and the other three business men, all of whom should devote the whole of their time to the work. It was regarded as being in the highest degree improper that a member of a local authority such as the London County Council, so long as it was the tramway authority, should have a seat upon this tribunal, as it was against the ordinary sense of justice that a man should be at the same time both promoter and judge. A very good instance of what might happen in these circumstances was the action of the London County Council in respect of the proposal to run a tramway across Hammersmith Bridge [referred to in our Editorial Notes last week]. Witness also referred to the action of the London County Council in connection with its omnibus service. which had to be discontinued in 1902 after legal proceedings had been taken by the 'bus companies. Returning to the tribunal, he said it was considered that it should be entirely judicial, and have no initiatory powers, as it was patent that no tribunal could approach the examination of a scheme with impartiality if it had already publicly expressed an opinion that some such scheme would be desirable. The decision of the tribunal should be subject to reference to a joint committee of Parliament. In conclusion, he impressed on the Commission that every effort was being made by the omnibus companies to obtain a serviceable motor in lieu of horse traction; they resisted the handing over of the omnibus traffic to the London County Council, on the ground that it would be very quickly discontinued in favour of the municipal tramway, which, however, did not come into the centre of London.

Friday, February 26.

Lieut.-Col. R. E. CROMPTON, R.E., who gave evidence on behalf of the Automobile Club, dealt with vehicular street traffic. He believed that immediate improvement would follow if notices were displayed ordering the heavy traffic to keep to the left kerb, further powers given to the police for the regulation of traffic, improved roadways and the provision of alternative routes, either underground or overhead. He strongly advocated an increase in the system of despatching postal traffic by means of pneumatic tubes. In Philadelphia the diameter of these tubes were being increased to 12in. diameter. If such pneumatic tubes were established in London it would very largely reduce the number of light parcel delivery vans which now occupied the streets.

EARL RUSSELL, who gave evidence on behalf of the Roads Improvement Association, said that tramcars should not be allowed in London except in connection with widened streets, and that shallow subway tramways were preferable either to surface tramways or tube railways. With regard to the opening of streets by statutory companies, he said the best way of putting an end to this nuisance was to construct subways, but at present the Parliamentary powers were inadequate. When a subway was constructed by the London County Council it had power to charge the company a rental to cover maintenance only. Therefore every subway was a charge upon the rates instead of the whole of the cost being charged to the statutory companies as it should be. He suggested that a period of five to eight years should be fixed, within which all pipes, &c., should be put in the subway, and that during the interval 1s. per square foot per 24 hours should be charged to every company when the surface of the roadway was broken by it. This would encourage them to move into the subway as soon as possible, or to work night and day to close the street up again. He also proposed the construction of a number of new streets.

Mr. W. REES JEFFREYS gave evidence as hon. secretary of the Roads Improvement Association. He said that, in his opinion, there was a need for a single authority having jurisdiction over all the means of communication within a radius of at least 25 miles of St. Paul's, but this would give no solution of the traffic problem unless the administration of roads as well as tramways and railways was brought within the scope of the tribunal. Many of the present difficulties could be traced to the fact that roads, railways and tramways were all considered separately instead of under one tribunal. In considering the constitution of this body he said he found himself in considerable difficulty, as difficulties could be raised against anything which might be suggested. In the first place, however, he thought there was a good deal to be said for making the Metropolitan Water Board the future authority, but as this was a co-opted body, it might not possibly inspire much public confidence. The second alternative would be a traffic commission appointed by the County Councils of London, Kent, Surrey, Essex, Buckinghamshire, Hertfordshire, and Middlesex, and the County Boroughs of Croydon and West Ham, although this might meet with opposition from the urban and rural district councils outside London and the borough councils inside London, owing to the refusal on the part of these authorities to transfer any of their existing powers. As a third alternative, he suggested a special commission of experts. A merely judicial tribunal, however, pronouncing judgment only on the schemes brought before it would be quite unsuited to the special circumstances of London. The duties of the new authorities should be, amongst others, the following:—(1) To draw up a plan of an improved larger London, to which all new streets and street improvements shall be required to conform. (2) To provide in that scheme for necessary new roads, railways, tramways, light railways, &c. Local authorities should be consulted as regards tramways, but their consent should not be necessary. (3) To obtain Parliamentary sanction for the construction of such roads, tubes, light railways, &c. (4) To arrange with and to empower local authorities, tramway or other companies, or other persons to construct and work the above under such conditions as may be agreed. (5) To undertake the construction of new trunk roads passing into more than one county. (6) To draw up regulations for the guidance of other authorities and persons who have statutory powers to open the roads, to which these authorities and persons shall be required to conform. Continuing, he he said he considered tramways were a cause of traffic congestion, for the reason that under present conditions it was more profitable to the tramway proprietors to appropriate existing main roads than to build special tracks. Other objections were the use of central trolley wire standards and the bad making-up of the roads by the local authorities outside the tramway track. To overcome this latter difficulty he suggested that a certain percentage of the tramway profits should be definitely ear-marked for the purpose of road maintenance. Further, tramway termini should be built on lands acquired for the purpose. An objection to the present system of legislation was that no authority existed to advise Parliament or the Board of Trade as to the effect of tramway schemes on the main lines of road communication. Nobody interested in the through traffic had any *locus standi* before Private Bill Committees in the House of Commons, and even if such were the case this would not meet the circumstances. A central department was necessary to protect the nation's interest in the nation's main roads, and an urgent practicable reform was that engineering inspectors, on the staff of the Local Government Board, should examine all roads on which it was proposed to lay tramlines, and advise the House of Commons, Board of Trade, or the Light Railway Commissioners as to the proposal from the point of view of the through traffic. Witness handed in to the Commission a map of suggested new roads round about London, and also some photographs showing the disadvantages of track construction in certain places belonging to the London United Tramways Co., principally in regard to making up of the roads and the use of central standards.

The Committee then adjourned.

Notes on Automobiles.—A Paper on this subject was read by Mr. B. Hopps before the Rugby Engineering Society last night. The author had very little to say concerning electrically-driven cars, and was of the opinion that the petrol electric combination will probably prove the most satisfactory system for propelling heavy service vehicles, where change-speed gears have proved unsatisfactory under the strains they undergo in the stopping and re-starting. He also briefly discussed electric ignition and mentioned the device suggested by Capt. Longridge, described in *The Electrician*, Vol. L., pp. 191 and 271. Mr. Hopps gave a considerable amount of detail relating to petrol cars, and this information is both interesting and valuable.

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CORRESPONDENCE.

CABLES AND THE RUSSO-JAPANESE WAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an article in the last number of your paper headed "Cables and the Russo-Japanese War," I find a remark about the Kiachta line to the effect that news sent through it will presumably be subjected to "strict censorship." I should feel obliged if you would mention in your next issue that telegrams sent via Kiachta are not subject to any delay or to any censorship whatever on the part of the Russian Government.—Yours, &c.,

For the GREAT NORTHERN TELEGRAPH CO.,
F. C. C. Nielsen.
The Company's Representative in England.

THE INHERENT REGULATION OF ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Miles Walker—in your issue of February 26th—criticises under the above heading my plea for a general adoption of specifying the inherent regulation of alternate-current generators as "rise" in volts instead of "fall" in volts, as is occasionally done in this country. May I be permitted to repeat what I have previously answered on a similar occasion.

In itself it would be immaterial whether the fall or rise in voltage is specified, as long as the figures are chosen accordingly, but in nine cases out of 10 where the fall in voltage is specified the figures correspond to the rise—*i.e.*, are so small that a design complying with such requirements becomes either impossible or altogether uneconomical. Now, since smaller figures seem always to be more attractive to those who cannot be expected to have a detailed knowledge of the design of alternators, and, furthermore, since in all engineering arts an international standard should be aimed at, I feel that the adoption of the rise in voltage as standard also in England would be beneficial, not only to the manufacturers, but also to the buying public.

In addition to the above, I must take strong exception to Mr. Walker's assertion that manufacturers prefer to sell to their customers rather a cheap machine than a good one. It lies certainly as much in the interest of the manufacturer as in that of the consulting engineer to see that the buyer obtains the best apparatus, and led by this idea, I tried to explain in my Paper on "Voltage Regulation" how, by exaggerated demands for regulation, other important features of the design must suffer. It is not the smallest, but the most economical figure for regulation which should be called for. For instance, while it would be all right to limit the rise in voltage from full load and 80 per cent. power-factor in a machine of, say, 500kw. to 13 per cent., such a figure specified as fall in voltage with no load excitation can certainly not be considered good engineering. This figure should be nearer 25 per cent. Table III. in my Paper was prepared to illustrate this point.

Mr. Walker's remarks as to regulation obtained by saturation are in exact agreement with my remarks in paragraph 4, Part (A), and therefore need no further comments.

On the other hand, I fail to understand the paragraph in Mr. Walker's letter dealing with the "crucial test of performance which the manufacturer of inexpensive alternators wishes to abandon." To take the above example, I cannot see the difference between testing a machine for a rise in voltage of, say, 13 per cent., or a fall in voltage of 25 per cent. If, however, a machine should have to answer a regulation test of 13 per cent. expressed as fall in voltage, I think cost, efficiency and operation would soon tell the customer that he had been ill-advised when ordering such a machine.

Finally, the fact that the representative bodies in two countries like Germany and America have both standardised the "rise" in voltage method ought to go a long way to prove that Mr. Walker's criticism is hardly justified.—Yours, &c.,

Rugby, March 2. H. S. MEYER.

ELECTRICITY IN MINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The report of the Departmental Committee on the use of Electricity in Mines recently issued, and reprinted in your journal, will, I hope, be carefully considered and discussed by all those interested in this matter before the proposed rules are given authority. With the general tenor of the report few will find themselves in disagreement; the number of direct-current plants already in use has doubtless deterred the Committee from recommending alternate-current working alone, but indirectly the rules as to allowable pressures make for such supply. This being so, I find rule 6, Section V., unsatisfactory, as obviously worded for a direct-current starting switch; a squirrel-cage polyphase motor needs no such rule as to starting, and I trust to see this deleted as having no direct bearing on the safety of operation.

Rule 2 of Section IV. as to the rating of fuses is so loosely worded as to be valueless; the time which the 100 per cent. overload would take to blow the fuse should surely be stated, or, better still, such an arbitrary figure (100 per cent.) omitted; that the fuse should protect the circuit and motor from burning out seems sufficient.

Rule 5 of Section II. requires a "reverse-current" cut-out for all generators which are run in parallel. A "reverse-current" cut-out may, I suppose, be taken to mean a reverse-power cut-out where alternating currents are used; this being so, the rule applies to both systems of working. I deprecate the insertion of such a requirement, on the necessity for which power station engineers themselves are not in agreement (even if a satisfactory return-power cut-out is to be had).

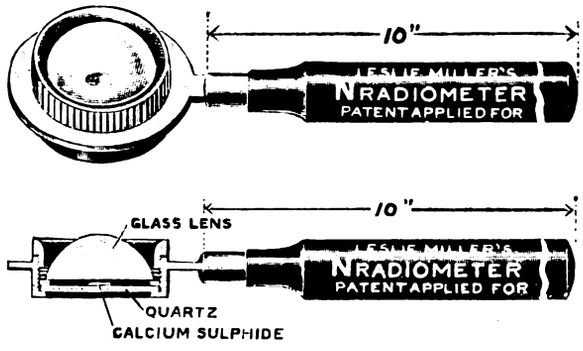
These are details, but details which may prove vexatious if enforced.—Yours, &c., W. B. WOODHOUSE.

Leeds, Feb. 27.

M. BLONDLOT'S N-RAY EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is satisfactory to be able to state that the chief experimental results of A. Charpentier on the rays that proceed from muscles and nerves are not mythical, no matter whether they are due to N-rays or heat, or, as I think, very often to



both. By means of the instrument shown in the illustration the objective existence of the rays can be clearly proved, and also a number of experiments made which seem to show that some other rays than those due to heat are concerned. Even if the latter can account for everything, an extremely delicate means of testing has been placed at the disposal of physicists.

A crucial experiment which eliminates all sources of error except heat may be mentioned:—Excite the calcium sulphide patch with daylight, magnesium wire, or an electric spark. Place the instrument on the thickest book obtainable, in a room so dark that an operator's hand cannot possibly be seen, and let the operator at irregular intervals place his wrist under the book. Another observer as well as the operator can tell by the increased illumination when the wrist is held underneath. If the effect is due to the difference in temperature between the wrist and the fluorescent screen the heat must be transferred through several inches of paper, or round the book through the air.

The conduction of the rays along a wire (or the reflection of the rays along the inside of it, like light along a solid glass rod)

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can be proved by fixing one end of a copper wire at the back of the calcium sulphide, and placing the other on a source of the rays; for example, the wrist or the muscles of the jaw. The wire diminishes the effect, but not seriously. M. Charpentier states that a piece of string impregnated with calcium sulphide acts in the same manner, and, if so, this seems a strong argument against the heat theory.—Yours, &c.,

London, E.C., March 2. LESLIE MILLER.

PARLIAMENTARY INTELLIGENCE.

In the House of Commons on Friday last week a number of gas bills came before the unopposed committee, amongst them being the Blyth and Cowpen and the Hampden-on-Arden Bills. The former is promoted by the Blyth and Cowpen Gas Co., and a clause is inserted in it enabling the company to "sell, let for hire and otherwise deal in, but not manufacture engines, motors, dynamos and fittings." In the Hampden-on-Arden and Mersden Gas Co.'s Bill, clause 44 gives the company authority to apply for electric lighting powers under the Electric Lighting Acts of 1882 and 1888 if it thinks fit.

The Great Northern and City Railway (Extension of Time) Bill is now unopposed, and has been withdrawn from the group of opposed bills in which it had been included. It will therefore go before the Chairman of Committees prior to being reported to the House of Commons for third reading.

In the House of Lords on Friday last week the Mid-Cheshire Tramways and Clyde Valley Electrical Power Bills were read a second time. On Tuesday the Preston and Lytham Tramroads Bill was read a second time.

In the House of Commons on Monday the Watford and District Tramways (Extension of Time) Bill was read a second time. On Tuesday the Saddleworth and Springhead Tramways (Abandonment) Bill was read a second time.

Mr. Hope Johnstone has been appointed Chairman of the Police and Sanitary Committee of the House of Commons, which will commence its sittings on Tuesday. Among the measures which will come before this Committee are the following:—Wolverhampton Corporation, Acton District Council, Doncaster Corporation, Leeds Corporation, Leyton Urban District Council, London County Council (General Powers), Radcliffe Tramways and Improvements, Swindon Corporation and Rotherham Corporation.

A group of bills has been arranged including the Tynesida Tramways, Newcastle-on-Tyne Tramways, and the Isle of Thanet Tramways, which will come before a House of Lords Committee on Tuesday.

The motion by Mr. Goddard in respect of the St. Marylebone Electric Lighting Bill, given in our last issue, has been postponed until Thursday next.

WEIGHTS AND MEASURES (METRIC SYSTEM) BILL.

The following Committee was appointed in the House of Lords on Monday to consider this Government measure:—Lord Belhaven, Lord Colchester, Lord Wolverton, Lord Kelvin and Lord Farrar.

LONDON COUNTY COUNCIL AND LIABILITY FOR TRAMCAR ACCIDENTS.

In the House of Commons on Wednesday,

Mr. HORNER called the attention of the Local Government Board to the case of "Parker *v.* London County Council" (*The Electrician*, Feb. 26, p. 750).

Mr. GRANT LAWSON replied that there had been a misapprehension as to the effect of the decision in the case referred to. The decision was not that the County Council were not responsible for injuries caused to the public by their tramcars, but that proceedings respecting the injury must be commenced within six months. This was in accordance with sect. 1 of the Public Authorities Protection Act, 1893.

ELECTRICITY ON MEN-OF-WAR.

In the course of the debate upon the Naval Estimates in the House of Commons on Monday, Mr. LUCAS referred to the lack of electrical appliances upon many of the ships in the navy. Last summer he had visited some of these ships and there had been no telephone, and the only cooling appliance had been steam air pumps. He had also gone aboard an American battleship, the whole of which was supplied with electrical appliances which made it very cool and agreeable. Perhaps electricity was not largely adopted in the navy because it was thought to be dangerous, and he would like to know if any well-considered plan had been or might be introduced.

TELEPHONE DIRECTORIES.

Lord STANLEY, in a printed reply to Mr. Richards in the House of Commons on Wednesday, said that the charge of 10s. for the complete directory of subscribers to the National Telephone Co. was the price fixed by the company for the general supply of such directory, and the Postmaster-General had no power to call upon the company to supply copies for the use of the Post Office subscribers or the public at a cheaper rate.

THE "PARLYPHONE."

Several forms of this little house telephone are now being placed on the market by the Berliner Telephone Mfg. Co. Models A and B are adapted for ringing in one direction only and are the simplest possible type. Model A consists of bell push fitted with a socket and hook, and a hand set provided with a key in the handle and a short length of flexible wire terminating with a two-pin plug. No induction coil is employed, but the receiver is of the two-pole pattern. Model B is designed for use in the kitchen or service room and it is similar to model A with the exception that a circular terminal board with a hook is provided instead of a push, the connections being so made that when the instrument is on the hook the bell circuit is completed through the case of the instrument and the hook. The price of this set is very small, and both instruments may be fitted to any ordinary electric bell circuit in a few minutes.

Other patterns are made for ringing in both directions, and in Figs. 1 and 2 the instrument is shown in connection with a complete set. In Fig. 1 (model E) the bell is mounted on the lid of a walnut box, and the box contains a two-cell dry battery. By means of two springs fixed on the case of the battery, the proper connections are made by simply inserting the battery and closing the door. Model F (Fig. 2) is for use as a table set, and, in addition to the parts which may be seen in the illustration, there is a buzzer fixed within the wooden base. The show rooms of the Berliner Company contain many fine specimens of the telephone industry, and there are several instruments for use on tramways and in connection with high-tension transmission lines. Railway companies insist on having telephones built very strongly, as they are frequently subjected to rough usage, and the Berliner Company exhibit several types constructed in accordance with this idea.

FIG. 1.

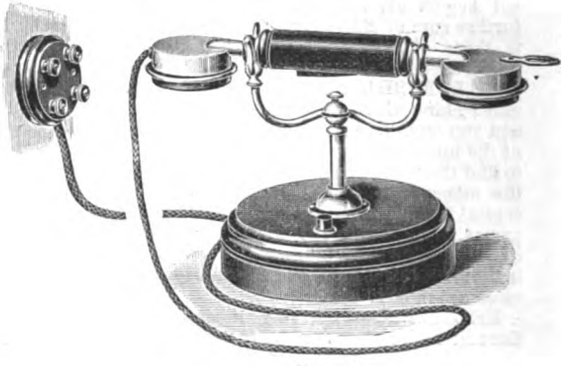

FIG. 2.

We have attached a pair of "Parlyphones" to one of the bell circuits in our office, and they work well, speech being clear and sufficiently loud.

Manchester Local Section Dinner.—The annual dinner of the Manchester Local Section of the Institution of Electrical Engineers was held on February 26th at the Grand Hotel, under the presidency of Mr. E. W. Cowan, chairman of the Local Section. After the loyal toasts had been honoured, Mr. T. L. Miller (President of the Liverpool Engineering Society) proposed "The Institution of Electrical Engineers," and coupled with it the names of Mr. R. Kaye Gray (the President) and Mr. E. W. Cowan. One of the best features of the work done by the Institution in recent years was the founding of the local sections, amongst which there was a healthy rivalry. The president had not been able to attend, but Mr. Cowan, in replying, said that the Manchester Local Section was not only thoroughly representative, but, with its large and growing membership, was worthy of the importance of the electrical industry in and about Manchester. They were living to-day in an age of high speed—not only in the methods of transport, but also in communication and in the methods of production. He hoped that trade would be better before long; in fact, he already saw signs of improvement. "Our Guests" was proposed by Dr. Bowman, and replied to by Mr. E. M. Lacey. In proposing "The Scientific and Technical Societies of Manchester," Prof. A. Schuster, F.R.S., said that all technical societies were scientific, but all scientific societies were not technical, and he therefore asked for a more distinctive comparison. Mr. A. Saxon (President of the Manchester Association of Engineers) replied.

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LEGAL INTELLIGENCE.

Metropolitan Electric Supply Co. (Ltd.) v. Marylebone Borough Council.

Mr. Justice Buckley, in the Chancery Division on Friday last, had before him a motion in which defendants asked for an extension of time to complete the purchase of the Marylebone portion of the plaintiffs' undertaking.

Mr. BUCKMASTER, K.C., recapitulated the circumstances familiar to our readers. He said the consent of the ratepayers had now been obtained for the presentation of a bill to Parliament, and the measure had passed the second reading. Under the order made by his lordship in August last, the Borough Council was held liable to pay £67,250 as the capital expenditure incurred by the company from the date of the recent arbitration, and were ordered to pay the company £60,000 and some other sums, and the company was also to receive interest at the rate of 4¾ per cent. on the balance. The Council had now handed over this £60,000, and had got nothing for it.

His LORDSHIP: Nothing for it! Why, you are the purchaser in default, and I do not see on what principle of common sense you should be relieved.

Mr. BUCKMASTER said the company got the whole of the profits of the undertaking until the purchase was completed. In order that the bill might receive Royal assent before a further application was made by the company, it was asked that time for completion might be extended till August 31, but plaintiffs wished to impose as a condition that a further sum of £27,500 in respect of capital expenditure should be paid to them. That was a difficult thing for the Council to do, and they would experience considerable trouble in raising the money.

His LORDSHIP: The position is that plaintiffs are in possession of an undertaking which is yours and not theirs. The horse is in the stable, and you must feed it. But for your default you ought to have possession of the undertaking, and I suppose the company say that they ought not to find the money for you—clearly you have to bear the onus of finding the money, for they do not wish to raise further share or debenture capital for the Council. I know that it is cruelly hard upon the ratepayers. The Council should have considered the matter when they began to think of getting statutory powers. Your position is that it is exceedingly uncomfortable to find the money, and you seek to put the discomfort on someone else.

Mr. BUCKMASTER said, if instead of borrowing the £60,000, the Council had levied a rate, there might have been no prospect of completing the contract.

His LORDSHIP: It does not come from you with much grace to say you cannot borrow. He suggested that defendants might, on paying so much in respect of capital expenditure each month, have an extension of time till August 31. He regarded a 20s. rate as hoplessly impossible and ruinous. Were the plaintiffs ratepayers in Marylebone?

Mr. BUCKMASTER: Yes.

His LORDSHIP: Then they may have great interest in opposing the bill.

Mr. CRIPPS (for the company): We only want provision to be made that as regards the money raised we shall be paid first.

Mr. BUCKMASTER said he preferred taking an extension till April 30, and suggested that £10,000 would be a reasonable payment for the Council to make.

Mr. CRIPPS said the company did not wish to do anything that would be oppressive, but there was over £25,000 due to them, and he asked for that sum. The company assumed that the bill would go through, and they wanted to deal with the matter on a business footing, and anything his lordship thought was right the company would assent to.

His LORDSHIP said he wished it was in his power judicially to discriminate between the ratepayers and the Borough Council. For the ratepayers, so far as it was proper for him to express sympathy at all, he had great sympathy. They found themselves saddled with an enormous obligation through no fault of their own, and, so far as it lay in his power to relieve them, he desired to do so. For the Borough Council he felt no sympathy at all. They were, no doubt, persons who, doing their best as they thought, but were minded to enter into an obligation the burden of which fell, not on them, but upon others. Judicially he could only consider the borough governed by the Council, but paying through the ratepayers. The point he had to determine was a very commonplace one, as between the borough and the vendors—the company—as to what were fair terms upon which he was to allow the purchasers, not to perform the present obligation, but to have time given them in order that they might meet the obligations which they could not at present discharge. The first judgment named December as the date at which the completion of the contract should be carried out. But the borough was not in a position to complete, and on Dec. 11 an application was made to him for an extension of time. He gave the extension until Feb. 29 on certain terms. There was a sum due to the company of £67,250, and further sums which were not exactly ascertained in respect of capital expenditure. The term he imposed was that £60,000 out of the £67,000 should be paid within a certain time, and the time for completion should be extended until Feb. 29. The borough had taken steps in the hope and expectation of putting it in a position to borrow money which it had not got in order to complete the purchase, and they introduced a bill into Parliament, and sufficient time was necessary in order to carry that bill to a successful or unsuccessful issue. Everybody hoped that it might be successful. Failing that, they had not got the money, and they asked for a further extension of time until Aug. 31. Their counsel had modified that by asking him to simply extend it until April 30. His lordship had suggested that it would be a useful form of order to grant an extension until April, and that there should be provision that in the event of the payment of certain sums before April 30 then there might be a further extension until May 31, and so on, month by month, until August arrived, the intention of the form of order being that such a sum should be named as a price of further extension so that the purchasers might keep the vendors out of cash advances. However, the defendants' counsel preferred not to take an order in that form. His lordship thought there ought to be an extension because it was nobody's interest that the matter should be brought to a stop before the purchasers were able to pay. The question was, What were the fair terms on which the extension might be granted? The general principle on which he was going to proceed was that there was an undertaking in respect of which further capital expenditure was necessary under the orders of Aug. 7 and Dec. 11, when provision was made for completion in the district of a conversion from high tension to low tension. That was going on and it would go on; more remained to be done and money must be found for doing it. Therefore, there was further capital expenditure necessary for this purpose, besides which new connections must be made. The position was that the vendors, through no fault of their own, but wholly through the default of the purchasers, were left in control of an undertaking which in equity was no longer theirs, but the purchasers and the vendors were bound to go on spending money. The purchasers said it was exceedingly inconvenient to them to find the money, and threw it on the vendors. The further moneys which were wanted ought to borne by the purchasers, through whose default the contract of purchase was not completed, and the fair principle to apply was that the purchasers and not the vendors should find the further cash which was wanted in order to do that which was necessary to keep alive the undertaking which the purchasers had agreed to buy. The question, therefore, was what figure he was to allow the vendors. He was desirous not to press hard on the ratepayers, who were the unfortunate victims in this matter, and he wished to name as low a figure as possible He would name a figure, but if the plaintiffs would name a lower figure and would accept it, it must be taken to be a great concession by them. If a further application was made to extend time in April he should regard it on the same principle as he was regarding the matter now, and if the defendants wanted further time they must find the current expenditure, so as to keep the plaintiffs out of cash advances, and he should not expect to hear that there was anything oppressive on the part of the plaintiffs in saying that if defendants wanted further extension they must find some money. Now, there was £27,904 claimed by the plaintiffs as capital expenditure. Defendants said that sum was not vouched at present. Then he had to add the March and April sums, and the capital expenditure account would then amount to, roughly, £33,000. The sum which he named, which ought to be fixed as a condition of the extension being granted, was £20,000, but he would invite the plaintiffs to say whether they would not accept £15,000.

Mr. CRIPPS said his clients would certainly accept £15,000.

His LORDSHIP: I am very glad to hear it. It is very good of your clients to assent to my suggestion. I think the ratepayers are much to be pitied. I will, therefore, extend the time until April 30, imposing as a term that the defendants pay to the plaintiffs on or before March 31 £15,000. Order accordingly.

Marshall v. Lock.

In the King's Bench Division last Thursday and Friday Mr. Justice Darling and a jury heard an action brought to recover £70 premium and other moneys paid by Mr. A. W. Marshall to defendant, Mr. J. H. Lock, for binding plaintiff's son as apprentice.

Mr. SAUNDERS, for plaintiff, detailed the grounds on which the action was brought. He alleged that defendant had fraudulently held himself out, and by verbal and written mis-statements had represented himself to be capable of taking plaintiff's son as an apprentice, when, in fact, he was not in a position to do so. In August, 1902, plaintiff saw and answered the following advertisement:—

"Electrical Engineering and Motor and General Engineers.—Well-known London works have a vacancy for pupil; hours, 9 till 6; wages, 10s. weekly after one year's training. Permanency. Premium, 35gs. Address, Box B., Taylor's, 154, Fleet-street, E.C."

In reply, plaintiff received a typewritten letter with printed heading, "Bouverie-street Engineering Works, Mechanical and Electrical Engineers; J. H. Lock, Engineer, established 1886; Makers of Steam, Gas and Oil Engines, Dynamos, Motors, &c. J. H. Lock's Exhibits at various Industrial Exhibitions have received high commendation and praise." This letter contained a number of unsigned testimonials and reprints from newspapers. Plaintiff had an interview with defendant, who told him he carried on a large business, and alleged that after a year's training plaintiff's son would be able to command a good position. He also said he was so full of orders that he had difficulty in executing them. A premium of 40 guineas was arranged, and plaintiff paid a further £40, which defendant was to return in pocket money to plaintiff's son. Plaintiff's son no sooner arrived at "the works" than he came to the conclusion that the whole thing was a swindle. There was no qualified man at the works except defendant. Plaintiff's son remained for three months, and was then appointed head of the drawing department, but junior pupils refused to obey his orders. Trouble resulted, and plaintiff's son left. £12 of the pocket money had been paid.

The jury at this stage inspected defendant's premises.

Plaintiff's son said at Bouverie-street the works were in a house of five floors. There were three or four lathes, a planer and a driller in the shop, but they were very seldom in use. There was no electrical engineering plant there at all. There were four or five other apprentices, but they

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came in so quickly afterwards that there was hardly room for them. There was no drawing to do, and none was done except what witness gave the pupils to do for exercise. Having nothing to do he amused himself putting in windows. He was not taught anything; there was nobody to teach him. Defendant only came into the place twice a week and stayed a few minutes. There was one man there who might be called an engineer, but for the best part of the time he smoked. There was also a blacksmith who used to make pieces of iron hot for the pupils to hammer at. They also used to take a marine engine to pieces and put it together again.

HARRY EDWARDS said he saw defendant's advertisement, and paid a premium of £25. He was first put into an office, where the foreman was smoking all day. This foreman was a Greek named Johnson. The only order he knew of during the 14 months he was there was a hoop brought by a little boy to be mended.

HUBERT MATTHISON, who paid a premium of 25 guineas, said he had never seen any orders executed while he was at defendant's works.

Mr. BRAY, for the defence, denied the alleged misrepresentations with regard to orders. There were no orders. It was not a works in the ordinary meaning of the word; it was a practical school of engineering, and the most practical that anyone could possibly send a lad to. Defendant was an engineer of large technical and professional experience. He took no orders, but gave practical instruction to all his pupils, and they all did practical work.

DEFENDANT said he had 27 years' experience as an engineer. He was apprenticed at the North London Railway locomotive works, and paid a premium of 150 guineas. He then worked in the Lancashire depot of the London and North-Western Railway Co., and afterwards for a large firm of Government contractors. He left that to become superintendent of the Crystal Palace Co.'s school of engineering, and resigned when he took out a patent for a boiler he had invented. When he started his present business he took in general work, but thinking it would be more beneficial to his pupils if he taught them the construction of engines from start to finish he ceased to accept orders. Twelve months ago he took over the whole five floors of his present premises and had constructed about £400 worth of compound engines. Since young Marshall came to him he had built two large compound engines, four smaller ones, two dynamos and an electrical motor. The pupils were employed making engines, one of which was then in the court. He had, of course, to teach these young men by degrees. It was necessary first of all to teach them drawing and how to use their tools. He had £1,500 worth of plant and everything necessary for the making of motor engines. The pupil would have the option either of going into the drawing office or one of the workshops. Plaintiff's son was an excellent draughtsman, but was idle, and the moment he was given work to do he went on strike. Witness was consulting engineer to a mining company at a salary of £500. He employed a paid staff of eight men and now had about 30 pupils. He had trained 300 apprentices, who had gone into situations and were doing well. He had received £10.000 in fees from pupils, and had never before had a complaint. He received 150 answers a week to his advertisement, which had been running for 10 years. His works had a floor space of 8,000 sq. ft.

S. L. STERN, a pupil, said he joined in December, 1902, paying a premium of 100 guineas for three years' training. He was satisfied that he was getting good value.

A. HUKINS said he paid 50 guineas for two years' instruction. He had been for 10 years in two of the largest engineering works in the United States, and had never seen a shop in which there were more facilities for learning than in defendant's.

Other pupils having given similar evidence,

The jury found for plaintiff for the amount claimed, and judgment was entered accordingly, with costs.

Mr. BRAY asked for a stay of execution on the ground that the verdict was against the weight of evidence. This was granted on the usual terms.

Alleged Carelessness in Shot Firing.

At Derby Assizes on Tuesday a colliery deputy named Stevenson, of Ilkeston, was indicted for manslaughter. Stevenson was employed at West Hallam Colliery, Ilkeston, and his chief duty was to superintend shot-firing in the mine by electric current. The caps to the charges of powder are attached to the end of an electric cable, and the duty of the deputy is to give warning when he is about to switch on the electric current. On Jan. 13 Stevenson was shot-firing, and during the proceedings one detonator cap missed fire. It was the duty of the man at the firing point to report to the deputy in the case of miss-fire, and for the latter to remove the shot from the mine and have it destroyed above ground. Stevenson was present at the miss-fire, so that a report to him of the incident was unnecessary. He, in fact, it was alleged, gave the cap to one of the colliers named Bowley, who fastened it up in his powder-tin, a distinct breach of the rules. Later in the day while shot-firing was still going on, Stevenson was said to have given Bowley two detonators, receiving back the faulty detonator. Bowley called attention to the fact that this had not been "trapped," and Stevenson went back from the heading to the battery to test the supposed bad detonator. He first took a short piece of loose cable, attached to one end the cap and to the other end the battery terminals. At this time the long cable used in shot-firing was lying close by, unattached to the battery, but with a cap at the further end, the firing point was already in position, and the men engaged in the work were waiting for Stevenson's shout of warning that he was about to fire that shot. Instead of going on with the shot-firing, however, Stevenson was intent on testing the supposed bad cap. Without giving any shout of warning, such being thought by him unnecessary, as the cap was at the end of a short piece of cable only a few yards away, and not in contact with any charge, he completed the circuit and immediately followed a double explosion. Not only did the supposed bad detonator at the end of the short piece of cable go off, but, by some means or other, the cap also at the end of the long cable, not attached to the battery. That cap was in contact with a charge, and the result was that Bowley was blown to pieces.

The question put to the jury was whether Stevenson had been guilty of criminal carelessness or negligence, and the technical point was submitted as to how the second shot at the end of the long cable came to be fired "in sympathy" with the other miss-fire shot. Several theories were given by witnesses on this point. One was that the short cable attached to the battery might have been in contact with the long cable, not in such a way as to cause a short circuit, but in such a way that the current would pass along the whole extent of both cables and so explode both caps. Another theory was the induction of a current in the long cable without actual contact. A third that the ends of the loose strands of the long cable, lying near the battery, had accidentally come into contact with the battery terminals at the moment Stevenson turned on the current. A fourth that leakage from the battery, and the electrification of the long cable by the consequent earth currents, caused the explosion.

For the defence Mr. de Grave, M.I.M.E., A.I.E.E., was called and suggested that the second cap, the cap attached to the long cable and in contact with the blasting charge, was not fired by any act of Stevenson's, but by some accident at or near the firing point. His theory was that the long cable had been caught by the foot of one of the men at the firing-point, so jerking the cap; or that the cable had been caught by a truck which one of the men was moving.

Eventually the jury stopped the case and returned a verdict of not guilty, at the same time expressing the view that carelessness had been shown.

Re Automatic Telephone Co. (1903), Ltd.

On Tuesday Mr. Justice Byrne heard the petition of H. Le Blanc Smith and others for winding up this company.

Mr. H. TERRELL, K.C., said petitioners were holders of 11,000 fully paid shares, and were supported by holders of 118,000 fully paid shares. They were opposed only by Mr. Max Margowski, the managing director, who, with members of his family, were supposed to hold 191,000 shares. Prior to 1897 there was a company called the Apostoloff Automatic Co., which was formed by Mr. Margowski to acquire some telephonic patents. Mr. Margowski promoted the Automatic Telephone Co. in 1897. There were two directors, Mr. Margowski and Dr. Sworn. These gentlemen possessed extraordinary powers. The company failed, and was reconstructed into the present company. When the 1897 concern was going into liquidation Mr. Margowski informed the shareholders that he could not produce the articles of association of their proposed new company as they were before counsel, but he assured the meeting that the objectionable clauses, giving him such full powers, had been eliminated as well as the preference to the preference shareholders. The shareholders never saw the articles until after the company was formed in January, 1903. It was then found that there were to be 4,000 preference and 400,000 ordinary shares, and the preference shareholders were to have five votes each, compared with one vote for each ordinary shareholder holding 100 shares. The whole of the preference shares were to be issued to Mr. Margowski, and so he secured control of the whole thing. The company had certain patents, which were taken out in the name of the company, and then Mr. Margowski made a claim against the company, the result of which was that the moneys of the company were handed over to Mr. Margowski in settlement of his claim. He took premises at Greenwich, which he called the offices of the company. There was a meeting called for winding up, but no notice of it was sent to the shareholders, though it was advertised in two daily newspapers. Fortunately, the shareholders saw the advertisement, and went down to Greenwich, where they found some works and stables, with a loft above, and here a crowded meeting was held. They asked Mr. Margowski for accounts. He replied that there were none, and that all they had to do was to pass the resolutions. These were said to be carried. A poll was demanded and taken, as the result of which Mr. Margowski declared the resolution to be carried, and walked out of the place. The urgency for a winding-up now was that the whole foundation of the company had gone.

Mr. EVE, K.C., who said he was perfectly ready to meet the charge of fraud made against Mr. Margowski, asked for an adjournment.

This was agreed to, and the petition ordered to stand over for a week.

Overcrowded Tramcars.

Lieut.-Col. H. D. Sickel recently refused to pay a penny fare on a Bradford Corporation tramcar as a protest against the Council overcrowding. The gallant Colonel appeared in the Police Court, Bradford, on Monday in answer to a summons and in support of cross-summonses against the conductor for failing to warn passengers that the car was full, and against the Corporation for failing to exhibit a notice stating the number of passengers the car was licensed to carry.

Mr. WARDLE (for the Corporation) said a notice on the cars contained an instruction to the conductor to permit 10 persons to stand inside.

Mr. NEILL argued that the instruction was contrary to the bye-laws, and that the committee had no power to enforce a resolution giving such instruction unless it were embodied in the bye-laws which were approved by the Board of Trade.

The stipendiary magistrate decided to convict, but adjourned the case until he had heard the cross-summonses.

Seven tramcar conductors appeared at Bristol last week in answer to charges of permitting overcrowding of the Bristol Tramways and Carriage Co.'s cars.

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Mr. WANSBROUGH, for defendants, said in most of the cases a few passengers were standing inside the cars on account of the wet weather, while only a few persons occupied the outside. The average number of passengers carried during the year was only 6¼ per car-mile.

The Bench imposed fines varying from 5s. to 40s., with costs in each case.

Govier v. Blackburn.

At Cardiff County Court on Wednesday Mr. W. H. Govier, electrical engineer, sued Mr. Walter Blackburn for £19. 10s. 4d. for electric lighting and work done in connection with the grocers' and bakers' exhibition held in Cardiff last year. Defendant was manager of and plaintiff was electrical engineer to the exhibition. The claim included £16. 2s. 10d. paid to Cardiff Corporation for electric current supplied. Judgment for plaintiff for £9. 8s. 6d.

MARYLEBONE ELECTRIC LIGHTING.

At the ordinary meeting of the Marylebone Borough Council last evening the Finance committee brought forward their estimates in relation to the rate to be made for the half-year ended Sept. 30, 1904, but no provision was made for any portion of the payments already made or in prospect under the electric lighting scheme. These were included in the amount for which the Council is seeking borrowing powers under the bill now before Parliament, and which, if the bill becomes law, will be chargeable to capital account. The amount of such payments up to date is approximately £127,504. Of this amount about £29,000 has still to be provided. The Council can deal with this by a further arrangement with the bank for overdraft, and this it is anticipated the bank will arrange. Mr. Justice Buckley (the committee's report states) distinctly contemplated such an arrangement in his judgment delivered on Feb. 26.

Dr. LEAF moved that the estimates be passed, and this was agreed to without discussion.

With regard to loans for electric lighting, the Finance Committee reported as follows:—

We have been in communication with the London County Council with regard to the financial arrangements necessary in the event of the passing of the Borough Council's bill. It is desirable that we should lay before the County Council at the earliest possible date a formal request for an advance of the loans authorised by the bill, subject to sanction. This will enable the County Council to insert the amount in their money bill, if thought desirable, and will materially modify any opposition on their part to certain clauses in the bill. We have therefore resolved to make formal application to the County Council to advance us, immediately upon the passing of the bill, the amounts authorised in it, or so much of them as may be required within the year. We are, of course, not bound to take up the loan, even if promised, so that any negotiations, whether with the Metropolitan Electric Supply Co. or any other company, will in no way be prejudiced.

The committee's recommendation that the Council approve their action in the matter was agreed to without discussion.

Councillor E. White's motion for a return showing the total costs incurred by the Council to date in connection with the purchase of the Marylebone electric lighting undertaking was then agreed to in slightly amended form.

A further motion by Councillor White, "That the engagement of Mr. Arthur Wright, the electrical expert, be determined, and that the necessary notice be given him terminating his engagement," was, in Mr. White's absence, formally moved by Ald. Anglim and seconded by Councillor Dunn. There was no discussion, and the motion was lost, "practically unanimously!"

An urgent motion was then brought forward by Councillor E. R DEBENHAM—

That a special committee of the full Council be appointed to consider the St. Marylebone Electric Lighting Bill, 1904, and several suggested amendments thereto, and that such special committee's report be referred to the Electric Supply committee to consider, in conference with the Council's Parliamentary agents with a view to the full report to the Council thereon.

This was agreed to after a short discussion, and the meeting of the Council in committee was fixed for Thursday, March 10.

A further urgent motion by Councillor DEBENHAM was then considered—

That the Council authorise and sanction a petition to be presented to Parliament for the amendment of the Marylebone Electric Lighting Order, 1904, by the insertion of an enabling clause empowering the Council, if desirable, to lease the electric lighting undertaking to an electrical company, or to enter into an agreement with a company for the working thereof.

This was agreed to after a short discussion, as was also a recommendation of the Electric Supply committee that the Town Clerk be empowered to take steps to promote the Council's bill as the Electric Supply committee may deem necessary, and that the Committee be authorised to act in all matters for and on behalf of the Council during the progress of the bill through Parliament, and report regularly to the Council on any action taken.

The following is the full text of the clause proposed to be inserted in the bill on petition:—

1. The Council may enter into agreements with any company with respect to the following purposes or any of them (that is to say):—

(*a*) The execution, maintenance and management of any works needed for the purpose of the electric lighting undertaking of the Council or of any part thereof.

(*b*) The supply and maintenance by the working company under and during the continuance of any such agreement as aforesaid of such mains and plant, and the maintenance and alteration of such existing mains and plant, and the employment of such officers and servants as may be necessary for the working of the electric lighting undertaking of the Council.

(*c*) The performance and execution by the working company under and during the continuance of any such agreement as aforesaid of the duties, obligations and powers of the Council under the Act and order of 1901, the order of 1889 and this Act.

(*d*) The fixing subject to the authorised maximum rates and the collecting and apportionment of the rates, charges and revenues taken or arising in respect of the electric lighting undertaking of the Council.

2. Any such agreement may provide for the supply of plant or the execution of the works by the working company at a price to be fixed by or in pursuance of the agreement, or at the actual cost, together with an agreed percentage by way of profit, or for the purchase by the Council at the determination of the agreement of additional works or plant or the taking at the determination of the agreement of any of the working company's officers and servants into the employment of the Council or for the payment by the working company to the Council of a fixed or contingent rent in consideration of the receipt by the working company of the revenue or part of the revenue of the electricity undertaking of the Council and generally may specify the conditions and obligations to be observed and performed by the contracting parties respectively during the continuance or upon the determination of the agreement.

3.—No such agreement shall be made for a longer period than ten years without the consent of the Board of Trade.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Municipal Commissioners of Singapore (Straits Settlements) require an electrical engineer, with experience in the management of three-wire continuous-current supply station, and qualified to superintend the laying and maintenance of underground cables on the solid system and to take entire charge of their electrical department. The appointment will be made for three years, at £360 for first, £390 for second and £420 for third year, with transport allowance. Further particulars are given in an advertisement. Applications to Mr. C. C. Lindsay, M.Inst.C.E., 217, West George-street, Glasgow, by April 19.

The Council of the University of Liverpool invite applications for the Chair of Physical Chemistry. The emoluments are derived from a fixed salary and a share of fees, the total guaranteed to be not less than £600 a year. Further particulars from the registrar, to whom applications by April 1. See also advertisement.

A draughtsman is required to take charge of drawing office in the Birmingham Corporation electric supply department. Salary £150 per annum. Applications to Mr. R. A. Chattock, Corporation electricity offices, 14, Dale-end, Birmingham, by March 12. See advertisement.

The Council of the University of Birmingham require an assistant lecturer and demonstrator in electrical engineering. Applications to secretary (Mr. Geo. H. Morley) by March 28. Salary £150 per annum. See advertisement.

An assistant professor of technical electricity and applied mechanics is wanted by the Admiralty for the gunnery and torpedo schools, Portsmouth, for a period not exceeding five years. Salary £250 per annum. Applications to the Secretary, Admiralty (C). See also advertisement.

The Council of the Institution of Electrical Engineers desire to receive applications for the position of secretary vacant by the death of Mr. W. G. McMillan. Commencing salary £500 per annum. Applications to chairman of the Secretaryship committee, Institution of Electrical Engineers, 92, Victoria-street, Westminster, London, S.W., by March 7.

Bridlington Corporation require a clerk of works for their electricity supply scheme. Salary £4 per week. Applications to town clerk (Mr. A. E. Matthewman) by noon March 8.

Manchester Tramways committee require a superintendent of their parcels department. Applications by March 12.

A medical officer is required to take charge of the electrical department of Westminster Hospital. Applications to the secretary by March 9.

Mr. Taylor, who was recently selected for the position of mains superintendent by the Wimbledon electricity department, has declined the appointment, and Mr. Reginald W. Klitz, of the London Electric Supply Corp., has been appointed.

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Mr. H. L. Brook has been appointed mains superintendent and Mr. E. Ralph power-house superintendent at the Ocker Hill station of the Midland Electric Corporation for Power Distribution.

Mr. G. L. Drury, engineer-in charge at the Ringsend power station, Dublin, has accepted an appointment in the electrical department of the North-Eastern Railway Co.

Mr. G. E. Clarke has been appointed borough surveyor and electrical engineer at Boston.

EDUCATIONAL NOTICE

Technological Scholarships.—West Riding County Council offer four technological scholarships (each of the value of £60) open to residents within the administrative area of the West Riding of Yorkshire and available for courses of instruction in connection with engineering (mechanical or electrical), metallurgy, textiles, dyeing or other approved industry. The scholarships are intended for young artisans who already possess suitable mill or workshop experience. Further particulars are given in an advertisement, and application forms, &c., may be obtained from the Director, Education department, County Hall, Wakefield.

Acton.—The Metropolitan Electric Supply Co., who have entered into an arrangement with the Council for the supply of electricity in bulk, recently asked the Board of Trade to postpone decision upon their application for a provisional order until the assent of the Board of Trade and the Local Government Board had been obtained to the proposed agreement. The Board have refused to adopt this course.

Admiralty Premium Scheme.—Notice is given by the Admiralty that on March 14 the premium scheme of payment for labour will be introduced. This is to be a trial of the system, and will at first be applied to certain classes of machine work only. If satisfactory results are obtained, the system may be extended. It is intended by the introduction of this systen to enable workmen to earn, in addition to their ordinary weekly wages, extra remuneration for work done in less time than that allowed for it when given out. The value of a "premium hour" is to be considered to be $\frac{1}{48}$th of the workman's weekly wages, and the premium earned on any particular job will bear approximately this relation to the workman's weekly wage. The time taken will be recorded to the nearest quarter of an hour, and will be calculated from the time of commencement of a job up to the time of commencing the next job. For overtime calculations and night and day shifts premium hours will only count as ordinary hours, overtime being paid at the same rates as at present. Lost time or absence without leave counts in the time taken to complete the job, whereas absence with leave will not be so included. Premiums will be paid weekly. Apprentices are not for the present to be employed on premium work. An exhaustive explanation of the principle of the premium system has been issued, and will be conspicuously displayed in Admiralty yards throughout the country.

Ashton.—The Lancashire Electric Power Co. have been requested to submit particulars as to terms for supply of electricity in bulk.

Berlin Electric Railway.—It has been decided to extend this line as far as the Grünewald. Special steps are to be taken to prevent panic or similar catastrophe in the underground tunnels of the Berlin electric line. Each carriage of a train is to be provided with a fire hose, and recesses are to be made in the tunnels where fire extinguishing apparatus is to be kept, such places to be indicated by coloured lamps. In addition emergency exists are to be provided between the stopping places in the tunnels.

Bermondsey (London).—The Thames Conservators have approved the plan for laying electric cables in the river bed across Lavender Dock entrance of the Surrey Commercial Docks at Rotherhithe.

Bradford.—The Corporation are recommended to purchase the Shipley section of the Mid-Yorkshire tramways.

Brazil.—In the budget of national expenditure for 1904 the Government is authorised to construct new telegraph lines.

Bristol.—Various extensions of the electric lighting mains, including Bedminster district, have been authorised by the Electrical committee.

Broughty Ferry (N.B.)—The electric lighting mains are to be extended.

Chorley.—The Council are in negotiation with Mr. Oswin Hanson, managing director of the Fleetwood and District Electric Lighting Co., in regard to taking a transfer of the Chorley provisional order, 1898.

Code Vocabularies.—Mr. J. C. Lamb, C.B., C.M.G., Second Secretary of the Post Office, writes us directing the special attention of code vocabulary compilers to the importance of utilising in a spirit of moderation the important concessions made by the recent International Telegraph Convention held in London in June last on the subject of code vocabularies. On the representations of the British delegates, and in spite of a feeling in favour of the decision which was come to at Paris in 1890, and was subsequently re-adopted in modified form at Budapest in 1896, the arguments adduced in support of the admission of artificial combinations of words on the same footing as real words, was, in a spirit of liberality towards the public, accepted by the London Conference, and pronounceability was made the criterion of admission into the accepted vocabularies. Mr. Lamb further points out that the Postmaster-General has not had the opportunity, nor would it be practicable, for the code vocabularies which are being prepared to be submitted and examined by the Post Office authorities, and it is therefore urged upon compilers to regard the concessions made as a great step in advance, and to make the words selected in the vocabularies as simple for telegraphic purposes as possible.

In this connection we may point out here that the International Telegraph Convention, and the newly-revised Service Regulations in the complete original French, and with full English translation, will be ready next week,* and will contain full particulars of the conditions regulating the use of code language and cipher in international telegraphy. These new regulations come into force universally on July 1 next.

Cuba.—Increased duties on imported goods have recently been ordered, and these include a 30 per cent. increase on electric insulators, the former rate of duty being $1 per 100 kilos.

Darwen.—An inquiry has been held into the application of the Council for power to borrow £6,500 for electric lighting extensions. £666 of the sum is for excess expenditure on previous work, and £3,129 for extensions of mains.

Dorking.—Electric lighting mains are to be laid in additional thoroughfares by Edmundson's Electricity Corp., and a supplementary loan of £2,177. 9s. 7d. is to be applied for.

Ealing.—The output of the Corporation electricity works for the nine months to Dec. 31 was 684,000 units, an increase of 17 per cent. over the corresponding period of 1902. The revenue was £14,172, increase £1,878. In spite of increased rates and taxes and some abnormal expenditure a substantial profit was made on the nine months' working. On the recommendation of the borough electrical engineer (Mr. J. Douglas Knight) the Corporation recently decided to put down additional plant to meet next winter's load, and tenders have been obtained for a new 750kw. set, estimated to cost, with foundations, condenser, piping, switchboard, &c., about £10,000.

East Ham.—The electrical engineer (Mr. W. C. Ullmann) has been instructed to prepare a specification for wiring the Technical College. The cost is estimated at between £500 and £600.

Eccles.—The Council have instructed the switchboard attendants to utilise their spare time in canvassing for new customers for the electric light. They are to be paid 2d. for each 8 c.p. lamp order obtained.

Egypt.—An interesting report on the trade of Alexandria for 1902 has just been presented, in which the imports into Egpyt (via the port of Alexandria) are epitomised. The value of telegraphic, telephonic and other electrical apparatus imported during 1902 was £52,019, or 30 per cent. in excess of the average for the previous four years. The United Kingdom's share of these imports was 21 per cent. in 1898, 54 per cent. in 1901 and 52 per cent. in 1902. It is stated that many of the specifications for Egyptian Government tenders are based upon English patterns, which renders it easier for British contractors to compete.

Electric Lighting of the Pyx Chapel.—The First Commissioner of Works has decided to light the Pyx Chapel, Westminster Abbey, electrically.

Exhibitions.—An electrical exhibition, organised by Hornsey electricity department, is being held at Christchurch Rooms, Edison-road, Crouch End-hill, N. The exhibition was opened on Tuesday, and remains open until to-morrow (Saturday). At the stall of the electrical department a variety of fittings and apparatus (including lamps, motors, cooking and heating apparatus, telephones, &c., is exhibited. A number of local firms also make interesting exhibits.

A Motor Car Exhibition will be opened at the Agricultural Hall on March 19. This is the ninth of a series, and promises to be well supported.

Exeter.—Mr. J. E. Waller will act as joint engineer for the Corporation tramway scheme with the city electrical engineer (Mr. H. D. Munro) and the city surveyor (Mr. T. Moulding), at a remuneration of 2½ per cent. on the amount expended.

Fatal Accident.—A colliery labourer named Hoyle was killed on Friday last whilst at work in the Lidgett Colliery. It appears that deceased was engaged laying steel rails, when, in some manner, the electric current was switched on, and the shock threw him

* "The International Telegraph (and Telephone) Convention and Service Regulations." (London: "The Electrician" Printing and Publishing Co., Salisbury-court, Fleet-street.) 6s. net.

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down with his face in a quantity of water. A fellow workman switched off the current, but life was then found to be extinct.

On Monday an inquest was held at Elsecar. The medical evidence was to the effect that deceased met his death from an electric shock, and a verdict in accordance with this evidence was returned.

Fire.—We are informed that a fire occurred behind the Trafford Park power station switchboard at 7 o'clock on Friday morning last owing to an overheated cable end dropping out of its socket and going to earth on the iron framework. Considerable sparking ensued, and the rubber cables in the vicinity and the wooden platform were burnt up before the flames could be got under. A booster was short-circuited, and as the connecting leads to the other booster were burnt up, the machines had to be shut down for an hour or so, and later on supply at 500 volts only between outers was substituted for the usual 250 volts on either side for part of the day.

Floating Coal Depot.—A new floating coal depot for Portsmouth Harbour was launched at Wallsend-on-Tyne on Saturday. The storage capacity is 12,000 tons. The new depot will permit of coaling a man-of-war afloat at the rate of 500 tons an hour. The transporters are operated electrically.

Floating Exhibition.—Such of our readers as may be interested in the "Imperial Floating Exhibition" which is being organised by Mr. John Henderson, Tudor-street, London, E.C., can obtain a pamphlet illustrating and descriptive of the ports of call to be made when all arrangements are completed. A feature of the enterprise is that only one firm is to be selected as representative of any one particular branch of industry where this is possible. The steamer which is to be chartered for this venture is, we understand, the "Lake Megantic," 5,500 tons, which has been for some time on North American service. She is to sail some time in May.

Fulham (London).—The Council have deputed the chairman of the Electric Light committee to accompany the borough electrical engineer (Mr. A. J. Fuller) to inspect a number of stations in the midlands and north of England to obtain information as to turbine plant. On Wednesday Mr. Fuller was authorised to lay additional cables at £202. 10s., and to erect (as an experiment) six incandescent or Nernst lamps. The gas lamps in Avenue-road are to be substituted by arc lamps at a cost of £190.

Glasgow.—The Corporation have excluded the Bearsden and Milngavie Tramways and the proposed extension into Dumbartonshire from their provisional order.

Gloucester.—123 arc lamps are to be erected along the tramway routes.

Huddersfield.—The accounts of the electricity department for the year 1903 show total receipts £24,795. 17s. 4d. (£12,686. 2s. 6d. for June and £12,109. 14s. 10d. for December half-years).

Total expenses of generation were £7,758. 8s. 1d:, and cost of distribution was £935. 6s. 9d. Cost of maintenance of public lamps was £122. 1s. 11d., rent, rates and taxes £1,145. 10s. 3d., management expenses £1,400. 9s. 10d. Bad debts are put at £55. 15s. 6d., leaving a balance of £13,378. 5s. Interest was £4,999. 4s. 8d., and sinking fund instalment £4,783. 1s. 3d., leaving a net balance of £3,915. 1s. 11d. (compared with £2,945. 12s. 1d. in the previous year). This has been transferred to depreciation and contingencies account, increasing this to £11,853. 11s. 7d. The total capital outlay is £173,507. 11s. 3d., an increase of £8,910. 15s. 8d. for the year. There are 1,888 consumers, representing an equivalent of 132,582 8 c.p. lamps connected, 1,559,960 units of current were sold. The per centage of gross profit was 7·8.

Hull.—The contribution by the tramways department in relief of rates was discussed at the last Council meeting, when the chairman of the Tramways committee (Ald. Larard) defended their action in reducing their contribution from £14,500 to £11,500.

During the five years the electric tramways had been running, he said, they had paid out of revenue £37,183 for interest and £33,740 for sinking fund, and had contributed £62,000 towards the rates. It was necessary to have substantial reserves. The traffic receipts had been continually increasing (this year the increase was £9,000), the expenditure had also largely increased, and there had been a decrease in net revenue.

Islington (London).—The special committee recently appointed by the Council to consider the wages, overtime, &c., at the electricity works, have isssued their report:—

The men asserted that the Council, by their resolutions passed in August last, had departed from the standing order as to trade union rates of wages, and implied that the spirit, if not the letter, of the standing order had been infringed by the abolition of "dirty money," &c. The committee find that the Council, by taking the action they did, were mainly actuated by a desire to do away with the abuse of overtime, and that, in altering the conditions upon which up till then the men had been engaged, they were giving the men more than an equivalent in the shape of a weekly engagement and other advantages. The committee are, however, satisfied that, by some inadvertence, the rate of pay for carpenters and bricklayers was fixed at a halfpenny per hour less than the proper rate of wages, and were also of opinion that the "dirty money" and overalls should be restored. They therefore recommend:—

(1) That the resolutions of Aug. 7, 1903, so far as they relate to the payment of "dirty money," the supply of overalls, and to wages, hours and conditions of labour of carpenters, bricklayers and labourers engaged at the electricity station be rescinded. (2) That one hour per day be allowed to men employed in cleaning flues, boilers, heaters, &c., when working out of daylight and in a cramped position. (3) That one suit of overalls and one additional pair of trousers be allowed annually to men continuously employed as above. (4) That carpenters and bricklayers in the electric lighting department be engaged at the rates of pay agreed to by the employers' associations and trades unions or as in practice obtain, and that the hours be 52½ hours, as is now the case, which hours, the committee were informed, have been agreed to by the trades unions concerned.

Various extensions of the mains, &c., are recommended by the Lighting committee, estimated to cost £828.

Keighley.—The Council discussed on Friday last a report recommending the extension and conversion of the present tramway system to electric traction on the overhead system at a total cost of £42,790. It was decided to construct and electrify a portion of the system only at present. Application for a loan has been made.

Lancashire Tramways Bill.—Lancashire County Council have decided to petition against the following bills in order to obtain protective clauses:—Preston and Blackburn Tramways, Preston and Lytham Tramways and Tramroad, Barrow-in-Furness Corporation, Radcliffe and Stretford District Councils, Preston, Chorley and Harwich Tramways, Trafford Park Dock Works and Tramroads and Manchester Corporation Tramways.

Leeds.—The Council have adopted the Lighting committee's proposal to substitute electric for gas lighting on all tramway routes within 1 mile radius from the junction of Boar-lane and Briggate, the lamps to be affixed to the tramway poles. In future the price for current for street lighting will be 1¼d. per unit instead of 1½d.

The Tramways committee are proceeding with the construction of the whole of the Hyde Park-road and Belle Vue-road tramways.

Light Railway.—The Leek, Caldon Low, and Hartington Light Railway (extension of time, &c.) Order has been submitted to the Board of Trade for confirmation. Objections by 26th inst.

Lincoln.—An inquiry has been held here into the application of the Council to borrow £11,500 for additions to the generating plant at the electricity works for current for the projected tramways, and also for extensions of the electric lighting mains, &c. The application was unopposed.

The Urban Sanitary Authority have decided to adopt the G. B. surface contact system of electric traction for their proposed electric tramways.

Liverpool.—On Wednesday the Council sanctioned the construction of an additional tramway route. A site has been acquired for new tramway offices, &c.

London County Council.—At Tuesday's meeting approval was given to the estimate of £6,600 for the reconstruction to double lines of conduit electric traction of the existing single line of tramways in Goswell-road between Clerkenwell-road and Upper Ashley-street.

Agreement with Dr. Kennedy.—A report was submitted by the Highways committee relative to the agreement between Dr. Kennedy and the Council under which he has acted as electrical engineer for the reconstruction of the tramways between Westminster and Tooting, Kennington Gate and Blackfriars, St. George's Circus and Waterloo-road. Dr. Kennedy was to be paid a commission on the work, and also with regard to the building and equipment of the generating station, so far as the working of these lines was concerned. The Council, instead of building the station at Camberwell, is building one of larger capacity than was at first intended at Greenwich and as the work in which Dr. Kennedy is concerned is almost completed he has suggested that the agreement be terminated on the basis of a payment of 2 per cent. on the cost of electrical plant and equipment and 1 per cent. on the estimated cost of buildings. The amount which would be payable to Dr. Kennedy would on this basis be £1,595, and the committee considered that this was fair remuneration for the work done, and recommended that the agreement, so far as regarded the work at Greenwich, be terminated on these terms.—Approved.

Shoreditch Electric Supply.—The Highways committee recommended that consent be given to the Shoreditch Borough Council to change the standard pressure on the distributing mains to 240 volts between the middle wire, and either of the outer wires, and to 480 volts between the outer wires, subject to certain conditions. These conditions provide for the undertakers carrying out the cost of changing the installation in a consumer's premises and for the consumer's lamps in use and in stock being replaced by the undertakers; for adequate precautions being taken to prevent any risk of shock from the wires; and "that the undertakers shall build up a renewals and reserve fund in connection with their electric light undertaking."

Manchuria.—An interesting report has recently been made by Mr. Consul Miller, of Niuchwang (China), upon the prevailing commercial conditions in Manchuria. From this it would appear that the city of Harbin, the scene of the present concentration of the Russian forces in Manchuria, is the centre of Russia's chief building and civilising operations in the vast area which the world knows as Manchuria. Harbin is 350 miles from Vladivostock and 600 miles from Port Arthur. It is practically in the centre of Manchuria, and is surrounded by hundreds

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of miles of fertile country, which, previous to the advent of the Russians, was a wild range of country. An important stretch of fresh water (the River Sungari) runs near the city. Already only Russians and Chinese are permitted to own land and property in the city. The administrator of the district is the chief railway engineer. In October, 1903, there was a population of 44,000, including 400 Japanese and 300 other foreigners, but not including the Russian military forces. Harbin has been made the centre of the entire railway administration of Manchuria and of Russian industrial and commercial development in this part of the world. Technical and commercial schools and special schools for teaching the Russian language to the Chinese and the Chinese language to the Russians have been established. The Sungari is navigable for nearly 200 miles above Harbin, and a regular traffic is carried on up this stream to the River Amur, a five days' journey. Railway communication has developed on an extensive scale. An automobile line has recently been started, these vehicles carrying 10 persons, and plying for hire between the city and the adjacent districts. This line of automobile vehicles is worked in connection with electric tramways owned by a private company. This company is about to supply electric current for lighting and general industrial purposes. It is stated that the Russian Government has expended on railways, fortifications, &c., in Manchuria nearly £60,000,000. The report, which is a lengthy one, is of much interest at the present time in relation to trading operations in this part of China (?).

Margam.—The inquiry into the application of the Council to borrow £15,000 for electric lighting has been postponed. Communications from a syndicate anxious to obtain Parliamentary powers to construct an electric tramway from Taibach to Aberavon, and from the Dolter Electric Traction Co. as to leasing the Council's provisional order have been referred to the consulting engineer (Mr. C. A. L. Prusman) for report.

Ottawa-New York Railway.—It is announced that this line, which runs from Ottawa to Tuper Lake, New York, is to be converted to electric traction.

Patents in Germany.—It is announced that the German Patent Office is overwhelmed with work. The number of patents taken out in 1902 was 27,565. This number had increased to 29,000 in 1903, and is expected to reach fully 30,000 in 1904. There is a corresponding increase in trade marks, which were nearly 10,000 in 1901, 11,200 in 1902, and about 12,000 in 1903. An additional director is to be added to the office, which employs 72 technical clerks. This number of clerks is being largely increased.

Plymouth.—At a special meeting the Borough Council last week discussed the action of the Local Government Board in disallowing portions of loans proposed to be raised by the Council.

Mr. DUKE said the amount of £1,648 paid before the equipment of the electricity works to the electrical engineer then in the Council's service (Mr. J. H. Rider) was charged to capital account, and the Local Government Board had decided that this amount, being a salary, was not properly chargeable to capital account, so that the sum would have to be put on the rates immediately. The amount of overdraft at the bank was £195,000, and the amount outstanding on unsanctioned work was from £120,000 to £130,000.

It was unanimously resolved to ask the Local Government Board to sanction the borrowing forthwith of sums amounting to £227,903, and also various amounts for certain improvements, &c., on the understanding that the bill in course of promotion by the Council shall be amended and submitted to the Board for approval, and shall not become law in the present session, the Council giving undertakings in regard to the paying-off of certain outstanding items.

Presentation.—The annual dinner of the staff of the Croydon Corporation electricity works took place on Friday last. After the dinner Ald. Miller (chairman of the Electricity committee), on behalf of the staff, presented Mr. J. Gray-Scott (the chief electrical engineer) with an illuminated address on the occasion of his departure to take up the duties of chief engineer and general manager of the Hongkong electric tramways. Ald. Miller referred to the excellent progress made by the electricity department under Mr. Scott's regime.

Provisional Order Revocation.—The Board of Trade have revoked the Farnham Electric Lighting Provisional Order, 1900.

Public Works in France.—An extensive system of river, harbour and canal improvements is about to be undertaken in France, an expenditure of about 1,000,000,000 francs being mentioned as the amount to be spent on the contemplated works. The contracts and concessions for these works are invariably let or awarded to French firms, but there appears to be a likely demand for a large quantity of machinery in connection with these enterprises, in which electric tramlines form a conspicuous feature.

Redditch.—The chairman of the Electric Supply committee (Mr. F. Dolphin) states that the cost of generation of current by the temporary steam plant now in use is greater than was the case with the gas plant.

St. Annes-on-the-Sea.—An unopposed inquiry was held last week into the application of the Council for sanction to borrow £4,000 for extensions of the electric lighting undertaking.

St. Helens.—Extensions of the electric lighting mains, estimated to cost £4,650, were authorised by the Corporation on Wednesday.

Shoreditch (London).—The district auditor (Mr. A. Carson Roberts) concluded his audit of the Borough Council's accounts last week.

Mr. COX objected to a debit of £635. 1s. 4d. against electricity revenue in respect of street lighting.

The AUDITOR said he had gone carefully into the facts and came to the conclusion that £400. 4s. 4d. could be lawfully sustained. He appreciated the great difficulties and complications which had been brought into existence through the London County Council's action in improperly sanctioning that class of expenditure with an electricity loan of £41,800, which they had sanctioned and consented to lend on March 18, 1897, and in the result he made an adjustment of £234. 17s. In regard to the transfer for the destruction of refuse, the auditor found that the destruction of refuse had been charged to the rates at 2s. a ton. He saw no objection to the Council charging the cost of maintenance upon the rates direct, and letting the rates charge the electricity revenue account the proper value of the heat which was supplied for their service. It would appear to be his duty to disallow the charge, but as it would not be possible to arrive at the correct figures from the transfer in regard to the heat for the past year, he would deal with the matter in default, and leave the Council to put it upon a more lawful basis in the current year's accounts. He considered it was a dusting and scavenging matter, and it was the duty of the Council to see that the correct fund was charged with the maintenance of its refuse destructor. He did not find that the electricity department had been charged with any share of the central establishment expenditure, and he found that during the past six years the general rate fund had, to a considerable extent, financed the electricity and refuse destructor funds.

The TOWN CLERK (Dr. H. Mansfield Robinson), said the electricity department had difficulties in getting loans promptly from the London County Council owing to different methods being adopted from time to time by that body, and the Borough Council had to finance the department.

The AUDITOR added that the only course open for the Council in regard to the three matters (the adjustment of interest on arc lamp expenditure, the establishment expenses and interest on the bank overdraft) was to set one off against the other. They could not arrive at correct figures, and it was a case for them all to let bygones be bygones, but he thought they ought to go on more accurate lines in future in determining the profit and loss of the electricity undertaking. The charge for bank interest to the Lighting committee by the Finance committee would not be a surcharge. He further remarked the loan service payments due on April 1, 1903 (£3,169. 3s. 6d.), were excluded, but similar items had been included in the accounts for 1902. He saw no reason in law for their inclusion, and he struck them out. The cost price of unused materials (£1,556. 19s. 11d.) was set off against expenditure on highways, sewering and scavenging for the first time. The intention was that an accurate account should be kept of unexpended material. He wanted it to be clearly understood that that was confined to the cost price of unused and raw material. Those two items (£3,169 and £1,557) fully covered the deficiency with which the year started. It meant that if the same principle had been followed in regard to those two matters in balancing the accounts on March 31, 1902, the year they were dealing with would have started without a deficiency. The balance-sheet of the general fund, the baths and washhouses and the library fund, the working-class dwellings account, and the electricity revenue account had separate balances shown; but in the general ledger they were merged into one account, showing the surplus of £1,984. 13s. 4d. He understood it was the intention of the Council that the separation as set out in the aggregate balance-sheet should be followed, and the accounts brought into agreement with the balance-sheet. That he proposed to see done. But when they had been dealt with on the lines he had suggested, there was still a deficiency of £6,259. 12s. 7d., the whole of which was due to the rating of the year. That was after the disallowance of £6,527, 7s. 1d. for plant. The deficiency occurred in the general rating fund. All the other funds would be found to have something in hand. The net deficiency was £4,755. On March 31, 1904, they expected no deficiency. As the deficiency had been dealt with by the Council, he did not see any reason to go into any person's responsibility in regard to it.

Dr. MANSFIELD ROBINSON said the question of £6,000 deficiency was an academic one, and should be brought the notice of the Local Government Board. The Borough Councils had to follow the antiquated receipts and payments system adopted by the London County Council. The latter adopted three different methods of dealing with their accounts, and the Borough Council could not do that. It placed an unfair responsibility upon the auditor and the Council's chief financial officer. It was important that the Local Government Board should formulate a definite system and order for keeping municipal accounts in London. At present local authorities were placed at a great disadvantage, and confusion would continue until the Local Government Board decided the position once for all.

Smoke Prosecutions.—At the Middlesex Sessions last week, the justices (presided over by Sir Ralph Littler, C.B., K.C.) heard the appeal of the Metropolitan Electric Supply Co. against a conviction by the justices of the Harlesden division for permitting black smoke to issue from their Willesden works on Sept. 16 in such quantities as to be a nuisance, and also against the fine of £5 and £20 costs and an order prohibiting the recurrence of the alleged nuisance.

Mr. MUIR, for the company, complained that the summonses were not issued for merely causing a nuisance, without specifying the smoke as

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black smoke. Under that sub-section appellants could have pleaded that they used the best appliances and had taken all proper care to prevent a nuisance, but under sub-sec. 8 that defence was not available to them. He denied that the smoke was black smoke, and called evidence to prove that all reasonable care was taken to prevent a nuisance.

The appeal was, however, dismissed, and the conviction and order were affirmed, with costs.

At Southwark (London) Police Court on Wednesday the City of London Electric Lighting Co. were summoned by the Council for permitting the issue of black smoke from three chimney shafts.

Mr. DAVID WILSON, superintendent of works, said the company were in an exceptional condition owing to the stress suddenly put upon their dynamos in consequence of weather changes. On the day in question nearly 100 per cent. more lights were instantly put into use. The extra load on the boilers necessitated extra firing, which caused the smoke complained of. The company took every means of providing for extra demand, and had tried hundreds of smoke appliances, but could not find one which would cope with the difficulty. The magistrate inflicted one fine of £10.

South Shields.—The report of the Electricity committee for the quarter ended Dec. 31 states that 315,508 units were sold, compared with 286,905 in the corresponding period of 1902, the income being £4,737, against £4,349. Total receipts, including public lighting and meter rental were £5,647, compared with £5,169.

Sowerby Bridge.—Halifax Electricity committee have submitted to the District Council three schemes for supply of electricity:—

1. Sup ly in bulk, with sub-station at gasworks, Sowerby Bridge. Machinery to be supplied by Halifax Corporation, buildings by Sowerby Bridge Council. Supply to be for period of not less than 10 years at agreed rates.

2. Sub-station at Albert-road for supply in bulk. Buildings and machinery by Halifax Corporation. Minimum consumption under each scheme to be not less than 18,500 units per annum at 2¾d. per unit under scheme one; 2½d. under scheme two.

3. Sub-station at Albert-road. Halifax Corporation to erect buildings and supply machinery, and lay low-tension mains and feeders, and to supply electricity in Sowerby Bridge compulsory area for not less than 10 years at 5d. per unit for lighting, and 2d. for motors for accounts per quarter under 300 units per H.P. demanded, and a cheapening sliding scale.

Stoke-on-Trent.—Sanction to a loan of £17,840 for electric lighting and £12,800 for a refuse destructor has been obtained by the Council.

Telephonic Communication with the Continent.—The statement made in a daily contemporary that the English and French Post Offices had decided to reduce the fee for the use of the telephone between London and Paris from 8s. to 4s. for three minutes' conversation, and that the charge between places in Scotland and Ireland and places in France will be 6s. for three minutes, is incorrect. As a matter of fact, London is at present the only town in the United Kingdom having telephonic communication with France, and there is no intention of reducing the present rates for ordinary day conversations to either Paris or Brussels. In a few weeks' time, however, a double period (*i.e.*, six minutes) will be allowed on the Anglo-Belgian line during certain hours of the night for the present single period rates, and the same rule will apply to London and other places in the United Kingdom which may by that time have facilities for using the line to Paris.

Transvaal Imports.—The value of electric cables, wires and fittings imported into the Transvaal for the 11 months ended November, 1903, was £60,000, compared with £41,000 in the corresponding period of 1902. The value of tramway material similarly imported was £76,000, compared with £30,000.

Underground Electric Railway Contracts.—The General Electric Co. have secured a contract for 340 40 H.P. electric motors for use on the lifts at the various stations on the Metropolitan Underground Railways. These motors are to be made at the company's extensive works at Witton. A contract has been entered into with the British Thomson-Houston Co. for the electrical equipment of the trains on the Underground system amounting to £1,400,000, and a contract for the station lifts, amounting to £400,000, has been placed with the Otis Elevator Co.

Wandsworth (London).—On Wednesday objection was raised to the proposed sale to the London County Council of a site on the north side of Wandsworth Common for an electricity generating station, on account of its depreciatory effect upon surrounding property. The County Council have been asked to remove the tramway feeder pillars in Upper Tooting-road and Balham High-road, on the ground of alleged obstruction to traffic.

West African Cables.—On Feb. 22 a credit was voted by the French Chamber of 3,937,500fr. for cables to the French West African possessions.

West Bromwich.—The difficulties in connection with the completion of the branch line of tramway connecting West Bromwich with Oldbury have been removed, and through communication has now been opened.

Wireless Telegraphy.—It is stated that a number of wireless telegraph stations on the French coast, hitherto used only for naval purposes, have been opened to the public, with certain restrictions.

Wood Green.—To prevent their provisional order from lapsing the County Council have decided to apply at once for sanction to a loan of £7,600 for mains in the compulsory area.

Worcester.—On the working of the electricity department for the past year there was a profit of £1,693.

Workhouse Lighting.—The Local Government Board have informed the Guardians of St. George's (Hanover-square, London), in regard to their proposal to light the Fulham-road Workhouse electrically, that, unless special reasons could be shown, gas should not be replaced by electric lighting where buildings are already sufficiently lighted. Further that it would be better to obtain a supply of current from a public source rather than for the Guardians to put down their own plant.

Salisbury Guardians have requested the local electric light and gas companies to tender for the lighting of the workhouse,

Wrexham.—The Council have decided as from Sept. 30 to charge a uniform rate of 5d. per unit for electric current for private lighting, except for the infirmary, which is to be supplied at 3½d.

Annual Dinner.—The annual dinner of past and present University College (London) engineering students will be held at the Criterion Restaurant, London, on March 11, at 7.30 p.m., under the presidency of Dr. A. B. W. Kennedy, F.R.S. Mr. P. T. J. Estler, 25, Laurence Pountney-lane, London, E.C., hon. sec. of the Past Engineering Students' Society, will be pleased to supply particulars. This will be the first occasion on which both past and present students have met together.

Municipal and County Club.—Sir William H. White, K.C.B., B.Sc., LL.D., F.R.S., late Chief Instructor of the Navy and President of the Institution of Civil Engineers, will be the guest of the evening at a house dinner and smoking concert on March 21 at 7 p.m.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1904 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date, and the Directorial Division of the new volume has been corrected up to February 11th, 1904. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates over 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. A number of large sheet Tables, Maps, &c., are included in the issue. Digest of Contents will be sent post free.

TENDERS INVITED.

Dartford Urban District Council invite tenders for construction and subsequent working for a term of years of light (electric) railways in the district. Copies of deposited plans, the Dartford Light Railway Order (1901) and Extensions Order (1903) can be seen at the offices of the consulting engineers (Messrs. Hawtayne and Zeden), 9, Queen-street-place, London, E.C., from whom further particulars may be obtained. Specifications, &c., from the clerk to the Council (Mr. W. Kay), Council offices, Dartford, and tenders by noon March 26. See also advertisement.

Leek Urban District Council invite tenders for electricity meters. Specifications, &c. (after 7th inst.) of the consulting engineers (Messrs. Burstall and Monkhouse), 14, Old Queen-street, Westminster, S.W., to whom tenders by noon March 14. See advertisement.

Plymouth Corporation invite tenders for the supply of stores during the 12 months ending March 31, 1905, including electricity meters, transformers and paper-insulated cables. Specifications, &c., from the borough electrical engineer, Mr. E. G. Okell, Prince Rock, Plymouth, to whom tenders by March 19. See advertisement.

Plymouth Corporation also invite tenders for 12 months' supply of lubricating oils, engine waste, &c. Tenders to borough electrical engineer by March 19.

Newport (Mon.) Corporation invite tenders for boosters, balancers, &c., switchboards, tramway poles and brackets, overhead material, section pillars, cables and trolley wire. Specifications from (and drawings may be seen at) the office of the borough electrical engineer and tramways manager (Mr. H. Collings Bishop) after March 8. Tenders to chairman of Electricity committee, Town Hall, Newport (Mon.), by first post March 21. See advertisement.

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Handsworth (Staffs.) District Council invite tenders for permanent way, pavement and roadwork, and overhead equipment. Specifications, &c. (after Monday), from the clerk, Mr. H. Ward. Specifications and drawings can also be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to the Council House, Handsworth, before noon March 30. An advertisement contains further particulars.

Norwich Corporation invite tenders for stores for the electricity department, including cables, wires and accessories, incandescent lamps, continuous-current meters and motor for 10-ton travelling crane. Specifications, &c., from the city electrical engineer (Mr. F. M. Long), Corporation electricity works, Duke-street, Norwich, by 10 a.m. March 14. See also advertisement.

The Scottish Office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring the installations, set out in an advertisement, for direct connection with the fire brigades at Edinburgh and Aberdeen. Tenders close 9th inst. Particulars from managing director, 49, Queen-street, Glasgow.

Poplar (London) Borough Council invite tenders for two 1,000kw. turbo-driven three-phase alternating-current generators and condensing plant. Specifications, &c., from the borough electrical engineer (Mr. P. N. Hooper). Tenders to the town clerk (Mr. Leonard Potts), High-street, Poplar, London, E., by 9 a.m. of March 12. An advertisement contains further particulars.

Poplar (London) Guardians invite tenders by 6:30 p.m. 11th inst. for 12 months' electrical requisites.

Sunderland Corporation invite tenders for 12 months' supply of indiarubber-covered cables. Specifications, &c., from the borough electrical engineer, Mr. John F. C. Snell. Tenders (addressed chairman of Electricity and Lighting committee) to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon, March 31. See advertisement.

Belfast Gas and Electric committee invite tenders for electric motors, insulated cables, stoneware conduits, troughs, &c., cast-iron pipes, troughs, street boxes, &c., bitumen and house service cutouts. Specifications from the city electrical engineer, Mr. Victor A. H. M'Cowen. Tenders to the town clerk (Sir Samuel Black), Town Hall, Belfast, by noon of Friday, March 11. See also advertisement.

Ilford District Council invite tenders for the supply and erection of one 1,000kw. steam dynamo (vertical engine coupled direct to multipolar dynamo); extensions to main switchboard and cable connections; works distributing switchboard; condensing plant, comprising surface condenser, water driven pumps, water cooling tower and pipe work; feeder and pilot cables, feeder pillar and joint boxes. Tenders to Chairman of Council by noon March 22.

Ilford District Council also invite tenders for materials and stores for their electricity department for year ending March 31, 1905. Tenders to Chairman of Council by 4 p.m. March 8.

Ilford District Council also invite tenders by March 7 for 12 months' supply of stores for tramways department.

The committee of management of *Londonderry* District Lunatic Asylum invite tenders for steam boiler, pipework, switchboard, &c., and for wiring and cables to villa and to new block. Specifications, &c., may be inspected at the offices of the consulting engineer (Mr. R. V. Macrory), Strand, Londonderry. Tenders, addressed to "Medical superintendent," must be delivered to the clerk (Mr. S. Haire) by noon on Thursday, March 17. See advertisement.

Manchester Tramways committee invite tenders for general stores, including fuses and switches, copper wire, incandescent lamps, cells, trolley heads, brackets for tramway poles, armature repairing material, rubber goloshes, gloves, &c., handcarts, barrows, &c., belting, truck springs, electrical accessories, trolley standards and booms, cable, tape, insulating material, bells, carbon brushes and carbons, galvanised steel span wire, bolts, nuts, &c. Tenders to chairman by 10 a.m. March 7.

Manchester Electricity committee invite tenders by March 10 for 5,000yds. of feeder cable, and for the substitution of high for low-voltage fittings in certain consumers' premises.

The Electrical committee of *Stepney* (London) Council invite tenders for supply and erection of one 1,000kw. steam turbine-driven double-current generator, four water-tube Babcock-Wilcox boilers, economisers, induced-draught apparatus, steam and other pipework, motor-driven feed pump and accessories. Tenders (addressed chairman of Electrical committee) by noon March 14.

Kilmarnock Corporation invite tenders for the supply and erection of pipe-work, feed-pump, economiser, jet-condensing plant, &c.; arc and incandescent lamps, posts and gear; lighting and traction feeders, mains, switch pillars and road-work, and electricity meters. Tenders to the town clerk (Mr. W. Middlemas), for arc lamps, &c., by Feb. 29 and for pipe work, &c., by March 14.

Wimbledon District Council invite tenders for various stores required during the year ending March 31, 1905, including engine-room stores, cables, joint boxes and jointing materials, transformers, meters, lubricating oils, incandescent lamps and carbons. Tenders to Mr. R. H. S. Butterworth, Council offices, Wimbledon, S.W., by noon March 18.

The Council of the Metropolitan Borough of *Shoreditch* invite tenders for the supply of stores for their electricity works department, &c., for the year ending March 31, 1905. Tenders to the town clerk (Dr. H. Mansfield Robinson), Town Hall, Old-street, London, E.C., by 3 p.m. March 8.

Hackney (London) Guardians invite tenders for providing and fixing electric lighting fittings in connection with the lighting of the casual wards and other buildings in course of erection at Gainsborough-road, Hackney Wick. Tenders to clerk, Mr. Frank R. Coles, Sidney-road, Homerton, N.E., by 2 p.m. March 9.

Loughborough Gas and Electric Lighting committee invite tenders for two dry-back boilers, one surface condenser with electrically-driven air and centrifugal pumps and piping and one battery of 260 cells. Tenders to town clerk (Mr. Harry Perkins) by noon March 12.

Gillingham Council invite tenders by noon 14th inst. for the supply of three 50 to 60kw. motor generators and switchgear.

Warrington Electricity committee invite tenders by noon, March 14, for 12 months' supply of electric motors, and also for paper insulated cables.

Hackney (London) Borough Council invite tenders by noon, March 24, for 12 months' supply of small steam coal.

Londonderry Corporation invite tenders for carbons, meters and demand indicators for one year from March 31, 1904. Forms of tender, &c., from the borough electrical engineer (Mr. R.V. Macrory), Strand-road, Londonderry.

Croydon Guardians require tenders for electrical fittings and appliances. Tenders to Union Offices, Thornton Heath, by 6 p.m. 14th inst.

Caerphilly District Council invite tenders for "free" wiring in connection with the Council's proposed provisional order. Tenders by noon 7th inst.

Tiverton Town Council invite tenders until March 12 for the erection of electricity station buildings.

South Shields Corporation invite tenders for engine room stores, &c., for their electricity works for 12 months. Tenders by 12th inst.

The Prussian State Railway Authorities, *Dantzig*, invite tenders until 10th inst. for 100,000 arc lamp carbons. Tenders to Die Königliche Eisenbahn Direction, Dantzig.

Malmo (Sweden) Municipal Council invite tenders for constructing and working electric tramways.

The "Madrid Gazette" of Feb. 26 notifies that calls for tenders for the establishment of telephonic systems in *Palamós* and *El Escorial*, which were suspended in September last, are now to be arranged at the earliest possible date.

Tenders are invited for contracting for the supply of electric light to Talavera de la Reina, *Spain*. Some further particulars will be found in the "Madrid Gazette" for Feb. 26.

TENDERS RECEIVED AND ACCEPTED.

London County Council have received the following tenders for the reconstruction for electric traction of the Streatham cable tramways and the construction of authorised tramways at Tooting:—

J. G. White & Co. (*accepted*)	**£95,005**	R. W. Blackwell & Co.	£104,605
G. Law	128,588	W. Underwood & Brother	99,221
W. Kennedy	113,897	Edmund Nuttall & Co.	97,133
J. Mowlem & Co.	111,710	Dick, Kerr & Co.	95,751
Pethick Bros.	110,143	W. Griffiths & Co.	86,624

Messrs. J. G. White & Co. will sub-let the following work:—To Hadfield's Steel Foundry Co., manufacture of points and crossings; to Anderson Foundry Co., manufacture of cast-iron yokes, road boxes and covers; to Associated Portland Cement Mfs., cement; to Bullers Limited, manufacture of porcelain insulators.

The tender of Bolckow, Vaughan & Co. for sole plates at £3,497 has also been accepted by the Council.

The Scottish Office of the May-Oatway Fire Appliances (Ltd.) have accepted the tenders of Wm. Douglas (Ltd.) for wiring installations for connection with the Edinburgh Fire Brigade at the works of S. Henderson & Son (Ltd.), T. C. and E. C. Jacks and the Edinburgh Laundry Co.; that of Jas. Maxwell & Son for the installation at the warehouses of D. M. Brown, Dundee; and that of Pratt and Keith for the Great North of Scotland Railway Co. at Aberdeen.

Messrs. Dick, Kerr & Co. have placed with Messrs. W. T. Glover & Co. the contract for the supply, laying and jointing of extra high-tension feeders, &c., in connection with the Leeds and District electric tramways.

Messrs. Belliss and Morcom, Ledsam-street Works, Birmingham, have secured (through the British Westinghouse Co.) an order for one 720-864 H.P. engine for coupling direct to a 500kw. three-phase Westinghouse alternator.

Glasgow Electricity committee recommend the acceptance of the tender of E. and J. Burrell, at £12,137. 12s. 9d., for excavation,

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mason and brick work of the northern section of the Port Dundas generating station.

Derby Town Council have accepted the tender of Mr. H. White for 120 incandescent lamp brackets for tramway poles at £54, and that of J. G. White & Co. (Ltd.) for lay-outs at tramway car shed at £1,359. 18s. 2d.

The contract for the supply of rails for the Derby electric tramways has been given to the North Eastern Steel Co., the terms of the original contract with a Belgian firm having, it is said, been broken.

The British Westinghouse Co. has secured a contract from Manchester Corporation for the supply of complete electrical equipments to 100 tramcars.

Islington (London) Borough Council have placed orders with the following for arc lamps, columns, carbons, &c.:—Rowland Carr & Co., Crompton & Co., A. Round and General Electric Co.

Belfast Corporation have accepted the following tenders:—
Chamberlain and Hookham (electricity meters).
Thos. Parker (Ltd.) (motor booster and motor balancer).

Bedford Town Council have accepted the tender of the British Thomas-Houston Co. for a switchboard at £1,278.

Broadstairs District Council have accepted the tender of A. Wood & Co. for wiring fire engine station, &c.

Southend Council have accepted the tender of the British Westinghouse Co. for five bogie cars at £3,008. 16s 6d.

Battersea (London) Borough Council have accepted the tender of C. A. Parsons & Co. for a 750kw. steam turbine dynamo at £4,890.

Southampton Corporation have accepted the tender of Bartlett & Son for a weighbridge at the Western Shore generating station at £90.

Leeds Corporation have accepted the tender of Wallis and Watson for wiring the branch library at Armley, at £95. 14s. 3d.

East Ham District Council have placed an order with Messrs. Dick, Kerr & Co. for 25 arc lamp poles at £14. 9s. 6d. each.

BUSINESS NOTICES.

The London offices of Belliss and Morcom (Ltd.) have been removed to larger and more convenient premises at 8, Victoria-street, S.W.

Mr. B. H. Jenkinson, C.E., A.M.Inst.E.E., has taken additional offices at 9, Gray's Inn-square, Holborn, London, W.C., but will conduct his local business as hitherto at Crouch End, N.

Mr. H. Laws Webb, who is well known to our readers in connection with telephone matters both at home and in the States, has commenced practice as a consulting engineer at 35, Old Queen-street, Westminster, London, S.W. Telephone 348 Westminster.

We are informed that Mr. F. G. Bell, who has been for many years connected with the telephone department of the General Electric Co., has resigned that position and has joined the senior staff of the Berliner Telephone Mfg. Co.

LIQUIDATIONS, BANKRUPTCIES, &c.

In the bankruptcy of S. H. and J. E. Thompson, electricians, 6, East-street, Plymouth, the first meeting of creditors takes place on 8th inst. at 6, Athenæum-terrace, Plymouth, and the public examination on same date at the Town Hall, East Stonehouse.

A first and final dividend of 4½d. is payable at Midland Bank-chambers, Southampton, in the failure of Edwin Ward, electrician, &c., formerly trading at Southampton as E. Ward & Co.

The public examination of Jackson and Smith, electrical engineers, Annetwell-street, Carlisle, was held last week. Liabilities £295, assets £76. To want of capital and bad trade during summer months the failure is ascribed. Examination closed.

A meeting took place on Monday of the creditors of Ernest E. Clark, 11, Claypit-street, Leeds, lately carrying on business as an electrical engineer. Liabilities estimated at £63 7s. 6d., no assets. Failure due to insufficient trade, law costs, &c.

McGuire Mfg. Co. (Ltd.)—Mr. Justice Byrne on Tuesday, on the petition of Electric Equipment and Securities (Ltd.), made a compulsory order against this company, which did not oppose.

Winding-up Petition.—A petition for winding-up the Electric Timber Seasoning and Preservation Co. (Ltd.) will be heard at the Royal Courts of Justice, London, on 8th inst.

Ferranti Limited —A meeting of creditors was held in London on Wednesday, when Mr. Ferranti presided. A report of the Committee appointed on November 18 last was presented.

This report stated that Mr. Henderson (of Thomas Bolton & Sons) was elected chairman of the Committee, which had visited the works at Hollinwood and had thoroughly investigated the affairs of the company. The Committee's rough estimate of the full and complete assets at the works was £302,000 including value of contracts, leases, patents, royalties, book debts, &c., and they consider that the works, plant, machinery, &c., if sold as a going concern, should realise £70,000. The assets should be sufficient to satisfy the claims of all creditors. Owing to the state of the money market there was some difficulty in finding capital to go on with.

Mr. Ferranti said there were three courses open (1) voluntary liquidation, (2) compulsory liquidation, (3) an endeavour to obtain the court's sanction to the continuance of the present arrangements. If the company were compulsorily liquidated the debenture-holders were entitled to a premium of 5 per cent., or if voluntarily liquidated to a premium of 10 per cent. There were about 60 holders of debentures. It was stated that most of the holders were in favour of compulsory liquidation.

Mr. Scott Lings said his firm were interested to a larger sum than all the other creditors put together, and he strongly urged that the best course was to continue under the present arrangement, as to liquidate at the present time would be disastrous to all concerned. That morning the Master had granted a fortnight's adjournment to enable contracts to be carried out. These contracts would be all completed by May or early June.

Mr. Taylor (Taylor, Tunnicliff & Co.) said a point had been overlooked in the discussion. It was stated in the committee's report that the creditors would be willing to take 10s. in the £, which the directors offered. He, for one, would gladly accept that offer, to save further loss of time and expense.

Mr. Scott Lings said the directors would be glad to adopt such a suggestion, but the only way to obtain 10s. in the £ was for the shareholders to come forward and agree to put more capital into the concern.

A resolution was then approved that the meeting should adjourn tor a fortnight, and that the receivers and managers should, in the meantime, prepare an exact financial statement of affairs to be presented to the adjourned meeting.

Sales by Auction.—Messrs. Farebrother, Ellis, Egerton, Breach, Galsworthy & Co. will sell by auction at the Mart, Tokenhouse-yard, London, E.C., on March 24, at 2 p.m., in one lot, valuable part freehold and part leasehold engineering works close to Maida Vale and Kilburn railway stations. Some particulars are given in an advertisement, and further information can be obtained of the solicitor, Mr. Frank Varley, 14, Copthall-avenue, London, E.C., at the Mart, and of the auctioneers, 29, Fleet-street, London, E.C.

To-day (Friday) is the concluding day of the sale by auction at the Salford Switch Works, Frederick-road, Pendleton, Salford, Lancs., by Messrs. Wheatley Kirk, Price & Co., of the entire stock-in-trade of electrical goods and fittings in *re* Heaton and Smith (Ltd.) (in liquidation). The sale commences at 11 a.m., and includes a large variety of tools, patterns, plant, apparatus and accessories.

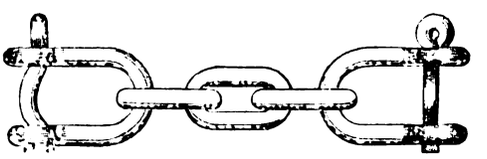
Plant for Sale —Govan Corporation invite tenders for three-wire Ediswan main switchboard, arranged for eight three-wire feeders, six dynamos, battery and balancer; also for three-wire booster by the British Thomson-Houston Co. The plant may be seen and full particulars obtained on application to the burgh electrical engineer, Mr. T. C. Parsons, Helen-street, Govan. Tenders to the town clerk (Mr. A. Macdonald), Town Hall, Govan, by March 29. See advertisement.

Two Crossley gas engines and two belt-driven Edison-Hopkinson dynamos, each giving about 140 amp. at 100v., with belts, switchboard, &c., are advertised for sale in another column. Particulars from the consulting engineers, Messrs. Massey and Allpress, 25, Queen Anne's-gate, London, S.W.

Premises to Let.—A substantially built warehouse in the west central district of London, suitable for manufacturers, &c., is advertised. Communications to Messrs. Fitch & Co., 43, Bedford-row, London, W.C.

Plant Required.—A combined steam and alternator set of about 100kw. at 50 periods is wanted. Particulars to British Electric Transformer Co., Hayes, Middlesex. See advertisement.

Safety Couplings.—Messrs. Bradford Bros., 63, Sydenham-terrace, Sunderland, are introducing a non-slipping safety shackle for connecting vehicles, cranes, derricks, &c. These couplings consist of two parts—the shackle and the pin. The device is intended to ensure automatic locking when the pull or load comes on. When



Bradford Non-slipping Self-locking Couplings.

in use the curve in the pin receives the pull, throwing it out of coincidence with the corresponding eyes and locking the device. The comparative frequency of accidents (and the liability of employers) where such contrivances as these are not employed should cause a demand for a well-made coupling of this character.

Steam Traps.—In spite of (possibly in consequence of) recent litigation Messrs. Geipel and Lange inform us they have found it necessary to extend their arrangements for the manufacture of the Geipel traps and ask their customers to bear with a little delay in delivery.

New Pattern Ceiling Rose.—Messrs. Dorman and Smith, of Ordsal Electrical Works, Salford, are placing on the market a new

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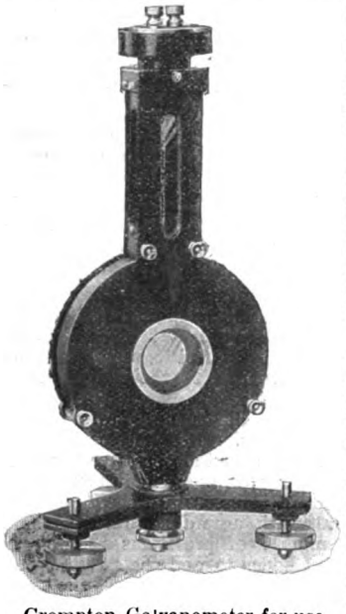
ceiling rose, designed to cheapen the cost of wiring where conduits are used. The porcelain rose is in one piece, the terminals being sunk into this on the inside, so that there is no need for a separate cover. These terminals, being both large and substantial, are suitable for looping through for the main wires to be carried on to the next ceiling box without break. The pendant flexible is first attached to the terminals through a deep V-shaped cord grip in the ceiling rose, which, with the flexible, is attached to the jointing box by two screws. 2-way and 4-way iron jointing boxes are supplied, screwed ½in. gas threads or ⅝in. or ¾in. Simplex.

Fire Alarm Installations.—The May-Oatway Fire Appliances (Ltd.) report that they are very busy with installations, including the following:—

For Midland Railway Co., passenger station, goods sheds, &c., at Heysham; for London County Council, Colney Hatch Asylum; also Lyceum Theatre and Theatre Royal, Edinburgh (first theatres in the United Kingdom to automatically connect with a fire brigade); Brown and Polson's works, Paisley; James Templeton & Co.'s warehouses and mills; J. and B. Stevenson's bakeries; and 18 other warehouses and bonded stores.

Municipal Year Book.—Messrs. Edward Lloyd, Ltd. (London) have just published the 1904 issue of the useful "Municipal Year Book of the United Kingdom," edited by Mr. Robert Donald. We have in previous years called attention to the value of this work as a book of reference on all matters relating to municipal government and in connection with the numerous departments into which municipal government is now divided. The 1904 issue of the book is an advance upon its predecessors, and gives evidence of even more careful preparation and arrangement for handy reference. Some 30 pages of the book, out of 500, are devoted exclusively to electricity supply, to which subject reference is also made in many places. The published price is 3s. 6d. net.

Catalogues.—Messrs. Crompton & Co., Salisbury House, London, E.C., and Chelmsford, have a second edition ready of their potentiometer catalogue, and a complete price list of Crompton potentiometers and accessories. The pamphlet is amply illustrated with numerous diagrams of connections of the instruments, various parts of apparatus, &c.



Crompton Galvanometer for use with Potentiometer.

The accompanying illustration shows one form of the Crompton galvanometer for use in the potentiometer installation. It is suitable for zero work with either potentiometer or bridge, and is fitted with a simple adjustable head.

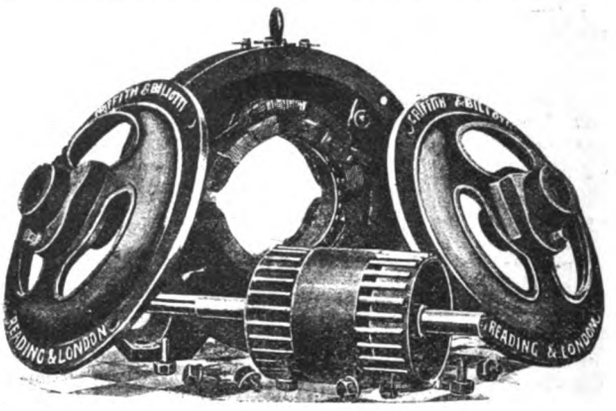
Separate lists are also issued of reflecting galvanometers, resistance boxes and other testing-room appliances manufactured by the firm, and there is, in addition, a sheet list illustrating and describing the Crompton electric pyrometer for use with steam plants. Messrs. Crompton & Co. claim that this last-named apparatus is a much simpler and more practical instrument for engineers' use than has ever previously been placed on the market. Copies of the new lists can be obtained free by post on application.

We have received Sections II. and VI. of the important main catalogue issued by the Edison and Swan United Electric Light Co. Section II. deals with ship, factory and mine fittings, and Section VI. with artistic electric light fittings. In the former a large variety of watertight and similar fittings are described and illustrated, and this is probably the first catalogue ever issued devoted exclusively to this line of goods. The articles listed are all made at the company's Ponder's End works, and the list should prove particularly useful to shipbuilding and mining engineers and contractors for factory lighting installations. In catalogue VI. there is a more pretentious display, a wide range of artistic and ornamental fittings being shown, from the elaborately designed electrolier, standard, pendant or lanterns, to the smallest accessory for this class of installation work. This catalogue will be indispensable to contractors engaged in the better class of electric lighting work.

A new catalogue has been prepared by the Electrical Mining Co., of Iron Gate, Derby. The plant illustrated includes an excellent assortment of up-to-date electrical machinery used in mining operations.

Messrs. David Bridge & Co., Castleton Iron Works, Castleton, Manchester, have ready an exhaustive catalogue of indiarubber and gutta-percha working machinery. In this catalogue a large variety of this special class of machinery is listed and illustrated. The machines illustrated include examples of every piece of heavy apparatus used in this important branch of industry.

A new list of polyphase induction motors is issued by Messrs. Griffith and Biliotti, of Reading, Berks., and John-street, Adelphi, London, W.C. Our illustration shows parts of the S.C. type of motor manufactured by this firm. Several other machines are



Parts of S.C. Type of Griffiths and Biliotti Motor.

listed, priced and illustrated. The firm claim that they have equipped their Reading works especially for the manufacture of this class of machinery, and that they have placed on the market an English-made machine of first quality.

Messrs. Falk, Stadelmann & Co., 83-87, Farringdon-road, London, E.C., have ready a revised catalogue of electrical fixtures.

Herr Anton Glöckner, Furstenstrasse, Dresden, Germany, sends particulars of a new registering velocimeter for electric railways, automobiles, locomotives, &c. This apparatus registers every two seconds, has a plainly visible recording scale, and is claimed to be specially suited for testing speeds of vehicles on roads, rails, &c.

Messrs. Strubin and Jaye, 61, Cornhill, London, E.C., are introducing the "Economic" closed arc lamp, for which certain advantages are claimed. The height of the lamp is 12in.

Callender Cables.—We have received from Callender's Cable Co. a neatly-framed reproduction of photographic views of the laying of Callender cables at Pangbourne, Berks. The views show the cable-laying operations alongside the river Thames.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from Feb. 24 to March 1, with the ports of destination:—

Africa—Alexandria, £117; Cape Town, £1,398; Durban, £2,074 (including £635 telegraph material); East London, £634; Port Elizabeth, £27; Port Said, £20; Sierra Leone, £48. *Argentina*—Buenos Ayres, £185; Rosario, £393 (telegraph material). *Australasia*—Adelaide, £107; Brisbane, £29; Lyttelton, £258; Melbourne, £132; Perth, £179; Sydney, £620 (including £59 telegraph material); Wellington, £114. *Belgium*—Ostend, £17. *Brazil*—Coatzacoalcos, £37. *Ceylon*—Colombo, £189 (including £30 telegraph material). *China*—Shanghai, £249; Tientsin, £22. *Cochin China*—Saigon, £42. *Germany*—Hamburg, £274. *Gibraltar*—£235. *Holland*—Amsterdam, £96; Rotterdam, £257 (telegraph cable). *Hong Kong*, £75. *India*—Bombay, £18; Calcutta, £669 (including £25 telegraph material). *Japan*—Yokohama, £309. *Madeira*, £24. *North Atlantic*, £10,264 (submarine cable). *Portugal*—Oporto, £381; Lisbon, £20. *Roumania*—Sulina, £25. *Siam*—Bangkok, £109. *Straits Settlements*—Singapore, £716. Total £20,363, against £17,880 in the corresponding week last year (Feb. 25 to March 3).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

December 30, 1903.

28,662 H. HELBERGER. Electric chain-welding machines.*

28,699, 28,700 and 28,701 H. O. RUGH. Telegraphy.*

December 31, 1903.

28,723 R. H. LINAKER. Manchester. Electrical ignition devices for motor cycles.

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28,735 F. W. Parkinson. Liverpool. Elastic supports and connections for incandescent lamp holders.
28,748 P. T. J. Estler and J. L. Jack. Trolley wheels or collectors.
28,769 W. E. Evans (A.E.G., Germany). Brakes.*
28,780 A. Eimer. Electric furnaces or ovens. (Date applied for, May 22, 1903, date of application in U.S.)
28,782 A. Eimer. Electric sectional furnaces. (Date applied for, May 28, date of application in U.S.)*
28,793 G. Lüdorf. Electrically-operated trains.*
28,794 J. H. Woolrich and E. R. Smith. Arc lamps.
28,805 C. P. E. Schneider. Electric furnaces.*
28,806 and 28,807 C. Bakeley and J. H. Schrage. Sockets for incandescent lamps.*

January 1, 1904.

12 T. W. S. Hutchins. Manchester. Dynamos and motors.
26 Curtis's and Harvey and T. Malson. Electric fuses for blasting.
33 G. Hall. Manchester. Trolley wires of electric tramways.
45 J. Richmond and R. F. Carey. Electrically-controlled lifts.
74 W. Moseley. Electric bell indicators.
86 P. Kirkup and W. Alderson. Shot-firing batteries for blasting.

January 2, 1904.

97 J. Rose, T. Henwood and J. Squire. Torpoint. Trolley-sheave guide for finding the wire.
107 S. Evershed and Evershed and Vignoles. High-tension generators.
113 G. Fürst and T. Kragl. Telephones and time recorders therefor.*
114 P. Duflos. Sparking plugs. (Date applied for, Jan. 7, 1903, date of application in France.)*
121 F. W. de Tall (Cooper-Hewitt Electric Co., U.S.). Gas or vapour electric apparatus.
124 M. Barbará. Electrically transmitting, receiving and checking signals.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

1,053 Carolan (G.E. Co., U.S.). Electric power-transmitting mechanism.
1,255 Rains. Trolley standards.
2,053 Armstrong and Orling. Electro-capillary relays and the like.
2,574 Hechwart, Coltri & Cie. Electrolytic process for direct extraction of metals from ores and for precipitation of metals from solutions. (Date applied for, Aug. 1, 1902.)
3,509 Sperryn and Wood. Lamp-holders.
3,673 Brecknell, Munro and Rogers. Automatic shunting points for trolley wires.
5,019 Hunter. Appliances for radiation treatment of lupus, &c.
5,237 Carolan. (G.E. Co., U.S.) Controlling electric motors.
5,283 Carolan. (G.E. Co., U.S.) Instruments for determining power-factor of alternating-current circuits.
6,163 Hardingham. Suspending electroliers.
6,169 Elkington & Co., Lockerby and Wilkinson (Ltd.) and Ryder. Manufacturing letters and the like in metals by deposition.
6,316 Herz. Alternating-current generator for ignition of explosion motors.
6,343 Ward. Safety guard for use on electric cars.
6,376 Best. Electrically igniting miners' safety lamps.
7,625 Aldworth. Trolleys for electric tramcars.
10,697 Ziegenberg. Watt-hour meter.
12,936 Brecknell, Munro and Rogers. Trolley wheels.
13,027 Weston. Rheostats.

COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction and Maintenance Co. (Ltd.).

The fortieth ordinary general meeting of this company was held at the offices, 38, Old Broad-street, E.C., on Tuesday, Sir Robert G. W. Herbert, G.C.B., presiding.

The SECRETARY (Mr. E. Dickens) read the notice convening the meeting and the certificate of the auditors. The report and accounts were taken as read.

The CHAIRMAN said: Gentlemen, the year 1903 has been a successful and an industrious year for the company. As you were informed at our July interim meeting, we succeeded in that month in completing the laying of the second great Pacific cable that we have been concerned in—between Honolulu and Manila, a very large undertaking. You may remember the length was 5,000 odd knots. Our ships returned from that operation, after the date of the meeting, in very good order, and having contended against considerable difficulties in various points of their work, and having surmounted them with that ability which is characteristic of Mr. Lucas, our engineer-in-chief, and of the captains of the ships. I may mention, as a rather trivial matter, that on the journey home one of our cable ships was able to pay its homeward expenses by undertaking a little amount of traffic which fell within its way, which shows that the ships are available occasionally for that purpose when they are coming away from their regular work. I think it will be agreed by you all that, looking to the high pressure under which our work has been done during the last two years, sometimes 40 miles of cable being made in a day, and even 60 miles in a day, it is highly satisfactory that the cables should have stood so well, and should have been, up to the present time, as I hope they will be for a much longer period hereafter, amongst the highest class cables that have ever been laid, transmitting their messages with accuracy and rapidity. It was a rather curious thing to note that during the test matches in Australia there was a competition, not between us and any other company, but between two of our cables, as to which should transmit the messages most rapidly and most promptly, and they were very nearly equal; but, at any rate, however it was, it was a record in rapid transmission, and was all our work with the exception of the Atlantic portion of one of the cables. The directors' report is in its usual brief and condensed form. Being a manufacturing company, it is not in our province to publish details of all the work that we do, and I am glad to say that we have hardly any occasion, year after year, to alter the language of each paragraph of this report, because we can tell you now, as we have always been able to tell you in the past, that our factories are in fine order, doing good work, that our ships are also in excellent order, and that everything connected with the company is on a thoroughly sound and satisfactory footing. I do not think I need take you through the figures of the balance-sheet and accounts in any detail; but I might observe, with regard to one item on the right-hand side of the balance-sheet, which may strike you as being rather singular in its appearance—the first one—stating that our property, consisting of freehold and leasehold premises, machinery, plant and so forth is for this year only £369,687, as against £999,561 in the previous year, that is attributable to the fact that in the accounts for 1902 we had to account for a very large amount of stock we had in hand. A cable had been constructed and it was in our works. This year all that has gone out of the works and has been laid, and therefore it does not appear. There is an item in the balance-sheet which will appear on this occasion for the last time, and that is the pension fund—£67,085. 3s. 6d. As you see in the report, the board have now been able to complete the matter which they have placed before you year after year, and owing to your generosity to the employés of the company, the sum of £67,000 has now been vested in trustees for the purpose of forming a permanent fund for the pensioning and granting gratuities to the employés of the company. I shall ask Mr. Chapman, our solicitor, to explain to you, at no great length, the details of the pension deed. I may simply say at this stage that it is not constructed on the footing of requiring contributions from the members of the staff who will benefit by it; that there will be a board of advisers appointed, on which the managers of some of the branches of this company will be represented, and the names of those permanent employés who would naturally become recipients of the pension fund when, through infirmity or age, they become no longer capable of doing their work, will be scheduled, and over and above that the pension board will have the power of granting gratuities on very special occasions to those who are not permanent employés of the company—working men and so forth. Supposing a working man is killed and a widow left without means, a gratuity will be able to be given in that way to them also. I do not think I have anything further to call your attention to regarding the paragraph in the report or the figures, so I will ask Mr. Chapman to give the meeting some explanation of the nature of the pension deed.

Mr. CHAPMAN: The pension scheme is constituted by a trust deed which has the scheme scheduled to it. The deed is proposed to be made between the company on the one hand and the trustees on the other hand, the first trustees being your respected chairman and the managing director of this company, Mr. Shuter, whom you all know, and also Mr. John George Griffiths, who has been for many years connected with the company, and has kindly consented to act as a trustee. The deed begins by reciting that you sanction the payment of £67,085. 3s. 6d. to the trustees for the purpose of the fund, and also that, with the like sanction, further payments may hereafter be made to it. It then provides that the trustees are to stand possessed of these moneys upon the trust of the deed and for the purposes declared by it, and when you come to the operative part, it authorises the trustees to invest the funds in what are known as trustee securities, and the investments which are to constitute the fund, and the income, are to be paid and dealt with according to the scheme in the schedule. Then come a number of provisions relating to the number of trustees, and their being added to and their retirement, and the investments of property and so on, and there is also the usual indemnity clause relieving the trustees from liability except for their own acts as embodied in the deed. It is also provided that an order for the consent of payment out of the funds may be made or given by a majority of the trustees, and they have power, with the sanction of the Court, to make modifications in the various provisions. So much for the deed itself. Then you come to the scheme which is scheduled to it. In the first clause the scheme defines the beneficiaries. They are persons who at any time have been in the company's service, and any person directly or indirectly dependent upon them for support. No beneficiary has any right to contribute to or share in the fund. The payments are such as have been already indicated by the chairman. First, assistance by way of compassionate allowance; then payment of pensions as the administrators may determine; and, lastly, by purchase of annuities for fixed amounts for the life of the beneficiaries or other persons. The administration of the fund is committed to a body called the administrators. That body is made up of two others, one being trustees and the other the advisory committee, as it is called. The advisory committee consists of the directors as ex-officio members, and, in the first instance, of three gentlemen who are respectively the present manager of the works at Wharf-road, the present manager of the works at East Greenwich and the secretary of the company. Then there are provisions for filling up vacancies and retirement, and so forth. The powers of the administrators are contained in clause 9. The administrators shall have full power to administer the fund by determining the conditions under which any person may become or continue to be entitled to the benefits of the fund, the amount and nature of the payment to be made, and to make and alter from time to time the rules and regulations for administering the fund. The administrators are then authorised to have a

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secretary and other assistance, and an office, and to carry on and pay the expenses of administration out of the fund. The scheme also provides for ordinary meetings being held of the administrators every six months, at which a statement of the condition of the fund, and of the receipts and payments, shall be presented. And then come what may be called the ordinary regulations with respect to the summoning of meetings, the serving of notices, quorums, and votings, which will be by majority, the chairman having a casting vote, and the power of the administrators to make rules for the conduct of their own business. Then it is provided that the income of the fund shall be first had recourse to for the payment of expenses and so forth, and subject to that the capital may be had recourse to. The unapplied income may be kept in hand so far as may be necessary, and the remainder of it is to be invested in the same way as the original funds of which the pension fund is made up. Provision is made that on the company ceasing to carry on business, or winding up, annuities may be purchased for persons who are or who may be at the time recipients of any pension, and any surplus the trustees are to administer or apply as the Court may direct.

The CHAIRMAN then put the resolution with regard to the acceptance of the report and accounts—"That the report and accounts of the directors to Dec. 31. 1903, submitted to this meeting be and the same are hereby received and adopted, and that a dividend of 24s. per share, together with a bonus of 12s. per share, making a total of 36s. per share (in addition to the 12s. per share interest or interim dividend paid to June 30, 1903) be paid upon all shares of the company for the year ending Dec. 31, 1903, and that such dividend and bonus be paid free of income tax."

Sir JAMES PENDER, Bart.: I have pleasure in seconding that.

Mr. CROFT: I should like to congratulate you and the Board upon the very satisfactory report which you have produced at this meeting, and I do not think there is anything which you have omitted except allusion to one subject which is always of special interest to the shareholders in this company; and I suppose, from the fact that you have not alluded to it, you do not attach a great deal of importance to it. Of course, I refer to the Marconi system of wireless telegraphy. I suppose, from your silence with regard to that matter, that the Board do not regard it as a very serious thing with which we have to face the future.

The CHAIRMAN: That is so.

Mr. CROFT: I think I need only add, on behalf of my fellow shareholders, that we congratulate you on the very satisfactory report you have presented.

The CHAIRMAN: With regard to the system of ethereal or aerial telegraphy, there are now a good many systems on foot in the world besides the Marconi system. There is a German and an American system. The gentleman who has addressed us has exactly stated what is the situation of the board with regard to that. We feel that no progress has been made in the Marconi operations which at all indicates any danger to our particular province of submarine cable work. We are aware that very useful work is done and will be done, and it will be somewhat developed no doubt by this system of wireless telegraphy for short distances communicating with ships from 60 to 100 or even 200 miles from the shore. But we have seen nothing yet to make us believe that important commercial and political messages can be transmitted from one side of the world to the other with rapidity, security, and secrecy, and it was for that reason that it did not occur to me at all to bring the matter of Marconi before the meeting, but that is how it stands.

The motion was adopted unanimously.

The CHAIRMAN: I now propose—"That the form of trust deed constituting a pension fund for employés of the company and their dependents, in accordance with the scheme for the administration thereof scheduled to the said deed which has been submitted to this meeting, be and the same is hereby approved. And that the directors be and they are hereby authorised to carry the same into effect, with or without modification as they shall think fit, and to take all steps necessary or proper in that behalf, including the payment to the trustees of the said deed of the sum of £67,085. 3s. 6d. appearing in the balance-sheet on Dec. 31, 1903, as set apart for the purposes of the pension fund, in order that the same may be held and applied by the said trustees upon the trust, and for the purposes set forth in the said form of trust deed and the schedule thereto."

Sir JAMES PENDER, Bart.: I beg to second that.

The CHAIRMAN: Now, has any gentleman any remarks to make?

Mr. CROFT: Of course, I think it is a most excellent thing that this pension fund has been established, because I am quite sure that our employés have served the company with very great zeal and ability, and are certainly deserving of having provision made for their retirement from the service. What I should like to know is: Supposing a man employed by us should take proceedings under the Workmen's Compensation Act, which, as you know, in all businesses is a very fertile source of litigation—and very properly so in proper cases—if a man did take proceedings against the company would he be entitled to a pension? I imagine that there is provision made for the administrators making rules and regulations; in fact, the solicitor read out something to that effect, and that, I presume, would be taken into account in framing the rules, because I think it would be rather an anomalous thing that a man who took proceedings should be entitled to a pension. I think the company would in any case act very liberally and probably very generously towards its employés, and I hope the occasion may not arise, but assuming it did and that a man took proceedings against the company, I should like to know whether the directors would consider that would disentitle him to a pension hereafter.

The CHAIRMAN: Any compensation that may be awarded by a Court of Justice in the event of proceedings being taken in the manner suggested by Mr. Croft would not be payable out of this pension fund but would fall upon the general funds of the company, and it would depend very much upon the result of the proceedings taken by such a person as to whether he would be equitably and reasonably entitled to any consideration from the pension fund. If the judgment of the Court appeared to indicate that he had wantonly and without good ground made charges against the company, of course the administrators of the fund would take that into their serious consideration if he came before them in any way as a claimant as having been a former employé. He could not possibly come upon the pension fund, because working men receiving ordinary weekly wages are not pensionable or liable to receive gratuities from the fund unless specially placed on the list in consequence of some peculiar recommending circumstances in their case. I take it that you will agree to the resolution which I have read with regard to the pension fund.

The resolution was carried unanimously.

The retiring directors, Sir Robert Herbert and Sir James Pender, were then re-elected, and the retiring auditors, Mr. John Gane and Mr. P. A. Glegg, were re-appointed, and the proceedings terminated.

Hart Accumulator Co. (Ltd.)

The fifth ordinary meeting was held on Wednesday, Mr. G. W. KIDD presiding.

The SECRETARY (Mr. J. H. Poulton) read the notice calling the meeting and the auditors' certificate.

The CHAIRMAN said, I think we can congratulate ourselves on another successful year, although competition in our particular business has become keener than ever. Every battery company is trying to get work, and in doing so have practically to reduce their prices. Although we have had a very successful year, perhaps our profits do not appear to have warranted our paying the same dividend we paid last year, but we could easily have paid the 15 per cent. to the shareholders this year as we did last. Our business is so increasing that we have thought it advisable to start another branch in Birmingham. This we did in January, and it is too early yet to say whether that is going to be a success or not, but we think we are doing the proper thing in having a representative in Birmingham as well as in Manchester. Two or three years ago I announced that our manager was busy designing plates for automobile work, and he has now not only designed one plate but a dozen, and we have put them on the market. They have proved a success, and we are doing a considerable business in the automobile trade to day. I think the plate, which is Mr. Clark's latest invention, when it is put into use, will be better than we have had before There has been a considerable increase in our South African trade. We have Hart batteries in use out there and if these prove successful we may look for a great increase in our trade with that part of the world. I think we ought to pay a just tribute to our manager and the staff in general for the enthusiasm with which they have worked during the year. Unless we had our men working with the feeling that they are being paid for what they are doing and that they are working for generous masters I do not think we could have attained the results we have to-day. The orders received for the current year so far are about up to the average, but our sales are considerably more than the average of any preceding year. I now move the adoption of the report.

Mr. S. W. HART seconded the motion, and it was carried unanimously.

The dividend of 12½ per cent. (less tax) was then approved, and the retiring directors (Mr. G. W. Kidd and Mr. George Hay) were re-elected.

The CHAIRMAN proposed a vote of thanks to the manager, secretary, and staff, and praised their energy and devotion to the interests of the company.

Mr. GEORGE HAY seconded, and said Mr. Clark had thrown his whole heart and soul into his work, and in their secretary (Mr. J. H. Poulton) the directors placed the utmost confidence.

The vote was carried unanimously.

Mr. CLARK said the company had done about £15,000 worth more work in 1903 than in the preceding year, but on account of keen competition they had had had to sacrifice a certain amount of profit.

Mr. POULTON also acknowledged the vote.

A vote of thanks to the chairman was carried, and after an extraordinary general meeting had approved resolutions to increase the capital of the company from £40,000 to £60,000, the proceedings terminated.

BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)—The chairman (Sir John A. Willox, M.P.), at the meeting on Friday last, said there had been a substantial increase in the number of their consumers and lamps connected. The latter was the largest they had had—15,624 8 c.p.—bringing up the total to 60,540 8 c.p. lamps. Since the end of the year the progress continued unchecked. There was a steady and continuous increase in revenue and in the profit realised. In the four years that the company had been at work the gross profits had grown from £144 to £11,041. After meeting all charges, there was a net profit in 1902 of £2,909, and last year £8,001. In 1902 they set aside £1,000 for depreciation, and last year they had increased the amount to £1,250, and they had also written off last year £1,185 from preliminary expenses. After making these provisions and providing for interest, the surplus was £5,219. They might have declared a dividend of 3 or 4 per cent. for the year, and as they were large shareholders their natural bias was in that direction, but on consideration they had come to the conclusion that in the permanent interests of the company it would not be judicious to pay a dividend this year. The bill promoted last session to acquire the Lewisham and Penge undertakings and to purchase the undertaking of the Crystal Palace District Electric Light Co. had been passed and the transfer took place on Sept. 30 last. After protracted negotiations a provisional agreement had been entered into for the purchase of the whole undertaking of the Crystal Palace Company, including

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generating stations, mains, &c., for £67,500, payable in instalments. The total expenditure on capital account to Dec. 31, 1903, had been £121,408, so that they propose to acquire the concern for little more than half its original cost.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for the year ended December 31 shows a credit balance of £29,233. 18s. 1d., or with £888. 8s. 3d. brought forward and £335. 7s. 10d. interest received, £30,457. 14s. 2d. Deducting £2,424. 3s. for interim preference dividend and £5,881. 11s. 10d. interim ordinary dividend at the rate of 9 per cent. per annum for the half-year to June 30, the directors recommend that the remaining £22,151. 19s. 4d. be dealt with in applying to depreciation £7,500, balance preference dividend £2,307. 17s., balance ordinary dividend at the rate of 11 per cent. per annum (making 10 per cent. for the year) £7,357. 16s. 3d., directors' additional remuneration £806. 18s., leaving £4,179. 8s. 1d. to be carried forward. The particulars published with the report show an increase of 17,527 8 c.p. lamps over 1902, bringing the total to 154,853, an increase in number of customers connected from 2,979 to 3,326; gross revenue increased from £45,655. 2s. 7d. to £50,272. 18s. 7d., expenditure increased from £19,036. 4s. 8d. to £21,039. 0s. 6d. and net receipts from £26,618. 17s. 11d. to £29,233. 18s. 1d.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for the year 1903 states that the profit amounted to £33,054. 19s. 2d., or, with £311. 12s. 10d. brought forward, £33,366. 12s. After deducting interest (£6,815. 1s. 5d.), interim preference dividend (£900), interim ordinary dividend of 4 per cent. per annum (£4,443. 12s.) and amount written off suspense account (£1,607), there remains £19,600. 11s. 7d., and the directors recommend that £9,724 be placed to renewals and depreciation, £900 to balance of preference dividend, £7,776. 6s. for a further dividend at the rate of 7½ per cent. on the ordinary shares (making 5½ per cent. for the year), leaving £1,200. 5s. 7d. to be carried forward. The increased business of the year has been accompanied by an actual reduction in working costs. Further capital expenditure of £3,026. 2s. 7d. has been incurred during the year in connection with changing the system of supply from 100 to 200 volts pressure. The number of lamps connected on Dec. 31 was 195,235, an addition of 19,233 during the year, and the improvement in the units sold per lamp continues. The total number disposed of in 1903 was 2,739,352, or 481,793 more than the previous year.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The report of the directors for the year ended Dec. 31 states that the expenditure on capital account for the year amounted to £81,029. 12s. 7d. The total revenue (including interest on deposits, investments, &c.) was £242,885. 19s. 5d., and total expenses (including interest transferred to debenture stock premium redemption and staff superannuation) £109,965. 15s. 11d., leaving £132,920. 3s. 6d., added to £22,619. 3s. 5d. brought forward, making £155,539. 6s. 11d. From this sum debenture interest absorbs £31,825, and reserves £45,500, leaving £78,214. 6s. 11d. The directors recommend the following dividends for the year:—Preference 12s. per share (6 per cent.), of which half was paid in July; ordinary 10s. per share (5 per cent.), of which half was paid in July. The dividends absorb £56,332. 12s. 6d., leaving £21,881. 14s. 5d. to be carried forward.

In the private supply of current the average prices obtained by the company have decreased from year to year since 1897 from 7·30d. to 3·72d in 1903. During 1903 the number of customers being supplied with current increased from 10,988 to 11,197, and the equivalent number of 8 c.p. lamps connected from 574,158 to 640,685. On Feb. 10, 1904, there were 700,766 equivalent 8 c.p. lamps applied for, out of which 661,195 were connected, and the number of customers was 11,255. The units sold during the year (excluding public supply) numbered 13,596,075, compared with 12,988,615 in 1902 and 11,526,951 in 1901, and the gross revenue showed a decrease from £250,667 to £242,886. The balance to credit of reserve at Dec. 31, 1903, was £219,642. 8s. 11d., in addition to debenture stock premium fund, £50,860. 2s. 4d.

Contracts with the Corporation of London—The judgment of the House of Lords in August last had, in effect, reference only to the public lighting of the main thoroughfares of the City, and does not in any way affect the validity of the company's statutory powers for the supply of electricity for lighting and motive power to private consumers throughout the City. The company is continuing the supply to the public street lamps as heretofore.

W. T. HENLEY'S TELEGRAPH WORKS (LTD.)—The directors 'report for 1903 states that the net profit was £44,450. 3s. 6d. After payment of directors' and auditors' fees, interest and income tax, and making the usual allowance for depreciation of buildings, plant, machinery, &c., there remains £36,742. 13s. 6d., or, with £25,967. 13s. 11d. from last year, £62,510. 7s. 5d. £1,000 has been transferred to debenture redemption fund, and the directors recommend payment of a dividend on the ordinary shares at the rate of 15 per cent. (less tax). An interim dividend of 6 per cent. has been paid. Including the preference dividend for the year, these items amount to £3,5125, leaving £27,585. 7s. 5d. to be carried forward. The directors have elected Sir Alfred C. Lyall, G.S.I.E., K.C.B., to a seat on the board.

LONDON ELECTRIC SUPPLY CORP. (LTD.)—In their annual report for the year ended Dec. 31 last the directors show that the profit was £36,177. 19s. 9d., or with interest and amount brought forward (£1,576. 8s. 7d.) £37,754. 8s. 4d. Out of this sum interest to Dec. 31 (£14,816. 1s. 9d.) has been paid, leaving £22,938. 6s. 7d. The directors propose to pay the balance dividend on the preference shares, requiring £14,952, to put £6,000 to reserve, and to carry forward £1,986. 6s. 7d. Supply of current has been efficiently maintained during the year, and the cost of production still further reduced. The number of lamps connected has been increased by 9 per cent., or the equivalent of 17,877 lamps of 8 c.p. Capital expenditure was £36,198. 0s. 10d., necessitated by the expansion of the company's lighting business and the contract with the London County Council to supply power to their tramways in South London. This supply commenced on Jan. 17 and is tending, as expected, to reduce the average cost of generation. The company is approaching the limits of the capital powers created in 1888, and the directors recommend the creation of 20,000 more preference shares. The plant and machinery have been maintained out of revenue, and are in efficient condition.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The chairman (Dr. John T. Merz) at last week's meeting said that 9,633,625 units of current were sold during the year, against 5,537,500 in the previous year. In previous year more than half the units sold were in connection with the Walker and Wallsend Gas Co. Last year they had taken over the business of the Walker and Wallsend Co., and became not only sellers but distributors. They had, therefore, to bear the additional cost of distributing, which was considerable. The County of Durham Power Co. had received a large supply in bulk to their station at Gateshead, and a smaller quantity had been sold to the Tyneside Tramways Co. The gross profit for the year was £42,567. 4s., against £26,522 the year before. The company had acquired an interest in the Priestman Power Co. At first that company limited its operations to Newcastle, but they had not lost sight of the fact that the company desired to extend its operations over Northumberland and Durham.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—At the meeting on Monday the chairman (Mr. J. E. Ellis, M.P.), said the additional expenditure during the year of £11,030. 11s. 10d. was made up of four items—the acquisition of new offices, the laying down of new machinery (including a new 500kw. generator), the relaying, improvement and extension of mains throughout the borough, and the enlargement of the generating station for the reception of the new machinery necessary for traction. With respect to the generating station there had been an outlay of £11,000. To meet that expenditure there had been an increase of capital during the year of £10,000. They had called up all the money due on the 8,000 shares, and had issued another 1,000 shares, on which on the last day of the year there was £1 called up. They would call up all those shares during the year. With regard to premiums, he held that all premiums should go to reserve, depreciation or something of that kind, and dividends should not be enhanced by premiums. There had been written off depreciation £1,400. Their total revenue amounted to £11,232, an increase of about 10 per cent. on the year. The balance divisible was £5,890. They paid in August a dividend of 2½ per cent. (5 per cent. per annum for first half-year) which absorbed £1,775. There was now, therefore, available for dividend £3,562. They proposed to pay 4½ per cent., which would absorb £3,504, and carry forward £57. They had entered into an agreement during 1903 with the tramway company on terms satisfactory to both parties, which would result in their machinery being employed during the daytime.

SOUTH LONDON ELECTRIC SUPPLY CORP. (LTD.)—The directors' report for the year ended Dec. 31 shows total receipts for the year £45,273. 14s. 11d., outgoings £26,337. 8s. 6d. After placing £4,000 to depreciation (bringing this fund to £6,448. 5s. 7d.) and writing £4,020 off preliminary expenses, there is a balance of £10,160. 16s. 1d. The directors recommend a dividend of 3 per cent. per annum, carrying forward £410. 16s. 1d. The plant, machinery and mains have been maintained in a high state of efficiency. The supply of power to London County Council for working the tramways was commenced on May 15, and has been uninterruptedly continued since, resulting in a considerable reduction in cost per unit sold. At the end of 1903 there were connected to the company's mains the equivalent of 91,902 8 c.p. lamps, an increase of 19,301 lamps for the year, or over 26 per cent. At the present time the number on circuit is 92,321, besides applications for a further 5,000.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26⅝d. per oz. (March 3). Consols 85¼—85⅝ for money, 85¼—85⅜ for account; 2½ per cent. annuities 85—85¼ (March 3). Consols Pay Day, April 7; Stocks and Shares Continuation Days, March 8 and 26; Ticket Days, March 9 and 27; Pay Days, March 10 to 28; Mining Share Carry-over Days, March 7 and 25.

COMMERCIAL CABLE CO. (LTD.)—A quarterly dividend of 2 per cent. on the capital stock has been declared, payable April 1, out of the net earnings of the company. The transfer books will be closed on March 30 and re-opened on April 5.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)—The directors recommend the payment of final dividend upon the ordinary shares at the rate of 4 per cent. per annum (less tax) for the half-year ended Dec. 31 last, making 4 per cent. for the year (after taking £10,000 from revenue for depreciation, &c., and carrying forward over £5,000); and the balance dividend on the 6 per cent. preference shares for the half-year to the same date (less tax). The transfer books are closed from 3rd to 14th inst. inclusive.

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ABERDEEN SUBURBAN TRAMWAYS CO.—At the meeting on Monday the directors' report stated that a contract with J. G. White & Co. had been arranged for the construction of the Donside line and the Deeside line as far as Bieldside.

BLACKPOOL AND FLEETWOOD TRAMWAYS CO.—The directors' report states that, including the amount from last year, the balance of profit, after providing for interest, is £10,678, and the directors recommend a dividend of 9 per cent. per annum. This was agreed to at the meeting on Friday last.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—At the meeting last week the chairman (Mr. D. Munsey) said that the new provisional order authorised extensions outside the limits of the borough and the company had already spent between £1,500 and £1,600, which they regarded as a lucrative investment. They had sold 40,000 units more than in the previous year. They proposed to place £1,500 to depreciation. The progress of the company continued satisfactory, and after July they intended to make a reduction in the price of electricity from 7d. to 6d. per unit. Mr. A. A. Campbell Swinton said that some time ago the British Electric Traction Co. proposed to take over and electrify the Cambridge tramways system, and an agreement was made by which their company were to supply electric power, which would mean a revenue of about £2,000 a year. Nothing had yet been done in the matter, however.

CONSOLIDATED ELECTRICAL CO. (LTD.)—Warrants for the payment of the interim preference dividend have been posted.

ISLE OF MAN RAILWAY CO.—Sir J. Denison-Pender presided at the annual meeting at Douglas on Saturday last, and announced that arrangements had been made to purchase the Manx Northern Railway and the Foxdale Railway Companies' undertakings for £67,000. The company would, he believed, benefit by the purchase, and the shareholders in the purchased companies would receive a sure return on their investments.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors have decided to recommend a final dividend of 9s. 6d. per share, being at the rate of 9½ per cent. per annum, making a total dsitribution of 17s. 6d. per share, or 8¾ per cent., for the year. £18,000 has been placed to depreciation and reserve and £2,485 carried forward.

NORTHALLERTON ELECTRIC LIGHT AND POWER CO. (LTD.)—At the meeting last week, the directors' report stated that the profit for 1903 was £262. 12s. 7d., compared with £152. 4s. 6d. last year; but after paying interest (£218. 4s. 3d.) and providing for depreciation on motors, meters and free-wired installations there was a credit balance of £44. 8s. 4d., compared with a debit balance of £34. 10s. 3d. The demand for current for both lighting and motive power is steadily increasing.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered the further issue of £12,500 4 per cent. perpetual first mortgage debenture stock of the *Electric Construction Co. (Ltd.)* and £50,000 4½ per cent. debenture stock of the *Isle of Wight Electric Light and Power Co. (Ltd.)* to be quoted in the Official List.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—The Hon. Sydney G. Holland has been elected a director of this company.

VICKERS, SONS AND MAXIM (LTD.)—The directors recommend the usual preferred and preference dividends, and a further dividend of 1s. 3d. per share (tax free) on the ordinary shares, making 2s. per share (10 per cent.) for year. £85,000 is carried forward, after placing £100,000 to reserve.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

CLEMINSON ELECTRIC LAMP ATTACHMENT (LTD.)—Reg. Feb. 25, capital £2,500 in £1 shares, to adopt agreement with N. Cleminson and to carry on the business of electric light engineers, electricians, contractors, manufacturers of and dealers in electrical, telegraph, telephone and traction supplies and appliances, manufacturers of switchboards, switches, cables, electrical plant, instruments, appliances, &c. First directors, J. Allen, D. E. Anderson and F. K. Macmorran. Reg. office, 19 and 20, York-chambers, 27, Brazennose-street, Manchester.

RHODES ELECTRICAL MFG. CO. (LTD.)—Reg. Feb. 25, capital £60,000 in £1 shares (2,000 deferred), to acquire business of manufacturing electrical engineers carried on at Bradford and London as the Rhodes Electrical Mfg. Co., to adopt an agreement with A. L. Rhodes, S. H. Fielden, J. A. Halford and H. H. Hopkins, and to carry on the business of electricians, electrical, mechanical and general engineers, makers of electric tramcars, motor cars, carriages, makers of and dealers in electric light cables, telegraph and other wires and accessories, dynamos, motors, telephones, bells, electroliers, arc and other lamps, electric light fittings, heating and cooking apparatus, insulating materials, &c. The subscribers are H. Holt, electrical engineer, F. Maddocks, T. J. Booth, May W. Vockers, F. Hertzberg, Ethel C. McDonald and H. H. Hopkins, engineer. Reg. office, 70, Bishopsgate-street Within, London, E.C.

RHODES ELECTRICAL (PARENT) SYND. (LTD.)—Reg. Feb. 25, capital £5,000 in 4,925 ordinary shares of £1 each and 1,500 deferred shares of 1s. each, to carry on business of electricians, electrical and general engineers, electric tramcar and motor-car manufacturers, manufacturers of electric cables, wires, fittings, &c. Reg. office as above.

TRAMWAYS EXTENSION SYND. (LTD.)—Reg. Feb. 23, capital £5,000 in £1 shares, to acquire or construct and work (by electricity or other power) tramways, railways, &c.

VAUGHAN, BROWN & CO. (LTD.)—Reg. Feb. 24, capital £15,000 in £1 shares (8,000 preference), to acquire the business of electric light and ventilating engineers and art metal workers carried on as Vaughan and Brown, to adopt an agreement with T. W. and G. C. Vaughan, and to carry on the said business and that of manufacturers of and dealers in motors, batteries, arc and incandescent lamps, electroliers, art metal work, chandeliers, electric light fittings, &c. The subscribers (with 100 preference shares each) are J. S. Shendar, H. Marlow, engineer, A. Balderson, E. I. P. de Laroque, T. W. Vaughan, engineer, E. S. Fergusson, J. W. Hyde and F. S. Guy, engineer.

MORTGAGES AND CHARGES.

DERBYSHIRE AND NOTTINGHAMSHIRE ELECTRIC POWER SYND. (LTD.)—Memorandum of satisfaction in full of charge dated March 19, 1902, securing £9,000, has been filed.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Feb. 27	1,067	+ 244	39	47,327	+ 9,301
Airdrie	,, 19	201	...	2	328	...
Ayr Corporation	,, 20	159	- 1	40	11,520	+ 180
Barnsley	,, 19	151	- 9	7	1,044	- 81
Barrow	,, 19	143	+ 87	2	313	+ 198
Bexley District Council	,, 26	134	...	21	3,141	...
Birkenhead	,, 28	927	- 9	...	...	...
Birmingham Corporation	,, 27	306	...	8	2,355	...
*Birmingham Tramways Co.	,, 27	4,976	‖+ 65	8	40,879	+ 2,618
*Blackburn Corporation	,, 26	734	+ 93	§48	40,268	+ 2,021
Blackpool Corporation	,, 25	290	- 27	§47	40,214	- 294
Blackpool and Fleetwood	,, 27	163	- 43	9	1,529	- 81
Blackp'l, St. Anne's & Lytham	,, 25	143	+ 143	†17	2,497	+ 1,917
Bolton Corporation	,, 28	1,547	- 58	48	86,748	+ 8,977
Bournemouth Corporation	,, 24	863	...	47	47,961	...
*Bradford Corporation	,, 28	3,332	+ 103	46	178,467	+ 22,786
Brighton Corporation	,, 28	672	- 28	47	42,729	+ 2,600
Brisbane Tramways	Jan. 18	2,297	- 16	2	4 353	- 98
*Bristol Trams & Carriage	Feb. 26	4,358	+ 24	14	62,967	+ 2,491
*Buenos Ayres & Belgrano	Jan. 31	2,962	+ 117	15	50,551	+ 2,713
Burnley Corporation	Feb. 27	861	+ 195	48	46,905	+ 9,011
Burton Corporation	,, 28	275	...	30	10,278	...
Calcutta Tramways Co.	,, 27	R36,178	+ R4,770	9	R312,255	+ R60,371
Camborne-Redruth	,, 29	91	...	17	1,907	...
Cardiff Corporation	,, 27	1,779	+ 188	48	93,339	+ 22,960
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 27	7,138	+ 74	9	63,117	+ 480
Chatham & Dist. Lt. Rys.	,, 25	474	+ 70	8	4,007	+ 571
City & South London Rly.	,, 28	3,127	+ 30	9	28,890	- 589
Cork Electric Trams Co.	,, 25	367	- 19	8	3,117	+ 2
Darwen Corporation	,, 26	200	- 16	48	10,780	- 280
Devonport & Dist. Trams	,, 19	419	+ 33	7	3,235	+ 497
Dover Corporation	,, 27	154	- 14	†48	10,495	+ 26
Dublin & Lucan Railway	,, 28	84	+ 23	9	781	+ 61
Dublin Southern District	,, 26	655	+ 26	} ¶8	35,185	+ 424
Dublin United	,, 26	3,491	- 11			
Dudley—Stourbridge	,, 19	732	+ 24	7	5,088	+ 208
Dundee Corporation	,, 24	759	- 11	40	34,098	+ 2,027
East Ham Council	,, 27	598	+ 105	†48	31,465	+ 8,578
Gateshead & Dist. Trams	,, 19	844	+ 24	7	6,131	+ 292
Glasgow Corporation	,, 27	12,997	+ 823	39	530,496	+ 53,349
Gravesend—Northfleet	,, 19	208	+ 31	7	1,457	+ 222
Gt. Northern & City Rly.	,, 27	888	...	2	1,740	...
Greenock & Port Glasgow	,, 19	458	+ 17	7	3,337	+ 457
Halifax Corporation	,, 17	1,030	- 65	} 47	62,295	+ 6,275
	,, 24	1,083	+ 36			
Hartlepool Tramways	,, 19	240	+ 18	7	1,741	+ 215
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 28	1,895	+ 192	†48	91,583	+ 7,279
Ilkeston Corporation	,, 24	122	...	15	1,793	...
Ipswich Corporation	,, 27	302	...	8	4,174	...
Isle of Thanet Co.	,, 28	218	- 32	...	...	...
Kidderminster & District	,, 19	96	- 7	7	649	- 56
Kirkcaldy Corporation	,, 24	247	...	52	9,482	...
Lanarkshire Trams Co.	,, 25	553	...	8	4,631	...
Leeds Corporation	,, 27	4,763	+ 137	47	259,818	+ 15,632
Liverpool Corporation	,, 20	9,257	+ 143	8	76,116	+ 2,886
*Liverpool Overhead Rly.	,, 28	1,477	- 2	9	13,694	+ 356
*London County Council	,, 20	9,653	+ 1,349	†47	458,670	+ 80,327
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 27	10,578	+ 2,456	36	424,732	+ 189,114
Mersey Railway	,, 27	1,377	+ 265	8	11,444	+ 2,810
Merthyr	,, 19	187	+ 10	7	1,324	+ 126
Middleton	,, 19	226	+ 1	7	1,700	+ 90
Newcastle-on-Tyne Corp.	,, 27	3,323	+ 250	8	27,670	+ 3,984
Newport (Mon.)	,, 27	417	+ 176	22	9,649	+ 5,946
Oldham, Ashton & Hyde	,, 19	472	- 39	7	3,465	- 232
Perth (W. A.) Elec. Trams.	,, 26	1,320	+ 177	8	11,273	+ 1,495
Peterborough	,, 19	108	- 6	7	776	- 151
Poole and District	,, 19	229	- 17	7	1,548	- 69
Portsmouth Corporation	,, 27	1,301	+ 108	†48	82,004	+ 5,557
*Potteries	,, 19	1,560	+ 86	7	11,358	+ 738
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 19	37	- 3	7	303	+ 12
Salford Corporation	,, 29	3,511	+ 678	48	182,354	+ 50,847
Sheerness	,, 17	46	...	7	315	...
Sheffield Corporation	,, 28	4,091	+ 1	†49	218,598	+ 17,839
*Southampton Corporat'n	,, 25	819	+ 15	8	6,787	+ 296
Southend Corporation	,, 24	229	+ 41	47	14,626	+ 2,255
Southport Tramways	,, 19	236	+ 9	7	1,680	+ 155
S. Staffordshire Trams.	,, 19	720	+ 47	7	5,136	+ 344
Sunderland Corporation	,, 28	1,024	+ 40	48	57,535	+ 2,747
*Swansea Trams	,, 19	430	+ 21	7	3,261	+ 184
Taunton Trams	,, 19	45	- 3	7	332	- 11
Tynemouth and District	,, 19	198	- 13	7	1,446	- 14
Tyneside Trams Co.	,, 24	276	+ 36	8	2,160	+ 443
Wallasey District Council	,, 27	550	+ 46	†48	32,416	+ 3,887
Weston-super-Mare	,, 17	22	- 7	7	156	- 14
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 19	334	- 22	7	2,298	- 85
Worcester	,, 19	264	+ 126	2	546	+ 266
Wrexham	,, 19	94	...	7	683	...
Yorkshire Woollen District	,, 19	483	+ 422	7	3,488	+ 422

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., Mar. 2	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Mar. 2 Highest.	Business Week to Mar. 2 Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅛—4⅞	5 2 6	April, Oct	4⅛ ..	..
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
St.	3½	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	99½	..
10	10/0	Barcelona Tramways Ord.	7 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	93½	92½
5	..	Brisbane Electric Trams. Invest. Ord.	2 —3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	8¾—4½	5 17 8	..	98½	98½
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	..	..
10	8%	†Bristol Tramways and Carriage Ord.	19½ —20½	4 10 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10½—10¾	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	82 —85	3 11 5	..	84½	84
St.	5%	Do. Pref. Ord. Stock	95 —98	5 3 3	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	4 13 0	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103¾—105%	4 7 0	..	..	..
100	4½	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9 —10	8 0 0	..	10 1/16	9 1/16
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11½	5 5 4	Feb, Aug	11	10 1/16
St.	5/0	Do. 5 per Cent. Perpetual Debs.	120 —123	4 1 4	..	122½	120½
5	..	Buenos Ayres and Belgrano Ord.	2¾—3	..	..	2¾	..
5	3/0	Do 6 per Cent. "A" Cum Pref.	5¼—5¾	5 4 0	..	5⅝	5⅛
5	3/0	Do. "B"	4¾—5¼	5 14 3	..	5	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	..	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 —100	5 0 3	..	..	..
5	2 6	Calcutta Tramways	6¼—7	4 12 10	..	6⅛	6⅛
100	4½%	Do 4½% 1st Deb. Stock (red.)	104 —107	4 4 2	..	106½	104½
1	1/0	Cape Electric Tramways Shares	1⅝—2	8 10 0	..	1⅞	..
St.	4%	Central London Ordinary Stock	92 —95	4 4 4	June, Dec	94⅛	93⅛
St.	4%	Do. 4 per Cent. Pref. Stock	97 —100	4 0 3	..	..	..
St.	4%	Do. Deferred Stock	86 —89	4 9 11	..	87½	..
100	4%	Do. 4 per Cent. Debs.	110 —115	3 9 9	..	110⅜	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾ - 5¼	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2%	City and South London Rly. Con. Ord.	49 —52	4 11 4	Feb, Aug	51	50½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	3 19 4	Feb, Aug	..	..
St.	5%	Do. (1896)	119 —122	4 2 0	..	..	..
St.	5%	Do. (1901)	118 —121	4 2 8	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	110⅜	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	102 —105	4 16 5	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½ —13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	3 —4	7 10 0	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 —8	3 15 0	..	7½	7⅜
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Spever Bros. Scrip Certs.	9 —10	..	..	..	..
10	9%	†‖Imperial Tramways Ord	19½ —20½	4 7 10	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	†Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	†Liverpool Overhead Railway Ord.	4⅛—4⅜	2 16 5	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	9¾—10½	4 17 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	95½ —100½	3 19 10	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11¼—11¾	4 5 1	..	11⅜	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	102 —104	3 17 4	..	103½	102
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	.. ..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅜—⅝	..	..	⅝	..
1	0/6	Do. 5% Cum. Pref.	⅛—⅜	4 8 11	..	..	..
100	5%	†Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	101 —103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	104 —106	4 4 11	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	..	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½—9½	5 5 3	..	8⅝	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	.. ..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	.. ..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	.. ..	..	Jan, July	..	..
St.	3%	†Waterloo and City Ord.	83 —91	3 8 8	June, Dec	90	89
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2⅛—3⅛	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	.. ..	..	..	..	..
St.	16/0	†Anglo-American	49 —52	5 17 3	F,My,Ag,N	49	..
St.	30/0	† Do. Preferred	92 —94	6 7 8	F,My,Ag,N	93½	92½
St.	2/0	† Do. Deferred	7 —7½	1 6 8	F,My Ag,N	7¼	7⅛
100	$2	Commercial Cable Capital Stock	180 —190	4 4 5	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 —91	4 8 3	Jn Ap,Jy,O	90¾	90½
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2¼—2½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7¼—8¼	5 17 8	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝—101⅝	4 9 1	Jan, July	..	..
20	3/0	Direct United States Cable	9⅛—10¼	6 6 10	Ja,Ap,Jy,O	10⅛	9⅛
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —101	4 9 1	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	117 —122	5 14 9	Ja,Ap,Jy,O	121	118½
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —90	3 17 10	Ja Ap,Jy,O	..	..
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	105 —108	3 14 1	May, Nov	105	..
10	2/6	Eastern Extension	10¾—11½	6 4 5	Ja,Ap,Jy,O	11	10⅜
St.	4%	Do. 4 per Cent. Deb. Stock	104 —107	3 14 9	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	98 —101	4 0 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝—102⅝	3 18 11	May, Nov	101½	..
10	5/0	Great Northern of Copenhagen	23½—24½	5 2 1	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	12/6	Indo-European	38 —41	6 1 11	May, Nov	40	39⅜
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..
2½	..	West Coast of America	⅛—¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	11⅜—12⅝	5 14 8	Mr,Jn,O,D	12⅜	11⅞
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 —103	4 18 2	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 3	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8¼—8¾	4 11 5	Ja Ap Jy O	8⅞	8½
10	3/0	Do. 6 per Cent. Pref.	12½—12¾	4 14 2	Ja Ap,Jy,O	12⅛	12½
5	4/0	Reuter's	6¾—7½	5 6 8	April, Oct	..	..
1	6%	Submarine Cables Trust (Cert.)	115 —120	5 2 2	April, Oct	..	..

Share.	Last Dividend	Name.	Price Wed., Mar. 2	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Week to Mar. 2 Highest.	Business Week to Mar. 2 Lowest.
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	4⅜—5¼	5 14 3	August ..	..	..
St.	6%	†National Co. Pref. Stock	98 —100	6 0 0	..	..	100½
St.	5%	† Do. Def. Stock	73 —76	6 11 8	..	..	76½
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	13 1/16	..
10	6/0	† Do. 6 per Cent. Cum. 2nd Pref.	13½ —14½	4 2 9	Feb, Aug	..	..
5	2/6	† Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5½	4 15 3	Feb, Aug	5 1/16	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 —97	3 12 2	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	100 —102	3 18 5	..	..	101⅛
		ELECTRICITY SUPPLY.					
		Blackheath & Greenwich Dist. Ord. (f.p.)	⅜—⅝	..	..	..	..
1	..	Do. 7% Cum. Pref.	1⅜—1⅝	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	115 —118	3 17 4	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12⅜—13⅜	5 18 6	..	..	12½
10	4/6	Do. 4½ per Cent. Cum. Pref	9⅜—10⅜	4 5 9	..	..	9½
10	6/0	Do. 6% Cum. Second Pref.	10⅞ —11⅞	5 4 4	..	..	..
St.	5/0	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10 —10¼	4 15 3	..	..	10⅛
5	3/6	Do. 7 per Cent. Pref.	9⅜—10⅛	3 8 4	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord. ex rights	6 —7	4 12 10	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7⅛ - 8⅛	4 14 2	Feb, Aug	7⅛	7⅛
5	2/3	Do. 4½ per Cent. Pref.	4¾—5¼	4 5 9	Feb, Aug	5¼	5¼
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾—5	4 10 0	..	..	..
5	1/7	Do. Do. (1903)	4¾ - 5	..	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 8	..	..	..
5	2 0	Chelsea Electric Supply Ord.	5⅛—6	4 11 8	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 3 1	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10⅜—11⅛	6 18 4	Feb, Aug	11⅛	10⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7⅛ - 8⅛	4 14 2	..	8⅛	7⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	11⅛—12⅛	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	104 —109	4 2 11	..	..	108
St.	27/6	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	..	100½
5	2/0	Folkestone Electricity Supply Co. Ord.	5⅜—6⅛	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 3	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7⅜—8⅜	5 0 0	..	..	..
St.	..	I of W. Elec Lt. & Power 4½% Db St (red.)	100 —105	..	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅜—⅝	..	..	..	..
5	7 0	Kensingtn & Knghtsbdge Ord and Cnous	10¼ —11½	5 4 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6⅜—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	103 —106	3 16 2	..	..	..
3	..	London Electric Supply Ord.	1½—2	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	4¾—5¼	5 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 1	Mr,Jn,S,D	97½	..
10	8 0	Metropolitan Electric Sup. Ord.	17½ —18½	4 3 9	April, Oct	18⅛	18⅛
5	..	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	..	..	..	5½
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 9	..	98½	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6.0	Notting Hill Electric Ord.	13 —14	4 5 9	March ..	13 1/16	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
5	2 6	Oxford Electric Ord.	5⅛—6	4 11 8	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97 —100	4 0 3	..	..	..
1	..	Rand Electric	⅞—1	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅛	14⅛
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	†Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	1/9	South London Electric Supply Ord.	3½ - 4	2 8 9	..	3⅝	..
5	2/6	Urban Electric Supply Ord.	4⅜ 5	5 0 0	..	4⅛	..
5	2/6	Do. 5% Cum. Pref.	4⅜—5⅛	4 17 7	..	..	..
5	7/0	†Westminster Electric Supply Ord.	12⅞ —13⅛	5 0 0	Mar, Sept	13	12¾
5	¾/6	Do. 5 per Cent. Cum. Pref.	6 —6⅛	3 16 11	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜—⅝	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	1/16—⅛		Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5¼—5⅝	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
St.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt. Db.	100 —103	4 7 5	..	..	101½
5	3/0	British Westinghouse 6% Pref.	3⅜—4⅛	7 1 2	..	..	3⅜
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 8 4	..	..	..
2	..	Brush Electrical Engineering	½ —1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1 —1½	8 0 0	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Db. Perpetual 2nd Deb. Stock	73 —78	5 16 6	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 6 11	Jan, July	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 8	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
1	0,7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½ —2	7 10 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8 —8½	..	..	..	..
5	..	Do 6% Cum. Pref.	5⅜—5⅝	..	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½—1	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6⅛	5 12 0	H'lf-yearly	5⅛	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜—6⅛	4 16 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 4 11	..	105	..
2	1/2½	Electric Construction Co.	1⅛—1⅜	6 7 1	Jan, July	1⅛	1⅛
2	2·9⅜	Do. 7 per Cent. Cum. Pref.	2⅜—3	4 13 4	July ..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	½—¾	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅛—9⅜	5 2 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 —98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	12 —13	7 13 10	Feb, Aug	12⅛	12
5	2/3	Do. 4½ per Cent. Pref.	5 —5¼	4 1 10	Feb, Aug	5⅛	..
St.	4½%	† Do. 4½ per Cent. Mort. Deb. Stock (rd.)	106 —110	4 1 10	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 —103	3 17 4	Mar, Sept	..	..
10	5/0	†Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	105	..
12	12/0	Telegraph Construction & Mainten'ce.	83 —86	6 13 4	Mar, July	3½	3½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	3⅛—4⅛	7 4 5	Apr, Oct	..	..
		Do. 6 per Cent. Cum. Pref.	5 —5½	5 9 1	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 5	May, Nov	..	..

In cases having the yield, allowance has been made for accrued interest, but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these.

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NOTES.

WE publish in another column Mr. H. FARADAY PROCTOR'S final report on the Bristol fire. Of the three primary causes of the conflagration which he suggests, the second is particularly worthy of consideration. If it is conceivable that design of the cable terminal head is such that an arc could form in the event of a breakdown within the head itself or at the point where the cable enters it, this constitutes a source of considerable danger, and should be carefully considered by central station engineers. The suggestion that the arc should have occurred at the fuse itself can only hold good on the assumption that the fuse-holder was not filled with oil, in which case, of course, the whole circumstance is explainable. A source of possible trouble which Mr. PROCTOR does not mention is the clip-contact arrangement at the back of the fuse compartment on the switchboard; heating or slight arcing there might not be perceived for some time, and as soon as the arc, whether from the cable head, the fuse itself or its connecting clip, had become intense enough to crack the porcelain vessel and allow the oil to leak out freely, the fire would take a firm hold. Mr. FARADAY PROCTOR deserves the thanks of other supply station engineers for putting all the facts before them so that considerable improvements in switchboard arrangements generally may result.

PROF. J. J. THOMSON'S Paper on "The Structure of the Atom," appearing in the current issue of the *Philosophical Magazine*, will be read with intense interest and admiration by all who follow the electric theory of the constitution of matter. The gist of the Paper will be found in our Contemporary Electrical Science columns; but here we may lay stress on the most notable features of this remarkable essay. The task of handling mathematically the swarm of flying electrons which, it is supposed, constitute the material atom, is obviously a formidable one. Yet, in this Paper, Prof. THOMSON has made a huge stride towards the goal. Starting with the examination of the stability of a single revolving ring of equidistant electrons—an apparently highly artificial conception—he builds ring outside ring all in stable orbital motion round a common centre till highly complex systems are reached, all completely dissected. Keeping to the restricted case of steady motion in one plane, and provided with a tabular statement of the anatomy of a typical set of nine atoms, he then develops, lucidly and with great perfection, a wonderful theory of the chemical elements. He shows how, on the scheme suggested, the elements fall into groups such as are given by MENDELEËFF'S periodic table. He explains the varying chemical affinity and valency of the members of a group. He deduces the main laws of the line spectra of a series of elements; and, finally, presents the most suggestive conception yet offered of the mechanism of the radio-active elements. Taken as a whole, this contribution to the electronic theory of matter is one of the brightest modern examples of that process which KARL PEARSON has called "the scientific use of the imagination," and cannot fail to be a source of stimulus and inspiration to the workers in the swiftly growing branch of electricity it deals with.

THE activities of the new Faraday Society have already extended beyond this country, and may now be reckoned cosmopolitan. M. HOLLARD, a French electro-chemist of note, has quite recently presented to the Society his views on the separation of metals electrolytically by a special method of controlling the voltage necessary for their deposition. The central idea in M. HOLLARD'S method is to use as the cathode

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on which the metal sought is to be deposited a metal either identical with the metal to be deposited or but little removed from it in the electrolytic series. The philosophy of this procedure is evident. When two metals—for example, zinc and cadmium—are present together in a solution, and a current is passed at a voltage lower than that of zinc, cadmium is deposited; but if it is deposited on a platinum cathode at the low-current density necessarily employed when the available margin of pressure is small, the platinum cathode will not be covered completely and at a stroke with cadmium. Hence there will be a local couple of cadmium and platinum and the cadmium will tend to re-dissolve. Where, however, the cathode surface is cadmium itself, no such couple can be set up, and deposition proceeds smoothly at a pressure below that requisite to deposit zinc. It is doubtful whether the results of this mode of separation are sufficiently exact for analytical use, but, whether or no, they are illustrative of a luminous idea.

On another page of this issue will be found a copy of the sixth quarterly report relating to photometric tests of street lamps in the City of Westminster. Mr. J. W. Bradley is to be congratulated on the useful work which he is performing in making these tests and on the fact that he gives the results to the public. Coming from a disinterested source, the figures are particularly valuable, especially items 3 and 5. From these it will be seen that the total cost per candle-power per annum for electric arcs supplied by the Westminster Electric Supply Corporation works out at 8·73d., while the corresponding figure for Sugg's high-pressure, trident-form lamps is 7·65d. At first sight it appears as though there were some discrepancy in the figures, but a glance at the average total cost obtained over the whole series of six tests goes far towards setting matters right. The comparative figures in this case are 8·7d. and 9·85d., and the inference is fairly obvious. Naturally, the only reliable figure in work of this kind is an average one, and from the data given it would seem that the electric arcs remain practically constant, or, in other words, the total cost per candle per annum is almost equal to the average no matter when the tests and calculations be made. From knowledge of the "falling off" property of the incandescent mantle, however, it is at once apparent that everything depends on the particular time at which tests are made. It may therefore be safely assumed that the tests set forth in the sixth quarterly report were made at a time specially favourable to the incandescent mantles, hence the large difference between the one value and the average.

When the Patent Law Amendment Bill of 1902 was on its way through Parliament we warned our readers that its provisions were not likely to effect any substantial improvement in patent procedure, but the Bill aroused little general interest and was passed almost without alteration. We note now that considerable dissatisfaction was expressed with the Act yesterday at the meeting of the Associated and Chambers of Commerce of the United Kingdom. A resolution has been passed calling on the Government to amend the law further, so as to secure "the forfeiture of all patents for inventions workable in this country which are not so worked within a reasonable limit of time." The desire for such a provision is quite proper, and should have popular support in view of the present attitude of the country towards foreign manufactures generally.

In our Parliamentary columns this week will be found a report of the proceedings before the House of Commons Committee which is considering the North and South Woolwich electric tube railway. As an engineering feat the construction of this railway presents no features of uncommon novelty or ingenuity; but it affords another instance of vexatious municipal opposition. The London County Council nominally opposed the bill for the purpose of securing protective clauses, a matter of little expense to the ratepayers, but this opposition was somewhat skilfully developed into a preamble opposition, on the ground that the Council fears that the promoters have some subtle intentions of converting the line into a tramway. How a deep-level tube railway could possibly become a tramway is not evident, and the contention that the whole object of calling the line a railway is to evade the necessity of obtaining the Council's consent under Standing Order 22 can hardly be considered seriously. In addition, the County Council is endeavouring to secure the insertion of clauses, some of which would preclude all possibility of the necessary capital for this short tube railway being subscribed. One such clause was that in the event of the Bill being passed and the County Council subsequently deciding to construct a free subway close at hand, the Company would pledge itself not to claim compensation. If such a condition were included in the Bill, obviously no financier would put any money into the undertaking, and the promoters themselves readily admit this. As a reason for the insertion of this clause the Council alleges that it has already projected this free subway; but, strange to say, not even the town clerk of Woolwich (who was one of the witnesses for the promoters) had even heard of it.

The letter from Prof. Blondlot, which appears in our correspondence columns of this issue, while not productive of fresh evidence with regard to the existence of X-rays, is an emphatic affirmation of the distinguished physicist's unwavering faith in his previous observations. Owing to the exigencies of space we have been unable to give hitherto more than a brief abstract of his most important Paper on the subject, but this week we are at last able to give a translation of the Paper in full.

University of Sheffield.—The Privy Council has decided to grant a charter to Sheffield for a university.

Manchester Students' Section of the Institution of Electrical Engineers.—The following are the officers and committee for 1904-5:—

Mr. S. F. Barclay (of Owens College), Mr. J. W. Campbell, Mr. H. N. Dutton (British Westinghouse Co.), Mr. H. G. Edmunds (Electricity Works), Mr. C. F. Hewitt (Salford Technical School), Mr. E. G. L. Mosley (Messrs. Mather and Platt), Mr. H. Pomeroy (General Electric Co.), Mr. A. Ricketts (Manchester School of Technology, day department), Mr. A. Williams (Manchester School of Technology, evening department), Mr. Winstanley (Lancashire Dynamo and Motor Co.) Vice-chairman, Mr. J. W. Bell, hon. sec. Mr. John Roberts, jun.

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The Royal Society.—The Papers down for reading at yesterday's meeting were, on "Electric Resistance Thermometry at the Temperature of Boiling Hydrogen," by Prof. J. Dewar, F.R.S.; "A Study of the Radio-activity of certain Minerals and Mineral Waters," by Hon. R. J. Strutt, communicated by Lord Rayleigh, F.R.S; "Some Uses of Cylindrical Lens Systems," by G. J. Burch, F.R.S.

Glasgow Local Section of the Institution of Electrical Engineers.—A special smoking concert of the Glasgow Local Section of the Institution of Electrical Engineers will take place on Saturday, March 19th at the Grand Hotel, Charing Cross, Glasgow.

Electricity in its Infancy.—We have received the following inquiry and announcement:—

Mresses Electriaton Office:

Dear Sirs

please State if its know to man. Where Electricity is generated from. I mean the principl *Element*. I have made a little discovery.

yours faithfully

. . . .

The Lancashire and Yorkshire Railway.—The electrical equipment of the Liverpool-Southport line of the Lancashire and Yorkshire Railway is practically completed, and it is anticipated that the regular passenger traffic will be carried by electrically-propelled trains from about the 20th or 22nd of this month. Members of the technical press have been invited to view the line to-morrow, and we hope to publish a description of it in our next issue.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Mole St. Nicholas—Port-au-Prince	Dec. 16, 1903 ..	Mar. 8, 1904
Tarifa—Tangier	Jan. 18, 1904 ..	—
Oran—Tangier	Feb. 3, 1904 ..	—
Cape St. Jacques—Haiphong	Mar. 7, 1904 ..	—

Leeds University.—The following letter has been received by the Yorkshire College (Leeds):—

Privy Council Office, March 3, 1904.

GENTLEMEN:—The Committee of Council have carefully considered the statements made at the conference on the 2nd inst., and direct me to say that, under all the circumstances represented to them, they see no reason to modify their opinion that the proper title to be assumed by a university with its seat in Leeds is the University of Leeds. In coming to this decision, however, their lordships are not insensible to the valuable work done by the Yorkshire College for the county at large and to the significance of the arrangements by which representatives of the county and of the county boroughs are to be given a share in the government of the new university. But they feel obliged to recommend to His Majesty the restriction of the title as aforesaid, both on the score of precedent and convenience.—I am, Gentlemen, your obedient servant,

A. W. FITZROY.

The charter will now soon be laid on the table of the House of Commons, and there will probably be no further delay in the matter. About £40,000 has been promised towards the establishment of the new university.

The Junior Institution of Engineers.—This Institution will visit the works of the Electrical Power Storage Co. at Millwall to-day at 3 o'clock. The works are entirely devoted to the manufacture of electric accumulators, and the chief shops to be visited will be:—The foundry, where all the various grids are cast and subsequently trimmed; the pasting shop, where the oxides are first mixed and then applied to the grids; formation rooms, in which the plates are formed; finishing shop, in which the smaller types are assembled into sections and the lugs or connections are burnt or cast on to them; power department, consisting of boilers, engines, dynamos for the various processes, and motor-generators to deal with that portion of the power which is obtained from the local supply mains; engineers' workshop, where all tools required in manufacture are made; wood-working shop, where boxes and all wood work in connection with accumulators are made; plumbers' shop, for the production of lead boxes and linings; mess rooms, baths and lavatories provided for the workmen.

Model of Behr's Monorail for the St. Louis Exhibition.—A working model of Mr. F. B. Behr's electric traction system, constructed, we are told, at the suggestion, and with the assistance of the Royal Commission, was exhibited yesterday at the Model Manufacturing Co.'s workshops in Addison-road North, before being dispatched to the St. Louis Exhibition. The model is built on a scale of ¾in. to the foot, and comprises a circular track and a motor car running upon it. Current is led to the car by means of two miniature rails running along each side of the track. This itself consists of the running rail, which is carried—in actual practice—a few feet above the ground, and of four guide rails which serve to steady the car in case it should tend to oscillate from any cause. The five track rails are carried by triangular supports of metal, the running rail being placed at the apex, and the guide rails at the sides of the triangle. Owing to the mechanical difficulty of reducing the motors to scale, somewhat larger motors had to be installed, and they have been placed in the passenger compartment of the model car. This, in conjunction with the fact that the curves of the model track are—in proportion—very much sharper than would be the case in practice accounts, we were informed by Mr. Behr, for the somewhat jerky and unsteady running.

Notes on Accumulators.—At a meeting of the Junior Institution of Engineers held on March 4th, a Paper was read by Mr. G. C. Allingham, entitled "Notes on Electric Accumulators." After a brief reference to the Edison and other types of cell, the author said that in lead stationary cells it was now the usual practice to employ Planté type positive and pasted negative plates; he then discussed the "formation" of the positives, the "shedding" of the peroxide from them and buckling. The pasting and formation of the negatives were then dealt with, as well as the gradual shrinkage of the active material and consequent loss of capacity. The older system of building up the plates in sections was contrasted with the modern plan of suspending the plates freely in the cells by their lugs, and the advantages of the practice of burning up all the connections on the spot after the erection of the battery were pointed out. Mention was made of the importance of free circulation and diffusion of the acid, and of the consequent failure of all attempts to construct "dry" or "solid" accumulators; the variation of capacity with the rate of discharge was also touched upon. The Paper concluded with a reference to the extreme importance of the chemical purity of the materials, not only of those used in the manufacture of the plates, but also the acid, and even the water used for filling up.

Annual Dinner of the American Institute of Electrical Engineers.—This function took place on February 11th at the Waldorf-Astoria Hotel, New York, when the twenty-fifth anniversary of the practical perfection and commercial introduction of the incandescent lamp was celebrated. Mr. Edison was present and each copy of the menu bore his autograph. Advantage was taken of the occasion to inaugurate the Edison Medal, which is to be awarded annually to an American student of electrical engineering. Mr. Edison was the recipient of congratulatory messages from President Roosevelt and from many distinguished scientific men resident in all parts of the world. In the course of an interesting speech, the president of the Institute, Mr. B. J. Arnold, said:—

It is especially fortunate that our profession is so young that we can select for our first distinction the one whom we all agree is now the most deserving, and instead of honouring him after he has passed beyond the appreciation of earthly honours, we are able to have him with us to-night, to see and feel the esteem in which he is held by his protégés, who recognise in him not only a man of great natural genius, but also the exemplification of what has been defined as genius itself, "the ability for hard work." Therefore, as the dean of the greatest technical school of the world through which the graduates of all other schools must pass, the school of practical experience, and in which school he has eclipsed us all in individual achievement in those arts which tend for the material benefits of his race, do we recognise him, and by these ceremonies honour ourselves in thus honouring and officially perpetuating the name of Thomas Alva Edison.

Mr. Edison had declined to make a speech of acknowledgement, but had consented to wire his response, and to carry out this purpose the Western Union Telegraph Co. had furnished for the evening an Edison quadruplex set with an extension key, so that Mr. Edison could send his message without leaving his place. The message was received at one end of the speakers' table on a portable Postal quad set up by Mr. A. B. Chandler, who, a great many years ago, gave

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Mr. Edison his first official position by making him electrician of the old Atlantic and Pacific Telegraph Co. The wires were carried above the table on a regular pole line. The message was transmitted at the same time over a wireless telegraph system, installed by the Marconi Company, between the table and the other end of the banqueting room.

International Engineering Congress at St. Louis.—The following is the text of a circular which we have received from the American Society of Civil Engineers

An International Engineering Congress, under the auspices of the American Society of Civil Engineers, will be held at the Universal Exposition, St. Louis, Missouri, U.S.A., during the week of October 3 to 8, 1904. The Congress will be one of a series of International Scientific Congresses to be held at the Exposition under the general authority and with the co-operation of the Director of Congresses. The development of engineering science during the past decade has been so rapid and has extended over so wide a field that the Universal Exposition at St. Louis seems to be a fitting time at which to review the work of the past and obtain an authoritative epitome of present practice. The object of the Congress is to secure a thorough International consideration of certain branches of engineering work which have been selected with special reference to their present interest and importance. In order to facilitate the work of the Congress and to insure the presentation of topics in a systematic manner, the Committee has prepared a list of the subjects which have been selected for review and discussion. It is to be understood that the list of subjects proposed is somewhat tentative, and may be slightly modified as the details of the programme are perfected. As a basis for discussion at the sessions of the Congress, the Committee has invited engineers specially qualified in each of the various branches to prepare a review of the development during the past 10 years in that branch in the United States, together with a summary of present practice. Engineers in other countries, experienced in these various lines, will be specially invited to prepare similar Papers presenting a review and summary of practice in their respective countries. It is proposed to print these Papers in advance, in order that a full discussion at the various sessions may be elicited without giving up any time to the reading of Papers at the Congress. All engineers in the United States and in all other countries are invited to become members of the Congress, to attend the sessions, and to take part in the discussions; or, if unable to attend, to forward written communications on any of the selected subjects. It is not expected that delegates will be formally appointed, it being intended that an opportunity to attend shall be afforded to any who may wish to become members of the Congress. The Papers, together with the discussions upon them, will be collated and published in one or more volumes by the American Society of Civil Engineers. The membership fee in the Congress will be $5 which will entitle the member to participate in the Congress and to receive a copy of the published proceedings. Membership may be secured by forwarding this fee, with name and address, to the secretary of the committee, Charles Warren Hunt, 220, West 57th-street, New York City, who will issue a receipt therefor. Each member will receive all notices, programmes, &c., issued in advance of the Congress.

The following are included in the list of subjects :—

Natural and Artificial Waterways; Lighthouses and other Aids to Navigation; Traffic on Improved Waterways, as Compared with Seaboard Traffic, and the Effect of this Development on Railroad Traffic; Purification of Water for the Production of Steam; Turbines and Water Wheels; Railroad Terminals; Underground Railways; Locomotives and other Rolling Stock; the Substitution of Electricity for Steam as a Motive Power; Disposal of Municipal Refuse; Ventilation of Tunnels; Passenger Elevators; Pumping Machinery; Steam Turbines; Electrical Power—(*a*) Generating Stations; (*b*) Transmission; Mining Engineering; and Engineering Education.

Bristol Fire.—At a recent meeting of the Bristol City Council the Electricity committee reported that the insurance companies had settled the claim in respect of the damage occasioned by the fire which occurred on Dec. 23 last (*The Electrician*, Jan. 1, p. 404), by paying the sum of £8,225 and handing over certain materials provided by them. The report of Mr. H. Faraday Proctor, the electrical engineer, dated Feb. 29, is as follows :—

In accordance with your instructions, I beg to report upon the fire at Temple Backs, which occurred on December 23, 1903. The damage done by fire may be said to have been practically limited to the high-tension Ferranti switchboards, the smallest of the arc lighting boards, and the connecting cables from the switchboards to the machines, and from the switchboards to the mains in the streets; and also as far as the building is concerned, to damage to the roof, teak window frames, and a portion of the switchboard gallery. A very slight amount of damage was also done to the stone window-sills and glazed brickwork. It is believed that the temporary arrangements now made are such as to obviate the likelihood of any further interference with the continuity of supply until such time as permanent switchboards are erected, and have to be joined up. To enable the fitting of these temporary arrangements, the current has had to be shut off on several occasions after midnight on Saturday until daylight on Sunday mornings, when a large number of the staff and employés have been engaged to execute the work that it would have been impossible to carry out with the current on the board. The old board has been very carefully examined, and several consultations have been held to ascertain the primary cause of the trouble, but there is not sufficient evidence remaining to point conclusively to any special features which constitute the primary cause. It is most probable that the origin is to be found from amongst the following causes :—

Firstly, by static discharge from the metal-work of the board charged at high pressure over the surface of the insulators and slate to "earth" or in other words, to the other pole of the board, in which case it is further possible that this may have been in a measure caused by an invisible crack in one of the insulators.

Secondly, by the breakdown of a cable receiver, or, in other words, what may be termed the joint-box, wherein the cables from the machines or the mains are jointed up to the switchboard.

Thirdly, by the abnormal action of one of the machine fuses, the blowing of the fuse causing an arc breaking the porcelain pot filled with oil in which the fuse is placed. The fuses were examined by the engineer in charge just a few minutes before the accident, and their temperature was quite normal. It is very certain, however, that when once the fault commenced the whole of the cause of the spreading of the trouble was attributable to the oil in the fuse-holders.

The fault was very much augmented by the fact that it was impossible to get the Avonbank supply cut off till after the elapse of a few minutes, as all our private telephones were rendered useless by induction on the wires, and owing to the great number of calls from consumers we were unable to immediately get into telephonic communication over the National Telephone Company's system. It was, therefore, not until the load at Avonbank became very excessive that they shut down the supply at that station. Apart from the oil, there is a small amount of wood on the oldest portion of the switchboard floor, which contributed somewhat to the fire. All portions of the flooring, excepting that first installed, were formed of iron chequer plating covered with linoleum, and this withstood the test perfectly, the linoleum within a few feet of the place where the most extreme heat occurred being quite intact even at the present moment. The window frames are of teak, and they were considerably charred, but these in themselves did not contribute largely to the trouble. In the roof the slates are laid upon match-boarding, and this formed one of the most serious features, as the fire reaching this spread rapidly along a considerable length of the engine-room, and necessitated the use of a great amount of water in the extinguishing of the flames, this water doing a considerable amount of temporary damage to the electrical machinery. The cables contributed largely to the flames, although they were all encased in lead and further protected with steel armouring. The steel armouring, however, is served over with impregnated jute, and this getting soaked with the oil was of course very inflammable.

Electrical Driving in Workshops.—A Paper, describing the electrical equipment of an engine works and shipyard, was read by Mr. H. O. Wraith before the Leeds Local Section of the Institution of Electrical Engineers last night. After describing the generating plant, the author gave the following figures to indicate the amount of power absorbed in the two instances mentioned below :—

Turning Wrought-iron Propeller Shaft.

Tool.	Lb. of metal removed per hour.	Cutting speed. Feet per min.	Cut. In.	Traverse. In.	Nett B.H.P.	Lb. of metal per B.H.P. per hour.
No. 1	284	28	0·5	$\frac{5}{32}$	8	35·5
No. 2	284	28	0·5	$\frac{5}{32}$	9	31·6

Planing Edge of Steel Boiler Plate 1¼in. + $\frac{1}{2}$in. thick.

Test.	Depth of cut. In.	Cutting speed. Ft. per min.	Lb. of metal removed per hour.	Total B.H.P.	B.H.P. in cutting.	Lb. of metal per B.H.P. per hour.	Remarks.
A	..	13·5	..	6·75	..	..	Tool running light.
B	$\frac{1}{16}$	13·5	221·3	28·0	21·25	10·4	..
C	$\frac{3}{32}$	13·5	331·7	34·0	27·25	12·15	..
D	$\frac{1}{8}$	13·5	110·7	18·0	11·25	9·85	..
E	$\frac{5}{64}$	13·5	165·8	25·0	18·25	9·01	..
F	$\frac{3}{32}$	13·5	..	Abt. 45	..	..	Tool very blunt.

The author thinks that as tools, such as punching and shearing machines, are, as a rule, scattered, intermittently used, and generally started and stopped by any man who may want to punch a hole in a plate, and knows nothing about electricity or electric driving, it would be advisable to keep well on the liberal side when selecting sizes of motors, so that rough usage is less liable to cause breakdowns. Three or four hours' stoppage of a single punching machine at a busy time may cause more loss than would occur in a year due to the less efficient running of a motor larger than is absolutely necessary. Wherever several machines were grouped within a short distance of one another, the plan was adopted of placing the double-pole switches and starters for the motors of the group in a cabin at a point visible from all the machines, and putting a boy to do all the starting and stopping of the machines in the group, at signals from men going to use the machines.

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The author is strongly in favour of liquid starters for motors, as they can be constructed in a simpler manner and with fewer parts to get out of order than metallic starters; the making and breaking of the circuit is done at the surface of the liquid, and so sparking at metal contacts is avoided. The objection to liquid starters, that the solution must be of the requisite strength and quantity and that it is liable to creep, has, in the author's opinion, no foundation in works where a proper electrical staff is employed. Stranded trolley wires are preferred to solid ones, because of the greater ease of handling and repairing and the greater readiness with which they may be patched up in the event of injury through short circuit or other cause. Recording ammeters are used in preference to integrating wattmeters, as they possess the additional advantage of giving a permanent record of all that takes place during working hours; although the method may not be quite so accurate, it is, of course, perfectly easy to calculate the watt-hour output given the record, the scale of the paper, rate of travel, &c.

Recent Advances in Electrochemistry.—The first of a course of three Cantor lectures on this subject was delivered by Mr. Bertram Blount, at the Society of Arts, on Monday evening. In commencing, the lecturer stated that the electrochemical industry, at the present time, appeared to be passing through a transition stage. He proposed to deal only with those processes which were of practical utility, although there were many existing processes which possessed features of absorbing interest. Copper refining was the most important of all, and although there were a large number of methods of carrying on this work, yet he had only sufficient time to deal with the principal ones. Competition between chemical and electrochemical manufactures was extremely beneficial, as it tended to stimulate workers in both fields to further exertions, and as a result it was found that any electrochemical process producing a substance which could also be produced chemically was in a more flourishing condition than one which formed the sole basis of manufacture. Pure carbonates could only be produced electrolytically, and therefore that particular branch of the industry was not in quite so healthy a condition as it might be. To define the terms "winning" and "refining," he said that metals were "won" from fused baths, but "refined" in aqueous solutions. The electrolytic winning of copper was much more difficult than the refining, which latter now depended to a large extent on engineering and not so much on the operator's scientific knowledge of electrochemistry. No less than 70 per cent. of the world's output of copper was refined electrically, and the lecturer proceeded to explain some of the methods by which the refining is effected. He thought the multiple better than the series system, but much depended on convenience. After refinement, extreme care had to be observed in fusing the copper, or it would absorb oxygen, and this was very detrimental. The power absorbed played a very small part in copper refining, and Americans had taken the lead in this industry owing to the fact that they had successfully endeavoured to reduce the labour and handling expenses. He mentioned one manufactory in America where the power plant was of 3,000 H.P. only, and yet they turned out no less than 100 tons of copper per day. The refining tanks covered 300 acres, and 128 tons of silver and ½ ton of gold were recovered per year. America was full of copper. In order that a process might be commercially successful it was necessary to employ a high rate of deposition, but unless special devices were adopted a very high rate would cause the formation of nodules. Mr. Blount briefly described the Dolphin plant, in which good circulation of the electrolyte is effected, together with the free admixture of air with the electrolyte. This process permitted of the use of a current density of 25 amperes per square foot. He also touched upon the Cowper-Coles process. Dealing next with zinc, the lecturer said that there was no demand for the pure metal, and in any case it could be produced in a pure state by distillation. This method, however, was expensive. It could be prepared electrolytically from an aqueous solution, but when the solution was slightly acid then an inconviently high E.M.F. was required; on the other hand, when it was neutral or slightly alkaline, then the zinc was obtained in a spongy condition. He thought that the prospect of obtaining zinc from a fused salt was hopeful. It was also difficult to obtain nickel electrolytically as the deposits curled up on the cathode. There were difficulties in separating it from its alloys, and pure nickel produced electrically was hardly known now owing to chemical competition. It would pay to make a copper-nickel alloy and deposit copper only, recovering the nickel chemically. The lecturer expressed considerable scepticism as to electrolytic processes for the production of lead, and said that electrical methods, no matter how ingenious, could not compete with existing methods. The electrolytic winning of lead he considered absolutely hopeless. The winning of zinc might be large, but the refining never. The two remaining lectures will be delivered on March 14th and 21st respectively; the following is the syllabus:—

LECTURE II.

Preparation of metals for fused electrolytes: zinc, aluminium and sodium—Non-metallic products obtainable electro-chemically—Alkali and bleach, hypochlorites, chlorates—Hydrogen, baryta, nitric acid—Organic substances.

LECTURE III.

The electric furnace—Calcium carbide, carborundum, graphite, fused quartz—Carbon disulphide, phosphorus—Iron.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 11th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7:30 p.m. Students' Meeting in the School of Technology. Paper to be read: "Switch Gear for Traction and Transmission," by J. W. Bell.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Meeting at 25, Great George-street, Westminster. Paper to be read: "The Premium System of Payment for Labour," by W. G. Banister.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Visit to the Works of the Electrical Power Storage Co., Milwall.

PHYSICAL SOCIETY OF LONDON.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "The Whirling and Transverse Vibrations of Shafts," by Dr. C. Chree, F.R.S. (2) "Notes on Non-homocentric Pencils, and the Shadows Produced by them. Part. II.: Shadows Produced by Axially Symmetrical Pencils possessing Spherical Aberration," by W. Bennett. (3) Exhibition of Apparatus by Messrs. Pye & Co., Cambridge.

SATURDAY, March 12th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture IV., on "The Life and Work of Stokes," by the Right Hon. Lord Rayleigh, F.R.S.

MONDAY, March 14th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture II.: "Recent Advances in Electrochemistry," by B. Blount.

WEDNESDAY, March 16th.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

2:30 p.m. Visit to Messrs. J. Broadwood & Sons' pianoforte works, Stour-road, Old Ford.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

2 p.m. Visit to the works of the British Thomson-Houston Co. Trains leave at 2:10 p.m.

7:30 p.m. Ordinary Meeting in the Birmingham University. Paper to be read: "Localisation of Faults on Low-tension Networks," by W. E Groves.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, Westminster. Paper to be read: "Notes on the Commercial and Experimental Testing of Continuous-current Machinery," by L. A. Lewis.

THURSDAY, March 17th.

RUGBY ENGINEERING SOCIETY.

8 p.m. Meeting in the Benn Buildings, High Street, Rugby. Adjourned discussion on Mr. Hopp's Paper on "Automobiles."

SATURDAY, March 19th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture V. on "The Life and Work of Stokes," by the Right Hon. Lord Rayleigh, F.R.S.

JUNIOR INSTITUTION OF ENGINEERS.

7 p.m. Conversazione at the Westminster Palace Hotel.

MONDAY. March 21st.

FARADAY SOCIETY.

8 p.m. Ordinary Meeting in the Library of the Institution of Electrical Engineers. Papers to be read: (1) "The Electrolytic Analysis of Gold," by F. Mollwo Perkin, Ph.D., and W. C. Prebble, (2) "Thin Film Electrolysis, with an Application to Printing," by Chas. R. Darling.

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A 1,000-KILOWATT DOUBLE-CURRENT TURBINE GENERATOR.

Tenders have been invited for the supply of a 1,000kw. double-current generator for the Stepney electricity works, and by the courtesy of Mr. Arthur Wright, the consulting engineer, we are able to give our readers some particulars with regard to the specification. The machine in question will consist of a turbine coupled to two 500kw. double-current generators in tandem on an extension of the turbine shaft. Contractors are to tender for the manufacture and erection of the machine, its maintenance for 12 months at the existing electricity works in Osborn-street, Whitechapel—where the turbine will be running non-condensing—and the subsequent conversion of the machine in about two years' time to suit it for running condensing and with superheated steam at the new generating station which the Stepney Borough Council will shortly erect. The set is to be running on test at the makers' works by September 30th next, and to be ready for work at the Osborn-street generating station a month later.

So far as the design and construction of the turbine is concerned, the specification is practically an open one, the contractor being simply asked to give very full particulars as to the type of turbine, together with detailed dimensioned drawings showing its construction and that of the dynamos. No steam consumption is specified by the consulting engineer, but the contractor is required to state in his tender the number of pounds of steam per kilowatt-hour which will be consumed at quarter, half and full load, and 20 per cent. overload, the guaranteed results to be obtained with a margin of 5 per cent. immediately after a six-hour full load run. These guarantees are to be given, first, for non-condensing running and, secondly, for running condensing on a 27in. vacuum and with steam superheated 150deg. The steam pressure in both cases will be 150lb. per square inch. The speed of the turbine is not to exceed 2,000 revs. per min. It is to have forced lubrication, and to govern within 5 per cent. on full load being thrown off. Tests will be made for water consumption on completion at the makers' works, the machine then running non-condensing, and subsequently at the new Riverside generating station above referred to, when the machine will be run condensing and with superheated steam, the water consumption in the latter case being determined by the weight of water discharged by the air-pumps, with the usual allowance for water condensed between the stop valve and the exhaust valve of the engine.

The two dynamos, as already stated, will have a full-load capacity of 500kw. each, and are arranged in tandem on an extension of the turbine shaft. Each machine is to be shunt-wound and multipolar, and provided with a smooth commutator and three slip rings. It must be capable of giving its full output either with continuous current at a pressure of between 500 and 600 volts, or three phase alternating current, or partly continuous and partly three-phase current. The contractor may tender alternatively for machines with a pressure of 250 to 300 volts. The alternating current must have a frequency between 40 and 60 ~ per sec. The temperature rise of the armature is not to exceed 70° F. after a six hours' run at its full load, the thermometer being inserted at the commutator end of the dynamo. The machine is to be capable of working in parallel with others. The field-magnet coil frames are to have iron or gun-metal foundation tubes, and iron loops are to be attached for the purpose of lifting them off the magnets. Special provision is also to be made for rapidly taking apart the field magnets, should it be desired to renew the armature. Eye-bolts are to be supplied for lifting the magnets, and an approved form of slinging ring for lifting the armature. The field will be excited from the main 'bus bars at a pressure between 500 and 600 volts, and the power for excitation is not to exceed 1 per cent. of the output of the dynamo. Regulating resistances are to be provided in the exciting circuit with 20 contact regulating switches. The usual clause specifying a fixed position of the brushes between no load and full load is included, but possibly through an oversight, for it is one which it is extremely difficult to fulfil in the case of turbine continuous-current machines of large size. The usual worm gear for shifting the brushes is, of course, to be provided, and six dozen spare brushes are to be supplied.

ON THE DISPERSION OF N-RAYS, AND ON THEIR WAVE-LENGTH.*

BY R. BLONDLOT.

To study the dispersion and the wave-length of the N-rays, I used methods quite similar to those employed for light. To avoid the complications which would have resulted from the storing of the N-rays, I used exclusively prisms and lenses of alumium, a substance which does not store the rays.

The method employed for studying the dispersion is as follows:—The rays are produced by a Nernst lamp enclosed in a sheet-iron lantern having a window closed by an aluminium sheet. The rays emitted by the lamp through the window are sifted by a plate of deal 2cm. thick, a second sheet of aluminium and two sheets of black paper, in order to eliminate all radiation but that of the N-rays. Outside these screens, and at a distance of 14cm. from the lamp filament, is placed a large screen of moistened cardboard, having a slit 5mm. wide and 3·5cm. high, exactly opposite the filament of the lamp. Thus one obtains a well-defined beam of N-rays. This beam is received on an aluminium prism whose refracting angle is 27deg. 15 min., and one of whose faces is normal to the incident beam.

It is then found that from the other refracting face of the prism there issue several beams of N-rays dispersed horizontally. To show this, a slit 1mm. wide and 1cm. high, made in a sheet of cardboard, is filled with phosphorescent sulphide of calcium. By shifting this slit, one determines without difficulty the position of the dispersed beams, and, knowing their deviations, one may deduce their indices of refraction. This is, in fact, Descartes' method. I have thus proved the existence of N-radiations whose indices are 1·04, 1·19, 1·29, 1·36, 1·40, 1·48, 1·68 and 1·85 respectively. In order to measure with greater accuracy the first two indices, I employed another prism of aluminium, having an angle of 60deg. I found for one of the indices the same value 1·04, and for the other 1·15, instead of 1·19.

In order to control the results obtained with the prism, I determined the indices by producing, by means of an aluminium lens, the images of the lamp filament, and measuring their distances from the lens. The lens, which is plane-convex, has a radius of curvature of 6·63cm. and an aperture of 6·3cm. The slit of the moist cardboard screen is enlarged in order to leave a circular opening 6cm. in diameter. The lens is placed at a known distance of p cm. from the incandescent filament, and the position of the conjugate images of the filament is searched for by means of the phosphorescent sulphide. The following table gives the values of the indices found, both with the prisms and the lens:—

Prism			Lens					
Of 27deg. 15min.		Of 60deg.	$p=40$		$p=30$		$p=22$	
1·85	....	—	1·86	....	1·91	....	1·91	
1·68	....	—	1·67	....	1·66	....	1·67	
1·48	....	—	1·50	....	1·49	....	1·48	
1·40	....	—	1·42	....	1·42	....	1·43	
1·36	....	—	1·36	....	1·36	....	1·37	
1·29	....	—	1·31	....	1·31	....	—	
1·19	....	1·15	1·20	....	—	....	—	
1·04	....	1·04	—	....	—	....	—	

Here is another verification of the results: If one takes for the fourth index the mean value 1·42, it may be calculated that for an aluminium prism of 60deg. the incidence which gives minimum deviation is 45deg. 19min., and that that minimum deviation is 30deg. 38min. The actual deviation observed is 31deg. 10min. With the same angle of incidence, the calculated deviation of the radiation whose index is 1·5 amounts to 37deg. 20min. The observed deviation is 36deg. With the same incidence, the calculated deviation of the radiation of index 1·67 is 57deg. 42min. The observed deviation is 56deg. 30min.

I now pass to the determination of the wave-lengths. With the above arrangement for studying the dispersion by the prism of 27deg. 15min. one obtains refracted beams each of which is sensibly homogeneous. By picking out one of these beams with a second screen of moist cardboard provided with a slit 1·5mm. wide one may isolate a very narrow portion of the beam.

* From the *Comptes Rendus*, Vol. CXXXVIII., pp. 125-129, January 18, 1904.

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Further, I attached a sheet of aluminium to the movable pointer of a goniometer so that its plane was normal to it. The sheet had a slit only $\frac{1}{15}$mm. wide, lined with phosphorescent calcium sulphide. The goniometer was so arranged that its axis was exactly under the second cardboard slit. On turning the pointer, the path of the beam may be traced exactly, and it is found that it is quite unique, and unaccompanied by any lateral beam, such as would be produced by diffraction in the case of the great wave-lengths A grating is then placed in front of the slit in the second moist cardboard, a Brunner grating with 200 lines to the millimetre, for instance. If now the issuing beam is explored by turning the pointer carrying the phosphorescent sulphide, one discovers a system of dlffraction fringes just as in the case of light. Only the fringes are much closer together and are sensibly equidistant. This already indicates that the N-rays have wave-lengths much shorter than those of the luminous radiations.

The angular distance of the fringes, or, what comes to the same thing, the rotation of the pointer corresponding to the passage of the phosphorescent line from one bright fringe to the next, being a very small angle, is determined by the reflection method, with the aid of a scale and a telescope, a plane mirror being glued to the pointer. Besides, one measures, not the angular distance of two consecutive fringes, but that of two symmetrical fringes of a high order; for instance, the tenth fringe on the right and the tenth fringe on the left. From these angular measurements and from the number of lines per millimetre of the grating, one deduces the wave-lengths by applying the usual formula.

Every wave-length was determined by three series of measurements taken with three different gratings having 200, 100 and 50 lines per millimetre respectively. The following table contains the results of these measurements:—

Refractive indices.	Wave-lengths. Grating employed. $\frac{1}{200}$mm.	$\frac{1}{100}$mm.	$\frac{1}{50}$mm.	Mean.
1·04 ..	0·00813 ..	0·00795 ..	0·00839 ..	0·00815
1·19 ..	0·0093 ..	0·0102 ..	0·0106 ..	0·0099
1·4 ..	0·0117 ..	— ..	— ..	0·0117
1·68 ..	0·0146 ..	— ..	— ..	0·0146
9·85 ..	0·0176 ..	0·0171 ..	0·0184 ..	0·0176

Wishing to control these observations by an entirely different method, I had recourse to Newton's rings. Producing these rings in yellow light, for instance, if one passes from one dark ring to the next the variation of optical retardation in the layer of air amounts to one wave-length of yellow. If now, with the same apparatus and the same incidence, one produces the rings by means of N-rays, and counts the number of such rings comprised in the interval between two dark rings belonging to the yellow light, one obtains the number of times that a wave-length of N-rays is contained in the wave-length of yellow light. This method, applied to the rays of index 1·04, gave the wave-length 0·0085$\mu\mu$ instead of the 0·0081$\mu\mu$ found with the gratings, and for the rays of index 1 85 it gave the value 0·017$\mu\mu$ instead of 0·0176$\mu\mu$. Although the ring method is inferior to that of the gratings, on account of the uncertain position of the dark rings in the optical experiment, due to the necessity of making these rings extremely wide, the agreement of the values obtained constitutes a valuable control.

In the above table I have retained all the decimals which came out in the calculation of the numbers deduced from observation. Although I cannot indicate with certainty the degree of approximation of the results, still I believe that the relative errors do not amount to 4 per cent.

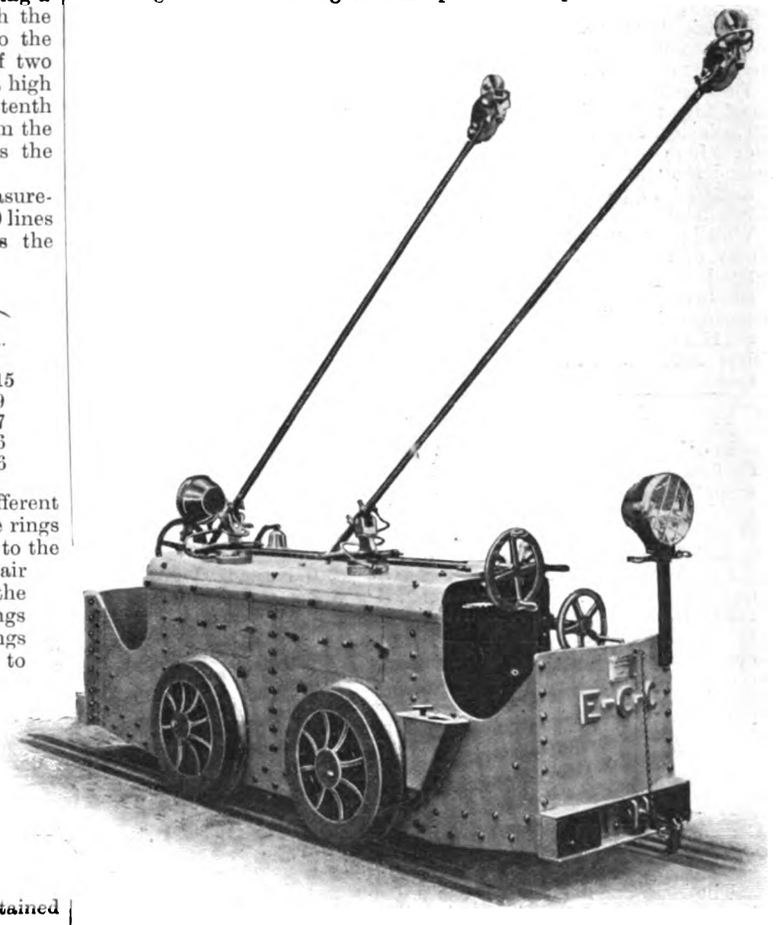
The wave-lengths of the N-rays are much shorter than those of light, contrary to what I imagined at first, and contrary to the determinations which M. Sagnac ventured to derive from the position of the multiple images of a source produced by a quartz lens, which images he attributed to diffraction. I had already observed that, while polished mica transmits the N-rays, matt mica arrests them, and also that, while polished glass reflects them regularly, ground glass diffuses them. These facts already indicated that the N-rays could not have a great wave-length. If one wishes to study the transparency of a body one must take care that the surface is well polished. Thus, I had at first classed rock salt among the opaque substances, because the specimen which I used, having been cut out of a big block, had remained unpolished. Rock salt is in reality transparent.

The radiations of very short wave-length discovered by M. Schumann are strongly absorbed by air. The N-rays are not. This implies the existence of absorption bands between the ultra-violet spectrum and the N-rays. The wave-length of the N-rays increases with their index, contrary to what takes place in luminous radiations.

If the increase of brightness of a small source of light must be attributed to a transformation of these rays into light-waves, such a transformation is in conformity with Stokes' law.

A MINING LOCOMOTIVE.

The accompanying illustration shows one of the latest electric locomotives designed by the Electric Construction Co. with the idea of meeting the increased demand for this convenient method of haulage both in mines and tunnel work. The great difficuty to contend with in this class of locomotive is, of course, the limited size of the tunnels down which they have to operate, and in this particular instance they were specified not to exceed 3ft. wide and 40in. in height, as the tunnel is only 6ft. high at its maximum point. The total weight of this locomotive when complete is about 4½ tons, and it is capable of hauling a load of 35 tons at a speed of 5 to 6 miles an hour; when running light it will reach a speed of 10 miles an hour. It is fitted with two motors, each having a normal working load of about 12½ H.P. They can be controlled from either end. The ordinary hand brake and also emergency brakes are provided, by means of which the locomotive can be pulled up in almost its own length when running at full speed. The pattern shown has



two trolleys, and is intended for use with insulated return conductors, but we are informed that this is only one of many types made by the above firm.

Manchester Students' Section of the Institution of Electrical Engineers.—The newly-formed students' section of the Manchester Local Section of the Institution of Electrical Engineers paid their first visit to works on Saturday afternoon. It was intended that a party, limited to 50 students, should visit the Stuart-street generating station of the Manchester Corporation electricity works, but owing to the dimensions of the party expanding to double the original number, the arrangements had to be altered to a certain extent. Fifty students visited the Stuart-street station from 2:30 to 4 p.m., while two other detachments, each consisting of 25 men, spent the hour between 2:30 and 3:30 p.m. at Bloom-street and Dickenson-street. The parties then changed places, as it were, so that all students were able to inspect the three stations. We are indebted to Mr. John Roberts, jun., hon. secretary to the Manchester Students' Section, for the above particulars, and he informs us that the students were delighted at the kindness shown them by the officials, who took great pains to explain matters in detail.

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PHOTOMETRIC TESTS.

The following is a statement, in tabular form, of tests of street lamps, with the comparative costs, extending over a period of 18 months. Similar tests are made and reports issued every three months, under the supervision of Mr. J. W. Bradley, engineer to the City of Westminster. Previous reports have been published from time to time in *The Electrician*, the one now under review being the sixth of the series.

Description and position of lamps.	No. of lamps in city, of class specified.	Lamps tested.	Av. candle power.	C'pital cost of lamp.	Interest and sinking fund per lamp per annum.	Cost of illum'nt per lamp per ann.	Cost of lighting and maintenance per lamp per ann.	Total cost per lamp per annum.	Hrs. of burning per ann.	Total cost per c.p.-hour.	**Test No. 6. Total cost per c.p. per annum.**	Av. total cost per c.p. per an. inc. tests to date (6 series).	Total No. of t'sts up to date
				£				£ s. d.		d.	d.	d.	
Electric arcs (Charing Cross & Strand Electric Light Co.) Opalescent globes	100	6	670	40	On 30 years' period, say £2	£28		30 0 0	3,940	·00273	10·75	11·49	40
Electric arcs (St. James' & Pall Mall Electric Light Co.) Muranese globes	60	6	474	45	On 14yrs' contract, say £4	£30		34 0 0	3,879	·00445	17·23	15·1	43
Electric arcs (Westminster Electric Supply Corp.) Opalescent globes	945	6	605	..		£22		22 0 0	3,940	·00222	8·73	8·7	35
Refuge lanterns, 4 mantles, Victoria-street	12	4	113	15	On 30 years' life, say 15s.	£8 15 6	£3 16 0	13 6 6	3,940	·0072	28·3	30·7*	24
Sugg's high-pressure lamps, Parliament-street. Trident form	29	6	573	15	Do. 15s.	13 6 2	4 3 10	18 5 0	3,940	·00194	7·65	9·85	35
Incandescent mantles, Victoria-street type	1,241	6	42	6	Do. 6s.	2 0 0	1 4 0	3 10 0	3,940	·00508	20·0	18·42	40
Triple flat-flame, † footway. Whitehall, now in process of removal, Scott Snell lamps being substituted	35	6	51	8	Do. 8s.	£5 19 2		6 1 2	3,940	·0076	29·9	25·65	33
Incandescent mantles, Carlton House-terrace type	251	5	38	6	Do. 6s.	1 10 11	1 1 0	2 17 11	3,940	·00465	18·3	18·18*	27
Triple flat-flame, Strand type	508	6	47	8	Do. 8s.	7 15 10	1 5 0	9 8 10	3,940	·0122	48·2	47·41*	30

* Average of five series only. † Burns 18·48ft. up to midnight, 5ft. after midnight; candle-power taken before midnight.

In order to anticipate any objections which might arise on comparing the figures obtained for the various lamps, I have the following comments to make on the tests. All tests are carried out under precisely similar conditions so that it would be manifestly unfair to accept one set of results and reject the rest. The Sugg photometer which has been used in making these observations is fitted with two and five candle standards for testing low and high-power lamps respectively, and will, from its construction, give results in all cases, if anything, slightly higher than the true values by a small amount which is practically constant for all the types of lamp tested, thus making the comparison of the various lamps approximately accurate. Further, precautions are duly taken during each test to guard against the effect of extraneous light, reflection from buildings, obstruction by any opaque object, such as glazing bars, and the tests are only carried out on clear nights.

In the case of incandescent mantles, including high-pressure lamps, great variations in candle-power are found to be due to the condition of the mantles—what appears to the naked eye as a slight diminution in intensity resulting in an enormous loss of candle-power. In the case of lanterns with groups of incandescent mantles it should be remembered that such mantles are difficult to keep in good order, and that the effective candle-power does not increase in the same ratio as the number of mantles. It has been repeatedly found that a slight defect in any of the incandescent mantles in high-pressure lamps causes a great loss of candle-power, and this circumstance renders it difficult to form any comparison between tests carried out in a laboratory and those made under actual lighting conditions.

J. W. Bradley, C.E.,
City Engineer.

ELECTRIC TOWING ON THE ERIE CANAL.*

The Erie Canal has been the scene of various attempts to haul barges by electricity, but although other canals in Europe and America have now been equipped with electric tractors of one kind or another, the famous old artificial waterway between Albany and Buffalo is still dependent upon mules and a few steam propellers for its motive power. It has thus been left in such hopeless competition with the railroads that the people of New York State have just voted to spend a sum of over $100,000,000 upon the Erie, Oswego and Champlain Canals in order to render them capable of floating 1,000-ton barges instead of those now employed with a capacity not exceeding 250 tons. The first electrical tests on the Erie Canal date back to 1893, when Mr. F. W. Hawley equipped with two Westinghouse electric motors an old steam propeller so as to drive the screw and took current by trolley from cross span wires on a pole line running along the bank, near Rochester. The test was at once successful, but the plan was open to the objection which applies to the propeller at any decent rate of speed—namely, the undue suction and wash caused, detrimental to the bank. Moreover, the lateral motion created various difficulties with the trolleys, two of which were employed. The next plan tried was that of Mr. Richard Lamb, who introduced an ingenious cableway supported along the towpath on short, substantial columns, with a telpher motor travelling along two cables, placed one above the other, the upper for bearing and the lower for traction. With this motor went a man to handle the mechanism and controller.

The newest system is that of Mr. Stephen W. Wood, shown in operation on the Erie Canal opposite the General Electric factories at Schenectady, by the International Towing and Power Co. of New York. It is a monorail system resembling methods already advocated by Messrs. Sachs in America and Thwaite in England, but having been worked out with considerable novelty, care and attention to engineering details. The experimental track is about 2,700ft. in length, with a sharp curve, and furnishing a good average section of the 7ft. prism. Along the bank are erected every 25ft. short posts set in concrete and supporting, on each side of the post, about 3ft. apart, continuous plate 18in. girder, the girder farthest away from the canal being raised above the inner one, as in a tier of seats. The girders are cross-braced so as to stiffen the structure; and, indeed, the whole work is of a most substantial character—too heavy, it would even seem, for the work in hand. The edges of each girder are faced with light 3in. rail for track. Over the two girder tracks extend a series of ordinary trolley brackets carried on poles set at the outer edge of the canal bank and carrying a trolley wire so placed as to be readily accessible to a trolley reaching up from either track.

The "electric mule" is very clearly illustrated, complete and in detail, by means of the photograph which we reproduce. The mule is a vehicle closely resembling a "hog-back" mine locomotive, and is 10ft. long by 2ft. wide, and 3ft. high from the rail. It is ironclad for better protection from the weather, but all the armour is quickly removable and all the parts are accessible. At each end is a 40 H.P. motor of street car, narrow-gauge type; but, owing to the low speed required, geared down by double reduction in the ratio of about 40 to 1. Each motor through this gearing drives a grooved wheel about 22in. diameter, which travels upon the upper rail; and, by reversing, the motor runs promptly backward and forward. At the rear end is a street car, or series-parallel controller, with few steps, and a resistance box serving as a seat for the driver, who would doubtless appreciate its warmth in such weather as accompanied some of the recent tests. The "mule" has two large hooks for the

* Abstracted from the *Electrical World* of New York.

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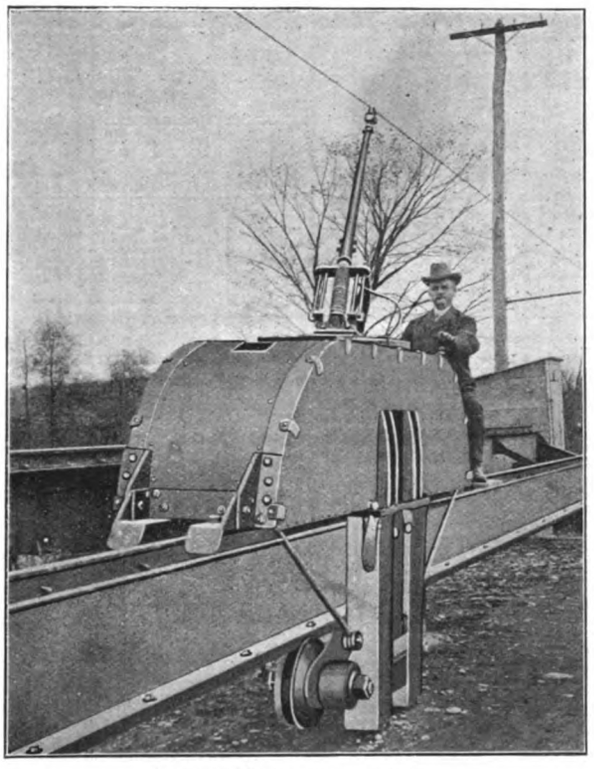
tow-ropes and has also a running board and guard hand rail, so that the driver can go around the machine without dismounting. Reaching upward from the centre of the top shell of the motor is a stout, short mine trolley, which can be pulled down so as to let another "mule" go by on the upper or lower track.

From the body of the motor mule extends downward a heavy arm, which carries springs pulling upwards two grooved wheels so as to exert a gripping effect on the under rail. This tension spring can be loosened or tightened at will, and the arrangement serves to keep the tractor steady, besides affording additional adhesion, to such an extent that the tractive effect due to the weight of the motor —over 5 tons—is virtually doubled, the "draw-bar pull" reaching, it is said, over 30,000lb. The amount of power or current consumed varies, of course, with the speed, the weight hauled, the depth of the prism, the condition of the track and other factors. In this connection it may be stated that a number of readings have been taken under all conditions, from which, later, a variety of interesting conclusions may be deduced. The current is continuous, furnished from the General Electric plant to the motors at 475-500 volts. It would be fair to assume that in practice, if necessary, instead of rectifying the current, single-phase or polyphose motors could be used, after stepping down the supply from such points as Niagara, Spier Falls, Mechanicville, &c. As to the tests themselves, they have been made in the presence of Governor Odell, State Engineer



Towing Motor seen end on.

Bond, the Canal Commissioners, the Superintendent of Public Works and others, and have naturally attracted public attention. As seen by one of the editors of *Electrical World and Engineer*, they included the hauling of two boats, each loaded with over 200 tons, at a speed up to 4¼ miles an hour, as recorded by tachometer in the observation car keeping abreast over the run These two boats would represent a total weight of probably 600 tons. Other tests included the haulage of four loaded barges at various speeds up to the same figure. In every instance the slight wave motion in the canal, or absence of wash, was most noticeable, the disturbance dying out in a mere ripple as it reached either bank. This would appear due to the steadiness of the breast pull and the abolition of the churning action consequent upon the use of a screw propeller. Some of the tests seen by the writer were conducted in a heavy snowstorm, but little, if any, difference was observed in the results; part of the monorail track was at times sanded by the driver to improve the tractive effect after some of the squalls. During the tests one or two mule tows passed in the opposite direction, making barely a mile an hour on the wet towpath. The contrast between the two systems was most striking, while it was not to be forgotten that both the old and the new methods were operating at the same time without interference.

Aside from the engineering superiority of an electric motor on a track over a mule on a yielding towpath, the main question is that of economic efficiency It would be a fair inference that, as on the trolley roads, mechanical power applied electrically has all the advantages. Awaiting further data, it may be well to cite, without approving, the claims of the company undertaking these tests. The cost of equipping the Erie Canal, 352 miles, with the Wood system is estimated to be:—

Structure electrically equipped for 80 H.P.	$6,290,000
300 motors, 80 H.P.	750,000
Total	$7,040,000

The gross earnings from the operation of the system, estimated at 50 cents. a ton for 10,800,000 tons, would be $5,400,000. The operating expenses would be: 4 per cent. on equipment, $281,600; cost of 24,000 H.P. seven months' use at $35 per horse-power per annum, $490,000; wages, motormen for 300 motors (three men each) eight-hour shifts, $378,000; trackmen, $11,340; repairs, salaries, &c., $150,000; total, $1,310,940, making the net earnings $4,089,060.

The Miami and Erie Canal, in the State of Ohio, has recently been equipped with electric traction by the Miami and Erie Canal Transportation Co., the work being done by the Cleveland Construction Co., of Akron, Ohio. The section now in operation extends from Cincinnati to Middletown, a distance of about 42 miles. Current for this section is at present taken from the lines of the Cincinnati Gas and Electric Co. as 4,200-volt 60-cycle three-phase current, received in a motor-generator station, which changes the frequency to 25 and separates the haulage system from the local lighting and power system. Part of the output, at 390 volts, feeds directly the first section of working conductors. The remainder is stepped up to 33,000 volts and transmitted along the canal bank. At four reducing stations transformers receive the 33,000-volt current and deliver it to the working conductors at 1,170 volts. The locomotive receives this current and transforms it to 390 volts for use in the motors. There are two trolley wires of the grooved No. 0000 type, the track serving as the third conductor. This plan differs greatly from others, one notable feature being the use of a locomotive on a track along the canal bank and another important item being the application of the three-phase current. The locomotive is of compact type and weighs 55,000lb. It has four 33in. wheels mounted on 6in. axles, with 5in. journals, and to each axle is geared with double reduction an 80 H.P. three-phase induction motor. These two motors are normally operated in tandem. The primary winding of the first motor is connected to the transformer secondaries, its secondary winding to the primary of the second motor, and the armature of this last is closed through a controller and a set of iron-grid resistances. This controller serves for reversal and speed variation when required, although the motors in tandem are designed to give the 3 miles per hour to which the speed is, at present, limited by statute. In this normal operation the motors give 40 H.P. each, and a horizontal effort with 25 per cent. coefficient of adhesion of 9,600lb. The locomotives have not only hooks for making fast the towing cable, but couplers for the direct haulage of freight cars whenever desirable. As the track is well laid with 70lb. rails such haulage is quite feasible.

The seven locomotives were built by the Baldwin Works, and the electrical equipment by the Westinghouse Company. The locomotive side frames consist of very heavy cast girders of channel section, framed across at the ends with similar castings. The axles are 6in. in diameter with 5in. journals, and the wheels are 33in. in diameter, of standard railroad pattern, with 1¼in. flanges and 4in. tread. At the extreme forward end of each locomotive is the plug switchboard, behind that the transformers, then one motor, then the cab with the controllers, then the second motor, and behind that the rheostat, which fills up the rest of the space. The locomotives are 14ft. long, 8ft. 4in. wide, and have a wheel base of 7ft. The extreme height of the standard locomotives was limited to 8ft. 6in. by the bridges and the extreme height of the switching locomotive, to be used at the southerly end of the line in Cincinnati, was made only 5ft. 6in. In this last, to save head room, the cab was omitted, and a cockpit provided for the motorman at the rear end, as in common practice with mining locomotives. The height of the trolley wires above the rail varies from 6ft. under some bridges in Cincinnati to 22ft. over railroad crossings, and is ordinarily 18ft. Under the bridges north of the first ½ mile in Cincinnati the minimum height of the trolley wire is 9ft. The standard boat is 80ft. 6in. long exclusive of rudder, 13ft. 6in. wide and 9ft. high, measured over all. Most of the boats are decked, leaving a clear height of 7ft. 8in. in the hold. There are some open boats for coal, gravel, empty barrels and other coarse and bulky freight. Loaded to a draught of 3ft., such boats can carry about 65 tons, but in the present condition of the canal bed it is seldom practicable to load deeper than 30in., at which they carry about 50 tons of freight. The transportation company has about 20 serviceable boats, acquired with a canal packet company which was purchased, and has building facilities for the needed increase of its fleet. A telephone line for despatching, &c., is also operated.

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THE RATED SPEED OF ELECTRIC MOTORS AS AFFECTING THE TYPE TO BE EMPLOYED.*

BY H. M. HOBART.

High speed is an unfavourable condition for the continuous-current motor, but up to certain limits, conduces to improved results for induction motors. Of course, the required speed can rarely be the determining factor in the choice between these two classes of motors, but it is well that the extent of the influence of the speed should be realised.

Now, it is most difficult to make consistent assumptions as the basis for a number of comparative designs, but I have taken for a set of continuous-current designs, for a 150 H.P. shunt motor, five speeds ranging from 68 to 1,224 revs. per min., and, without figuring out the details with any elaboration, have nevertheless endeavoured to proceed on fairly reasonable lines. I have followed this same policy with two groups of induction motors, the first group being for 21-cycle motors ranging from 36 poles and 68 revs. per min. to 4 poles and 612 revs. per min., and the second group being for 63-cycle motors and ranging from 12 poles and 612 revs. per min. to 6 poles and 1,224 revs. per min. Although I should have preferred

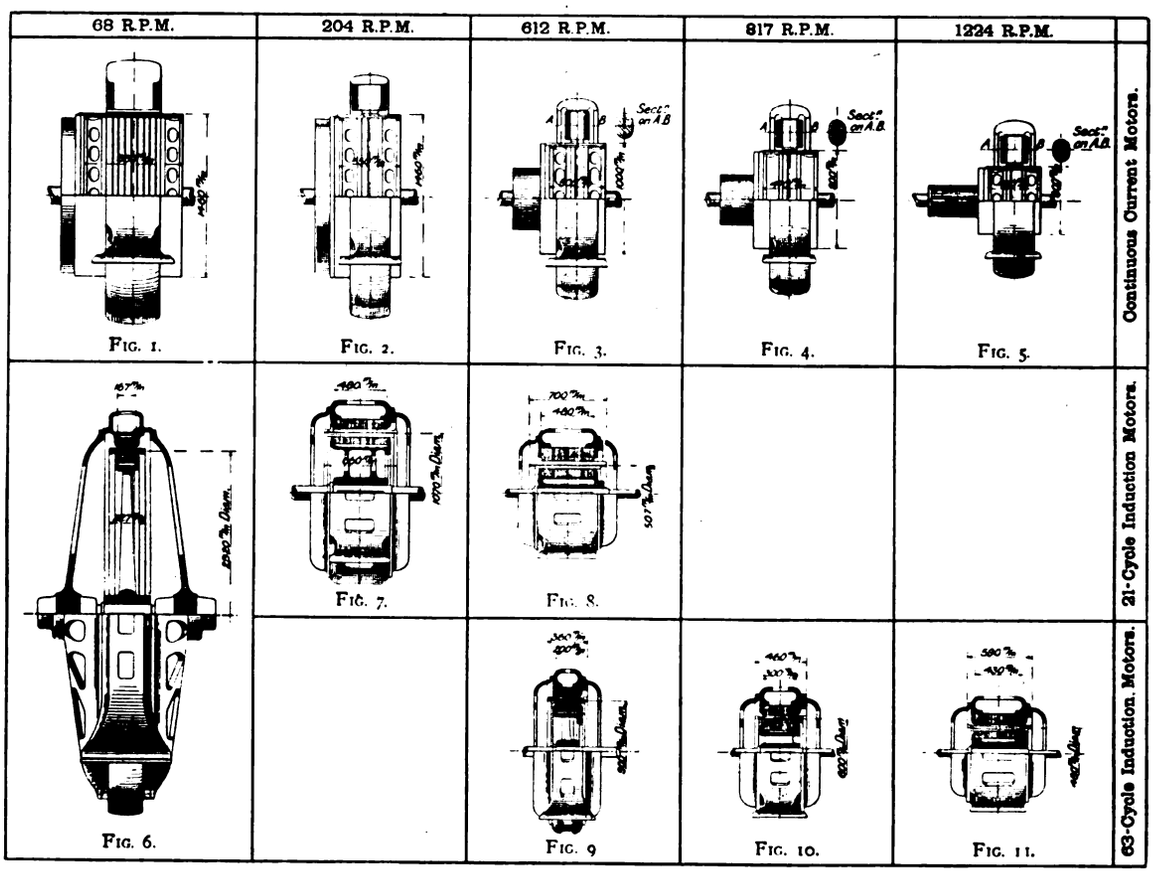

FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5.

FIG. 6. FIG. 7. FIG. 8.

FIG. 9 FIG. 10. FIG. 11.

o concentrate attention upon the influence of the speed, and not to enter upon the question of the influence of the periodicity, the extreme range of speeds which I wished to cover, made this impracticable. Thirty-six poles is already abnormal enough for a 150 H.P. induction motor, and yet this leads to a group of three motors, the last of which, at 630 revs. per min., has but four poles, thus requiring stepping up to a higher periodicity for a higher speed design.

The general design of these 11 motors and some of their leading constants are set forth in Figs. 1 to 11, and 1A to 11A. In Fig. 12 are shown curves roughly indicative of the relative factory costs of these 11 designs for the three groups These costs have been derived from the product of diameter D, of rotor in centimetres and length L, over armature winding in centimetres—*i.e.*, from $D \times L$ for the continuous-current machines. The windings of induction motors being less definite as to overall lengths, L has been taken equal to the gross core length, λ_g, plus seven-tenths of the air-gap pitch τ, *i.e.*, $L = \lambda_g + 0{\cdot}7\tau$ for the induction motors. $D \times L$ has been found to be fairly proportional to the total factory cost for continuous-current dynamo-electric machines, for a given voltage and for so-called "barrel"-wound armatures. The same expression has also been found fairly proportional to the total factory cost for induction motors.

* Paper read before the Institution of Electrical Engineers last night.

The total factory cost may thus be set equal to $K_c \times D \times L$ for continuous-current motors, and to $K_i \times D \times L$ for induction motors, where K and K_i are constants for any one firm. The ratio of K_c to K_i which we may denote by $R(R = K_c/K_i)$ has been found to vary greatly with different manufacturers. From a study of the data kindly supplied to me for the purpose by four manufacturers, it is believed that 1·5 is a fair value to take for R for the purposes for which it is required in this Paper. Thus for motors having equal rotor dimensions, the continuous-current motor will be taken as costing 50 per cent. more than the induction motor. This, however, would not be the ratio of cost for the same *output*, because different diameters and lengths would be taken in the two cases. As a rough value for the total factory cost of continuous-current motors 1·00s. per $D \times L$ may be taken (although this varies considerably with different manufacturers), D and L being expressed in centimetres. Hence 0·67s. per $D \times L$ will be the corresponding total factory cost for induction motors. This would rise to 0·75s. per $D \times L$ for motors with wound rotors, and would fall to 0·60s. per $D \times L$ for motor with squirrel-cage rotors.* At low speeds the diameter would be much greater in the case of induction motors. At high speeds, and especially at low periodicities, the reverse would be the case. This is shown in Fig. 13. In the upper part of Fig. 14 are given the full-load efficiencies for the continuous-current and the induction motors. Whereas the former are lower for the higher speeds, the efficiencies of the induction motors rise fairly rapidly, starting from a very low value for the lowest speeds. In the lower part of Fig. 14 are given corresponding curves of half-load efficiencies.

From Figs. 15 and 16 it may be seen how the power-factor improves with the speed, and how the no-load current at the same time decreases. Fig. 17 shows the increase in reactance voltage at full-load for increasing rated speed. As is evident, the results are very unfavourable for the higher speeds, whereas they are decidedly favourable for the lower speeds. The peripheral speed of the commutator in metres per second is shown in Fig. 18. Where special, and as yet, not thoroughly proven methods of commutation are not resorted to, these high commutator speeds must be employed for high-speed designs of continuous-current dynamos.

It is thus evident that with increasing speed, while all the properties of the induction motor improve markedly, the reverse is the case for the continuous-current motor, and one would be inclined to believe that this points out the best field for these respective types, and that the influence of the speed should be taken into consideration when other circumstances permit.

* This Paper does not concern itself with *absolute* costs. The comparisons are purely relative. Nevertheless, it serves to fix ideas to employ some unit of value, and the equivalent chosen has been shown to apply approximately in an article published in No. 40 of the *E.T.Z.* for 1903.

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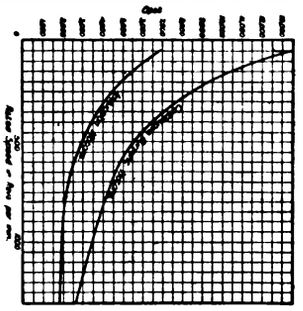

Fig. 12.

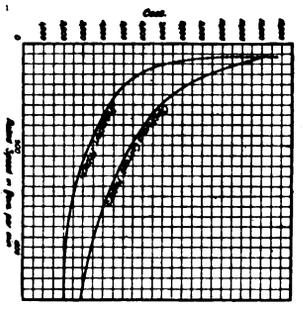

Fig. 12A.

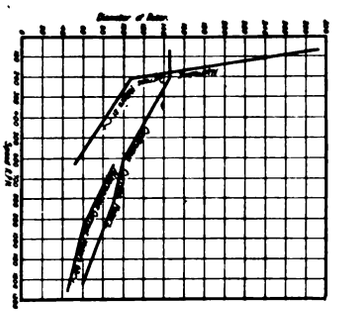

Fig. 13.

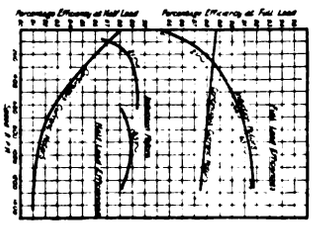

Fig. 14.

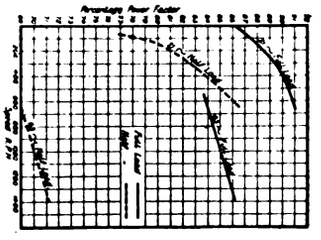

Fig. 15.

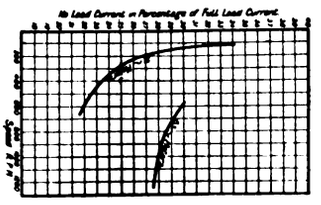

Fig. 16.

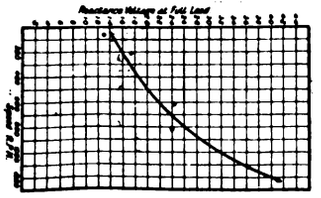

Fig. 17.

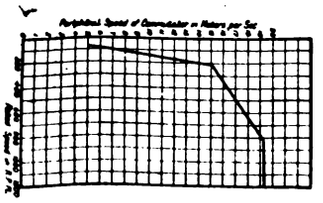

Fig. 18.

	Induction Motors.	Continuous Current Motors.	
21 Cycles per Second.	Fig. 6A.	Fig. 1A.	68 R.P.M.
	Fig. 7A.	Fig. 2A.	204 R.P.M.
	Fig. 8A.	Fig. 3A.	612 R.P.M.
63 Cycles per Second.	Fig. 9A.		
	Fig. 10A.	Fig. 4A.	817 R.P.M.
	Fig. 11A.	Fig. 5A.	1224 R.P.M.

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Although, as has already been stated, the demonstration of the influence upon the results (very favourable for induction motors and exceedingly unfavourable for continuous-current motors) of increase in the rated speed does not, owing to the preponderating extent of this influence, require the exercise of any great care in the preparation of the designs compared, it is nevertheless of interest to set

TABLE I.—*150 Horse-power Continuous-current Motors.*
(All dimensions are in centimetres.)

Revolutions per Minute	68	204	612	817	1,224
SPECIFICATION.	A.	B	C.	D.	E.
Number of Poles	8	8	6	6	4
Kilowatts Input as Motor	126·7	126·0	127·3	126·8	127·8
Full Load Voltage	350	350	350	350	350
" " Amperes	361	360	363	362	364
External Diameter of Armature (D)	146·0	146·0	100·0	90·0	60·0
Gross Length Armature Laminations = (λg)	48·0	15·0	12·0	12·5	14·0
Polar Pitch = (τ)	57·5	57·5	52·5	47·0	47·2
Length of Armature over Winding L = λg + 0·7 τ	88·2	55·2	48·8	45·4	47·0
D × L. (This is proportional to the Total Factory Cost)	12,900	8,060	4,880	4,080	2,820
Number of Ventilating Ducts	8	1	1	1	1
Width of each Duct	1·0	1·0	1·0	1·0	1·0
Effective Length of Laminations in Armature Core (λi)	36·0	12·6	10·6	10·3	11·6
Internal Diameter of Armature Laminations	100·0	100·0	56·6	48·0	23·0
Diameter of Commutator	140·0	140·0	56·0	45·0	30·0
Length of Commutator	12·0	12·0	24·0	30·0	45·0
Width of Segment at Surface (including Insulation)	0·393	0·393	0·368	0·368	0·368
Total Number of Segments	1,120	1,120	480	384	256
" " " Slots	224	224	120	96	64
Number of Segments per Slot	5	5	4	4	4
Turns per Segment	1	1	1	1	1
Width of Slot (as Stamped)	1·18	1·18	1·04	1·04	1·24
Depth of Slot	3·0	3·0	3·0	3·0	3·0
Radial Depth of Air-Gap	·5	·5	·5	·5	·5
" Length of Magnet Core	25·0	25·0	25·0	25·0	25·0
Equivalent Diameter of Magnet Cores	36·0	21·0	18·5	18·0	18·0
Cross Section of Magnet Cores (Sq. Cms.)	1,020	347	270	255	255
Shape of Cross Section of Magnet Cores	Circular	Circular	Elliptical	Elliptical	Elliptical
Pole Face Dimensions	48 × 40	15 × 40	12 × 34	12·5 × 30·5	14 × 29·8
Ratio of Pole Arc to Pole Pitch	·692	·692	·640	·640	·620
External Diameter of Magnet Yoke (D_1)	225·0	212·2	165·0	154·6	124·0
Width of Magnet Yoke	48	35	30	30	30·5
Radial Thickness of Yoke	12	5·6	5·0	4·8	4·5
Height of Armature Conductors	1·05	1·05	1·05	1·05	1·05
Width " "	·13	·13	·14	·14	·18
Current Density in Armature Conductors (in Amperes per Sq. Cm.)	330	328	411	410	482
Thickness of Armature Slot Insulations (Copper to Irons)	·125	·125	·125	·125	·125
Space Factor in Armature Slot	·386	·386	·378	·378	·405
Average Voltage per Commutator Segment	2·5	2·5	4·38	5·46	5·46
Amperes per Sq. Cm. of Brush Contact	3·75	3·75	3·75	3·75	3·75
Total Armature Interference (Ampere Turns per Pole)	6,320	6,300	4,850	3,860	5,820
Types of Winding	8 Circ. Single	8 Circ. Single	6 Circ. Single	6 Circ. Single	4 Circ. Single
Paths through Armature Winding from + to − Brushes	8	8	6	6	4
Amperes per Pole	45·1	45·0	60·5	60·3	91
Length of Arc of Brush Contact	2·0	2·0	2·0	2·0	2·0
Frequency of Commutation in Cycles per Second	126	378	450	482	482
Mean Length of Armature Turn	240	180	159	138	138
Embedded Length per Turn	72	25	20	20	23
Free Length per Turn	168	155	130	98	115
Reactance Voltage with Full Load Amperes	1·3	1·76	2·44	2·4	4·12
Apparent Tooth Density (Lines per Sq. Cm.)	21,100	20,400	17,600	16,400	18,100
Width of Tooth at Root	·79	·79	1·42	1·71	1·42
Radial Depth of Laminations below Slots	20·0	20·0	10·0	18·0	15·5
Density below Slots (Lines per Sq. Cm.)	8,800	8,000	8,450	8,800	9,050
Cycles per Second for Reversal of Magnetisation in Armature Iron	4·55	13·6	30·6	40·9	40·9
Total Armature Flux at Full Load Rated Voltage (Megalines)	12·9	4·35	3·47	3·26	3·26
Factor for Magnetic Leakage	1·2	1·2	1·2	1·2	1·2
Flux in Magnet Cores (Megalines)	15·5	5·22	4·16	3·91	3·91
Density in Magnet Core	15,200	15,200	15,400	15,300	15,300
Density in Magnet Yoke (Lines per Sq. Cm.)	13,400	13,400	14,000	13,700	14,200
Pole Face Density	6,700	7,250	8,500	8,580	7,800
Field Ampere Turns at Full Load	6,000	6,000	6,000	6,000	6,000
Material of Magnet Yoke	Cast Steel	Cast Steel	Cast Steel	Cast Steel	Cast Steel
" " " " Cores	"	"	"	"	"
" " " Armature Sheets	Steel	Steel	Steel	Steel	Steel
Peripheral Speed of Armature Meters per Second	5·2	15·6	32	38·5	38·5
" " Commutator " "	5·0	15·1	18·0	19·3	19·3
Centrifugal Force at Armature Surface in Kilogrammes per Kilo	3·8	34	208	335	500
" at Commutator Surface	3·62	32·6	116	167·5	250
LOSSES AND EFFICIENCIES AT 60° C.					
Core Loss	3,150	3,200	4,200	3,800	2,300
Armature Copper Loss	8,000	6,000	3,580	2,660	3,150
Commutator C^2R Loss at Brushes	580	580	580	580	580
" Brush Friction Loss	320	940	1,120	1,160	1,160
Loss in Shunt Winding	1,600	1,070	830	820	620
Friction Loss at Bearings and Air Friction	1,000	2,200	5,000	5,800	8,000
Total Constant Losses	6,040	7,300	11,090	11,550	12,060
" Variable "	8,580	6,580	4,160	3,240	3,730
Total of all Losses	14,650	13,900	15,310	14,820	15,810
Commercial Efficiency Full Load	88·4	89	88	88·3	87·6
" " ¾ "	88·3	88·2	86·2	86·3	85·5
" " ½ "	87	86	82·1	81·9	81·0
" " ¼ "	80·5	78·1	71	70·2	69·4
Watts per Sq. Dcm. of Peripherial Radiating Surface of Armature	27·5	36·2	49·5	48·5	61
Watts for Commutator Surface	17	28·6	40	41	41
Watts per Sq. Dcm. of External Cylindrical Radiating Surface of Field	6	6·05	6·2	6·26	7·05
WEIGHTS AND COSTS IN KILOGRAMMES AND SHILLINGS.					
Weight of Armature Laminations	2,275	800	415	340	195
" " " Copper	328	246	94	69	59
" " Commutator Copper	235	335	190	190	190
" " Field "	406	245	175	169	100
" " Pole Faces	243	77	40	36	26
" " Magnet Core	1,760	555	323	306	204
" " Yoke	3,050	1,040	600	530	410
Total Weight of Effective Material	8,297	3,198	1,837	1,660	1,184
Cost of Copper (at 2·0 Shillings per kilogram)	1,940	1,450	920	840	700
Cost of Laminations (at 0·6 Shilling per kilogram)*	1,500	525	250	225	130
Cost of Cast Steel (at 0·4 Shilling per kilogram)	1,920	635	365	330	245
Cost of Net Effective Material	5,360	2,610	1,535	1,395	1,075
" " per H.P.	35·7	17·4	10·2	9·3	7·2
Total Factory Cost in Shillings per H.P. Output (from D × L rule)	86	53·7	32·3	27·2	19·3
Percentage which Cost of Net Effective Material bears to Total Cost	41·5	32·5	31	34·5	38·4

* This price is for completed discs, and includes labour and waste material.

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these forth in some detail. A more careful study of each of the individual designs might easily lead to a considerable percentage improvement in the results for a given cost, or in the cost of the results obtained.

Where continuous-current and induction motors come up for comparison, it is natural that one should seek for some common ground as a basis for the designs. It has seemed to me that the

TABLE II.—*150 Horse-power Induction Motors.*
(All dimensions are in centimetres.)

	21 Cycles per Second.			63 Cycles per Second.		
Rated Horse-power	150	150	150	150	150	150
Number of Poles	36	12	4	12	8	6
Synchronous Speed in Revolutions per Minute	70	210	630	630	940	1,260
Voltage	350	350	350	350	350	350
External Diameter of Stator Punchings	318·2	132·4	84·1	114·8	85·8	70·8
Internal " " " "	292·4	107·4	51·1	90·4	60·4	45·4
External " " Rotor " (D)	292·0	107·0	50·7	90·0	60·0	45·0
Radial Depth of Air-Gap (Δ)	0·18	0·18	0·18	0·18	0·18	0·18
Internal Diameter of Rotor Punchings	272·0	87·0	30·0	70·0	40·0	25·0
Circumference at Air-Gap.	920·0	338·0	160·0	283·0	190·0	143·0
Polar Pitch at Air-Gap τ	25·6	28·2	40·0	23·7	23·7	23·7
Gross Length between Flanges (λ_g)	16·7	48·0	48·0	20·0	30·0	43·0
Number of Ventilating Ducts	0	3	3	1	2	3
Width of each Ventilating Duct	—	10	10	10	10	10
Net Length Laminations between Flanges λ_n	150	400	400	171	252	300
$\frac{\lambda_n}{\tau}$	0·585	1·42	1·00	0·72	1·07	1·52
Type of Slots Employed	⅔ Closed	⅔ Closed	⅔ Closed	⅔ Closed	⅔ Closed	⅔ Closed
C in Behrend's Formula	10·8	10·2	10·5	13	11·9	11·2
$\sigma = C\frac{\Delta}{\tau}$	0·075	0·0645	0·0465	0·098	0·090	0·085
Maximum Power-factor	0·870	0·886	0·915	0·849	0·848	0·855
Watts Output at Full Load	112,000	112,000	112,000	112,000	112,000	112,000
Full Load Efficiency	86 %	89 %	90·5 %	90·5 %	91·3 %	91·8 %
Watts Input at Full Load	130,000	125,800	123,800	124,000	122,800	122,000
Volt-Amperes Input at Full Load	149,000	141,500	135,500	147,500	144,800	142,500
" " " per Phase	49,700	49,700	49,700	49,170	48,270	47,500
Connection of Stator Windings	Δ	Δ	Δ	Δ	Δ	Δ
Volts between Terminals	350	350	350	350	350	350
Volts per Phase	350	350	350	350	350	350
Full Load Amperes per Stator Winding	142	135	129	140	138	136
Energy Component of Full Load Amperes per Stator Winding	123	120	118	117	117	116
Full Load Line Amperes	246	234	223	243	239	235
Dimensions of Bare Conductor in Stator	·5 × 1·27	·45 × 1·05	·35 × 1·3	·4 × 1·12	·4 × 1·12	·4 × 1·12
" Insulated Conductor in Stator	·55 × 1·32	·50 × 1·1	·40 × 1·35	·45 × 1·17	·45 × 1·17	·45 × 1·17
Solid or Stranded	Stranded	Stranded	Stranded	Stranded	Stranded	Stranded
Cross Section of one Stator Conductor	0·54	0·47	0·386	0·445	0·445	0·445
Current Density at Full Load	262	377	334	314	312	306
Depth of Stator Slot	3·4	3·0	3·5	3·2	3·2	3·2
Width " "	1·43	1·38	1·55	1·75	1·75	1·75
Number of Conductors per Slot	4	6	6	6	6	6
Arrangement of Conductors in Stator Slot	2 × 2	3 × 2	3 × 2	3 × 2	3 × 2	3 × 2
Number of Stator Slots	432	144	72	108	72	54
Total Number of Stator Turns	864	432	216	324	216	162
Number of Stator Turns per Phase	288	144	72	108	72	54
" " " Pole per Phase	8	12	18	9	9	9
Approximate Internal Voltage per Phase (E)	340	340	340	340	340	340
Megalines Flux per Pole = M = (E = 4·2 TNM × 10⁻⁸)	1·35	2·14	5·35	1·19	1·78	2·38
Width of Stator Slot-opening	0·43	0·57	0·9	0·8	0·8	0·8
Stator Tooth Pitch	2·13	1·88	2·25	2·64	2·64	2·64
Per Cent. Exposed Iron at Stator Surface	0·8	0·7	0·6	0·7	0·7	0·7
" " " at Rotor Surface	0·8	0·7	0·6	0·7	0·7	0·7
Mean for Stator and Rotor	0·8	0·7	0·6	0·7	0·7	0·7
Exposed Cross Section of Iron at Air-Gap	308	970	960	284	447	565
Spreading Coefficient	1·15	1·15	1·15	1·15	1·15	1·15
Corrected Air-Gap Cross Section	354	910	1,100	326	515	685
Gap Density—Average	3,810	3,540	4,850	3,650	3,480	3,470
Maximum Gap Density	6,460	6,000	8,200	6,200	5,900	5,850
Ampere Turns for Gap	920	850	1,170	890	845	840
Total Ampere Turns	1,080	1,000	1,420	1,050	980	960
Ampere Turns per Pole per Phase	540	500	710	525	490	480
Maximum Current at No Load	67·5	50·0	39·5	58·5	54·5	53·5
R.M.S. Current at No Load	48·0	35·4	28·0	41·5	38·5	37·8
" " in Percentage of Full Load Current	34·0 %	26·2 %	21·7 %	29·6	27·9	27·8
Total Radial Depth of Stator Punchings	12·9	12·5	16·5	12·7	12·7	12·7
" " " above Slot	9·9	9·5	13·5	9·5	9·5	9·5
Magnetic Cross Section of Stator Core (*i.e.* above Slot)	2 × 142	2 × 380	2 × 520	2 × 162	2 × 239	2 × 342
Stator Core Density	4,750	4,250	5,150	3,660	3,750	3,490
Width of Tooth at Narrowest Point	7·1	5·1	7·1	9	9	9
Cross Section per Pole at Narrowest Point	128	305	510	138	203	356
Maximum Density at any Stator Tooth at Narrowest Point	17,900	17,900	17,900	14,700	15,000	14,000
$\frac{DC}{100}$ for Stator	1·00	0·89	1·08	2·31	2·36	2·20
Watts Stator Core Loss per kilogram	1·5	1·3	1·6	3·5	3·6	3·4
Net Weight Stator Punchings (kilograms)	1,400	1,500	1,100	520	570	640
" " Rotor "	1,000	1,000	500	330	320	320
Core Loss in Stator Iron	2,100	2,000	1,800	1,800	2,100	2,300
" " Rotor Iron	420	400	360	360	420	460
Total Core Loss	2,520	2,400	2,160	2,160	2,520	2,760
Embedded Length of one Stator Turn	30	80	80	34	50	72
Free " " "	73	80	110	67	67	67
Mean " " "	103	160	190	101	117	139
Total Length of each Stator Winding (*i.e.* Winding One-Phase)	29,600	19,200	13,700	10,900	8,400	7,500
Resistance per Phase at 60° C. — Ohms	0·109	0·082	0·071	0·0577	0·0382	0·034
Total Stator C²R Loss	6,500	4,500	3,500	3,500	2,250	1,930
" Rotor " "	8,100	5,300	4,100	4,000	3,350	2,900
" Core Loss (Stator and Rotor)	2,520	2,400	2,160	2,160	2,520	2,760
Allowance for Friction Loss	1,200	1,600	2,000	2,000	2,200	2,400
Total of Losses	18,320	13,800	11,760	11,660	10,320	9,990
Output in Watts	112,000	112,000	112,000	112,000	112,000	112,000
Input "	130,320	125,800	123,760	123,660	122,320	121,990
Full Load Efficiency (in Per Cent.)	86·0 %	89·0 %	90·5 %	90·5 %	91·3%	91·8%
Weight of Stator Copper (Kilograms)	415	240	140	127	102	89
" Rotor " "	285	170	100	88	60	52
Total Weight of Copper Conductors	700	410	240	215	162	141
" " Laminations	2,400	2,500	1,600	850	890	960
Cost of Copper at 2·0 Shillings per K.G.	1,400	820	480	430	324	282
" Laminations at 0·6 Shilling per K.G.*	1,440	1,500	960	510	530	575
" Net Effective Material (in Shillings)	2,840	2,320	1,440	940	854	857
Cost per H.P. for Net Effective Material (in Shillings)	18·9	15·5	9·6	6·2	5·7	5·7
Diameter of Rotor (D)	292	107	50·7	90	60	45
$L = \lambda_g + 0{\cdot}7\,\tau$	34·7	67·7	76	36·6	46·6	59·6
Total Factory Cost of Motor (D L)	6,700	4,850	2,610	2,200	1,870	1,820
Cost of Effective Material in Per Cent. of Total Cost	42 %	48 %	55 %	43 %	46 %	47 %

* This price is for completed discs, and includes labour and waste material.

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most significant common attribute for this purpose is the ratio λ/τ, in which λ equals the length of laminations between end flanges (λ_g = gross core length and λ_n = net core length) and τ = polar pitch at the air-gap—*i.e.*, the circumference at the air-gap divided by the number of poles. As already described, the cost of the induction motors has been taken proportional to $D \times (\lambda_g + 0{\cdot}7\tau)$, and the cost of the continuous-current motors to $D \times L$, where L = length over end connections. In general for continuous-current motors, L is also approximately equal to $\lambda_g + 0{\cdot}7\tau$, although in the case of well-defined windings having the end connections lying in extensions of the armature core's external cylindrical surface, it is more instructive to use the expression $D \times L$ as the basis for cost estimates and comparisons. λ/τ is again useful in obtaining the value of C in Behrend's formula for the leakage factor σ, which is $\sigma = C\Delta/\tau$, Δ being the radial depth of the air-gap. The writer obtains the values for C from curves showing it as a function of the ratio λ/τ, and finds that this leads to results rather more accurate than are otherwise obtainable from Behrend's formula, and far more conveniently arrived at than by means of the more complex formulæ sometimes employed for the estimation of σ.

In the case of the induction motors the radial depth of the air-gap has been taken at 0·18cm. for all cases. This is not in accordance with practice. A lesser gap with the corresponding electromagnetic advantages would be employed by most designers for the higher speed designs. But to avoid entering into the discussion of the most suitable respective values, I have adhered throughout to the value of 0·18cm., and the induction motors come out so greatly superior to the continuous-current motors at high speed that they are well able to stand this handicap.

For a moderate range of speeds, for the same output, say a range of 1 to 4, I should have taken the same number of poles and the same diameter for all my continuous-current designs, as I find this to be a practicable and correct designing principle for this class of machinery. Here, however, with a speed range of 1 to 18, the lower speed designs are given more poles and larger diameter, and vice versa for the higher speed designs. The range of diameters is, however, far less than is customary with most designers, and this is a point of interest, since, although I do not claim to have devoted to each design more than enough attention to ensure a sound demonstration of the main proposition, it nevertheless appears that, in this respect, the designs are about right for the required conditions.

Further details of these 11 designs are given in Tables I. and II.

It is interesting to derive the costs by another and independent method which consists in determining the cost of the effective material on the one hand and of the non-effective material independently on the other. The latter component can be derived if a sufficient number of machines of the same diameter, but of variable length, are plotted with the cost of the non-effective material as ordinates, and the effective length l as abscissæ. By these means a curve can be obtained which, if produced, intersects the axis of ordinates at a point giving the cost of non-effective material for zero effective length of armature.

This has been investigated by the author as described in *E.T.Z.* No. 40, 1903, and it has been found that the cost of the non-effective material for zero net length of armature core equals approximately $D_1^2/10$s., if D_1 denotes the external diameter of the yoke in centimetres. Such a curve also shows the increase in the cost of the non-effective material in dependency upon the net length of the armature core, and taking into account the influence of the diameter, one could roughly set this increase as equal to $0{\cdot}18D_1\lambda_n$.

The estimation of the costs by this method is carried out in Table III. for the continuous-current motors.

The same method has been applied as shown in Table IV. to the induction motors, $D_1^2/15$s. being taken as the cost of non-effective material for zero net length of armature core, and $0{\cdot}12D_1\lambda_n$ being the increase in cost of non-effective material with increased length. It will be seen that a good agreement is obtained in all except the first case.

The costs as obtained in Tables III. and IV. are plotted in the curves of Fig. 12A, and it will be seen that the results lead to much the same conclusions as were arrived at by the $D \times L$ method and plotted in Fig. 12.

The principal conclusions arrived at in this Paper are as follow:—

I. Induction motors are, for all capacities, considerably cheaper than continuous-current motors of equivalent ratings.

II. The general performance and the mechanical construction of induction motors improve rapidly with increasing rated speeds.

III. The general performance and the mechanical construction of continuous-current motors improve rapidly with decreasing rated speeds.

IV. The use of very low-speed induction motors and very high-speed continuous-current motors ought to be avoided whenever this is commercially practicable.

These conclusions are not new. They must, however, be much more widely understood if the electric transmission of power is to proceed on rational lines.

Table III.—*Estimation of Total Works Cost of 150 h.p. Continuous-current Motors.*

Diameter over all (D_1)	225	212	165	154·6	124
Cost of non-effective material for zero length of armature core	5,100	4,500	2,700	2,400	1,550
Increase in cost of non-effective material with increased length	1,460	480	30 0	285	260
Cost of effective material	5,360	2,610	1,535	1,395	1,075
Total works cost	11,920	7,590	4,535	4,080	2,885
Do. by D × L rule	12,900	8,060	4,880	4,080	2,820

Table IV.—*Estimation of Total Works Cost of 150 h.p. Induction Motors.*

Diameter over all (D_1)	364	164	116	146	116	102
Cost of non-effective material for zero length of armature core	8,900	1,800	890	1,420	900	700
Increase in cost of non-effective material with increased length	660	790	560	300	350	440
Cost of effective material	2,840	2,320	1,440	940	850	860
Total works cost	12,400*	4,910	2,890	2,660	2,100	2,000
Do. by D × L rule	$6{,}7_0^0$*	4,850	2,610	2,200	1,870	1,820

* This is an abnormal machine in every respect, but nevertheless closely follows lines of machines at present in operation. The D × L rule in so extreme a case gives far too low a value, and the value obtained by the analytical method is a trifle too high.

SOME APPLICATIONS OF THE THEORY OF ELECTROLYSIS TO THE SEPARATION OF METALS FROM ONE ANOTHER.*

BY A. HOLLARD.

In the present study I have co-ordinated a certain number of facts and experiments already published here and there in such a way as to bring them into line and show what philosophic bearing they have on one another. It thus clears the way for the presentation of an actual theory of electrolytic analysis that has not up to the present been put forward. The only principle involved hitherto in electrolytic analysis for the separation of elements is that which is based on the successive separation of the metals by gradual increase of the potential across the electrodes, each metal depositing itself at a potential spoken of as the potential proper to the metal. Strictly speaking, this principle is hardly directly applicable. Indeed, it supposes the constant use of low potentials and consequently small intensities, thereby prolonging the duration of the experiment. In fact, the only applications of this principle which have been made are the separations, with very weak currents, of copper and silver, of silver and bismuth, and of mercury and bismuth—that is, of metals whose polarisation potentials are lower than that of hydrogen. As to metals with polarisation potentials higher than that of hydrogen (zinc, cadmium, iron, cobalt, nickel, tin, lead), they cannot be separated according to this same principle. In fact, the current, already very weak, which precipitates one of the metals, separates hydrogen from the bath just as much, and then the fraction of the current utilised for the deposit of the metal is so small, especially towards the end of the electrolysis, when the concentration of the metal ions becomes very low (Nernst's law), that the deposition of the metal is never complete. Thus zinc and nickel, which have a relatively large P.D. (0·54), have not been separated by us, when we used a slightly ammoniacal solution of the sulphates with a current of 0·01 ampere, the zinc always depositing itself with the nickel. We ought to work with a current of less than 0·01 ampere, seeing that a fraction only is utilised, but this would make the operation interminable.

Recognising that the foregoing principle is entirely insufficient, we have sought for other applications of the theory of electrolysis permitting of effectual analytical separations. The applications we have found will be ranged under three headings. I. Reduction of the resistance of the bath by suppressing the formation of gas at the anode. II. Influence of the nature of the cathode. III. Formation of complex salts. (This application has already been studied, especially by Frendenberg.)

1. *Reduction of the Resistance of the Bath by Suppressing the Formation of Gas at the Anode.*—We have shown above that the metals whose polarisation potentials are higher than that of hydrogen cannot be separated from one another by gradual increase of the E.M.F. on account of the extremely small fraction of the current used to precipitate the metal. We have been able, however, considerably to increase the current by diminishing the resistance of

* Paper read before the Faraday Society.

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the bath, and that in two ways: 1. By suppressing the liberation of oxygen at the anode. 2. By the use of soluble anodes.

1. To suppress the liberation of oxygen at the anode (or at least greatly to diminish it), we introduce a reducing agent into the bath, such as sulphurous acid, which prevents the liberation of oxygen gas by combining with it. This suppression of gas greatly augments the conductivity of the bath; for the same potential applied to the bath the current which passes is much more intense and permits the precipitation of one of the metals on the cathode in a relatively short time. Let us take a mixture of zinc and nickel, which cannot be separated by the application of the first principle: the sulphates of the metals are treated with sulphate of ammonia (10 grammes), sulphate of magnesium (5 grammes), 5 cubic cm. of a saturated solution of sulphurous anhydride, finally an excess of 25 cubic cm. of ammonia (specific gravity 0·924). This is diluted to 300 cubic cm. and electrolysed at a temperature of about 90deg.,* with a current of 0·1 ampere. The electrodes we used are shown in Fig. 1, the cathode being of platinum gauze and sand-blasted.† At the end of four hours at the most, for quantities of nickel which do not exceed 0·25 gramme, 1 to 2 cubic cm. of the bath should not be blackened by ammonium sulphide. The electrolysis is allowed to continue for an hour, then the cathode is removed.

It is very important to adhere to the proportions of the reagents indicated, otherwise the separation may fail. Thus an excess of sulphurous acid leads to the formation of zinc sulphide. This portion of the work was carried out with M. Bertiaux.

Experimental Results.

Quantities weighed.	Nickel deposited.	Quantities weighed.	Nickel deposited
Ni = 0·2500 Zn = 0·05	0·2508	Ni = 0·2500 Zn = 1·0	0·2501
Ni = 0·2500 Zn = 0·1	0·2494	Ni = 0·1000 Zn = 0·1	0·0969
Ni = 0·2500 Zn = 0·25	0·2517	Ni = 0·1000 Zn = 0·5	0·0963
Ni = 0·2500 Zn = 0·5	0·2500	Ni = 0·1000 Zn = 1·0	0·0973
Ni = 0·2500 Zn = 0·5	0·2506		

2. The use of a soluble anode to avoid the liberation of oxygen at the anode is less simple than the above procedure. On the other hand the soluble anode in dissolving produces sufficient electric current to electrolyse the bath, and render the use of an external source of electricity unnecessary. The metal selected for the anode should be of such a nature that it can replace in the solution the metal that is to be separated, and that only. In order that this may not be precipitated on the anode, but only on the platinum cathode, the anode must be immersed, not in the bath B itself (Fig. 2) but in the solution A containing an indifferent salt (salt of an alkali or an alkaline earth) separated from the bath B by a membrane of vegetable parchment. If it is required to separate nickel from zinc, we make use of a zinc anode. We take a vessel separated into two cells by a membrane *pp* of vegetable parchment (paper treated with sulphuric acid.) We place in one of the cells, B, the solution containing the nickel and the zinc, and in the other, A, a salt solution, which must be a conductor of the current—a solution of magnesium sulphate serves very well. The zinc sheet intended to precipitate the nickel is immersed, not in the solution B containing the nickel, but in the magnesium sulphate solution. In the solution B a sheet of platinum HH is placed. Finally the platinum and zinc are connected by an external copper wire. We thus make a reversible cell of two liquids of the Daniell type, in which the current goes from the platinum to the zinc by an external conductor, and from the zinc to the platinum in the interior of the liquid. We will, therefore, examine an actual electrolysis of a nickel salt, giving a deposit of pure nickel on the platinum sheet. In practice we proceed as follows:—

The nickel and zinc in the state of soluble sulphates are contained in a Bohemian beaker (655 cubic cm. capacity, 7cm. diameter). This solution should contain an excess of 20 cubic cm. ammonia, 22°Bé, and 100 grammes of anhydrous ammonium sulphate, and should occupy a volume of 250 cubic cm. Obviously, this liquid is a good conductor of the current. We put into it our electrode of platinum gauze (Fig. 3). A glass tube 55mm. internal diameter, closed at the base by a membrane of vegetable parchment, is immersed in the solution of nickel and zinc in the beaker, so that the membrane is as near as possible to the electrode without, however, touching it. A solution of magnesium sulphate, 250 grammes to the litre, is poured into the tube to fill it to a depth of about 70mm. This strength of magnesium sulphate solution possesses the maximum conductivity. The choice of this salt as conductor for the inner cell is that it is one of the few salts which have no chemical action on zinc. Finally, an amalgamated zinc disc, 5cm. diameter, attached to a rod of copper insulated by caoutchouc, is immersed in this liquid. The copper rod is connected externally to the platinum electrode. The zinc disc is pierced with several holes to facilitate the circulation of the inner cell liquid, and placed 15mm. to 20mm. above the parchment. During the whole of the experiment, the contents of the outer cell are heated nearly to boiling (about 95deg.). At the end of several hours the nickel is completely deposited on the electrode as a fine, strongly adherent metallic layer. The electrode is withdrawn, swilled with water, then plunged into distilled water for 10 minutes to complete the washing, finally dried and weighed.

Experimental Results.

Quantities taken.	Nickel deposited.
(1) Ni = 0·2000 Zn = 1	0·2026
(2) Ni = 0·2000 Zn = 0·5	0·1995
(3) Ni = 0·2500 Zn = 1	0·2499
(4) Ni = 0·2500 Zn = 1	0·2525
(5) Ni = 0·5000 Zn = 0·0000	0·4989
(6) Ni = 0·4500 Zn = 1	0·4506
(7) Ni = 0·5000 Zn = 1	0·5048 (contained a little zinc)
(8) Ni = 0·0500 Zn = 1	0·0524

One sees from the above table that the method can be applied to varying proportions of zinc and nickel. On the other hand, the mixture should not contain more than 1 gramme of zinc or 0·45 gramme of nickel, otherwise the simultaneous deposition of

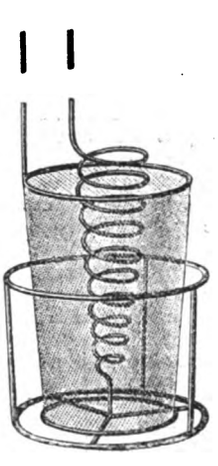

Fig. 1.

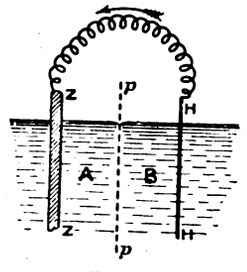

Fig. 2.

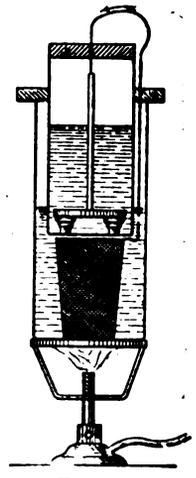

Fig. 3.

zinc becomes possible. Experiment 7 shows that already, with 0·5 gramme of nickel and 1 gramme of zinc, there is a deposition of zinc. When there is no zinc in solution, at least 0·5 gramme pure nickel can be deposited (experiment 5). These limits as to the quantites of nickel and zinc find their explanation in the theory of the method we are about to give. This theory is none other than that of reversible cells. The solution pressure P of the precipitating metal* (in this case zinc) being higher than the solution pressure P^1 of the precipitated metal† (here nickel), a positive E.M.F. is established between the two metals, according to Nernst's formula

$$(1) \qquad e = \frac{K}{v}\log\frac{P}{C} - \frac{K}{v^1}\log\frac{P^1}{C^1},$$

K is a constant for a definite temperature, v and v' are the valencies of the precipitating and precipitated metals, C and C' the concentrations of the two metals.‡ One sees according to this formula, that when the concentration C of the zinc in the inner cell increases (consequent upon the deposition of nickel on the platinum electrode) e will diminish. It is necessary, then, that there should not be too much nickel to deposit; 0·45 gramme can, however,

* It is important that the temperature should never fall below this value.

† These can be procured from the des Moutis, of London and Paris, and Poulenc, of Paris.

* The idea of solution-pressure has been suggested in the ionic theory by the analogy which has been established between the tendency which bodies have of becoming ionised, and the tendency which bodies have of passing into the state of vapour. Just as the measure of the second is called the vapour-pressure, so the first has been called the solution-pressure.

† The order of the solution-pressures is the same as that of the polarisation potentials.

‡ In the Nernst formula we have put C and C' as the concentration of the metals, in place of their osmotic pressures p and p', which should have been used, because C and C' are proportional to p and p' on account of the relatively great dilution of the solutions we have employed.

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be easily deposited. According to the same formula, if the concentration of the nickel diminishes, e tends towards zero, which means that the nickel can never be completely deposited. This would indeed happen if we were working with a solution of the normal sulphate of nickel, but we work with a solution containing a large excess of ammonia—that is, a solution containing a large concentration of the ions $NH_4^{\cdot}$; thus C^1 does not represent the concentration of the nickel ions, but a mean of the concentration of the ions $Ni^{\cdot\cdot}$ and $NH_4^{\cdot}$. This ammonium gives rise to a disengagement of hydrogen during the electrolysis. Therefore, when one would generalise this method for other separations than that of nickel and zinc, care must be taken to put into the solution an excess of ammonia or acid or any other substance capable of forming hydrogen ions, or ions playing the same part. In reality, the phenomenon is complicated by secondary reactions which it will be always necessary to take into account when it is desired to extend the method to other separations than that of nickel and zinc.

1. The concentration of the zinc sulphate should not be too great, for then this salt on the one hand, and the dilute solution of zinc sulphate which is formed, on the other hand, by the solution of the zinc in the inner cell, will form a *concentration cell* (Zn | $ZnSO_4$ dilute || Pt | $ZnSO_4$ concentrated ; Zn and Pt representing the poles of the cell—that is, the zinc disc and the platinum electrode). Otherwise the total E.M.F. of the system may reach such a point that the zinc can be precipitated with the nickel, which we found to be the case when the nickel was accompanied by 2 grammes and more of zinc. That is why we have recommended that there should not be more than 1 gramme of zinc in the nickel solution.

2. The sulphate of zinc formed in the solution of magnesium sulphate by the solution of the zinc attacks the disc of zinc, especially when warm, hence a voltaic couple which produces a new increase of the E.M.F., an increase which we have endeavoured to diminish as much as possible by arranging the cell so that the disc is in the coolest part of the apparatus. The concentration of zinc sulphate increases as the nickel is deposited, causing the attack on the zinc disc and the E.M.F. to become greater; this would end by favouring the deposit of zinc with the nickel. Fortunately, this concentration decreases the E.M.F. of the concentration element spoken of in the previous paragraph, as well as the E.M.F. of the principal element (see Nernst formula), so that one can easily deposit 0·45 gramme of pure nickel even when accompanied by 1 gramme of zinc. When nickel alone is present one can deposit still more, for in this case there is no concentration element. Hence it follows that the quantity of pure nickel that can be deposited is greater as the accompanying zinc is less (for then the effect of the concentration element is reduced), and inversely that the quantity of zinc accompanying the nickel can be greater according as the nickel is present in smaller amount (for then the E.M.F. of the cell is reduced). By not having more than 0·45 gramme of nickel and 1 gramme of zinc in the solution, one is always certain to have pure nickel deposited.

3. Finally, there is another secondary phenomenon which does not occur with nickel sulphate, but which is manifest with certain other salts. This can be discussed for the sake of completeness. We mean the migration of the salts in the course of the electrolysis from the cathode (here the platinum electrode) to the anode (here the precipitating metal). This is Hittorf's phenomenon. For each metal, then, it is necessary to find out if it forms a salt which does not show the Hittorf phenomenon, and if it is preferable to work at one temperature more than another, for the losses in concentration round the cathode (and around the anode) vary with the temperature. The method cannot be applied to every class of salt, and so is not general. It cannot be used for copper in particular, the $Cu^{\cdot\cdot}$ ions passing very rapidly to the anode cell.

II. *Influence of the nature of the Cathode.*—By suitably choosing the metal for the cathode, it is possible to avoid completely the liberation of hydrogen, even in strongly acid solution, and thus to increase sufficiently the conductivity of the bath so that the separation of the metals becomes possible. Moreover, if the metal of the cathode raises the polarising E.M.F. of hydrogen above the polarising E.M.F. of the metal M it is proposed to deposit, at the same time keeping it below the polarising E.M.F.s of the metals which are to remain in the bath, it becomes impossible, as a rule, for these metals to be deposited. In fact, if one does reach the E.M.F. at which they are deposited, this potential, being higher than that of hydrogen, causes in acid solution a sufficiently abundant evolution of gas to prevent their deposit. If evolution of hydrogen occurs it shows that the E.M.F. being used is too great. The above requires amplifying a little. Let us call to mind, first, that in electrolytic analysis the metals are divided into two principal classes, according as they are or are not capable of being deposited on the cathode in strongly acid solution. The metals which cannot deposit themselves in strongly acid solutions are those which, in order to cover the cathode, require potentials higher than that at which hydrogen begins to evolve; one sees then that under the influence of these high tensions a strongly acid solution (that is, one containing a large proportion of H. ions) gives rise to such an abundant evolution of hydrogen at the cathode that all precipitation of metal there becomes impossible. On the other hand, metals which can be deposited on the cathode in strongly acid solution are those which require for this precipitation potentials lower than the polarisation potential of hydrogen; their deposition is not then interfered with by hydrogen. If we call the polarisation potential of hydrogen zero we shall have the following values for the polarisation potentials of the principal metals:—*

Table I.—*Metals which Cannot be Deposited in Strongly Acid Solution.*

Zn +0·77	Co, Ni +0·23	Pb +0·15
Cd +0·42		—
Fe +0·34	Sn +0·19	H 0·00

Metals which Can be Deposited in Strongly Acid Solutions.

As −0·292	Sb −0·47	Pd −0·79
Cu −0·33	Hg −0·75	Pt −0·86
Bi −0·39	Ag −0·77	Au −1·08

As one sees, the division of the metals into two groups has for its basis the position occupied by hydrogen in the table of the polarisation potentials of the metals. But this position is only fixed in the practice of electrolytic analysis because platinum cathodes are always used. In fact, hydrogen has—as shown by Caspari†—a polarisation potential varying with the metal of the cathode. If one then uses, as we have done, cathodes of other metals besides platinum, the polarisation potential of hydrogen takes another position in the above table, causing a certain number of metals to pass from one group into the other. By appropriately choosing the cathode metal it is evidently possible to achieve the separation of two metals of the same group whose polarisation potentials are too near to be separated with a platinum cathode; a metal is chosen giving to hydrogen a polarisation potential intermediate between those of the two elements to be separated. In a strongly acid solution the element with the lowest polarisation potential will be precipitated, the bath being made a good conductor by the non-evolution of hydrogen at the cathode. In order to choose the most suitable metal the following table, due to Caspari, must be consulted; this gives the values of the polarisation potential of hydrogen when disengaged on different metals taken as cathode in normal sulphuric acid:—

Table II.

Pt, platinised	0·00	Cd	0·48
Au	0·02	Sn	0·53
Fe (in NaOH)	0·08	Pb	0·64
Pt, polished	0·09	Zn (in acid zinc solution)	0·70
Ag	0·15	Hg	0·78
Ni	0·21	Cu, amalgamated	0·51
Cu	0·23	Pb „	0·64
Pd	0·46	Cd	0·68

But it is not enough to choose as cathode a metal which has the property of raising the polarisation potential of hydrogen above the polarisation potential of the metal to be precipitated, for this property of the cathode metal disappears when it is covered by the precipitated element, and then acts as if made entirely of this precipitated element. In order that the deposition may continue, it is necessary that the precipitated metal itself should also possess the property of raising the polarisation potential of hydrogen above its proper value. By taking cathodes made of the same metal as that to be deposited it is seen that, according to the preceding table, it is possible to precipitate in strongly acid solutions, not only the metals whose potentials are lower than that of hydrogen (Table I.), but lead, tin and cadmium. In fact, the polarisation potential of lead (+0·15) is notably lower than that of hydrogen when disengaged on a lead cathode, and the same can be said of tin and cadmium. As an

Experimental Results.

Quantities weighed.‡	Cadmium deposited.	
Cd 0·1991	0·1972	Cathode of tinned platinum gauze.
Zn 2		
Cd 0·2996	0·3010	
Zn 2		
Cd 0·1996	0·2002	
Zn 1		
Cd 0·1991	0·1984	Cathode of platinum gauze plated with cadmium.
Zn 2		
Cd 0·2188	0·2484	
Zn 2		
Cd 0·1991	0·1968	
Zn 0·0		
Cd 0·2000	0·0002	Cathode of platinum gauze.
Zn 2		

* Nernst and Wilsmore, *Zeit. für Elektrochem.*, November 8, 1900.

† Caspari, *Zeit. für Physik. Chem.*, 1899, 30, 1889.

‡ The cadmium used in the first three experiments contained Pb = 0·231, Fe = 0·000, Zn = 0·000 per cent. That used in the three following contained Pb = 0·245, Fe = 0·193, Zn = 0·000 per cent. The figures given in the table as "Quantities weighed" differ from the amounts actually weighed by the quantity of impurity present.

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application of this new method of analytical separation, we will give the separation of zinc and cadmium, metals which we have not been able to separate before with a platinum cathode* on account of the small difference of their polarisation potentials. On the other hand, we have been able to carry out the separation with a tin or cadmium cathode in a strongly acid solution. Our cathodes were none other than our platinum gauze electrodes covered electrolytically with tin or cadmium. The cadmium or the zinc, in the state of sulphates, were treated with 10 grammes of ammonium sulphate and an excess of 5 cubic cm. of concentrated sulphuric acid. the solution was diluted to 300 cubic cm. and a current of 0·3 ampere allowed to pass.

III.—*Formation of Complex Salts.*—One way of preventing a certain number of metals from precipitating themselves on the cathode, is to make them pass into the state of *complex* salts—that is, salts which dissociate to give, not the metallic ions, but complex ions containing the metal. For example, if we wish to make arsenic or zinc pass into the state of complex salts, we can form the following combinations :—

Sodium arsenate, Na_3AsO_4 - $N3a'AsO_4'''$
Potassium zincate, $K_2Zn(OH)_4$ - $2K'Zn(OH)_4''$

The complex salts have been studied from the point of view of their application in electrolytic analysis, especially by Frendenberg (*Zeit. Phys. Chem.*, 13, 97). As a matter of fact, a certain number of complex anions are partially dissociated into metal ions; the metal can then be deposited on the cathode, but will require an E.M.F. higher than the polarisation potential of the simple salts. If in a solution of several metals some of them pass into the state of complex salts, then those metals taking the part of non-dissociable complex anions will not separate under the influence of the current, and the metals taking the part of dissociable complex ions will only separate at a higher potential than the polarisation potential of their simple salts. This is, then, a means of widening the intervals between the polarisation potentials and of applying the principle of the successive separation of metals by gradual increase of the E.M.F. The separation of antimony and tin in a concentrated solution of sodium hydrogen sulphide, as indicated by Classen, is an example of the use of complex salts. The tin here passes into the state of a complex anion. If copper is present with the tin, the copper, being slightly soluble in the sodium hydrogen sulphide, deposits itself with the antimony. This has been shown by us.† We avoid this precipitation by adding potassium cyanide to the bath; this causes the copper to pass into the state of a slightly dissociated anion which is not electrolysed by the potential employed. (For further details see Hollard, "Separation and Determination of Antimony by an Electrolytic Method," *Bull.* Soc. Chim., 1903, 29, 262.)

ON THE MAGNETIC DISPERSION IN INDUCTION MOTORS, AND ITS INFLUENCE ON THE DESIGN OF THESE MACHINES.‡

BY DR. HANS BEHN-ESCHENBURG.

(Continued from page 743).

A second mode of estimating the value of σ_2 is afforded by comparative observations on similar types of motor with different air-gaps δ, provided that for such type the amount due to flank-dispersion σ_3 has been adequately eliminated by other measurements. We adduce the following examples out of a large series :—

In a motor of type 365 the air-gap was altered from that usual in motors of this type by a careful displacing of the slot-stampings in the iron sheets.

Motor Type 365 : With 8 poles.
$D=70$; $b=30$.
$N_1=120$; $N_2=160$.
Slots closed.

In the first case $\delta=0{\cdot}1$; in the second case $\delta=0{\cdot}14$. Using the earlier-found constants, the contribution due to flank-dispersion was found

(1) $$2\sigma_3=\frac{5\times0{\cdot}1\times1{\cdot}25}{30}=0{\cdot}021.$$

(2) $$2\sigma'_3=0{\cdot}029.$$

With the short-circuit current at saturation-value there was observed in the mean

$$\sigma-\sigma'=0{\cdot}009;$$

so that in both cases there may be reckoned a value of 0·001 for the difference of the peripheral dispersions, and, therefore, for the peripheral-dispersion itself the value

$$\sigma_2=0{\cdot}0025;$$

or, for $K_2=1$, $X=0{\cdot}90$; therefore about four times greater than was reckoned for a slot-opening of 2mm.

Motor Type 3072 : With 14 poles.
$D=150$; $b=28{\cdot}5$.
$N_1=168$; $N_2=210$.

Slots open, with slits about 1·5mm. wide
$\delta=0{\cdot}1$; $\sigma=0{\cdot}046$;
$\delta'=0{\cdot}14$; $\sigma'=0{\cdot}055$;

$$2\sigma_3=\frac{5\times0{\cdot}1\times1{\cdot}25}{28{\cdot}5}=0{\cdot}022;\quad 2\sigma'_3=0{\cdot}030;$$

$$2(\sigma'_2-\sigma_2)=0{\cdot}055-0{\cdot}046-(0{\cdot}030-0{\cdot}022)=0{\cdot}001;$$

therefore $\sigma'_2=0{\cdot}0035$.

Calculation gives $$\sigma_2=\frac{0{\cdot}14}{0{\cdot}15\times13\times33}=0{\cdot}0025.$$

Motor Type 368 : With 12 poles.
$D=94$; $b=40$.
$N_1=108$; $N_2=144$.
Slots closed—
$\delta=0{\cdot}04$; $\delta'=0{\cdot}1$.

For saturation values of the no load current
$\sigma=0{\cdot}040$; $\sigma'=0{\cdot}054$;

$$2\sigma_3=\frac{5\times0{\cdot}04\times1{\cdot}25}{40}=0{\cdot}006;$$

$2\sigma'_3=0{\cdot}015$;
$2(\sigma'_2-\sigma_2)=0{\cdot}005$; $\sigma'_2=0{\cdot}008$.

From this we may calculate the magnetic resistance X of the closed slot

$$X=0{\cdot}5,$$

therefore about five times greater than for a slot-opening of 1mm.

All the observations set forth in this chapter show a sufficient agreement of the observed results with the values calculated from the theoretical considerations of Chapter II., § 2, and lead to the inference that in the ordinary constructions of motors with open slots the part relatively contributed by the peripheral-dispersion to the total values of the dispersion coefficient σ plays a very subordinate rôle, and is, in any case, capable of being represented by formula (5) as

$$\sigma_2=\frac{\hat{c}}{2N\tau X}.$$

For closed slots, in which the iron bridge is made thin enough, this dispersion-coefficient may be estimated about four times greater than for slots with slits. The theoretical consideration led to a tentative difference to be expected from the tenfold contribution for closed slots. But the dimensions of the magnetic resistances of the slot apertures do not lend themselves to any precise determination.

§ 3. Winding-Coefficients.

After having dealt in the two preceding chapters with the two chief sources of magnetic dispersion, and having established their importance, we now finally deal with the experimental verification of the operation described in Chapter II., § 1, of the *Winding-coefficient* σ_1. Formula (4) gives the definition

$$\sigma_1=\frac{1{\cdot}3K_1}{N^2};$$

in which the coefficient K_1 may be put as about equal to unity.

This expression is distinguished from the dispersion-coefficients σ_2 and σ_3 by its independence of the magnetic reluctance in the path of the main flux, and therefore by its independence of $\hat{c}$, τ and b. Since the value of the coefficient σ_2 of the peripheral-dispersion turns out, according to the previous chapter, to be, for moderately well-proportioned motors, always considerably smaller than the sum of the other coefficients σ_1 and σ_3, it follows that the coefficient σ_1 will originate mainly from the differences of the values of σ which are found for different numbers of slots when the other dimensions remain alike.

Here a very large series of examples are afforded by all those cases in which motors of similar type, and with equal total numbers of slots, are wound for different numbers of poles. Since N denotes the number of slots in one pole-pitch, then, for a given similar total number of slots, the coefficient σ_1 is obviously proportional to the square of the number of poles.

For two different numbers of poles, in the case of the same motor, one obtains two different values of the total dispersion coefficient σ;

* Besides using weak acetic acid or cyanide solutions and the feeblest possible currents.

† *Compt. Rend.*, 1896, 123, 1064. *Ann. de Chim. Analyt.*, 1897, 242.

‡ The researches described in this communication were imparted in April, 1903, to Prof. Silvanus P. Thompson, on whose suggestion they were communicated in their present form to the Institution of Electrical Engineers in the summer, and have since been translated into English. The Paper was read in abstract by Prof. Thompson at the meeting of the Institution on January 15, 1904.

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the difference between these values being, from formula (8), set out as

$$\sigma - \sigma' = K_1 \times 2{\cdot}6\left(\frac{1}{N^2} - \frac{1}{N'^2}\right) + \frac{\delta}{X}\left(\frac{1}{N_\tau} - \frac{1}{N'_\tau}\right).$$

If Z is the total number of slots of the motor, and if $\tau = \pi D \div P$, then we have

$$\sigma - \sigma' = \frac{K_1 \times 2{\cdot}6}{Z^2}(P^2 - P'^2) + \frac{\delta}{X \times Z \times \pi D}(P^2 - P'^2).$$

If, therefore, according to the previous chapter, the second member, which shows the value of the peripheral-dispersion, is determined, the comparison of the two values of σ and σ' can afford a direct decision as to the amount of the winding-coefficient.

A second method of determinng this coefficient proceeds from the circumstance that for several different positions of the rotor with respect to the stator the winding-coefficient must in general attain different values. This circumstance has long been known in practice, and, indeed, makes itself evident in a very unmistakable manner in the case of short-circuited rotors by the torque of the rotor, at starting, having minimum values in certain positions; so much so, that in some cases the rotor has to be pushed by the application of external forces out of its position of rest into certain other positions; or, also, in some cases, the rotor takes up a steady speed which is a fraction of the normal speed. In such motors one has frequently resorted to the expedient of increasing the total dispersion by widening the air-gap, in order to cause the relative differences to vanish compared with the total or mean value. Further, it has been the practice to arrange the slots in one part slightly oblique with respect to those of the other part, or to choose the winding-pitch differently in the two parts. Besides this, the inequality of distribution of the magnetic field here comes into play. At each pole-pitch of a three-phase motor with the usual distribution of winding, there exist, as is known, three places where the strength of the field at its maximum can be about 15 per cent. lower than it is at other places. Practice has for long dictated the advantage of choosing the ratio of the slot-numbers in the two systems as an irregular ratio in order to diminish the fluctuations of the winding-coefficients between one place and another place. A numerical estimation of the winding-coefficient is made much more difficult by the circumstance that the minimum and maximum values of σ (which are evidenced by the regular variations of the short-circuit current as the rotor is slowly turned round by hand) are such that they do not reveal exactly the absolute amount of the winding-coefficient, since in general there is no position in which this coefficient vanishes.

A third more exact method of determining this coefficient is afforded by the case of motors in which, while the dimensions of δ, τ, b, P and X are maintained alike, the number of slots alone is changed.

For the calculations of Chapter II., §1, in the final formula (4), there was inserted for the mean value of σ_1 the half of the maximum value, in order to allow for the various intermediate positions between the extreme end places. In our experimental determination of σ from the short-circuit current the value of σ was, however, observed for one position only. In general this position will be that in which the mutual-induction is a minimum, since the rotor generally has a very energetic tendency to remain in this position and to turn into this position. Other positions can be retained only with application of great care. We might with great probability assume* for the following observations of the short-circuit current that the short-circuit current, as measured in Chapter II., § 2, corresponds to the place denoted as the second position, and we have, therefore, for comparison of the observed values with the results calculated by formula (4), to insert the maximum value for the value of the constant K_1 in that formula, K_1 having in that place, from its nature, the mean value unity. We have, therefore, to expect, in the comparison of results which follows, that K_1 will turn out to be of the magnitude 2.

(*a*) *Motors with Different Numbers of Poles.*

Motor Type 8048:

$$D = 58; \quad b = 30;$$
$$\delta = 0{\cdot}07; \quad X = 0{\cdot}1;$$
$$N_1 = 120; \quad N_2 = 160;$$
$$Z = 140.$$
$$\begin{cases} P = 8; & \sigma = 0{\cdot}042; \\ P = 4; & \sigma' = 0{\cdot}022; \end{cases}$$

$$\sigma - \sigma' = 0{\cdot}020 = \frac{2{\cdot}6 \times K}{(140)^2}(64 - 16) + \frac{0{\cdot}07}{0{\cdot}1 \times 140 \times 180}(64 - 16).$$

The second term has the value of 0·0013, therefore approximately

$$2(\sigma_1 - \sigma'_1) = 0{\cdot}018;$$

from which it follows that

$$K_1 = 2{\cdot}9; \quad 2\sigma_1 = 0{\cdot}024.$$

On the other hand, from Chapter III., §1, for the flank-dispersion of this motor, we have

$$2\sigma_3 = \frac{5 \times 0{\cdot}07 \times 1{\cdot}25}{30} = 0{\cdot}0146;$$

therefore, in total,

$$\sigma = 2\sigma_1 + 2\sigma_2 + 2\sigma_3 = 0{\cdot}041,$$

while, as observed,

$$\sigma = 0{\cdot}041.$$

Motor Type 3066:

$$D = 90; \quad b = 23;$$
$$\delta = 0{\cdot}1; \quad X = 0{\cdot}15;$$
$$N_1 = 144; \quad N_2 = 180;$$
$$Z = 162.$$
$$\begin{cases} P = 12; & \sigma = 0{\cdot}067; \\ P = 6; & \sigma' = 0{\cdot}0328; \end{cases}$$

$$\sigma - \sigma' = 0{\cdot}035 = \frac{K_1 \times 2{\cdot}6}{(162)^2}(144 - 36) + \frac{0{\cdot}1 \times (108)^2}{0{\cdot}15 \times 162 \times 280}.$$

The second term has the value 0·0016, from which follows

$$K_1 = 3; \quad 2\sigma_1 = 0{\cdot}043.$$

The value of the flank-dispersion of this motor is

$$2\sigma_2 = \frac{6{\cdot}25 \times 0{\cdot}1}{23} = 0{\cdot}028;$$

$$\sigma = 2\sigma_1 + 2\sigma_2 + 2\sigma_3 = 0{\cdot}073,$$

while there was observed,

$$\sigma = 0{\cdot}067.$$

Motor Type 361:

$$D = 49; \quad b = 19;$$
$$\delta = 0{\cdot}07; \quad X = 0{\cdot}1;$$
$$N_1 = 72; \quad N_2 = 120;$$
$$Z = 96.$$
$$\begin{cases} P = 8; & \sigma = 0{\cdot}064; \\ P = 4; & \sigma' = 0{\cdot}034; \end{cases}$$
$$\sigma - \sigma' = 0{\cdot}030.$$

The value of the second term is 0·0023; from which one gets

$$K_1 = 2; \quad 2\sigma_1 = 0{\cdot}025.$$

Motor Type 3067:

$$D = 90; \quad b = 32;$$
$$\delta = 0{\cdot}1; \quad X = 0{\cdot}15;$$
$$N_1 = 144; \quad N_2 = 180;$$
$$Z = 162.$$
$$\begin{cases} P = 12; & \sigma = 0{\cdot}060; \\ P = 8; & \sigma' = 0{\cdot}043; \end{cases}$$
$$\sigma - \sigma' = 0{\cdot}017.$$

The value of the differences of the peripheral-dispersion is 0·0012.

One finds $K_1 = 2$; $2\sigma_1 = 0{\cdot}029$. For flank-dispersion $2\sigma_3 = 0{\cdot}020$.

$\sigma = 0{\cdot}051$; as observed, $= 0{\cdot}06$.

From the foregoing examples we obtain as mean value, $K_1 = 2{\cdot}5$ for the most unfavourable position, and for mean positions we write $2\sigma_1 = 3/N^2$.

(To be continued.)

* More exact results one would obviously obtain in practice if the rotor were slowly revolved during the observation of the short-circuit current. For reasons of convenience this precaution was not observed in the older measurements now under consideration.

Electrical Methods of Measuring Temperatures.—In his second lecture at the Royal Institution on Thursday of last week, Prof. Callendar discussed some of the chief practical applications of electrical methods for measuring temperatures, the principles of which he had discussed in his previous lecture (see *The Electrician* of last week, p. 767). One of the problems which could be solved by their application was the determination of the absolute expansion of mercury. Although this had been done previously, the results required verification, especially since the earlier observations were made with air thermometers, which very much restricted the length of the mercury column used in the experiments. The speaker mentioned that he intended to carry out investigations in this direction, using a mercury column 60ft. long in conjunction with a platinum resistance thermometer. For determining the expansion of various other materials with the temperature, the electrical methods were likewise very convenient, and the speaker demonstrated this by carrying out such experiments with a rod of silica and platinum. In the latter case, the platinum rod served at the same time as the resistance of the thermometer. In other demonstrations Prof. Callendar showed how the electrical thermometer can be applied for determining the latent heat of solutions and the heat which is produced on solidification. These methods were useful also for measuring the specific heat of water and steam, for determining the cooling curves of different metals, for observing the lowering of the freezing point of ice under pressure, for determining the temperature of steam at different pressures, for comparing the thermal conductivities of substances, and for other purposes.

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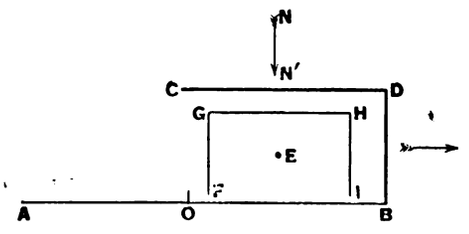
CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Photographic Records of N-rays.—In order to disprove the assertion that the effect of the N-rays is purely subjective, R. Blondlot has made 40 experiments in photographic registration of the effect of these rays upon a small electric spark. He placed a very small electric spark under a light tight cover FGHI (see diagram) placed over a photographic plate so that only the half OB of the plate was exposed to the light from the spark. Over the box was put a screen consisting of lead covered with moistened paper. N-rays were transmitted along the line NN'. The plate and lead screen were fastened together in such a manner that they could be shifted to the right without disturbing the box and the N-rays. They were left in the new position for five seconds and then returned to



the old position, and so on alternately till both parts of the plate had been exposed for 50 seconds. The plate was then developed. The side exposed to the spark while influenced by the N-rays was found to come out decidedly blacker than that exposed to the spark by itself. Of all the 40 experiments, made in the presence of a number of physicists, only one was unsuccessful, and that was probably due to an imperfect adjustment of the spark. The latter was produced by means of a "chariot" induction coil as used by du Bois-Reymond. The spark-gap was made as short as possible without risking a contact between the balls. The N-rays were derived from various sources, such as a Nernst lamp, compressed wood, tempered steel, and Rupert's drops, always with the same result. The photographs reproduced are very convincing.

[R. BLONDLOT, *Comptes Rendus*, February 22, 1904.]

Simultaneous Telegraphy and Telephony.—E. Brune and C. Turchi describe an instrument called a separator, by means of which any existing telephone circuit, whether using earth return or metallic return, can be utilised for simultaneous telegraphic and telephonic messages. The separator is constructed on the principle illustrated in the diagram (Fig. 1),

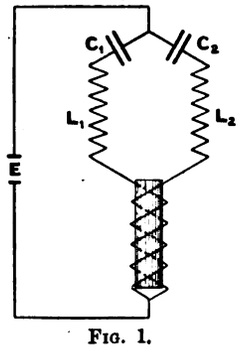


FIG. 1.

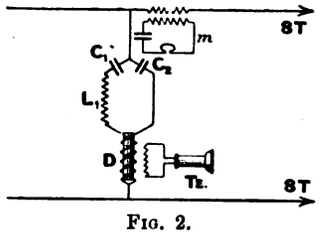


FIG. 2.

where E is the source of energy in the shape of an alternating E.M.F., and the current divides into two branches of inductances L_1, L_2 and capacities C_1, C_2. If this circuit is traversed simultaneously by two sine currents of frequencies a_1 and a_2, and the constants of the circuit are regulated so that

$$a_1 = \frac{1}{2\pi}\sqrt{\frac{C_1 - C_2}{C_1 C_2 (L_2 - L_1)}},$$

then only the current of frequency a_2 will give rise in the core to a resultant flux differing from zero, and the effects of the two currents are thus separated. Fig. 2 illustrates the manner in which this system would be utilised for sending one telephonic and two telegraphic communications simultaneously over the same metallic telephone line, *m* being the microphone, *Te* the telephone and *St* the telegraphic station.

[BRUNE and TURCHI, *Nuovo Cimento*, October, 1903.]

Photographic Action of Radium Rays.—S. Skinner finds that the density of the image produced on a plate by exposure to the radium rays β and γ increases to a critical value and then decreases, at first rapidly and afterwards very slowly, until a time is reached when the image is totally reversed. Spark images are at first obliterated by radium rays, which do not cause such a great density as that of the spark images obliterated. With prolonged exposure, radium rays reverse spark images.

[S. SKINNER, *Phil. Mag.*, March, 1904.]

Structure of the Atom.—The view that the atoms of the elements consist of a number of negatively electrified corpuscles enclosed in a sphere of uniform positive electrification has suggested to J. J. Thomson the mathematical problem of the motion of a ring of negatively electrified particles placed inside a uniformly electrified sphere. He investigates the positions of equilibrium which the electrons will assume under the action of their mutual repulsion on the one hand and the attraction of the sphere on the other. He finds that the conditions of equilibrium vary steadily with an increasing number of electrons, but that at certain points a sudden change occurs. These points correspond to those at which the elements change their properties in the periodic system, and it seems, therefore, very probable that the electron theory may be made to account for the properties of the chemical elements themselves. The author considers only the various arrangements of the electrons in one plane, as he has not yet succeeded in finding a general solution for spherical distribution; but the results already attained are extremely suggestive. Those elements which easily lose a single electron are monovalent electro-positive elements such as sodium. Those which become more stable on acquiring another electron are monovalent electro-negative elements like chlorine. Those which lose or acquire two electrons are divalent elements, and those which are incapable of permanently acquiring or losing electrons are elements of no valency like argon and helium. Radio-activity is accounted for as follows:—Some systems of electrons are stable when rotating with an angular velocity greater than a certain value, but become unstable when the velocity falls below this value. Such a fall may be brought about by radiation from the atom. When, after a long interval, the velocity reaches the critical velocity, there will be what is equivalent to an explosion of the electrons, the electrons will move far away from their original positions, their potential energy will decrease, while their kinetic energy will increase. The kinetic energy gained in this way might be sufficient to carry the system out of the atom, and we should have, as in the case of radium, a part of the atom shot off. In consequence of the very slow dissipation of energy by radiation the life of the atom would be very long.

[J. J. THOMSON, *Phil. Mag.*, March, 1904.]

N-rays in Pathology.—G. Ballet has employed N-rays successfully in order to diagnose some diseases of the nervous system. There is a diminution in the emission of N-rays in paralysed or atrophied muscles in myopathic and other cases.

[G. BALLET, *Comptes Rendus*, February 22, 1904.]

New Source of N-rays.—P. Jégou has found that any wire carrying an electric current emits N-rays. A simple means of obtaining N-rays is to take a Leclanché cell and to close the circuit for some time. The N-rays are stored in the liquid, which becomes a powerful source of them.

[P. B. JÉGOU, *Comptes Rendus*, February, 22 1904.]

N-rays in Inhibition Phenomena.—A. Charpentier and E. Meyer have found that the intoxication and curarisation of certain nerves produces a perceptible effect upon the radiation of N-rays by the muscles which they control. Thus the heart emits less when placed in diastole by its inhibitory nerves, and more when those nerves are not excited.

[CHARPENTIER and MEYER, *Comptes Rendus*, February 22, 1904.]

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TELEPHONY IN GREAT BRITAIN.

There are indications that the telephone industry in this country is approaching a crisis. At present we are provided with our means of telephonic communication from three main sources. The Government itself possesses a large telephone system in London and a network of trunk lines; the National Telephone Co. has an equally large system in London and also exchanges in every provincial town of importance; and, lastly, Glasgow, Portsmouth, Brighton and Swansea Corporations have established telephone exchanges in competition with those of the National Telephone Co. The National Telephone Co. has a capital of between nine and ten millions, about £400,000 is invested in municipal telephony, and the Post Office has spent about £1,500,000 on its London telephone system and slightly over £2,000,000 on its trunk lines; the total capital expenditure on telephony in the United Kingdom being, therefore, between 13½ and 14 millions. This sum is large, and it is not even unduly small in comparison with what has been spent in America—probably between 50 and 60 millions—when the relative sizes of the two countries are considered. Yet there is no doubt that there is considerable demand for extensions: new subscribers have been waiting months for connection to telephone exchanges, many of the trunk line routes are congested, and, generally, there are indications that more capital must be expended to keep up our proper rate of progress. The Postmaster-General stated in the House of Commons a fortnight ago that it had been found necessary to restrict the expenditure on telephone work in London, and to reduce the number of workmen employed, until a new Bill should have been passed authorising the provision of additional capital. One after another the municipalities which have telephone exchanges are applying for powers to borrow more money, and the National Telephone Co. is issuing an additional £1,000,000 in debenture stock. A demand for more capital in order to deal with increasing business is, generally speaking, a healthy sign; but if the business has not been particularly remunerative this view may not be correct.

Up to the present, telephony has not been one of the most successful industries in England; some of those who are carrying it on are doing so at a loss, while others are just making it pay its way. Take as an example, first, the Post

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Office telephone service in London. The Postmaster-General's report for the year 1902, published last August, showed a balance of £6,165 towards meeting interest, depreciation, &c. (estimated at £60,870), on a capital of £1,112,500. This does not look very promising. Then some of our municipalities have borrowed money for their telephone undertakings for periods extending longer than their actual telephone licences. Hull Corporation, for instance, was granted a loan of £47,350 last August, repayable in 25 years, but its licence expires in 1911. The accounts of these municipal telephone exchanges, moreover, would all show a considerable loss if adequate sums were written off for depreciation and sinking fund. In consequence, it is not surprising that there is strenuous opposition on the occasion of every application to the Local Government Board for permission to borrow more capital. Glasgow municipal licence may be taken as another instance. This expires on December 31, 1913, when the Post Office can acquire the undertaking as second-hand plant, paying nothing for goodwill; and yet the Telephone Committee is only writing down the enterprise on the basis of a 30 years' sinking fund. In addition, according to a statement made in the Council Chamber last week and not disputed, the capital account of the concern has been debited with wages that should have gone to the account of expenditure out of revenue, and even with such charges as clerks' wages, advertising and canvassing. The National Telephone Co., in fact, is the only undertaking of this character that is paying its way, and in this case, also, there is apparently difficulty in obtaining capital on reasonable terms. The new debentures referred to above are to bring an interest of 4 per cent., and are being issued at 5 per cent. discount; moreover, it has been deemed advisable to alter the Articles of Association of the Company so as to give the Directors powers to increase the sum allowed for underwriting new issues of capital. Yet the Company is paying a dividend of 5 per cent. on its ordinary shares, and has a reserve fund of nearly 1½ millions invested in its business.

All this indicates that the outlook is not bright for the further extension of telephone enterprise in this country. The reason is evident: it is that those connected with the industry feel that its present basis is not sufficiently firm. The position of competing telephone concerns must necessarily be insecure, for telephony is, in the nature of things, a business in which competition cannot continue to exist; one or other of the competing parties must eventually go to the wall or be "absorbed" by the other. This has happened repeatedly in America, it has already occurred here in the case of Tunbridge Wells, and it will occur again elsewhere without a doubt. Moreover, in 1911 the Government will be able to buy up the London exchanges of the National Telephone Co. and most of the provincial exchanges at a "scrap" valuation. In 1913, the two exchanges in Glasgow will follow, in 1920 Swansea, and in 1926 Brighton and Portsmouth. The Hull municipal licence, as already stated, will expire in 1911, and the exchange is not yet built. Undoubtedly the Government has erred gravely in impeding telephone enterprise as it has done, and it should repair the error as quickly as possible by taking over the whole business, as it did the telegraph business of the country in 1870, and extending it on broad lines.

Before leaving the subject of telephone enterprise, we would refer to one peculiar feature of municipal telephony which differentiates it from other forms of municipal trading. With regard to electric lighting and tramway works owned by Corporations publicity is courted in connection with all their operations, accounts are presented in a clear and fair manner, and discussion on them is encouraged. With municipal telephone enterprise the reverse appears to be the case. We have ourselves repeatedly endeavoured to gain admittance to the Portsmouth and Brighton telephone exchanges, but permission to view the exchanges has been refused us. Statements have been made at the various Local Government Board inquiries that the equipment of the municipal telephone exchanges at both these places is not as good as it should be, and this refusal to admit us to view the exchanges certainly lends colour to these statements. Mr. A. R. BENNETT is consulting telephone engineer to the Corporations in question, and has designed the exchanges. It is on his "advice" that we are refused admission to them. When the Glasgow and Tunbridge Wells exchanges were opened our representative was permitted to visit them. At Tunbridge Wells we saw no cross-connection board, test board or terminal cable heads, the wires being brought straight from cable pot-heads to the switchboard, a method which is recognised to be an unsuitable design for an exchange of any considerable size. At Glasgow the call-wire system, already tried and condemned by the National Telephone Co. at Manchester and Glasgow, was adopted, and now the advisability of adopting a different system of calling is already under consideration. A circular marked "Private," which we produce textually in another column, has conveyed this information to certain of the Glasgow subscribers, but (if we may credit the statement of Mr. RUSSELL, a member of Glasgow Corporation) not to all. Of the newer exchanges at Brighton and Portsmouth we are unable to speak definitely, for the reason already mentioned; but Mr. BENNETT'S estimate of the capital expenditure for them is regarded by other leading telephone experts in this country as being too low a figure to pay for the best material. Moreover, to judge from a brief description of the exchange at Brighton which has been recently published, presumably under Mr. BENNETT'S auspices, a "ring-through" system with automatic calling and clearing is employed, which, although extremely ingenious, involves, we believe, the employment of a passing contact in connection with the switch-hook of the subscriber's instrument—an expedient which is most undesirable for reasons obvious to the telephone engineer. At Glasgow last week, when the recommendation to obtain further borrowing powers was before the Council, Mr. BRUCE MURRAY, the Convener of the Finance Committee, essayed to show that the undertaking hitherto had been carried on at a loss, but was ruled to be out of order as the accounts themselves were not under discussion. We will conclude by quoting Mr. MURRAY'S words: "Municipal enterprise should be conducted on lines that will bear the most stringent inquiry."

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Light Railways Procedure: Reports and Precedents. Vol. II By J. STEWART OXLEY, M.A., assisted by S. W. P. BEALE, B.A. (London: P. S. King & Son.) 21s.

This work, which is a continuation of the reports contained in the first volume of the author's "Light Railway Reports and Precedents," is divided into three sections—light railway reports, tram railway reports and an appendix, which contains the Light Railways Act, 1896, the Board of Trade rules issued thereunder, and precedents of orders and special clauses which have been inserted in orders to meet particular circumstances. The author has maintained the same high standard of accuracy which characterised the first volume, and nearly every order of importance which was granted by the Commissioners and submitted to the Board of Trade down to the end of 1902 is referred to. In fact, the publication is a monument of industrious and judicious compilation, and should prove invaluable, not only to light railway promoters

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and engineers, but to officials of local authorities, Parliamentary agents and members of the legal professions interested in light railway practice.

We are pleased to see from the reports that the Board of Trade do not encourage gas and water companies in their attempts to get inserted special protective clauses against electrolysis, the standard clause of the Joint Committee being considered sufficient. We also notice that the Board object to schedule special agreements made by promoters in order to avert opposition, and these are only scheduled to orders when it is absolutely necessary inorder to save the schemes from falling through or to make the subject matter of the agreement *intra vires*.

On many occasions we have advocated an amendment of the law relating to electric traction and electricity supply, and a perusal of the present volume confirms our opinion that unsuitable legislation has been one of the greatest obstacles to electrical progress in this country. The fact that the Light Railways Act of 1896 has had to be continued from year to year since 1901 by the Expiring Laws Continuance Act is, in itself, proof that this branch of industrial legislation has been neglected. There are many objections to the act, and particularly to sec. 9, under which it has been decided that the proposals of the promoters involving competition with existing railways are to be submitted to Parliament, but the act makes no provision for this being done, and the Light Railway Commissioners have no option but to reject the application. Several important schemes have been rejected on this account alone, thus involving useless expenditure of time and money. For some time there has been a gradual decline in the number of promotions under the Light Rail ways Act owing to this unsatisfactory state of affairs, and it is to be hoped, therefore, that Parliament will find time to deal with the important subject of light railway legislation in the forthcoming session.

Elektrisch betriebene Strassenbahnen. By S. Herzog. (München and Berlin: R. Oldenbourg.) 1903. 8s.

In this handy little pocket-book Mr. S. Herzog has succeeded in compiling a large number of practical data and figures, mostly relating to German and Swiss electrically-operated tramways. Much of the matter, and especially the particulars regarding actual tests and experiences bearing on questions of tramway work, is taken from publications by Continental authorities, the original source being quoted for the benefit of students desiring to pursue the subject further.

The opening chapters deal in a general way with central stations and sub-stations. Steam turbines are accorded a short notice, and the steam consumption of the Elberfeld turbine plant, now several years old, is quoted. Since then, however, considerable progress has been made in the manufacture of such engines, and more recent and more favourable figures might have been included. The remaining chapters deal fully with details of track and overhead construction, and the design of motor cars and their equipments is discussed at length. A large number of model specifications for various machines and materials, wiring rules and other regulations bearing on tramway work and issued by different authorities, standard rules for carrying out tests, and, finally, a host of practical tables of the most varied kind conclude the pocket-book.

Occasionally, the illustrations are so small and indistinct as to be of no value. The author introduces into his book the "gilbert," a new C.G.S. unit which is to be proposed for international use at the forthcoming exhibition at St. Louis.

Table of Multiplication, Division and Proportion. By Robert H. Smith. (London: Archibald Constable & Co.) 6s. net.

This table has been devised for the ready calculation of quantities and costs, estimates, weights, strengths, wages, &c. It is bound in a very convenient form, and so arranged that it need never be opened to its full extent. By columns of figures ranging from 1 to 160, it is possible to multiply, divide or find the proportion of any figures by a very simple process. To persons who have to make lengthy calculations such as those enumerated above, we can recommend this table as being extremely useful.

MAGNETIC UNITS AND OTHER SUBJECTS THAT MIGHT OCCUPY ATTENTION AT THE NEXT INTERNATIONAL ELECTRICAL CONGRESS.*

BY A. E. KENNELLY.

The committee appointed by the British Association for the Advancement of Science for the selection and nomenclature of dynamical and electrical units published its first report in 1873. That report recommended the adoption of the centimetre, gramme and second as the respective fundamental units of length, mass and time, on which the dynamic and electromagnetic systems of units should be based. The centimetre was selected in place of the metre, so as to make the density of water equal to unity. The C.G.S. system of units thus promulgated has become the recognised international scientific unitary system. It has met with almost universal satisfaction. In constructing the C.G.S. basic units of electricity and magnetism it is now easy to perceive that a bad selection was made. The unit magnetic pole was chosen as one which repelled its prototype at unit distance with unit force. A better selection would have been the pole which emitted unit magnetic flux with a similar definition for the unit electric point-charge. The assumed system of electromagnetic units thus amended is sometimes spoken of as the "rational" system, in contradistinction to the existing system, which is then described as the "irrational system." The rational system would be more simple to express and to remember, for the reason that the numerical constant 4π or 12·566, which now appears in many fundamental eleotromagnetic equations, would have been eliminated and introduced into spherical problems where the constant naturally belongs. For example, the M.M.F. in a magnetic circuit would become equal to the current-turns linked therewith instead of 4π times the current-turns. Consequently, many spherical electromagnetic problems that would naturally expect the 4π constant now exclude it, and plane or rectangular problems, that would be simpler without it, now embrace it. This criticism could scarcely have been foreseen at the time the C.G.S. electromagnetic system was constructed. It has taken years of acquaintance with the system to make the defect apparent.

If we could go back with our present knowledge and create the C.G.S. electromagnetic system afresh it would probably be better to adopt the "rational" system. To make the change now would require changing the magnitude of the ohm, volt, ampere and other magnetic units by some power of 4π. The only exceptions would be the watt and the joule. They would escape. It would be very troublesome to change all our electromagnetic measures. The trouble would be felt by every electrical industry. The change could only be made effective by international agreement. The only compensation for the trouble and expense would be a certain amount of scientific simplification in the theory of electromagnetism, and a certain benefit to scientific computers. The electrical industries would not receive any practical benefit, and any benefit they could receive would be that small indirect amount derivable from the simplification in theory already mentioned. It seems too late, therefore, to attempt reconstructing electromagnetic units upon the C.G.S. system on a more rational basis. The majority would be inconvenienced for the benefit of the minority. It seems better that the student minority should make a little more effort to work with the existing "irrational" units, than to upset the existing order of electromagnetic measure in the hands of the many. In fact, it is probably inadvisable for scientists to adopt the "rational" system in their writings, since the labour of reading electrotechnical papers is often greatly enhanced by the uncertainty as to which of the two systems is being employed.

The case is reversed as regards the rational use of the metric system of weights and measures. In this country, and in Great Britain, the system of customary weights and measures is a burdensome incoherent medley with absurd inconsistencies and ambiguities. The metric system is far simpler and better, besides being in otherwise international use. The change from the customary to the metric system would entail much trouble and some expense, but it would effect a great reduction of aggregate national labour in learning, employing, exchanging and computing. The change would be nationally economical, so far as can be judged from the internal evidence presented, as well as from the evidence of the various countries that have already made a similar change. Several ingenious expedients have been proposed for effecting partial "rationalisation" of the C.G.S. electric and magnetic units without changing the values of the concrete practical units. All thus far proposed introduce a new factor into fundamental or defining equations in order to get rid of the 4π constant in other equations, so that the 4π difficulty is thereby not eradicated, but merely transported. It is very doubtful whether such half-hearted expedients can succeed. It seems better to let the existing system alone.

* Paper read before the American Institute of Electrical Engineers, and referred to in an editorial note in *The Electrician* of December 11, 1903.

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In adapting the C.G.S. system of magnetic units to practical requirements the inconvenient magnitudes of many C.G.S. units became apparent. The C.G.S. unit of E.M.F. was ridiculously small, since an ordinary Daniell cell showed 110 millions of them. A similar condition was found for the C.G.S. unit of resistance; since a Siemens unit, in extended use at that time, containing about a trillion C.G.S. units. In order, therefore, to aid practicians the working unit of E.M.F. was selected as 10^8 C.G.S. units of E.M.F. under the name of the "volt," while the working unit of resistance was selected as 10^9 C.G.S. units of resistance under the title of the "ohm." These practical magnitudes having once been adopted, a practical system of units inevitably came into existence, 1 volt through 1 ohm producing 1 ampere, 1 ampere carried for one second delivering 1 coulomb, and so on. The practical units differed from their parents, the corresponding C.G.S. units, by differing multiples or powers of 10. In one instance the ratio between a C.G.S. unit and its practical representative is 10, in another it is 10^9, in another 10^7, and so on. Moreover, the practical system of the ohm, volt, ampere, coulomb, joule, watt and henry is such as would have been arrived at directly if the unit of length had been an earth quadrant, or 10^9cm., instead of 1cm., and the unit of mass 10^{-11} gramme instead of the gramme, the unit of time being the second in both systems. Thus there has been created the fundamental centimetre gramme-second system, in which the theory of electromagnetics is learned and to which all science is referred. Side by side with the C.G.S. system is the practical or quadrant-eleventh et gramme-second system, or Q.E.S. system, in which most of the units have been christened for industrial use. The C.G.S. system is thus the language of the esoteric, while the Q.E.S. system is the electrical vernacular.

The divorce of the practical from the scientific system was a grave mistake, although it was probably hard to foresee. After years of experience it is now easy to see that the correct original course would have been to christen the C.G.S. magnetic units, without regard to their particular magnitudes, and at the same time to adopt a suitable series of prefixes for decimal multiples and submultiples, in extension of the existing micro-milli-kilomega system. If, for example, the C.G.S. magnetic unit of current strength (10 amperes) had been originally christened the ampere, our present ampere would have been known as the deci-ampere, and in a few days we should have become as familiar with such a deci-ampere as we are with the existing ampere. This is shown by the case of the microfarad, which is as simple and convenient a term as if this standard capacity had been originally called the farad. We should then have retained the C.G.S. system for both the esoteric and the vernacular, but would have adopted for practical work certain multiples with their appropriate prefixes. It is probably now too late to retrace our steps. We cannot annul the Q.E.S. system and exclusively adopt the C.G.S. system for practical work. Nor is it worth while upheaving decimal relationships. Thus it has been suggested that the existing dekavolt might be changed in name to the volt, by increasing the volt to 10 times its present magnitude, in order to make the new ampere agree with the C.G.S. unit of current. This would entail a slight advantage over the existing practical system. It would, however, effect a confusing hiatus in technical literature, and would still leave a practical system divorced from the C.G.S. system with numerical ratios of 10^9 and 10^{-9}. The Q.E.S. system is in satisfactory industrial use all over the world, so far as it goes—viz., through the eight units: volt, ampere, ohm, farad, coulomb, henry, joule and watt. But we can with advantage stop further unnecessary divergence by refraining from christening any more units in the Q.E.S. system and by bestowing all future names on the C.G.S. system. A start in this direction has already been made. The international electrical congress at Paris in 1900 christened the C.G.S. magnetic units of flux and flux density under the names of maxwell and gauss respectively. These terms have already come into fairly extended use in America and into somewhat more limited use in Europe.

It is very desirable that the next international electrical congress should complete the units of the magnetic circuit by bestowing names upon the C.G.S. units of M.M.F. and of reluctance. The American Institute of Electrical Engineers has for several years provisionally recommended the names "gilbert" and "oersted" for these two units. They are already in some use in America. If they should be adopted, we would have the relations: gilberts/oersteds =maxwells; and maxwells/sq. cms. = gausses. The ampere-turn is a very convenient unit of M.M.F. close to the C.G.S. unit in order of magnitude; but a name for the C.G.S. unit is very desirable. By rights, every C.G.S. electromagnetic unit should have a name. There is not even a recognised weed or germ that does not have a name. Practically all the fifteen hundred millions of people inhabiting the world have names. It would seem that a fundamental C.G.S. electric or magnetic unit is of as much importance as a weed or a bacillus. Moreover, it is fortunately unnecessary to learn the names for units or commit them to memory if the units are rarely used. It would be sufficient to have authorised names accessible and definite, ready for use when required. Moreover, our minds are so constituted that until we possess a name for a thing the thing remains more or less symbolical, and is not fully realised as concrete. Thereby the C.G.S. system of electromagnetic units, which is necessary and fundamental, becomes hampered and retarded. It is desirable for scientific purposes, for educational purposes, and in the interests of progress, that these international C.G.S. units should have recognised names. For example, the fundamental rule for the E.M.F. of a direct-current bipolar dynamo is $e=\phi n w$, C.G.S. magnetic units of E.M.F., where ϕ is the useful flux from pole to armature in maxwells, n the speed of rotation in revolutions per second and w the number of wires on the surface of the armature. If we divide e in this equation by 10^8, we get the result in volts; but the *C.G.S. magnetic unit of E.M.F.* is worthy of a name, if only to avoid the objectionable periphrasis.

The expedient suggests itself of attaching the prefix *ab* or *abs* to a practical or Q.E.S. unit in order to express the absolute or corresponding C.G.S. magnetic unit. The advantages of the plan are that it is almost self-explanatory, and requires no effort of memory to acquire; also that it is self-suggesting in all the important European languages. According to this plan, the

C.G.S. magnetic unit of	E.M.F.	would be the	abvolt
,,	,,	,,	resistance	,,	,,	absohm.
,,	,,	,,	current	,,	,,	absampere.
,,	,,	,,	quantity	,,	,,	abcoulomb.
,,	,,	,,	capacity	,,	,,	abfarad.
,,	,,	,,	inductance	,,	,,	abhenry or cm.
,,	,,	,,	energy	,,	,,	abjoule or erg
,,	,,	,,	power	,,	,,	abwatt.

We would also have the following ratios:—

1 abvolt	=0·01 microvolt	$=10^{-8}$ volt
1 absohm	=1 bicrohm	$=10^{-9}$ ohm
1 absampere	=1 dekampere	=10 amperes
1 abcoulomb	=1 dekacoulomb	=10 coulombs
1 abfarad	=1 begafarad	$=10^9$ farads
1 abhenry	=1 bicrohenry	$=10^{-9}$ henry=1 cm.
1 abjoule	=0·1 microjoule	$=10^{-7}$ joule=1 erg
1 abwatt	=0·1 microwatt	$=10^{-7}$ watt

On such a basis, the preceding equation would be written $e=\phi n w$ abvolts, with great advantage in clearness and comprehensibility. In a comprehensive system of electromagnetic terminology, the electric C.G.S. units should also be christened. They are sometimes referred to in electrical papers, but always in an apologetic, symbolical fashion, owing to the absence of names to cover their nakedness. They might be denoted by the prefix *abstat*. Thus, the

C.G.S. electric unit of	E.M.F.	would be the	abstatvolt
,,	,,	,,	resistance	,,	,,	abstatohm
,,	,,	,,	current	,,	,,	abstatampere
,,	,,	,,	quantity	,,	,,	abstatcoulomb
,,	,,	,,	capacity	,,	,,	abstatfarad
,,	,,	,,	inductance	,,	,,	abstathenry

The abstatjoule and abstatwatt are the same as the abjoule and abwatt respectively. These units would also be almost self-explanatory in any European language and would call for no appreciable effort of memory. We should then have the following ratios ($v=3\times10^{10}$ approximately):—

1 abstatvolt	$=v$ abvolts	=300 volts
1 abstatohm	$=v^2$ absohms	$=9\times10^{11}$ ohms
1 abstatampere	$=v^{-1}$ absampere	$=3\cdot3\times10^{-10}$ ampere
1 abstatcoulomb	$=v^{-1}$ abcoulomb	$=3\cdot3\times10^{-10}$ coulomb
1 abstatfarad	$=v^{-2}$ abfarad	$=1\cdot1\times10^{12}$ farad
1 abstathenry	$=v^2$ abhenrys	$=9\times10^{11}$ henrys.*

It is desirable that some such system of christening the C.G.S. magnetic and static units, without burdening the memory, should be adopted by an international electrical congress. It seems also desirable that an international electrical congress should sanction the use of the Hefner Alteneck Reichsanstalt standard amyl-acetate lamp as a secondary standard of light or luminous intensity. The lamp is in extended use for determining the intensity of incandescent lamps, and as such should receive recognition. It is also desirable that steps should be taken by an international electrical congress to establish a uniform international basis for the standardisation of electrodynamic machinery. The American Institute of Electrical Engineers has already formulated, through the work of a committee, a series of standardisation rules, relating to nearly all classes of dynamo-electric machinery. A similar series of rules differing from the last named in various details has been promulgated in Germany by the Verband der Deutscher Elektrotechniker. Still other rules are extant locally in other countries. It is perhaps possible to carry the principle of international standardisation too far into detail, since many details depend in each country upon local, commecial and industrial conditions; but on the other hand, there are many underlying physical and electrotechnical conventions that might receive international consent among electrical engineers. For example, a dynamo machine ought to have the

* The abstat henrys regarded as a length according to the conventional system of dimensions contains 9×10^{11} earth quadrants, a distance that light would take nearly 1,000 years to cross.

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same rating, based on temperature-elevation under load, all over the world, and the rules by which the rating of a dynamo is experimentally determinable might well be adopted by an international electrical congress, together with many similar matters, under this general title of standardisation. Such a concensus of opinion would probably take time to evolve, and an international electrical congress might appoint a standing committee to confer upon the question of standardisation with instructions to report at a future time. Much scientific and engineering benefit might be hoped for from the efforts of such a standing committee on international standardisation.

THE LEGALISED STANDARD OF ELECTROMOTIVE FORCE.*

BY HENRY S. CARHART.

It is not necessary to enlarge upon the importance of a legal standard of E.M.F. It is quite as essential as a legal standard of resistance. It will be remembered that the Chamber of Delegates of the International Congress of Electricians at Chicago in 1893 adopted a value for the E.M.F. of the Clark cell, and appointed a committee to prepare a specification for its construction. The committee consisted of Prof. Helmholtz of Berlin, Prof. Ayrton of London, and the writer. Unfortunately, before the committee reached an agreement the eminent chairman died; the two remaining members being unable to agree, one form of cell was accordingly adopted by the British Government, and another by the Congress of the United States. The latter represents the survival of the fittest, for reasons that were assigned in 1893. Germany contented itself by legalising the units of resistance and current.

The legal value of the E.M.F. of the Clark cell is 1·434 international volts at 15°C. In the 10 years which have intervened since the Chicago Congress, it has become quite certain that the actual E.M.F. of the Clark cell at 15°C. is nearer 1·433 than 1·434. Indeed, the Helmholtz absolute electro-dynamometer at the Reichsanstalt gave, in the hands of Dr. Kahle, 1·4322 volts. This value has not been used at all, but for the past six or seven years 1·4328 at 15°C. has been used at the Reichsanstalt. This value was not obtained by means of absolute measurements but by the silver voltameter, corrected by reference to the measured ratio between the E.M.F.s of the Clark and cadmium cells.† But the electro-chemical equivalent of silver is not known with any greater accuracy, to say the least, than the E.M.F. of the Clark cell. Hence, the Reichsanstalt method is open to grave objections. In 1899 an absolute determination of the E.M.F. of the Clark cell was made by the writer and Dr. Guthe.‡ The result was 1·4333 at 15°C. We have never regarded this value as final, because certain changes in the dimensions of our absolute electro dynamometer did not permit us to repeat the measurements a sufficient number of times to get a satisfactory series. Later, Dr. Barnes, of McGill University, made a series of determinations of the mechanical equivalent of heat in terms of the international electrical units. His results will agree with those of Reynolds and Moorby, made by a purely mechanical method, if the E.M.F. of the Clark cell is 1·43325 at 15°C., and they will agree with Rowlands if the Clark is 1·43355.§

During the past year we have again taken up the matter with the purpose of measuring the E.M.F. of the Weston cadmium cell and the electro-chemical equivalent of silver. The Weston cell, with a saturated solution and excess of cadmium sulphate crystals, is chosen because of its low temperature coefficient and the close agreement between the different cells of a series. The temperature coefficient of this cell has been so carefully determined at the Reichsanstalt that it is not necessary to repeat that part of the work. For cadmium cells with saturated solutions and an excess of cadmium sulphate crystals, the formula for the E.M.F. at any temperature between about 10°C. and 30°C. is $Et = E_{20} - 0{\cdot}000038(t-20) - 0{\cdot}00000065(t-20)^2$. Further, the ratio, Clark 15deg., cadmium 20deg., has been determined at the Reichsanstalt in several series of comparisons with the greatest care and the most refined precautions. In one of these series the writer assisted. Giving due weights to the several series, the result is as follows:—

$$\frac{\text{Clark at 15deg.}}{\text{Cadmium at 20deg.}} = 1{\cdot}40670.$$

An absolute determination of the E.M.F. of the cadium cell is, therefore, one also of the Clark cell, for the above ratio is known with much greater accuracy than we can measure the E.M.F. of either in absolute measure. Our absolute electro-dynamometer has been rebuilt for permanency as follows:—The stationary coil is wound in a single layer of 593 turns of No. 22 silk covered wire, on a plaster of paris cylinder a little more than 47·3cm. in diameter. The variation in diameter from one end to the other is only about one-tenth of a millimetre. The winding is about 41cm. long, or the length is to the mean radius of the axis of the wire as $\sqrt{3}$ to 1. The suspended coil, consisting of No. 22 wire rolled flat, is wound in 40 turns on a ground porcelain cylinder 10cm. in diameter. This cylinder is suspended by a phosphor-bronze wire 1 metre long and approximately 0·7 mm. in diameter. The theory of the instrument and its construction were fully described by Patterson and Guthe in their paper on "A New Determination of the Electrochemical Equivalent of Silver."* The preliminary measurements on the cadmium cell, which we hoped to make before this meeting, we have not been able to carry out. A series of cadmium cells, with amalgam containing 12·5 per cent. cadmium, have been made. No pains have been spared in the preparation of materials throughout. The cells agree well among themselves, the variations being smaller than the limits of accuracy we are attempting. The very low temperature-coefficient of the cadmium cell is an advantage of the greatest importance, and the uniformity shown by different series of cells is so marked as to constitute another count in its favour as a standard. No definite specification has ever been drawn up for the construction of this cell. I have, therefore, the following recommendations to make:—

First.—That the Institute appoint a committee of three to prepare a complete specification for the normal cadmium or Weston cell.

Secondly.—That the cadmium cell, as thus specified, shall be adopted by the Institute as the standard of E.M.F., and that steps be taken to secure its legal adoption by Congress, provided it be dedicated to the public by the inventor, one of the distinguished past-presidents of this Institute.

* Paper read before the American Institute of Electrical Engineers, and referred to in an editorial note in *The Electrician* of December 11, 1903.

† *Phys. Rev.*, Vol. XII., No. 3, 1900.

‡ *Phys. Rev.*, Vol. IX., No. 5, 1899.

§ *Phil. Trans.*, Series A, Vol. CXCIX.

PHYSICAL SOCIETY.

At a meeting of the Physical Society on February 26th, Dr. R. T. Glazebrook, F.R.S., President, in the Chair. Dr. W. WATSON read a paper on

"A Quartz-thread Vertical Force Magnetograph."

The late Dr. Eschenhagen was the first to show that when the moment of inertia of the suspended system in a horizontal-force magnetograph is made very much smaller than that employed in the ordinary form, it is possible to detect variations in the earth's field of quick period. The design of a satisfactory form of instrument to record rapid variations of the vertical component presents very considerable difficulties. Thus if an attempt is made to reduce to any great extent the moment of inertia, and hence the mass of the balanced magnet in the ordinary form of Lloyd's balance, it is found that irregularities are immediately introduced owing to imperfections or dirt interfering with the free movements of the knife-edge. Further, slight tremors cause the knife-edge to slip about on the plane, and thus the azimuth of the magnet varies. The instrument which the author has designed and constructed resembles, in principle, the quartz-thread gravity balance of Prof. Threlfall. In addition to the advantages derived from the suppression of the knife-edge, the instrument can be simply and accurately compensated for the effects of changes of temperature. The principle of the instrument is to have a magnet suspended on a horizontal quartz fibre kept stretched by means of a spring. The centre of gravity of the magnet and the torsion of the fibre are so adjusted that the axis of the magnet is horizontal. Any variation of the vertical force produces a rotation of the magnet about the fibre which can be suitably recorded by means of a mirror attached to the magnet. The temperature compensation is effected by weighting the magnet on the same side of the axis of the fibre as the south pole, so that the magnetic couple and the couple due to the torsion of the fibre act in the same direction. Hence, since an increase in temperature causes one of these couples to decrease and the other to increase, by suitably adjusting the weight, and therefore the magnitude of the torsion couple, complete compensation can be obtained. The suspended system in the instrument shown at the meeting consists of two magnets 8 cms. long and 1 mm. diameter attached by means of small platinum straps to two fused rods of silica which form part of the plate of fused silica forming the mirror. The upper surface of the mirror is platinised. The fixed mirror is supported on the base of the instrument, and is capable of adjustment. The instrument has been tested at the National Physical Laboratory and it is proposed to set up one of the instruments in the new magnetic observatory.

Mr. C. V. BOYS congratulated the author and said he had had the opportunity and privilege of watching the growth of the instrument. It showed that the properties of quartz-fibres were even more perfect than

* *Phys. Rev.*, Vol. VII., No. 39, 1898.

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anything he himself had ever claimed for them. The fact that it was possible to design and construct such an instrument in a physical laboratory showed an advance in scientific education. The theory of the instrument had been carefully worked out, and everything that had to be done practically had been done in the best possible way.

Prof. J. D. EVERETT expressed his interest in the Paper, and said there was no novelty in using a horizontal fibre for a control. Horizontal wires were so used in Kelvin's portable electrometer and in the gauge of an ordinary quadrant electrometer. He thought the instrument would be improved by increasing the number of needles.

Dr. J. A. HARKER asked the author for the ordinary working sensitiveness of the instrument. When working with magnetographs of the Eschenhagen type, he had found they became unstable when the sensitiveness was increased to about three times the Kew standard sensitiveness.

Mr. T. H. BLAKESLEY asked for the period of vibration of the suspended system.

Mr. J. R. ASHWORTH sent a letter which was read by the Chairman, stating that the temperature compensation might be effected by using drawn steel wire magnets with an incremental temperature coefficient. Magnets can now be made to have, within limits, any assigned temperature coefficient (from negative, through zero, to positive).

The CHAIRMAN congratulated the author upon his success, and said that he was glad that Dr. Watson had been able to obtain assistance from the National Physical Laboratory.

Dr. WATSON said he did not think that the magnets suggested by Mr. Ashworth would be of much advantage for vertical-force magnetographs, as there would have to be a gravity bob in all cases in order to adjust the centre of gravity of the moving system. This might, however, be of use in a horizontal-force instrument. Replying to Dr. Harker, he said that 1 cm. on the records corresponded to 8γ, whereas 1cm. on the Kew records represented 50γ. Replying to Mr. Blakesley, he said the period of vibration was large, but it was not necessarily important to have as long a period as possible. With regard to Prof. Everett's remarks, he pointed out that all metallic wires were ruled out of the question on account of elastic fatigue. He had used two magnets only because of the experimental difficulties in attaching them to their support.

A Paper by Mr. G. W. WALKER on

"Stresses in a Magnetostatic Field,"

was read by the Secretary. Quincke found that when a glass bulb containing a solution of ferric chloride was placed between the poles of a strong electromagnet, the level of the liquid, in a capillary tube attached to the bulb, fell. This has been held to require for its explanation a system of stress which differs from the magnetic stresses of electrical type. The object of this Paper is to show that the experiment can be quite well explained by the stresses of electrical type.

Dr. W. WATSON gave

Some Hints on the Preparation of Diagrams

He pointed out that many curves accompanying papers submitted to scientific societies have to be re-drawn on white Bristol board before they are suitable for reproduction by photographic processes. It is now possible to obtain blue-lined section-paper such that the lines do not show in a photograph of a diagram drawn upon it. There are many advantages in using such paper. For instance, it practically dispenses with the use of scales and T-squares. When lettering diagrams a great saving of time and a uniformity of lettering can be effected by using indiarubber type. These can be purchased cheaply in different sizes and different founts. The larger types are sold as "Easy Sign Markers," and are supplied with rods to ensure alignment and proper spacing, and also with rods by means of which the letters may be arranged upon a circular arc. A suitable ink for use with the type can be obtained by mixing Binfield's Persian black with glycerine. Using this ink for the lettering, and ordinary Indian ink for the line work of a diagram drawn on blue-lined section paper, it is possible to slightly overexpose a photograph so that the section lines are invisible in lantern slides or prints prepared from it.

Mr. R. J. SOWTER exhibited a portable electroscope of high insulation and adapted to show and measure the discharging effect of radio-active substances. Strips of gold leaf were mounted near the ends of a strip of gutta-percha tissue, leaving sufficient gutta-percha between the metal to provide the insulation. This compound strip, when doubled in two and attached to a small metal clip, constitutes a portable electroscope which may be supported on a glass rod by the hand or in any convenient manner. The effects of arbitrary amounts of radium, pitchblende and uranium oxide were such as to discharge the leaves after electrification in 5 seconds, 5 minutes and $7\frac{1}{2}$ minutes respectively. The discharge curves are practically straight lines. One of the electroscopes shown had leaves 9in. long, and for large deflections was charged by an electrophorus. As an electrophorus, Mr. Sowter has found a metal tea-tray supported on three glasses, together with a piece of brown paper warmed and brushed, satisfactory.

Prof. J. D. EVERETT mentioned that he had seen the discharging effect of radium shown by means of silk tassel electrified by stroking it with a rubber glove.

Mr. C. V. BOYS said that many years ago he had used a tea-tray and sheet of brown paper as an electrophorus, and had obtained from it sparks up to 2in. in length.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, March 3.

Mr. F. B. BEHR, the promoter of the Manchester-Liverpool Overhead Railway, referred to the recent tendencies of Parliamentary Committees to require a guarantee from promoters of railways that the whole of the capital would be subscribed. Promoters were now so much in the dark as to what guarantees they would be called upon to give, that the appointment of a central tribunal for this and other reasons seemed to him essential, so that schemes need not be promoted at great expense until the report of this authority was made. An indication of the possible success or otherwise would then be given. With regard to the lay-out of the tube railway lines in London, he considered there had been too much duplication and over-capitalisation, and he regarded the possibility of a dividend being paid by new lines of this nature as very remote. This especially applied to the tube railways which had been amalgamated by the Underground Railways Co. of London. The cost per mile of the City and South London Railway—viz., £390,000—was the limit at which a dividend could be anticipated. It was true that the Central London Railway cost £615,000 per mile and paid 4 per cent., but the traffic on this line during the past year was less than the preceding year. Something of a climax was reached in the case of the Great Northern, Piccadilly and Brompton Railway, in connection with which the capital expenditure per mile, according to the prospectus, was £858,000. All the money which it was intended to expend upon tube railways could be much more advantageously invested in overhead railways, which could be constructed at a cost varying from £25,000 to £220,000 per mile. A line had been constructed in Berlin for this latter sum which had not affected the beauty of the neighbourhood in any way. In London it would be possible to construct similar lines, and if it were impossible to carry the pillars down the main streets, they could be placed at the backs of the houses. He made the following proposals for mono-rail railways in London. A main line starting from the Royal Oak station of the Great Western Railway, and passing along the Regent's Canal for the whole of its length via St. John's Wood, on to Edgware-road, Regent's Park, Camden Town, King's Cross, Haggerston, Hackney, and on to the Victoria Docks. A branch line could be constructed from Paddington to Willesden Junction, another from Haggerston along the Kingsland-road to Broad-street (making use of the existing North London Railway), and another route down the roadways along the streets by the river on to the Chelsea Embankment, finishing at Putney Station. For the route along the Regent's Canal he had a conditional assent from the canal company upon reasonable terms. This line would have to be in tunnel for $\frac{3}{4}$ mile. The total length of these lines would be 17 miles 5 furlongs 8 chains of double track. The construction of these lines could be carried out at a comparatively small expense compared with the cost of tube railways—viz., £120,000 per mile, whilst the line down the Embankment he considered could be constructed for as low a figure as £50,000.

By the CHAIRMAN: He had never brought any of his schemes for London before Parliament, as he had had such a severe fight over the Manchester-Liverpool line that he had not the courage to risk another.

Mr. FRANCIS FOX corroborated the evidence given by his brother, Sir Douglas Fox (see *The Electrician*, January 22). He was of opinion that under wide new streets shallow subways could be constructed with satisfactory results, provided the strata encountered was of a suitable nature, and that the reconstruction of the sewers did not render the cost excessive. But to attempt to construct such subways under metropolitan streets would be fraught with great danger to the public using the streets and also on account of damage to property. In London the subways would have to be constructed almost wholly in wet sand and gravel, and the pumping out of the water would draw away the sand and gravel from beneath adjacent property, with resultant damage. It was with a view to obviating this trouble that the late Mr. Greathead invented his system of driving tubes, and to abandon this method in favour of shallow subways he considered would be disastrous and a retrograde step. He then went on to describe the arrangements upon the Great Northern and City Railway with regard to fire and management of the traffic, which were dealt with in our description of this line (see *The Electrician*, January 15 and 29). The greatest difficulty to be contended with in connection with tube railways was the question of ventilation. In a steam tunnel, if the carbonic acid could be kept as low as 20 parts in 10,000 no injury would result, but such a proportion he considered quite inadmissible in an electric railway tube. In normal air the proportion of carbonic acid was 3 to 3·5 volumes per 10,000, and it had been found by actual experiment that a person could exist in air with as high a proportion as 160 per 10,000, provided it were pure carbonic acid, but if it were carbonic acid emanating from the human body a proportion of 20 parts in 10,000 was highly objectionable. Taking the traffic on a tube railway on a Bank Holiday, and trains running every $2\frac{1}{2}$ minutes, carrying 600 passengers each, calculations indicated that the supply of air in each tunnel was only sufficient for half an hour. There was, of course, a certain amount of natural ventilation, but this was both uncertain and variable. To ensure healthy ventilation, the entire air in the two tunnels should be changed every hour.

Sir JOHN WOLFE BARRY, taking up Witness' point that the construction of shallow subways through the sand and gravel necessarily involved damage to property, said that both during the construction of the Inner Circle and of the Glasgow Railway, the lines ran through this very strata, and no damage whatever was occasioned.

WITNESS replied that he had not intended to convey this meaning. His opinion was that the danger of damage was very great.

Friday, March 4.

Mr. J. F. S. GOODAY, General Manager of the Great Eastern Railway Co., said he appeared before the Commission owing to unfounded state-

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ments having been made to the effect that workmen's trains were run at a profit, and he wished to contradict the evidence of the witnesses of the London County Council in this respect. The receipts per train mile of workmen's trains with 2d. fares was 3s. 3·2d., and the working expenses 3s. 7·76d. It had been suggested that there would be room for an electric tube railway to the north-eastof London, but it was obvious that such a line could not be remunerative if it were only to carry a portion of the traffic during the busy hours of the day.

Sir HENRY OAKLEY, chairman of the Central London Railway, and ex-general manager and now a director of the Great Northern Railway Co., described the general working conditions of the Central London Railway, which are now familiar. He said the lift journey occupied some 20 to 30 seconds, and the whole time from platform to exit was about 2 minutes. The lifts worked satisfactorily and economically, the cost of maintenance being about 8 per cent. of the total working expenses. If, in connection with future tube railways, booking halls were allowed under the pavement whenever possible, as in Paris and at the Bank station of the Central London line, a considerable saving in cost of construction would be effected, and the lift journey shortened. After detailing the circumstances which led to the adoption of motor cars instead of locomotives, Witness said that the question of ventilation had also occupied the attention of the Central London board, and a large fan had been erected at Shepherds Bush which exhausted the air in the tunnels during the night. Considerable improvement had been noted in the atmosphere since the introduction of this fan. In addition to this the company had followed the advice of its engineering and electrical experts, and by carrying out their recommendations had done everything possible to ensure the safety of the public. Contrary to the experience of the suburban steam railway companies, it had been found that approximately the demand during the whole of the day on the Central London line was a regular one, with, of course, an extra rush in the morning and evening. This confirmed his opinion that the conditions with regard to suburban as compared with town traffic differed considerably. Much of the pressure in the principal thoroughfares in London would be lessened if ready means of locomotion were provided, and it was with this object in view that the directors of the Central London Railway on two occasions introduced their bill for a circular extension of the existing line by way of Piccadilly Circus and the Strand. In a general discussion of the existing means of communication in London, Witness took the view [expressed in our leading article last week] that there were almost sufficient lines of railway and tramways, provided efficient intercommunication and thoroughfares could be arranged for. He thought it would be commercially impossible to construct shallow subways in London. When the Great Northern and City Railway was first considered, shallow subways were proposed, but after careful enquiry the engineers advised in favour of the deep-level tube. Dealing with the question of the establishment of a special tribunal, Witness stated he opposed the decision of such a board being the final one. Any scheme for a tube, subway or tramway in London must almost necessarily interfere with roads and other public property, such as parks, &c., as well as with private property, and it appeared to to him that a final decision after one inquiry only would be antagonistic to the general principles that governed the settlement of disputed questions either in Parliament or at law. If some provision for appeal were made, the report of the tribunal to the House would, in effect, have only the weight of a recommendation, and, if appealed against, a hearing of the whole case would be inevitable, so that neither time or money would be saved. He thought a more practical course would be to provide that, as far as possible, all new schemes should harmonise with general principles laid down by the present Commission, and that all schemes, whether complying or not, should be submitted to public inquiry by two committees, as at present, or by a Standing Committee of both Houses. In addition, the Standing or separate Parliamentary Committees might be usefully assisted by a report from some public department, say, the Board of Trade through its technical advisers, on every scheme proposed within the limited area. Such a report should also be furnished to promoters and opponents. All inter-urban lines were unavoidably costly, and some inducement must, in his opinion, be offered by way of encouragement to investors if the lines were to be promptly constructed. The needs of the day must be met, and though at the present moment certain lines might seem the most advisable, the claims of the public five years hence might require material additions to be made. Investors had, therefore, no security that their undertaking would not be subject to competition and their traffic diverted. Pecuniary aid by the London County Council and the borough councils was out of the question, and the question of rates seemed to be the only way by which any relief could be afforded. The Central London Railway Co. had to pay nearly £5,000 per mile per annum for rates, or 18 per cent. of the net receipts. Considerable relief would be afforded if tubular railways were assessed only on the value of the land before the line was constructed. It was impossible to assert that there was any practical value in the space occupied by the tube, say 50ft. underground, yet when a railway was made the easement of this valueless earth was assessed as if it were a valuable space on the surface. Further, the property of railway companies on the surface was not assessd on its annual value as house property, but on the cost of the station, so that, practicallyspeaking, they were assessed on the profits.

Wireless Telegraphy in America.—We are informed that the de Forest wireless telegraph system has been established between Fort Wright, Fisher's Island, and Fort Schuyler, New York, a distance of 97 miles. Messages of 1,000 words each have been exchanged at a speed of 30 words a minute.

CORRESPONDENCE.

M. BLONDLOT'S N-RAY EXPERIMENTS.

[TRANSLATION.]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to several articles on N-rays which have recently appeared in *The Electrician*, may I be allowed to give you the following information:—

On January 14th last, M. Mascart, president of the Académie des Sciences of Paris, and M. Cailletet, member of the same Academy, did me the honour of coming to Nancy to witness my experiments. They saw and repeated them themselves, they determined themselves the deviations of the N-rays by a prism of aluminium, and the focussing of them by an aluminium lens, they observed the fringes produced by gratings, Newton's rings, &c. They did not show the least doubt in the existence of the N-rays. M. Mascart took away with him a double photograph, taken in his presence, or rather with his co-operation. At his request I handed him a note "On the Dispersion of the N-rays and their Wave-lengths," which was presented to the Académie des Sciences by him on Monday, January 18th. I enclose a cutting from *Le Temps* of January 19th, containing an account of this presentation. [An abstract of this Paper appeared on p. 612 of our issue of February 5th, and we publish the Paper in full on p. 810 of the present issue.—ED. *E.*]

A few days later I was visited by M. J. Becquerel, who observed without difficulty the N-rays phenomena and who proposed, in parting, to follow up the study of some of them. Amongst the gentlemen who have seen the phenomena produced by the N-rays, I will cite first, as being possibly known in England, Prof. A. Waller of St. Mary's Hospital Medical School (at M. Charpentier's) then M. Macé de Trépinay, d'Arsonval, Dr. Ballet, Dr. Broca, &c.

I do not know whether it is in consequence of his own experiments or due to the testimonies of the gentlemen, some of whom have been cited above, that Sir William Crookes honoured me, on February 24th, with an invitation to deliver a lecture on N-rays before the Royal Institution in London, but it is certain that he would not have made such a proposal had he had the slighest distrust even in the subject of my work. Unfortunately, my state of health does not permit me to come to London, but I shall gladly receive here those who come to see the experiments with N-rays.

The phenomena observed have been attributed to heat, but this notion, I believe, need not be entertained for an instant after perusal of the notes which I presented to the Académie des Sciences de Paris.

I may add that I have not published one single experiment which had not been repeated by several colleagues and also by persons not acquainted with scientific research work.

In conclusion, I recommend the physicists desirous of studying this subject to take every precaution to eliminate disturbing influences, particularly with regard to heat, by interposing several layers of wood, aluminium and cardboard, with large surfaces and separated from each other by air. The screen of moistened cardboard ought to be interposed *near to the source* and *away from the sensitive screen*. I should also advise them to avoid every effort and tension of the eyes, every fixation. Otherwise psycho-physiological phenomena occur, of the kind observed by M. Lummer. Although the actions of the N rays require delicate methods to be observed (they would otherwise have been detected long ago) I believe that investigators will be compensated for the trouble expended, inasmuch as I have encountered but three or four persons—out of a great number—who were not able to observe the phenomena.—Yours, &c.,

Nancy, March 6. R. BLONDLOT.

WINDAGE AND FRICTION LOSSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It has occurred to me that perhaps it would be advisable to give a list of figures, from recent tests, upholding the 1·5 law for the friction and windage. The tests comprise data from machines from 15in. diameter with four poles

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up to multipolars with diameters exceeding 6ft. and including tests on direct-current turbo-generators :—

Machine.	Revs.	Experimentally determined friction and windage.	Calculated friction and windage.
4-pole	650	1,150	1,300
	350	530	505
4-pole	500	750	950
6-pole	300	9,000	8,500
8-pole	350	22,500	26,000
	200	11,600	12,800
	230	26,400	28,000
	90	5,520	6,880
	135	10,650 11,350 11,570	12,500
10-pole	165	20,000 15,200	17,100
	200	21,000	23,000
	210	23,200	24,500
	230	30,000	32,600
	130	13,500	13,900
	100	7,800	9,300
Turbo direct-current generator	2,400	20,000	26,000
	1,500	6,000	13,000
	600	1,200	3,300

When it is understood how erratic friction tests generally are, and how a friction reading will depend upon the state of the oil, the oil renewal, and so on, it surely ought to seem that the formula above mentioned gives results in quite good agreement with the observed values. It will be noted that even on such high speed generators as the turbine-driven type the formula furnishes results that are in tolerable agreement when on normal high speed. After all, there are two elements mentioned in the formula—friction and windage. Perhaps, where the ventilation is very large compared to the friction the second power would be in greater accord with the Kapp straight-line mathematics. It is to be observed that, by inverting Dr. Thornton's method of Kapp straight-line analysis and assuming the value of x as known, to wit, 2, and giving a value, y, for the friction and windage index, this latter value must be 2 or 1. But, the friction may vary as anything from the first power to the 1·5 power according to temperature, range of speed and the oil used, &c, whereas the power required to drive a fan varies as the third power of the speed. It is for this reason, I take it, that in the case of the turbo-generator the agreement is better on the higher speed, where the windage is undoubtedly more predominant, than it is on the lower speeds. On lower speeds it would seem that the friction losses come more and more in evidence. After all, it was rather my intention to bring notice to the fact that in experiments where it is proposed to bring forth unusual conclusions, whether they relate to toothed armatures or untoothed armatures, a little more care might be expended in at least separating those various losses from which the novel theory is to lend support.—Yours, &c.,

A. PRESS.

London, March 9.

PARLIAMENTARY INTELLIGENCE.

ST. MARYLEBONE ELECTRIC LIGHTING BILL.

On Thursday last week the Court of Referees of the House of Commons considered an application by the Metropolitan Electric Supply Co. for a *locus standi* to be heard against the St. Marylebone Electric Lighting Bill.

Mr. BALFOUR BROWNE, K.C., in relating the history of the bill, which was the outcome of the arbitration proceedings under the award of which the St. Marylebone Borough Council were ordered to purchase that portion of the undertaking of the Metropolitan Electric Supply Co. within its boundaries, said that his clients, the Metropolitan Electric Supply Co., would have supported the bill had it only sought to enable the Borough Council to carry out this award. But it sought to do other things, included in which was the raising of several hundred thousand pounds in addition to the amount of the award, and it was the desire of the company to prevent this sum becoming a charge upon the rates prior to the £1,250,000, which was the amount of the award.

Mr. H. LLOYD, K.C., for the Council, contended that the company had no *locus*, as everything it wished to do could be done through the Court of Chancery.

After consultation, the Court disallowed the locus

POWERS FOR FREE WIRING AND MOTORS.

KETTERING URBAN DISTRICT COUNCIL.

The Police and Sanitary Committee of the House of Commons, presided over by Mr. Heywood Johnstone, had before it the omnibus bill of the Kettering Urban District Council on Tuesday.

Mr VESEY KNOX, for the promoters, said the electrical clauses of the bill had reference to the wiring of premises on the assisted payment system, the hiring of electric motors, the supply of electrical energy in bulk to outside authorities if requested to do so, and there was also a clause having reference to extensions of the electricity generating station. With regard to the latter point, the bill asked that in respect of certain lands adjoining the existing generating station, sec. 176 of the Public Health Act should apply—viz., that the Local Government Board should grant a provisional order for the compulsory acquisition of this land when the Council required it. It was not anticipated that the land would be required until after three years, the period allowed if the land were scheduled in the present bill. The Local Government Board had reported, however, that there was no precedent for such a clause, and to this he could not dissent.

Evidence was first taken as to the clauses providing for free wiring and hiring out of motors.

Mr. J. BOND, clerk to the Urban District Council, said that an electric lighting order was granted in 1896, and the works would be put into operation in April. The outstanding loans in respect of the electricity undertaking amounted to £43,275, out of which commitments were, up to the present, incurred to the extent of about £35,000. There appeared to be a large demand for electrical energy, and already a number of applications had been made for a supply under a system of assisted payment.

Mr. CHARLES SAUNDERS, chairman to the Kettering Urban District Council, said he regarded it as absolutely essential for the success of the electrical undertaking that the powers asked for should be granted, and more especially the authority to hire out motors. Already the gas company in Kettering had been transacting similar business for a number of years. In Kettering there were a large number of persons who worked at the boot trade in their own homes, and to whom a cheap supply of electricity, together with the purchase of a motor on the hire system, would be a great boon. It was anticipated that, to start with, at least 400 houses would be fitted upon the assisted wiring system, which, it was estimated, would cost about £10 per house. It was proposed to charge 4½d. per unit for lighting under this system and 1½d. per unit for power. The sum which it was contemplated borrowing would be £13,000. For motors the sum of £6,900 was asked. The initial instalment of motors was as follows :—30 ½ H.P. costing £30 each, 25 1 H.P. at £40 each, 25 3 H.P. at £60 each, 20 5 H.P. at £80 each, and 20 10 H.P. at £100 each, making a total of £6,900. The period of repayment for wiring and fittings was 10 years, and for motors five years. These estimates had been based upon one-half or five-eighths of the total number of factories in Kettering. Many of the larger factories had already installed gas installations, and these had been left out of consideration in connection with these estimates. A number of applications had been made for motors to be hired out. The total amount of money spent to date upon the electrical undertaking was £33,500, and all the probable consumers under the new scheme of wiring and hiring motors were within reach of the existing mains.

Prof. A. B. W. KENNEDY, F.R.S., consulting engineer to the Kettering Urban District Council, said his original estimate for the Kettering electricity undertaking was approximately £30,000, but when they applied to the Local Government Board for their loan they asked for £32,600. The cost of mains was about £8,000. The tender for the initial portion of the equipment amounted to £22,000. The present buildings accommodated 750 H.P., but there was room within them for 2,400 H.P., which would provide for the equivalent of 70,000 8 c.p. lamps. The buildings had been laid out so that they would not require extension during the next few years. He agreed with the evidence of the chairman of the Council. The revenue looked forward to originally from the electricity works, whose present capacity was 360,000 units per annum, was £5,875, with a net profit of £1,085, but since then the Council had decided to charge the lowest price consistent with being able to pay interest, sinking fund and working expenses, and at present probably little margin would be left.

Mr. LEES, chairman of the Beckenham Urban District Council, said that the same powers with regard to assisted wiring as were asked for in this bill had already been granted to his Council. At Beckenham a tri-party agreement between the tenant, Council and owner of the house was entered into. The price of current was 6d. per unit originally but it was now 5½d. under the assisted payment system and 5d. under ordinary conditions. If the tenant did not consume a certain amount, he had to make an extra payment to cover the expenses of wiring the premises. If this system had not been adopted at Beckenham, he considered they would not have had anything like the demand for electricity which now existed. The Beckenham works had been opened in November, 1900, and within 18 months they had reached their maximum capacity. Their present capital expenditure was £73,000. It was estimated that wiring would last for 30 years, but they were only asking for 10 years in the present bill as the period of repayment.

The Committee passed the preamble of the clauses relating to free wiring and the hiring out of motors.

Mr. VESEY KNOX then addressed the Committee with regard to the surplus land at the site of the existing generating station, endeavouring to show that the compulsory powers asked for were merely with a view to preventing the owners imposing unfair conditions upon the Council, as under the Electric Lighting Acts the land could only be acquired by agreement.

The CHAIRMAN : There is no precedent for such a clause.

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Mr. VESEY KNOX: No.

The CHAIRMAN: The Committee are unanimous that the clause should not be granted.

Two other clauses in the bill were passed without comment—viz., one giving the local authority power to attach brackets to buildings for the purposes of electric supply, and another to supply electricity in "bulk" to neighbouring local authorities.

A NEW TUNNEL UNDER THE THAMES.

NORTH AND SOUTH WOOLWICH ELECTRIC RAILWAY.

This bill came before a House of Commons Committee, presided over by Mr. Russell Rea, yesterday (Thursday). Sir Ralph Littler, K.C., with Mr. Courthope Munroe, appeared for the promoters. The chief opponents are the Woolwich Borough Council and the London County Council.

Sir RALPH LITTLER, K.C., said this bill would be an interesting one from the public point of view. In North and South Woolwich there were a large number of workmen who lived on the opposite side of the river to which they were employed. A quick means of communication was, therefore, absolutely necessary. Originally the only means of communication was by a ferry in connection with the railway company. Later the London County Council was instrumental in supplementing this with a system of free ferries, but there were obvious dangers in carrying on any system of ferry. There was, first of all, the liability to fogs, and very often the men had to run the risk of crossing in skiffs. So uncertain was this communication that several employers made it a practice, when the winter came on, to discharge all men who lived on the other side of the river. The London County Council had done all it could, but the construction of the Blackwall Tunnel had not benefited the districts served by the proposed railway. The line, which was ¾ mile in length, would be worked electrically in an ordinary single tube upon the shuttle system, the cars being similar to those used upon the Central London Railway. The platforms would be long enough to provide for six carriages, which would carry 630 passengers, the journey being accomplished in a little under 3 minutes. It was expected, without the slightest difficulty, to maintain a service every 6 minutes in each direction. The fare would be 1d. The capital powers asked for were £240,000 and the usual one-third borrowing powers. It was anticipated that a surplus of £70,000 over the estimates would be left. On such a railway as this it could fairly be expected that the working expenses would be lower than the usual 50 per cent. The South Woolwich terminus would be quite close to the Arsenal, and on the north side of the river the districts served would be Silvertown and East Ham. Everything would be done to submit to the regulations of the Board of Trade with regard to engineering detail.

Major ISAACS, one of the promoters of the railway, said the idea of such a line had appealed to him on account of the fact that the London County Council appeared to be too much occupied with other matters to afford any expenditure in the direction of such a means of communication as this. Arrangements had been made with the Woolwich Borough Council to take electrical energy from the municipal electricity works there, and a concession had been made to the borough council by agreeing to allow them to carry their electric lighting cables through the railway tunnel in the event of a supply being given in North Woolwich.

Mr. LEWIS COWARD, K.C., on behalf of the London County Council, said that the engineer to the Council had reported with reference to a scheme for a tunnel a little further away from the proposed one, and that the details would be discussed at a meeting of the Council in April.

WITNESS replied that he was not aware of it.

Mr. COWARD: Do you mean to contend, then, that if the London County Council convert their free ferry into a free tunnel you would come upon us for compensation?—Yes, I do.

Do you propose to make a physical junction with tramways on either side?—No.

Will you give us a clause to the effect that you never will do so?—No. I will not bind my Company for all time.

Mr. COWARD said the London County Council feared that, although the line was designated a railway, it might possibly be intended in the future to run it through as a tramway, and in that event this particular promotion would be an evasion of the standing orders, inasmuch as the consent of the London County Council had not been obtained.

WITNESS replied that there was no intention of any such thing.

Local evidence was then called in favour of the bill, including a representative from the Royal Woolwich Arsenal.

Sir JAMES SZLUMPER, engineer for the proposed line, said it would start from Beresford-square, practically the centre of South Woolwich, to a point practically in the centre of North Woolwich. The diameter of the tunnel would be 11ft. 6in. The traffic carried by the free ferry was about 5½ millions per annum.

Cross-examined by Mr. LEWIS COWARD as to the possibility of the money being provided for this line in face of the fact that the London County Council contemplated constructing a similar tunnel, Witness said he was not aware of any such intention on the part of the County Council.

Sir RALPH LITTLER, for the promoters, interrupted to the effect that no mention of the intended construction of this tunnel by the London County Council was made in the petition against the bill.

Sir JAMES SZLUMPER said he had had an appointment with the Bridges committee of the London County Council some time ago to ascertain whether the Council would support this scheme, and he had been assured that they would not oppose it. On the contrary, he had been told that anything which would improve the communication between the north and south of the Thames would receive a hearty welcome.

Sir RALPH LITTLER again protested that nothing of this was in the petition of the London County Council, and that this point ought not now to be used as a preamble opposition. Their opposition must be confined to clauses.

The CHAIRMAN said that he must agree with Sir Ralph Littler on the point as to what was in the petition, which did not seem to be a preamble opposition, but he could not exclude the discussion of any matters which the petitioners considered vital to their interests.

Sir JAMES SZLUMPER, under further cross-examination by Mr. Lewis Coward, refused to insert a clause in the bill to the effect that he would not claim compensation from the County Council in the event of the latter constructing a free tunnel near the one proposed under this bill.

By the CHAIRMAN: He was perfectly satisfied with the financial conditions of the proposal, engineering estimates, &c.

Mr. L. R. VIGERS, surveyor to the promoters, also gave evidence.

Mr. SCHUSTER, one of the financial supporters of the bill, said it was eminently a scheme which he could feel justified in laying before his clients. The money market at present was not in a very flourishing condition, but this was only momentary, and when a recovery took place the money would without doubt be at once subscribed.

This concluded the case for the bill, and evidence was then called in opposition, on behalf of the London County Council.

Mr. B. S. STRAUSS, vice-chairman of the Bridges committee of the London County Council, said it was the conviction of the Bridges committee that a free tunnel at Woolwich was absolutely essential. It was quite certain that this question would be one of the first matters dealt with by the new Council. He considered an application for Parliamentary powers would assuredly be made for such a tunnel. The attitude of the Council was that if the promoters would bind themselves not to seek compensation in the event of a free tunnel being constructed, they would not oppose the bill. At the interview referred to by Sir James Szlumper, the committee had been led to believe that this would have been agreed to. It was now also asked that the company should be precluded from making physical connections with tramways and light railways at either end.

The committee adjourned.

TUNNEL UNDER THE SOLENT.

SOUTH-WESTERN AND ISLE OF WIGHT JUNCTION RAILWAY (EXTENSION OF TIME).

A Committee of the House of Commons, presided over by Mr. Ashton, considered this bill on Wednesday.

Mr. J. D. FITZGERALD, K.C., who appeared for the promoters with Mr. Lynden Macassey, said the bill was for the purpose of extending the time for the compulsory purchase of land and the completion of works. The railway was authorised in 1901. It was only 7½ miles in length and commenced by a junction with the Lymington branch of the London and South-Western Railway and was conttnued south to the Solent near Milford, from whence it was continued by means of a tunnel under the Solent and made a connection in the Isle of Wight with the Freshwater, Yarmouth and Newport Railway. The construction of the line, for the working of which powers had been taken to apply electricity, would do away with the present necessity for crossing the Solent by steamer. The original promoters had been the late Sir John Blundell Maple, Capt. Middleton and several other well-known gentlemen, and the measure had been passed as practically unopposed. In 1903 powers were granted for the construction of a short branch line to serve a deep-water pier which the company were intending to build in order that cross-channel passengers might be carried direct to London by rail instead of having to go all the way to Southampton. The pier would also be available for the North German Lloyd passengers. Naturally, the negotiations with the various railway companies had taken up an immense amount of time, and the death of Sir John Blundell Maple had also brought about considerable delay. Negotiations to the effect that the London and South-Western Railway Co. should work the line were almost completed. All the landowners whose property would be required took no exception to the present extension of time except one on the Isle of Wight. This opposition came from the executors of the late Lord Heytesbury, with whom an agreement had been entered into for the acquisition of about 50 acres of marshy land on the mouth of the River Yar, and very liberal terms were granted to Lord Heytesbury originally. The executors now sought to get better terms as the price of their consent to the extension of time. The promoters of the railway had also secured, at considerable expense, a controlling interest in the Freshwater, Yarmouth and Newport Railway Co. He now asked for two years' extension for the acquisition of land and three years for the completion of works, a request necessitated by the negotiations with the railway companies and in order to enable them to be brought to a conclusion.

Capt. MIDDLETON, one of the original promoters, confirmed the opening. In cross-examination by Mr. Acland, K.C., on behalf of the executors of the late Lord Heytesbury, he said it was seriously intended to construct the railway, but he objected to being enforced to acquire the land in question within six months instead of two years.

The Committee found the preamble of the bill proved.

GREAT NORTHERN AND CITY RAILWAY (EXTENSION OF TIME) BILL.

This bill came before the Unopposed Committee of the House of Commons on Friday last week, Mr. Jeffreys, Deputy-Chairman of Committees, presiding.

Mr. BIRCHAM, for the promoters, said the bill asked for an extension of time for the completion of works. Under the company's original powers, a short length of line was authorised extending beyond the present Moorgate-street terminus for the purpose of sidings and shunting. This, however, had not been constructed, and the time expired this year. What was asked for now was a three years' extension of time, so that this piece of line could be constructed as a portion of the authorised extension

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to Lothbury sanctioned in 1902, and for which the company still had three years in which to construct.

Formal proof of the preamble having been given, the bill was ordered for third reading.

OTHER ELECTRICAL BILLS.

The Isle of Thanet Tramways Bill will not now be proceeded with.

Lord Addington has been added to the Committee of the House of Lords considering the Weights and Measures (Metric System) Bill. The other members were given in our last issue.

In the House of Lords on Friday last week the Victoria University (Yorkshire) Bill and the Victoria University (Manchester) Bill were read a second time. On Tuesday the Blyth & Cowpen Gas Bill was read a second time.

The Govan Burgh (Electricity) Bill came before the Unopposed Committee of the House of Lords on Tuesday. Under the bill the Govan Burgh Commissioners take powers to supply and fix electrical fittings, &c., and to borrow money for this purpose under the Electric Lighting Acts of 1882 and 1888. Provision is also made whereby any fittings supplied by the local authority shall not be liable to distress. Further powers include special charges being made to persons already having a supply of electricity of their own, and the refusal to supply consumers already in debt to the Council. Formal proof of the preamble having been given, the bill was ordered for third reading.

The Court of Referees last week heard petitions by the Wakefield and District Light Railways Co. and the Yorkshire Electric Tramways Construction Synd. for locus standi to appear against the Soothill Nether Urban District Council Tramways Bill. The Court decided to allow the locus standi in both instances.

An inquiry will be opened in Edinburgh on March 21 into the following measures, among others, under the Private Legislation Procedure (Scotland) Act, 1899:—Leith Corporation Tramways, Dundee, Broughty Ferry and District Tramways and the Kirkcaldy Corporation Bills.

Mr. KIMBER has a motion down in the House of Commons to move that it be an instruction to the Committee to which the Acton District Council Bill is referred to insert the well-known "Bermondsey" clause. This clause was quoted on p. 748 of our issue of February 26, in connection with the St. Marylebone Electric Lighting Bill.

Battersea Borough Council have deposited a petition praying to be heard against the Electric Lighting (London) Bill.

The following petitions have been withdrawn:- East Ham Urban District Council against the North and South Woolwich Railway; Paddington Borough Council against Baker Street and Waterloo Railway; London, Brighton and South Coast Railway Co. against East London and Lower Thames Electric Power; Grand Junction Waterworks Co. against Harrow Road and Paddington Tramways and the London County Council Tramways.

THE TELEPHONE SYSTEM.

Mr. JOHN CAMPBELL, in the House of Commons on Friday last week, asked the Postmaster-General whether he could state the sum expended on telephone instruments in connection with the Post Office system up to date; how much of this amount has been spent on instruments manufactured in England, and how much on instruments manufactured in Sweden, Antwerp and America; and whether he could give the patent number of the instruments which he was compelled to purchase from foreign firms.

Lord STANLEY in a printed reply stated that the sum expended on telephone instruments for the new system in London could not be given without a careful analysis extending over four years, and this would involve much labour and expense. The amount expended on stores of all kinds for the telephone system of the whole country during the four years was £1,328,966. Of this amount about £176,500 was spent on articles manufactured abroad, but most of this was on account of central battery switchboards and their equipment, which are patented, the patent numbers being as follows:—20,099 (1890), 4,127 (1892), 4,128 (1892), 17,160 (1892), 3,831 (1893), 9,638 (1893), 8,222 (1895), 11,548 (1895), 11,549 (1895), 18,613 (1898), 6,712 (1899), 24,718 (1899), 10,124 (1900). Telephones for the use of subscribers had had to be obtained from abroad from time to time because they could not be obtained in this country; but he was glad to say that British companies were now prepared to manufacture them, and he hoped he would be able to reduce more and more the amount spent with foreign manufacturers.

Mr. JOHN CAMPBELL also asked the Postmaster-General whether his attention had been called to the recent report of the National Telephone Co. in which the chairman stated that they were working in partnership with the Post Office; if so, whether he would state when the present partnership with the National Telephone Co. expired and what were the arrangements made for taking over their business; and whether, in view of the increasing business of the National Telephone Co., he would endeavour to expedite the completion of the new Post Office system.

In a printed reply Lord Stanley stated that the statement made by the chairman of the National Telephone Co. had reference, probably, to the arrangement made in 1901 for free inter-communication between the exchange systems of the Post Office and the company in London. This arrangement had proved to be a great convenience to the large body of telephone users in the London area. It would continue until the termination of the company's licence. The company were bound at the expiration of the licence to sell to the Post Office their plant in the London area at a valuation on what are known as "tramway" terms. As soon as funds had been provided under the bill which he hoped shortly to obtain leave to introduce, the development of the London telephone service by the Post Office would be expedited as much as possible.

TELEGRAPHIC ADDRESSES.

Sir M. BHOWNAGGREE having asked the Postmaster-General whether he could see his way to allow such words as Bethnal Green, Charing Cross, &c., to be counted as one word in telegrams,

Lord STANLEY, in a printed reply in the House of Commons on Monday, said he could not propose any change in the present methods.

LEGAL INTELLIGENCE.

St. James' and Pall Mall Electric Light Co. (Ltd.) v. the King

This case came before Mr. Justice Farwell in the King's Bench Division on Tuesday.

Mr. CRIPPS, K.C., said this was a petition of right. It really raised a question as to the liabilities of the Postmaster-General or his contractors, because the ultimate liability would be upon them, under the Telegraph Acts of 1863 and 1868. Under the Act of 1863 the Postmaster-General was entitled to carry out certain works in respect of telegraphic or telephonic communication, with a liability to compensate anyone who might be injured in the carrying out of those works. In carrying out certain works injury was done to a water-pipe which resulted in the flooding of a main of plaintiff company, whereby short-circuiting occurred and a good deal of injury was done. Upon that the company took steps to have the amount assessed before a compensation jury under the Telegraph Acts. The amount had been assessed at £145. 19s. 6d. and the only question involved was whether there was jurisdiction for a compensation jury to deal with a question of this kind. Counsel then referred to sec. 6 of the Act of 1863, as amended by sec. 2 of the Act of 1868, by which the Postmaster-General was empowered to lay a telegraph under any street by breaking it open and relaying any pipes, &c., not being a main for the supply of water or gas. By sec. 2 of the Act of 1868 the Postmaster-General was to make full compensation to all bodies and persons interested, for all damage sustained by them in consequence of the exercise of the before-mentioned power, the amount of such compensation to be determined in the manner provided by the Lands Clauses Consolidation Act. The important words in the section were: "For all damage sustained by them by reason or in consequence of the exercise of the above-mentioned power." The compensation claimed was only for recoupment of the expense the company had actually been put to in remedying the damage. The issue was important, not only as regards the plaintiff company, but as regards all electric lighting companies, and whether damage as suffered under the conditions as in the present case was damage in respect of which compensation could be claimed under the Telegraph Acts of 1863 and 1868. He understood the contention of the other side to be, that supposing the work done by the Postmaster-General was done negligently and the damage was the result of such negligence, then he was not liable under the 1863 Act. The Postmaster-General said it was quite true that if this work had been done in a perfectly proper manner, he would not have denied that he would be liable for that sum, but he alleged that this particular damage resulted from some workmen working in a negligent manner. On behalf of the Postmaster-General it was also said that if it could be shown that there was negligence then the remedy was a common law remedy and not a remedy by compensation under the Act of 1863. His (Mr. Cripp's) answer was that so long as the work was done and so long as the damage was sustained by reason and in consequence of the powers conferred by the acts, it was not material whether there was negligence or not. He contended that no one against whom compensation was claimed because of damage sustained as a consequence of statutory powers could set up a defence that the damage resulted from what might be called negligence.

Mr. SALTER, K.C., for the King, said that the correct procedure had been followed here on the assumption that the petitioners conceived themselves entitled to compensation under the section, and the Postmaster-General conceived that he was not liable to make such compensation. It was clear that there could be no petition of right against the Crown for negligence. He admitted, however, that on account of negligence they would have a cause of action for negligence in common law. But he denied that anything in the statute before them had taken away that cause of action, and he submitted the proposition that it was the law that where statutory powers were exercised negligently or unreasonably, right of action was not taken away. The onus was upon the other side to show that the right of action, which presumably would arise upon such a state of facts as they had complained of, had been taken from them, and he submitted that they had not shown it.

Mr. PARKER, replying, said that if the other side were going to set up negligence, they should put it on their pleadings, and the plaintiffs would sue them at once. Negligence was only suggested, and the plaintiffs were told that compensation could not be obtained because there had been negligence.

His LORDSHIP, in giving judgment, said that after reading the sections of the acts bearing on the point, the only fact that he had got before the Court was a statement contained in a letter dated Jan. 30 from the Post Office authorities, admitting that the damage done was by the department's contractors. Mr. Salter had said that the damage was really occasioned by the negligent exercise of the powers of the acts. Neither side said that there was anything ultra vires, but the Postmaster-General said that the contractors' workmen in carrying out the powers of the act acted negligently, and that for the negligent exercise of statutory powers a common law action was the remedy. In cases of that class it was obvious that the onus of proof practically went to the root of the matter. But taking the view that he did, that when negligence was

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intended to be set up as an answer to that which was otherwise a prima facie case for compensation the onus of proving negligence lay on the respondents. There was therefore no practical difficulty in his way in the present case. The result was that in his opinion the company succeeded.

Both parties agreed that the taxed costs of the proceedings before the sheriff should be added to the amount of compensation, and the company were given the costs of the present proceedings.

Vigor v. Chloride Electrical Storage Co. (Ltd.)

This action was heard by Mr. Justice Grantham and a special jury on Tuesday. The plaintiff (Mr. F. G. Vigor) sought to recover damages by reason of defendants' alleged breach of warranty on the sale of certain secondary batteries, Defendants denied liability.

Mr. F. DODD, for plaintiff, said that in 1899 his client required an electrical installation at his house at Lingfield, Sussex, and received a circular from defendants and eventually an estimate for supplying a battery of 54 cells at £168. This was supplied in March, 1900. It was, he urged, unsuccessful, and began to deteriorate from an early stage. Complaints were made, and up to a certain date the battery was being watched. Instead of charging the battery and trusting to it to supply all the electric lighting, he had to run a dynamo and get the electric light in that way, which was more costly.

His LORDSHIP: I do not think it is more costly. It is more convenient to have accumulators, no doubt.

Mr. DODD said he was told the battery was ample for the size of the house, and if it had been a proper one would have been all that was needed for the electric lighting. A properly made battery should last seven years. This one was practically useless at the end of 12 to 15 months. In November, 1901, defendants undertook to put the battery in repair and sent down a man and did something for which they claimed £36 odd. While this work was being done plaintiff sent down Mr. Miller, electrical engineer, who made a report in December, 1901. This gentleman found the plates were not sufficiently strong for the purpose. Mr. Partington, defendant's manager, on the same day also made a report. He (counsel) understood that one of the suggestions defendants made was that plaintiff had undercharged the battery. The end of the matter was that the battery became useless. After allowing a reasonable sum for the time the battery had been in use there was a substantial sum due to plaintiff.

CHARLES McKINLEY, electrical engineer, and chief of the electrical department of John Barker & Co. (Ltd.), London, said he had had 17 years' experience. In 1899 Mr. Vigor (who was a director of Barker & Co.) gave him instructions to approach the Chloride Company and to prepare a specification for the electric lighting of his house at Lingfield. Mr. Vigor gave no instructions as to the kind of battery he wanted. He went to the Chloride and other companies, and finally obtained an estimate from defendants upon the specification he had prepared. Batteries were purchased for £168, less 10 per cent. for cash. He remembered having an interview with a representative of the defendant company at their London offices, and he was almost positive that he told him for whom the batteries were wanted. The terms upon which Mr. Vigor was dealing with Barker & Co. were not known to him, as he had nothing to do with the ordinary books of the firm. He saw the batteries at Lingfield, and was present part of the time when they were erected. He knew they were properly erected. There was a dynamo there. This was driven by an oil engine, and was connected to the battery and was also connected with a 3½ H.P. motor which drove the pump from the batteries. The motor could be driven direct from the dynamo if necessary. The motor took about 25 amperes of current, and the current not required for the plant would go into the storage battery. The capacity of the dynamo was 50 amperes. When the pump and the dynamo were working at full power about 15 amperes were going into the battery each hour. A properly-constructed storage battery should last under ordinary conditions about seven years. Subsequently he got the records which had been kept and sent them to defendants. (These were handed to witness, who said he did not think they were all there.)

Mr. HORRIDGE, K.C., for defendants, said they had all been kept. The company always supplied a counterfoil book with the record forms, and that would show how many records there were.

Continuing, Witness said that after reading the report made by the company's manager, he wrote to Mr. Vigo: "How the battery has been brought to such a condition is a question which is not easily answered," and added that he could not accept the opinion of the company's expert that the batteries had been badly charged. Barkers had entered into a contract to do certain work for Mr. Vigor. The contract was for building, and there was no separate contract in respect to electric lighting. Defendants supplied an exactly similar battery to Barker's in 1898 for Baron de Bush's place at Winchester, and as far as he knew the battery had been perfectly satisfactory. He believed his firm were allowed the trade discount of 10 per cent., and all defendant company had to do was to deliver the goods at the station. Barkers did the erection work. After the battery was erected, Barkers charged it with the acid, this being in their contract. If the man in charge said the initial charge had only been for 16 hours that would not be a correct statement. There had been an obvious mistake in the record, but as the man in charge seemed to have filled in volts in the current column, he did not seem to have known that current meant amperes.

His LORDSHIP: Were the amperes entered at all?

Mr. HORRIDGE: No, the current was not entered in the returns. He submitted that an excessive discharge had set upsulphating on the plates. To Witness: Assuming that plaintiff cut off four cells in May, 1901, should he not have mentioned it to the makers?—Yes, if he wanted their assistance.

Witness admitted writing a letter to Mr. Vigor at the time of the house being let to an Indian Maharanee that it might be necessary to have a more economical working of the light. He had heard that the Maharanee was rather extravagant with the light.

Mr. HORRIDGE: Supposing you left the battery uncharged for three months, would it not play havoc with the battery?—Yes, but it would not ruin the battery. If there was much short-circuiting it might show that the battery had not been well attended to. He did not know that the battery had not been properly supervised. He knew it had been reported that the specific gravity was down to 6·30, whereas this should not have been less than 6·75.

A long discussion followed in reference to the correspondence from plaintiff as to whether he did not regard Barkers as principals and not as his agents for the supply of the battery.

Mr. VIGOR said he had no knowledge of electrical storage batteries. When he proposed to put in electrical lighting he asked Mr. McKinley to give him some idea of the cost, which he did. His arrangement with Barkers was that they should do everything he directed and he would pay them their net expenditure or cost plus 10 per cent. which they estimated for establishment expenses and 7½ per cent. profit.

His LORDSHIP said it looked as though Barkers were the persons liable to plaintiff, if anybody was.

Mr. HORRIDGE said there had been an arbitration between Vigor and Barkers about this very matter.

WITNESS said the arbitration was as to what was due to him from Barkers as director and what was due from him to them as director. He made no counterclaim against Barkers on account of these storage batteries. From April, 1900, to April, 1901, the battery installation worked satisfactorily. At the end of May, 1901, his engineer reported that four of the cells had gone wrong, and said it was best to cut them out of use. Lear, his engineer was a mechanical engineer, and for some time was in Barker's electrical department. In June of that year he let the place to the Maharanee of Kooch Behar; Lear remained in charge of the electrical installation. Lear had told him that the Maharanee's use of the light was excessive and too much for the battery, and witness advised that they should run direct off the dynamo all the time they were using the light instead of from the cells, and then leave the batteries for any light they might want after they had gone to bed. About a fortnight after Sear reported that more cells were getting defective. He then asked McKinley to see defendants on the matter. Defendants then sent him an estimate to put the thing right for £66, but he protested that he ought not to pay anything. The estate carpenter looked after the installation when Lear left. Between May and August, 1901, nothing was done to put the cells into working order. It was not until the defendants claimed payment of their account of £36 that he set up the claim in this action.

G. F. SEAR said he was a mechanical engineer, and had had 2½ years' experience in electric light installations. He complied with the defendants' instructions to the best of his ability. The records he kept were accurate. During the first 12 months the battery worked well, but later the cells had a tendency to buckle. That, of course, caused short circuiting. Up to the time he went to plaintiff's place he had never had a battery in his charge.

The jury here stated that they had decided on a verdict for defendants

His LORDSHIP said he agreed with the verdict, and gave judgment for the company, with costs; also for the company on their claim for £36, with costs.

Callender's Cable and Construction Co. v. Killarney Electric Lighting Co.

In the Chancery Division, Dublin, on Monday, application was made on behalf of Messrs. Crompton & Co. (Ltd.) for an order that they may be at liberty to issue a writ against the defendant company for the recovery of an alternator the property of the applicants, but now in possession of defendants, as the receiver appointed under a hire-purchase agreement of June 20, 1899, had not paid instalments due, or, in the alternative, for an order that the machinery be delivered forthwith to the applicants or the instalments paid.

Counsel said the arrangement was that £12 per month was to be paid for the alternator, and on payment of that sum for 12 months, with £1 in addition, the machine was to become the property of the hirer. His clients had only received payment for six months, and could not obtain the balance.

The MASTER OF THE ROLLS said, on the receiver appearing and plaintiffs not objecting, he would make an order that the machine in question be delivered up.

Re Automatic Telephone Co. (1903).

Mr. Justice Byrne resumed on Tuesday the hearing of the petition of Mr. H. Le Blanc Smith and others for winding up this company. Mrs. Margowski had been directed to attend for examination, but as this lady had received a bad shock at the stormy meeting held at Greenwich, where Mr. Margowski had been threatened by the shareholders, the hearing was further adjourned.

Electric Timber Seasoning and Preservation Co. (Ltd.)—Mr. Justice Byrne on Tuesday heard the petition of Louis de Layou (formerly secretary of the company) for the winding-up of the company. The company did not oppose. There are £50,000 debentures issued, which are a first charge on the assets. His lordship made the usual winding-up order.

Electric Tramways Construction and Maintenance Co. (Ltd.) Mr. Justice Byrne on Tuesday dismissed with costs the petition of F. H. Barr and others for the winding-up of this company.

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MUNICIPAL, FOREIGN, & GENERAL NOTES

APPOINTMENTS VACANT AND FILLED.

The Municipal Commissioners of Singapore (Straits Settlements) require an electrical engineer, with experience in the management of three-wire continuous-current supply station, and qualified to superintend the laying and maintenance of underground cables on the solid system and to take entire charge of their electrical department. The appointment will be made for three years, at £360 for first, £390 for second and £420 for third year, with transport allowance. Further particulars are given in an advertisement. Applications to Mr. C. C. Lindsay, M.Inst.C.E., 217, West George-street, Glasgow, by April 19.

The Council of the University of Birmingham require an assistant lecturer and demonstrator in electrical engineering. Applications to secretary (Mr. Geo. H. Morley) by March 28. Salary £150 per annum. See advertisement.

Radcliffe District Council require an electrical engineer to take charge of their electricity undertaking. Salary £150 per annum. Applications to the clerk (Mr. S. Mills), Council offices, Radcliffe, by March 19. See advertisement.

A meter reader and tester is required for Coventry Corporation electricity works. Wages 30s. a week. Applications to the manager, Mr. J. A. Jeckell by 10 a.m. of 16th inst. See advertisement.

The Council of the University of Liverpool invite applications for the professorship of Physical Chemistry. Total guaranteed salary, not less than £600 a year. Particulars from registrar, to whom applications by April 1.

Swansea Town Council require an inspector of overhead equipment during the construction of the tramways.

An executive engineer is required for the Public Works Department of the Federated Malay States, chiefly for the construction of hydraulic works in connection with the electric lighting of Kuala Lumpor. Applications to the Crown Agents for the Colonies, London, by 26th inst.

Mr. D. M. Macleod, chief distributing engineer at Poplar has been appointed assistant borough electrical engineer with an increase of £50 upon his present salary. Mr. J. Fairbairn, charge engineer, has also been granted an increase of salary.

Bradford Corporation have confirmed the appointment of Mr. Thos. Roles, of Poplar, as assistant electrical engineer.

Mr. Melville Walton, assistant engineer to the Wolverhampton Corporation electric tramways department, has been appointed assistant electrical engineer to the Bengal-Nagpur Railway Co.

Armourer-Sergeant Handford has been appointed claims superintendent by the Sheffield Tramways committee.

Mr. G. Hughes, manager of the Horwich locomotive works of the Lancashire and Yorkshire Railway Co., has been appointed chief mechanical engineer of the company. Mr. O. Winder has also been appointed manager of the locomotive works.

Aberdeen.—The Council were engaged for a long time on Monday in discussing a proposal to grant permission to the National Telephone Co. to lay telephone wires underground. It was pointed out by Treasurer Wilkie that the company's proposals meant that a large number of people in outlying districts would get their telephones at the rate of £8. 10s. instead of £10, as at present; the Corporation would get £50 for wayleaves and 50 per cent. reduction on the charge for telephones used by the Corporation. The proposal to grant permission was carried by 16 votes to 14, "subject to satisfactory adjustment of the agreement between the parties."

Barnet.—The agreement between the North Metropolitan Electric Power Supply Co. and the Council for the supply of electricity entitles the Council, on giving 12 months' notice in writing, to take over the undertaking as a going concern at the expiration of seven years from Aug. 31, 1905, or of any subsequent year, upon paying to the company the amount of capital expended and a sum equal to one-third of such capital expenditure.

Belfast.—It was reported to a special meeting of the City Council on Friday last that Lord Balfour of Burleigh, acting for Lord Morley, chairman of committees for the House of Lords, objected to the compulsory clause of the Corporation Tramways Bill, as introducing a wholly new principle in the private legislation of the country. It has been resolved to proceed to obtain permissive power of purchase, and with the other provisions of the bill.

Bohemia.—A new electric railway is being constructed to connect Teplitz and Klostergrab, two towns near the frontier of Saxony. There previously existed an electric railway from Teplitz to Eichwald, and the new line completes the connection.

Bradford.—The third 1,600 H.P. engine installed at Valley-road electricity works was started last week. The engine is coupled to a 1,000kw. British Westinghouse generator, which can supply current for either lighting or traction. Last year 11,000,000 units were sold, and after providing for sinking fund and interest, and setting aside £8,426 for depreciation, the net profit was £487. In point of output, there are only three municipally-owned electricity works in the kingdom which exceed Bradford—Glasgow, Liverpool and Manchester.

The Corporation have decided to proceed with the extension of the Allerton tramway at a cost of £4,580, and with the reconstruction of Wakefield's-road tramway at a cost of £5,677.

The special sub-committee appointed to negotiate for the proposed taking over of the Mid-Yorkshire (Shipley) tramways recommended the Council to enter into agreements with the Shipley Council and with the owners of the Mid-Yorkshire tramways on terms as under:

Shipley to grant a lease to the Corporation, to expire at the same time as the Keighley-road section of the lines now leased to the Mid-Yorkshire Tramway Co. The Corporation to pay 6 per cent. on amount of purchase money to be paid by Shipley (£32,751); also to pay for electricity supplied in Shipley district on the same terms and conditions as apply to Keighley-road section; to pay £100 per mile of single track (5·93 miles) towards maintenance and repair of permanent way; to maintain the overhead equipment at their own expense, and Shipley Council to maintain all other portions of the undertaking; to pay £4. 10s. 3d. per cent. on £5,000 expended in street improvements on tramway route; and to take a lease of the continuation in Shipley of the Valley-road section if latter is constructed. The owners of the Mid-Yorkshire tramways, on payment of £32,751 by Shipley for purchase money, and £7,249 by Bradford for surplus stock and materials and 10 cars, to surrender their lease of Shipley lines and transfer the whole of their undertaking and deliver up the surplus stock and materials and 10 cars. The owners to transfer to the Corporation their powers to construct and work the Baildon section subject to their retaining running powers over the Baildon section and through Shipley by special route to Bingley.

A discussion arose upon this recommendation at the Corporation meeting on Tuesday. The scheme involved the expenditure of £40,000 to £50,000, particulars of which, it was urged, have not been submitted.

The Chairman of the committee (Mr. HILL) said the trouble always was that gentlemen outside the Council, who had no means of acquiring a knowledge of the true facts, were the persons most ready to adversely criticise. He maintained that from the beginning, after they had come into the hands of the Corporation, the Shipley tramways would pay. Under present conditions Shipley would find it difficult to make the line pay, although he was told it was improving. An addition to a line already constructed could always be worked more economically than a new short line. The Corporation would only have to pay interest and sinking fund on what it paid and not on what the lines cost.

Mr. F. FOSTER moved that the proposals for the purchase of the Shipley tramways should be referred back for further consideration. In Shipley the line was a laughing stock. On the previous night he counted nine passengers in 13 cars, these cars being provided with 13 drivers and 13 conductors. Anyone who examined the facts would see that the ratification of the agreement would be the greatest mistake the Council could make. The Corporation would lose £100,000 by the transaction. Why was it proposed to pay 6 per cent. interest on £32,751 when the interest paid at present on account of the line from Frizinghall to Saltaire was £5. 14s. 6d.? With electricity at 1d. a unit instead of 1¾d. the average cost of working in Bradford was 9d. per car mile. Up to the present the receipts in Shipley had only been 5d. per mile, and it would be impossible to run the cars at less than 10d. or 11d. per mile. Then there was £100 a year to be paid for the upkeep of overhead equipment, £226 as interest on £5,000 spent on street improvements, and £593, representing £100 per mile of single track, for the maintenance of permanent way, and there was a cash payment of £7,249 for 10 cars and plant, and the usual depreciation and interest on that amount made another £600. Consequently, over and above the loss on working, which had amounted to £163 in 24 weeks, there would be an annual outgo of £3,484. He wished to point out that after the Mid-Yorkshire Co. had been running this line for about five weeks the contractor had to take it over because the company could not pay its way. One shareholder, he was informed, had lost over £20,000 in the venture, and the contractor was willing to sell it at a loss of £18,000.

Ald. E. PRIESTLEY said at the outset he looked upon the business as risky, and he should have been prepared to vote against the purchase, but after going into details it was his opinion that the Council would not take the course suggested by Mr. Foster. The Corporation were practically not asked to find the money; the Shipley Council were to find it, and the Corporation were only asked to find 6 per cent. on £33,000.

Eventually the amendment was defeated and the report adopted.

Bristol.—In presenting their report to the Council on Tuesday (referred to on another page in this issue) the Electrical committee regret that, in spite of the attention which has been given to an investigation of the causes of the recent fire at the Temple Back electricity station, it is impossible to state definitely how the fire originated. The Committee reported, in connection with the settlement with the insurance companies for £8,235, that this sum had been transferred to suspense account. During 1903 (the report continued) the increase in the lighting business had not been maintained although the power load showed an increase of 50 per cent. The report was adopted.

Burnley.—A substantial profit (about £4,000) has been made on the electricity department during the past year, and the question of reducing the charge for current is under consideration.

Burton-on-Trent.—For the past half year's working of the electric tramways the total receipts were £9,311. 14s. 1d.; the total car-

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miles were 212,532, or a mean of 8,174·3 per week. 2,019,087 passengers were carried, or a mean of 77,657·18 per week; 7,646 parcels were carried, or a mean of 294·07 per week. The traffic receipts per car-mile were 10·28d., and the number of passenger per car-mile 9·46. The total receipts per car-mile were 10·48d., the mean cost of power per car-mile being 1·91d. For the first five weeks there was no Sunday running.

Camberwell (London)—A petition signed by 1,135 of the 1,347 owners of property and residents having frontages to the London, Camberwell and Dulwich Tramways, praying that support be given to the company's bill, so that the system should be modernised and electrically equipped, was presented to the Borough Council on Wednesday. The petitioners are, we understand, to be notified that the Council have already decided to oppose the bill.

Carlisle.—The Electricity committee advise the Council to continue the present rates for electric current, but ask authority to make special contracts in exceptional cases.

Carnarvon.—The Council have reconsidered the electric lighting schemes put forward by the National Electric Construction Co. and the North Wales and District Light Railway and Electric Power Syndicate, and have decided to adopt the proposals of the former company. The Local Government Board have been asked to continue the inquiry commenced on Sept. 2 last.

Cheltenham.—An inquiry was held on Friday into the application of the Council to borrow £4,132 for extensions of the electric lighting mains, &c.

The borough electrical engineer (Mr. Hamilton Kilgour) gave evidence showing that the loan was required to meet applications for current made by would-be consumers, and that in each case more than 20 per cent. return had been guaranteed upon the outlay. He also explained the necessity for extensions to the plant and for house services, and said that practically the whole of the expenditure had already been made. 235,000 units were sold for traction last year, and the total output was 1,287,000 units. The cost of the traction worked out at 1·57d., and the cost of traction, public and private lighting together worked out at 3·53d., inclusive of capital charges. When the undertaking was likely to pay depended upon whether the recommendations for increasing the charges to private consumers and for public lighting and traction were adopted by the Council. If they were, Mr. Kilgour thought that next year they would turn the corner.

There was no opposition.

Colwyn Bay.—A profit of £340 was made on the electricity works during the past year.

Cork.—Mr. T. H. Walker, of Dalkey, who is acting for a syndicate which proposes to erect electricity works in various parts of Ireland, has been in communication with Fermoy Council in regard to electric lighting.

A similar scheme for Mallow has been put forward and approved by the Council.

Crediton.—Messrs. Christy Bros. and Middleton, who are applying for a provisional order, notify the Council that they cannot agree to the Council having the right to purchase the undertaking at the end of 14 years, but are prepared to sell after 21 years at a sum representing capital, with an additional 20 per cent.; after 28 years, with an additional sum of 10 per cent. on capital; after 35 years, an additional 5 per cent.; and after 42 years, under the provisions of Sec. 2 of the Electric Lighting Act, 1888. The promoters agreed to add certain thoroughfares to the third schedule of the draft order. The Council decided to adhere to its decision that underground mains should be adopted, and that the power to purchase should be 21 years instead of 14.

Darlington.—The Council have reduced the charge for electric current for lighting by ½d. per unit, and for power to 2d. per unit for 2,000 units per annum and 1½d. afterwards.

Douglas.—Out of the profits of the past year's working of the municipal tramways £2,350 has been devoted to the relief of rates.

Exeter.—The Electric Light committee have fixed the charges for current from Jan. 30 as follows:—5d. per unit for private lighting and 2½d. for power, heating and street lighting. Meter rentals are to be reduced one half.

Exhibition.—There will be an International Industrial, Agricultural and Scientific Exhibition held at St. Etienne, France, from April to September. The goods of intending foreign exhibitors will be admitted into France free of duty and a reduction of 50 per cent. on transport will be allowed by the French railways.

Falmouth.—The agreement with Messrs. Crompton & Co. for the erection of electricity and refuse destructor works has been sealed.

Felixstowe.—The Council applied some time ago for sanction to a loan of £17,160 for acquiring and extending the local electricity works, and an official inquiry was held in due course.

The Local Government Board now intimate that they have some doubt whether the proposed arrangement is one favourable to the ratepayers. If, however, after consideration of this expression of opinion the Council desire to press their application, the Board will not refuse sanction.

The Council have unanimously resolved to press the application.

The local electric light company has been permitted to put down a gas-driven set at the generating station.

Fire.—On Monday evening a fire broke out in the top storey of the Victoria Works, Aston, Birmingham, belonging to Veritys Limited. A few minutes before the fire was discovered the watchman completed his rounds, and everything was apparently in order, but some employés working overtime discovered the outbreak, notified the local fire station and themselves took the necessary steps to keep the fire under control. On the arrival of the brigade the fire was promptly extinguished and little damage was done. The remainder of the Victoria Works are in full operation, and Messrs. Veritys have also their Plume works. It is not, therefore, likely that any delay will occur with contracts or other work in hand.

Gillingham.—The Council have entered into a three years' contract with the Admiralty for the supply of electric current to the Naval Hospital for the equivalent of 3,250 16 c.p. lights.

Glasgow.—A a special meeting of the Corporation on Monday, the Electricity committee reaffirmed their recommendation to accept the tender of the Electrical Co. for the supply of motor-generators at £9,958, provided that the contractors pay the standard rate of wages or piece prices to all their competent workers for all classes of work, whether contract or otherwise. The Amalgamated Society of Engineers protested against the acceptance of the tender, as did also the Associated Society of Iron Moulders, alleging that the proposal involved giving work to a foreign firm. After a long discussion the report was carried by 30 votes to 23.

Gorton.—Manchester Corporation have been offered a transfer of the Gorton electric lighting order for a minimum of 18 and a maximum of 21 years.

Hackney (London).—The Finance committee recommend application being made to the London County Council for a further loan of £26,000 for extensions of the electricity supply and refuse destructor works.

Interest on Local Loans.—The Treasury give notice that, in pursuance of the powers conferred upon them by the Public Works Loans Act, 1897, they directed, by a minute of March 3, 1904, that on loans granted out of the Local Loans Fund, on the security of local rates, subsquently to the date of that minute, there shall be chargeable, in lieu of the rates of interest fixed by the Treasury minute of Jan. 18, 1900, the following rates of interest:—

On loans for not exceeding	20	years,	3½	per cent.	per annum.
,, ,,	30	,,	3¾	,,	,,
,, ,,	40	,,	4	,,	,,
,, ,,	50	,,	4¼	,,	,,

The periods and rates fixed by the Treasury minute in 1900, when the rate of interest was raised ¼ per cent. per annum, were as under:—

On loans for not exceeding	30	years,	3¼	per cent.	per annum.
,, ,,	40	,,	3½	,,	,,
,, ,,	50	,,	3¾	,,	,,

Hartlepool.—The Town Council have decided to waive their claim to the right to take over the Hartlepool section of the electric tramways, the lease of which expires shortly. It is probable that the lease to Hartlepool Electric Tramway Co. will be renewed for 21 years, and the re-laying of the line will then be proceeded with.

Hastings.—The accounts of the electricity department for the past year submitted to the Council last week show a deficit of £951.

Islington (London).—On the recommendation of the Lighting committee, the Council at last week's meeting decided to alter the system of supply in a portion of their area from the two-wire to the three-wire system at 100 volts, and to adopt a similar method of supplying the motor load in another portion of the area. The estimated cost is £488.

Kingswood.—The application of the Kingswood Electric Supply Co. for a provisional order has been granted. The Council have the option of purchasing at the end of 21 years, and the maximum price of current has been fixed at 7d. for lighting and 3d. for power

Kirkcaldy.—During the past year 2,580,000 passengers were carried on the local electric tramways, the receipts amounting to about £10,000.

Leek.—Sanction to a loan of £300 for extensions of mains has been applied for. The question of adopting a "free" wiring scheme is under consideration.

Light Railways.—The Board of Trade have, after modification, approved the County of Hertford Light Railway Order, No. 1, authorising light railways in Arkley, Barnet Valley, Chipping Barnet, Bushey and Watford.

The Board of Trade have, after modification, confirmed the Bradford Corporation (Nidd Valley Transfer) Light Railway Order, 1904, transferring to Bradford Corporation the powers conferred by the Nidd Valley Light Railway Co.'s order 1901.

The Witney, Burford and Andoversford Light Railway Order has been submitted to the Board of Trade for confirmation. Objections by April 2.

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Longton.—The annual municipal exhibition of electric and gas lighting fittings, electric motors, &c., will be held in April.

Lowestoft.—Application has been made to the Board of Trade for sanction to borrow £9,712. 0s. 7d. to meet excess expenditure on the tramway undertaking. When this sanction is received the Electric Lighting committee are to take over the machinery and plant and will be responsible for its future maintenance and renewal and pay sinking fund instalments and interest on the loan. The charge for current for traction has been fixed at 2¾d. per unit until the consumption shall reach 250,000 units, when the charge is to be reconsidered.

Manchester.—The tramways department have decided to contribute £50,000 out of the profits of the department during 1903 in relief of city rates, compared with £30,000 in the previous year.

Manchester District Tramways.—Barton-upon-Irwell District Council give notice of intention to acquire the Manchester Southern tramways in the Council's district. A similar notice has been given by Stretford Council in regard to tramways in Stretford.

Metropolitan Railway of Paris.—An order has been placed with the French Westinghouse Co. for equipment of 91 cars on the multiple unit control system for the line between Maillot and Vincennes. Each train will consist of three motor coaches and four trailers. The contract also includes the supply of nine 200 H.P. double equipments for the multiple unit control trains which are to be placed in operation during the summer between Villiers and Gambetta.

Municipal Telephony.—At last week's meeting of Glasgow Corporation, the Telephone committee recommended that they be authorised to apply for powers to borrow an additional £50,000.

The Chairman of the committee (Mr. JAMES ALEXANDER) said that 14 months ago they received authority to borrow £80,000, raising the borrowing powers to £300,000. At that time the money was required for wiring up subscribers. Now they had over 11,000 subscribers, and there was only £15,000 of unemployed money. The additional money was required to enable them to wire up additional subscribers.

Mr. RUSSELL moved that the proposal to borrow £50,000 be remitted back for further consideration. It was just a year since the last £80,000 was borrowed, and if £80,000 had only lasted one year how long would £50,000 last? He said the department at the beginning of the year started with a deficit of not less than £31,000, and that on the basis of a 5 per cent. depreciation only. It would take £3,000 a year during the remaining period of their lease to write that off, while if they added interest at, say, £8,500 (a moderate figure), depreciation at 5 per cent. (equal to £15,000) and working expenses as last year (£21,000) a total expenditure of £47,500 was reached. Last year's revenue was £35,000, and assuming that the increase of instruments to date (1,813) would bring in £4. 10s. per instrument, which was more than they would average, that gave an increased revenue of £8,300, or a total net revenue of £43,300, leaving, on his calculations, a shortage of £4,200 per annum on a basis of only 5 per cent. depreciation. Mr. Alexander last year estimated the surplus at £5,000 for this year, and, capitalising that, he brought out that at the end of the lease it would yield £50,000, and taking a sinking fund of £10,000 per annum, equal to £100,000, it would mean at the end of the lease that they had written off £150,000. He would be pleased if Mr. Alexander would show them where the £5,000 of profit for this year was to come from. He would throw aside altogether the £30,000, which he maintained had been lost as at the end of last year, and would deal with this year on its merits. Taking a 4 per cent. depreciation (£12,000), and interest at £8,500, with working expenses at £23,000, this made a total of £43,500, and with a revenue which he believed would not exceed £43,300, he challenged Mr. Alexander to bring out the promised profit of £5,000. Taking either of the estimates he had given, it must, he thought, be agreed that the Glasgow telephone enterprise was in a most unsatisfactory condition. The whole of the plant for the telephone department was erected at a time when copper was at an inflated price and other material correspondingly high, and he felt safe in saying that the cost of construction was, including material, 40 per cent. higher than present prices. It was, further, well known that the capital account of the undertaking had been debited with wages which should have gone to revenue, and even with such charges as clerks' wages, advertising, &c., a method of allocating outgoings which should never be tolerated in municipal accounting. The accounts had been kept in a way that even the auditors, for their own credit, had to protest against it. It must be remembered that Mr. Bennett's estimate of cost per line had been £19, while the actual cost worked out at £35. If, therefore, a £5. 5s. rental had been arranged on an estimated cost of £19 per line, how was it possible to continue that rental when the actual cost worked out £35? A circular was sent out in February which was marked "Private." Although he was a subscriber to the Corporation telephone, he did not receive a copy of that circular, and as there might be other subscribers there who were in a similar position, he would read it—

> "The committee of this department have at present under consideration the question of altering the existing system of calling the exchange, and I am instructed to ask you whether you prefer to retain the present system of call-wire, or whether you consider it desirable to alter it to a method of calling the exchange direct without requiring to give your own number? A reply by return will oblige.—A. R. BENNETT, General Manager."

If the present system of call wire was to be changed did that not mean a further expenditure of many thousands of pounds, and a good deal of scrapping of the present fixtures? As to the proposed loan, the Secretary of State for Scotland sanctioned the last loan "in reliance on the offer of the Corporation to make such arrangements by setting up a reserve fund or otherwise as would prevent the reasonable possibility of the ratepayers being called upon at a future date to pay off a debt contracted in providing—at a price which, if that course was not taken, would be under cost price—a service which was used by a comparatively limited proportion of the community." He asked, had that condition been complied with? Had there been a single penny set aside as reserve, or even a generous depreciation? The Finance committee were already obliged to renew their floating promissory notes for many hundreds of thousands of pounds at a rate which had better not be stated. Surely under those circumstances no expenditure of money should be sanctioned to the Telephone department unless the Corporation were assured it would at all events earn what it was costing them. No figures nor any statement could contradict the fact that the department was being carried on at a serious loss, and that it was quite impossible to maintain a £5. 5s. service.

Mr. STEVENSON said Mr. Russell's speech was quite irrelevant. Did he suggest that they should give up the undertaking? The subscription rates could only be increased when the annual account came before them. The convener would then show whether he could pay his way, and if he was unable to do so then they would have to consider the situation. Meantime they must carry on their work, and they could not do so without further borrowing powers. As to the question of depreciation, they were writing down the enterprise on the basis of a 30 years' sinking fund; and in that respect they were doing better than the Post Office.

Mr. BRUCE MURRAY said that, as convener of the Finance committee, he had endeavoured to make himself acquainted with the state of affairs in the telephone department up to date. He would not enter into figures, but to the best of his judgment their affairs were not in a satisfactory position. Before they applied for increased borrowing powers they should face the situation, and ascertain whether the money would be invested remuneratively. He held that he was the best friend of the Telephone committee, that he was the best friend of municipal enterprise when he insisted that it should be conducted on lines that could bear the most stringent inquiry. They were competing unfairly with private enterprise if they supplied telephones under cost.

The minutes were approved on a division.

A dispute has, it is stated, arisen between Swansea Corporation and the National Telephone Co. The Corporation has received from the Postmaster-General the right of intercommunication with the Post Office service. Application has been made for a similar right over the National Telephone Co.'s lines. The company has replied, however, that it cannot accept the Corporation's figures as to the number of subscribers on the municipal service, but asks to inspect the Corporation's list. The company further points out that intercommunication, when granted, will only be with the company's local service in Swansea and not to subscribers outside that area.

Neath.—Application has been made for sanction to a loan of £5,000 for electric lighting.

Overhead Wires.—Islington (London) Borough Council propose to ask the London County Council to amend their bye-laws so as to ensure that notice shall be given to the local authority in all cases where it is proposed to discontinue the use of overhead wires.

Poplar (London).—The Electricity committee reported on Wednesday that, following upon their report upon electricity supply extensions, presented to and adopted by the Council on 25th ult., which would involve an expenditure of £65,500, of which sum £16,000 had been passed for providing two 1,000kw. generators with foundations, condensing plant and switch gear, the chief engineer (Mr. P. N. Hooper) had now submitted the following estimates for other parts of the scheme:—

Sub-station plant £17,150, made up of two 250kw. asynchronous motor generators £3,500, three 500kw. synchronous motor generators £10,500, battery £1,500, switch gear, &c., £1,650; mains £20,250, made up of cables £2,275, trench work, ducts, manholes, drawing-in and jointing, permanent reinstating £17,375, contingencies £600; buildings, &c., £5,600, made up of land £500, ferro-concrete buildings in north and south districts £4,600, two travellers £300, contingencies £200. Total £43,000. The whole of the plant should be erected and running by the week ending Sept. 17, and if that was to be accomplished the estimates should be passed and contracts placed without delay.

The Committee recommend that the Council proceed with the scheme in its entirety, that the estimates be adopted, and that advertisements be issued inviting tenders.

At the Council meeting last evening the above proposals were approved.

The committee further reported that the engineer was of opinion that for power the demand system was not really applicable or necessary, and, further, that the desirability of its abandonment should be considered, together with a reduction in price in order to compete with gas engines. They proposed that the price should be altered to a flat rate of 1½d. per unit net, and submitted a statement showing that in 1902-3 the maximum load demanded was 912kw., that the capital cost to provide that was £187,539. 16s. 2d., and the average daily output in units during the year was 5,403. During the 12 months under review the daily standing charges were £31. 2s. 6d. and the running charges (0·66d. per unit) £14. 17s. 2d., or a total of 2·04d. per unit generated. It could not be expected that the full load should be maintained for the 24 hours, but there was every reason to believe that with a

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reduction of price, liberal advertising and energetic canvassing 60 per cent. of this amount might be attained, in which case the cost of production would be reduced to 1·23d. per unit generated. The engineer further suggested that if the arc lamps were run the whole of the night instead of being switched off at 1 a.m. the cost of current be reduced, the same as for motive power (1½d. per unit), but plus maintenance and capital charges. Under the existing system the public lighting charges for the coming midsummer quarter would be £9,970. 0s.8d.; under the scheme as proposed they would be £9,077. 16s. 5d. He estimated that, provided the ratio of units sold under the foregoing proposals for motive power and public lighting were increased from 50 per cent., as at present, to 80 per cent., the net result would be that the £4,284 profit shown on the undertaking last year would be raised to £11,458. From a canvass made it was confidently anticipated that a reduction of price for current would immediately be followed by an accession of demand of at least 500kw.

The committee approved the proposals, the reductions to take place on 1st prox. At last night's meeting of the Council the committee's approval was endorsed.

Power Signalling on the North-Eastern Railway.—The directors of the North-Eastern Railway Co. have decided to put in an extensive installation of Westinghouse power signalling at the new Paragon Station, Hull, and the contract has been let to Messrs. Mackenzie and Holland, agents for the Westinghouse Brake Co.

Presentations.—Recently a presentation was made, consisting of a silver tea and coffee service, to Mr. F. E. Wilkinson, who is leaving the service of Callender's Cable and Construction Co. to take up the position of secretary to the British and American Mortgage Co. The presentation was subscribed for by the staff of Callender's Company, and was made by Mr. T. O. Callender, who eulogised the services rendered by Mr. Wilkinson, and expressed keen regret at Mr. Wilkinson's departure. After a few words from Mr. Petersen Mr. Wilkinson suitably replied.

Mr. John Telfer, car-shed foreman at Rotherham, has been presented with a gold watch on his leaving to become manager of Warrington municipal tramways.

A portmanteau and a purse of gold has been presented to Mr. W. D. Newsum, of the Rotherham Corporation tramways, on his leaving for Canada.

Railway Station Lighting.—Tay Bridge station, Dundee, was lighted electrically for the first time on Saturday. Current is taken from the Corporation mains.

Reading.—At the Council meeting last week the differences which have arisen between the Council and the Reading Electric Lighting Co., as to making good the roadway after cable-laying operations, were discussed.

Mr. Elliott referred to an interview he had had with the Board of Trade, and said there could be no doubt that the Board would allow the company to cut up every path in the borough, although a large sum had been spent in getting them in order. The objections laid before the Board were indifferently received, and the Roads committee had concluded that it would be best to make some compromise with the company, by making it a stipulation that if the paths in the main streets were to be chopped up, those in the suburbs, where consumers were not likely to be so numerous, should be left untouched. After discussion, it was decided to leave the Road committee to make the best terms possible with the company.

St. Anne's-on-the-Sea.—An inquiry was held recently into the application of the Council for permission to borrow £4,000 for electric lighting extensions.

The CLERK (Mr. T. Bradley), after giving particulars of the area, population, rateable value, outstanding loans, &c., stated that the total capital expended to Jan. 31, 1904, on buildings, plant, mains, &c., was £31,568. 2s. 11½d., the sum sanctioned for electricity works being £37,404, leaving a balance of £5,620, which would soon be required, as the Council were proceeding with the laying down of the remainder of the plant. The present application was due to the rapid growth of the electricity undertaking, and the amount required was the estimated cost of laying mains, service lines, &c., for connecting new consumers during the next two or three years. On March 31, 1903, there were 175 consumers, representing an equivalent of 10,822 8 c.p. lamps connected, the number of units sold for the 12 months being 155,555; on Jan. 31, 1904, the consumers were 244, the 8 c.p. lamps connected 13,457, and the units sold for the 10 months 154,956 for lighting and 242,648 for traction. Further consumers, representing 700 8 c.p. lamps, awaited connection. The estimated revenue for the year ending March 31 current, after payment of interest and sinking fund, leaves a surplus of at least £1,000 to provide for reserve and depreciation. The gross profit for 1903-4 was estimated at about £3,000, equal to nearly 9 per cent. on the total capital expenditure.

The electrical engineer, Mr. J. H. Clothier, was also present at the application, which was unopposed.

Scarborough.—A portion of the electric tramways system is to be formally opened on April 30.

Sheffield.—A report has been prepared by the tramways manager, Mr. Fearnley, which shows that cars are being run on the new route—city and stations section—at a considerable loss. Certain recommendations made by Mr. Fearnley are to be carried out.

Shoreditch (London).—The Council have rejected a motion in favour of the Metropolitan Borough Councils undertaking the wiring and fitting up of consumers' premises for electric lighting.

South Africa.—The "British and South African Export Gazette" states that *Kalk Bay and Muizenberg* (Cape Colony) Municipal Council have negotiated a loan of £36,000 for electricity supply, &c.

Electric driving is being adopted in the machine shops of the Central South African railways at *Pretoria*. A generating station has been erected at the Durban workshops, and is expected to be open by May. The station is equipped with three 300 H.P. steam dynamos supplied by Belliss and Morcom and one 200 H.P. supplied by Davey, Paxman & Co., and will supply current for arc lighting and machine driving. The storage sheds at *Lourenco Marques* are now lighted electrically, and a scheme for the electric lighting of *Volksrust* station and district is under consideration.

The scheme for the conversion to electric traction of the sections of the Central South African railways from Springs to Krugersdorp and between Komatipoort and Belfast has been temporarily deferred from financial considerations.

The estimates of *Cape Town* Corporation for the ensuing year include £70,000 for electrical purposes.

Harris, Lee & Co. have secured a concession for electricity supply in *Heilbron* (Orange River Colony).

British goods sent to South Africa during January and February last were valued at £23,728, compared with £43,524 in January and February, 1903.

The A.E.G. are opening an office in Johannesburg, with Baron Mannheim and Mr. W. M. Arnot as joint managers.

Spennymoor.—The Council have acquiesced in the application of the United Kingdom Tramway, Light Railway and Electrical Syndicate for a provisional order to construct electric tramways on the overhead system and to extend the period of purchase to 42 years.

Stockton-on-Tees.—The Electricity committee have agreed to supply electric current to the Stockton Forge at 1d. per unit, if a minimum of £180 per annum is taken for five years.

Stretford.—The estimates for the year's working of the electricity undertaking to March 31, 1905, are: Receipts £7,310, expenditure £6,021, profit £1,289.

Sutton Coldfield.—Extensions of the electric lighting mains have been authorised.

Tonbridge.—A system of wiring consumers' premises on the hire-purchase principle has been adopted.

U.S. Exports of Electrical Goods into Canada.—In 1902 the value of electrical apparatus exported to Canada from the United States reached a value of $1,350,505 (£271,000), and similar exports for 1903, the detailed figures for which are not yet ready, are said to have largely exceeded this sum. The U.S. exports to Canada of machinery and other manufactures of iron, steel, brass and copper were on an equally large scale.

Wallasey.—The profit on the electricity undertaking during the past year was £4,700.

Walsall.—The accounts of the electricity department for the year ended Dec. 31 show receipts from sale of current for lighting £5,661. 6s. 1d., for power £518. 5s. 6d. and for traction £1,744. 15s. 2d. Adding £495. 2s. 6d. for public lighting and £146. 8s. 6d. for meter rentals the total was £8,383. 10s. 5d. Generation expenses were £3,018. 15s. 10d, repairs and maintenance £849. 15s 1d., cost of distribution £322. 17s. 9d., repair of public lamps, &c., £93. 14s. 1d., rents, rates and taxes £493. 17s. 11d., management expenses £684. 16s. 6d. and special charges (insurance) £34. 15s. 6d., total £5,497. 12s. 11d. Interest absorbed £1,457. 17s. 2d. and sinking fund £1,114. 4s. 9d. After deducting the deficit of £244. 2s. 3d. for the previous year there was a net balance of £69. 13s. 4d. to be carried forward; 897,000 units of current were generated, of which 29,708 were supplied to public lamps and 593,121 were sold to private consumers. The total maximum demand was 521kw. Total capital expenditure is £78,572. 19s. 5d. an increase of £22,032 5s.2d. for the year.

West Bromwich.—Additional electric tramway routes were opened for traffic on Wednesday.

Westminster (London).—The Works committee reported to the Council on Tuesday that they had considered a report from the engineer (Mr. Bradley) referring to experiments made with a view to securing a globe for the arc lamps in the St. James' district which would allow a better diffusion of light. The engineer stated that a globe considerably less opalescent than the ordinary globes and superior to those now in use had been found, and that the St. James' and Pall Mall Electric Light Co. offered to substitute the new globes, including the necessary fittings and painting of canopies at £1. 12s. per lamp or £96 for the 60 public lamps lighted by them. The committee decided in favour of the acceptance of the offer. The Highways committee reported that the assistant engineer pointed out that a storage battery for incandescent electric lighting at Shot Tower Wharf would effect a considerable reduction in the consumption of gas on Sundays and they had decided to put in the battery at a cost of £160.

Whitby.—The capital expended on electricity supply to Dec. 31 was £26,240, out of £28,000 authorised. Receipts exceeded working expenses during 1903 by £56. 10s., compared with a deficiency of £433 in 1902. Sinking fund charges were £583 and interest £912. 13s. 1d, leaving a deficiency of £1,439. 3s. 7d. It is proposed

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to supply consumers who take current on the maximum demand system at 6d. and 2d. instead of 8d. and 3d. as hitherto, and to reduce meter rents from 1s. 6d. to 9d. per quarter. The equivalent of 8 c.p. lamps connected is 5,550, compared with 3,730. Applications have since been received for the equivalent of 1,302 8 c.p. lamps.

An honorarium of £25 has been granted to the electrical engineer (Mr. L. H. King) for extra work during 1903.

Sanction to a further loan of £3,000 for extensions of the electric lighting mains, &c., has been applied for.

An arrangement has been made with the General Electric Co. for the supply of electric motors on the hire-purchase system.

Willesden.—At the meeting of the District Council on Tuesday, the chief electrical engineer, Mr. E. T. Ruthven-Murray, reported that he had patented an improvement in connection with the laying of mains. (This apparatus—a new bridge piece for supporting cables in troughs—was described on p. 786 of our last issue.) An order was made sanctioning the use of this appliance in the district. Mr. Ruthven-Murray was also asked to report upon the question of adopting a flat rate for the supply of current and a tariff for short-hour consumers. Extensions of distributing mains estimated to cost £488. 17s. were sanctioned.

Wolverhampton.—The Dudley-road tramway extension and the Horseley Fields route were officially inspected on Tuesday.

Worcester.—The accounts of the electricity department for the year 1903 which were approved by the City Council on Tuesday show that the gross revenue was £13,669. 8s. 10d. and the annual expenditure £5,785. 17s. 11d., leaving gross profit £7,883. 11s. 6d. Interest absorbed £3.480. 0s. 6d. and sinking fund £2,705. 12s. 11d., £150 was transferred to reserve, £550 devoted to purchase of "free" wired installations, £157. 10s. was granted to the city electrical engineer (Mr. C. J. Sutherland) for special work in the designing and erection of Hylton-road station, and £500 to the general district rate, leaving a balance of £1,866. 16s. 1d. (£172. 18s. being balance profit for 1902 and £1,693. 18s. 1d. for 1903) to be carried forward. 923,885 units were generated. The total maximum supply demanded was 556kw. The total capital expended was £120,649. 18s. 10d., representing £2. 15s. 11d. per lamp connected, or £70. 10s. 5d. per kilowatt installed normal, or £74. 14s. 11d. in flood or drought.

In the report of Mr. Sutherland, which accompanies the accounts, it is stated that the profit, £1,693. 18s. 1d., was the largest yet made, and more than had been anticipated. It was equal to 6½ per cent. on the capital expended. The revenue from private lighting had increased by £801. 11s. 2d., and from private motors by £45. 3s. 6d. over the previous year. There was a further large falling off in the waterworks motors account, which was £225. 7s. 3d. lower than last year. The costs showed an upward tendency, partly owing to the want of water power and partly to the running of the new station under uneconomical conditions due to the failure of the Tramway company to take current on the date fixed. The works costs had increased from 1·29d. to 1·46d. per unit, chiefly owing to increased coal consumption, and the total costs had risen from 1·59d. to 1·86d., which included for the first time under the head of salaries £200 as the contribution of the department towards salaries of other officials. They sold 41,158 units more for private lighting, an increase of 10 per cent. compared with 5 per cent. in the previous year. The decrease of 30,907 units supplied to the waterworks motors and the small decrease in public lighting units had the effect of reducing the total increase to 12,932 units. Private motors had risen by 4,149 units, an increase of 120 per cent. They had already 40 H.P. of continuous-current motors connected. The equivalent of 3,988 additional 8 c.p. lamps, representing 56 new customers, was connected during the year, compared with 2,944 lamps and 37 customers in the previous year. The supply to the Tramways company was started on Jan. 25.

Workhouse and Infirmary Lighting.—Walsall Guardians have decided to adopt electric lighting in their new workhouse buildings.

St. Olave's, Southwark (London) Guardians have decided to adopt electric lighting at Rotherhithe Infirmary.

Bohemian Concert.—The sixth annual Bohemian concert promoted by the Traffic Department of the Eastern and Associated Telegraph Companies, was held on Friday evening last at the Great Eastern Hotel, Liverpool-street, London, E.C., under the presidency of Mr. W. Hibberdine. The gathering, which numbered over 200, thoroughly enjoyed a lengthy programme, many of the principal items of which were contributed by members of the Eastern and Associated staffs.

Dinners.—The first annual dinner of the members of the Leeds Local Section of the Institution of Electrical Engineers was held on Tuesday. Mr. H. Dickinson presided over a large gathering, including Mr. R. K. Gray, president of the Institution, Mr. Robert Hammond, Mr. H. Brown (Leeds), Mr. W. T. Green, Mr. A. A. France, the members of the local committee and Mr. G. R. Blackburn (Bradford), the hon. secretary.

Among the toasts was "The Leeds Local Section," given by Mr. R. K. Gray, who announced that there were now about 5,000 members of the Institution.

Mr. Dickinson, who responded, said the Leeds section had only been established since the latter part of 1902, and had already a membership of 191. Referring to the subject of education, Mr. Dickinson said it would be a good thing if a commission were formed of the representatives of the various engineering industries, of representatives from the principal colleges, and of representatives of the manufacturing interests, to consider carefully the educational facilities offered in this country for technical education in connection with the engineering profession and industry.

Mr. R. Hammond gave the "Corporation of Leeds," and credited the prosperity of the city to the shrewdness of its citizens rather than to its geographical position.

Other toasts followed, and the proceedings were enlivened by an excellent musical programme.

The first annual dinner of the members of the Scottish Electrical Contractors' Association was held in Glasgow last week. The company included electrical contractors, representatives of manufacturers, and of Corporation tramway and lighting departments. In the absence of Mr. Wright, president of the Association, through illness, Mr. McWhirter occupied the chair.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1904 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date, and the Directorial Division of the new volume has been corrected up to February 11th, 1904. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates over 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. A number of large sheet Tables, Maps, &c., are included in the issue. Digest of Contents will be sent post free.

TENDERS INVITED.

Stockport Gas and Electricity committee invite tenders for one 500kw. steam alternator. Specification, &c., from the electrical engineer, Mr. A. J. H. Carter, electricity works, Stockport, to whom tenderers must submit drawings and full particulars by March 25. Tenders (addressed chairman, gas and electricity department, electricity works, Stockport) by March 30. See also advertisement.

Aberdeen Electric Lighting committee invite tenders for two water-tube boilers and accessories. Specifications from the city electrical engineer (Mr. J. Alex. Bell), Millburn-street, Aberdeen, to whom tenders by noon 31st inst. See also advertisement.

St. Annes-on-the-Sea District Council invite tenders for the supply, delivery and erection of surface condensing plant and natural draught cooling tower. Specifications, &c., from the chief engineer, Mr. James H. Clothier. Tenders to the clerk, Council offices, St. Annes-on-the-Sea, by noon March 26. See also advertisement.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring the installations set out in an advertisement for direct connection with the fire brigade of Glasgow. Tenders close on 16th inst. Particulars from the managing director, 49, Queen-street, Glasgow.

Electrical contractors willing to make a speciality of fire alarm signalling with direct fire brigade connection should keep in touch with the London offices of the company, 92 and 94, Paul-street, E.C., where urgent contracts are occasionally given out without advertising.

The Executive committee of *Winsley* Sanatorium will consider proposals for the electric lighting of their sanatorium now being erected at Winsley, Wilts. Particulars from Messrs. Silcock and Reay, architects, 47, Milsom-street, Bath, to whom proposals with estimates by March 21. See also advertisement.

Ilford District Council invite tenders for the supply and erection of one 1,000kw. steam dynamo (vertical engine coupled direct to multipolar dynamo); extensions to main switchboard and cable connections; works distributing switchboard; condensing plant, comprising surface condenser, water driven pumps, water cooling tower and pipe work; feeder and pilot cables, feeder pillar and joint boxes. Tenders to Chairman by noon March 22.

Plymouth Corporation invite tenders for the supply of stores during the 12 months ending March 31, 1905, including electricity meters, transformers and paper-insulated cables. Specifications, &c., from the borough electrical engineer, Mr. E. G. Okell, Prince Rock, Plymouth, to whom tenders by March 19. See advertisement.

Plymouth Corporation also invite tenders for 12 months' supply of lubricating oils, engine waste, &c. Tenders to borough electrical engineer by March 19.

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Wimbledon District Council invite tenders for various stores required during the year ending March 31, 1905, including engine-room stores, cables, joint boxes and jointing materials, transformers, meters, lubricating oils, incandescent lamps and carbons. Tenders to Mr. R. H. S. Butterworth, Council offices, Wimbledon, S.W., by noon March 18.

The Electrical committee of *Stepney* (London) Council invite tenders for supply and erection of one 1,000kw. steam turbine-driven double-current generator, four water-tube Babcock-Wilcox boilers, economisers, induced-draught apparatus, steam and other pipework, motor-driven feed pump and accessories. Tenders to chairman of Electrical committee by noon March 14.

Norwich Corporation invite tenders for stores for the electricity department, including cables, wires and accessories, incandescent lamps, continuous-current meters and motor for 10-ton travelling crane. Tenders to the city electrical engineer, Mr. F. M. Long, Corporation electricity works, Norwich, by 10 a.m. March 14.

Dartford District Council invite tenders for construction and subsequent working for a term of years of light (electric) railways in the district. Particulars from the consulting engineers (Messrs. Hawtayne and Zeden), 9, Queen-street-place, London, E.C. Tenders to Mr. W. Kay, Council offices, Dartford, by noon March 26.

Newport (Mon.) Corporation invite tenders for boosters, balancers, &c., switchboards, tramway poles and brackets, overhead material, section pillars, cables and trolley wire. Tenders to chairman Electricity committee by first post March 21.

Newport (Mon.) Corporation also invite tenders by 17th inst. for tramrails, fishplates and setts.

The committee of management of *Londonderry* District Lunatic Asylum invite tenders for steam boiler, pipework, switchboard, &c., and for wiring and cables to villa and to new block. Tenders to "Medical superintendent," by noon March 17.

Derby Corporation Tramways committee invited tenders by March 14 for 80 punches and 6,000,000 tramway tickets; also for the exclusive right of advertising on the Corporation tramcars for five years.

Handsworth (Staffs.) District Council invite tenders for permanent way, pavement and roadwork, and overhead equipment. Tenders to the Council House, Handsworth, before noon March 30.

Leek District Council invite tenders for electricity meters. Tenders to Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster, S.W., by noon March 14.

Sunderland Corporation invite tenders for 12 months' supply of indiarubber-covered cables. Tenders to chairman of Electricity and Lighting committee, Town Hall, Sunderland, by noon March 31

Tenders are invited by 9:30 a.m. 23rd inst. for 12 months' supply of incandescent lamps and various stores to *Rotherham* tramways department.

Tenders are required by 10 a.m. 25th inst. for supply to *Keighley* tramways department of rails, overhead equipment, section boxes, bonds, cars, cables and switchboard and for erection of car shed.

Glasgow Corporation invite tenders by 11 a.m. March 21 for the construction of new tramways.

Twickenham Urban District Council require three steam boilers, refuse destructor plant, &c. Tenders by noon 23rd inst.

The *Metropolitan Asylums Board* invite tenders by 10 a.m. March 22 for fire alarms and telephones at Leavesden Asylum

The *London* County Council invite tenders by 10 a.m. of March 22 for a 30-ton jib crane for their Greenwich power station.

Tenders are invited by 22nd inst. for 12 months' supply of electric lighting sundries to West Sussex County Asylum, *Chichester*.

Tenders are required by 16th inst. by *Walsall* Guardians, for wiring the new workhouse buildings.

Natal Government is open to receive tenders for the supply erection and completion (including maintenance for three months), of the equipment of the ground and first floors of the Railway Customs Bond warehouses, Port Natal, with a complete system of electric telpherage. Full particulars, plans, specification, &c., can be obtained from the Agent General for Natal, 26, Victoria-street, London, S.W., or from the harbour engineer, Natal.

The Cuban "Official Gazette" of Feb. 19 contains particulars of tenders invited by 2 p.m. April 15 by the Director-General of Communications, *Havana*, for the establishment and working of a telephonic system for the town of Guantánamo. The successful tender will be that which states the largest percentage of the total revenue obtained (in any case not less than 6 per cent.), which the concessionaire is prepared to allocate to the Government.

TENDERS RECEIVED AND ACCEPTED.

Kalk and Muizenberg (Cape Colony) Municipality have accepted the tender of the British Westinghouse Co. for electric generators, transformers, motors, high-tension switchboard, ash and coal trucks, turntable, pipework, &c., at £15,261.

The British Westinghouse Co. have sub-let to Babcock and Wilcox a contract for two boilers with superheaters, to Belliss and Morcom for two 22 B.H.P. engines, to Meldrum Bros. for a destructor, to the Worthington Pumping Engine Co. for electrically-driven and steam-driven pumps, to E. Green & Son for a 144-tube economiser, to Carrick and Ritchie for cranes, to W. T. Glover & Co. for cables, and to Rowland Carr & Co. for junction boxes, transformer pillars with switch-gear, and 150 street lamp-posts.

The following tenders have been received by the New General Traction Co. (Ltd.) for the construction of about 2 miles of new tramways and the reconstruction of 5½ miles of tramways at Coventry:—

R. W. Blackwell & Co. (*accepted*)	£34,296	19	1	Herbert Holloway ..	£38,686	17	10
J. & W. S. Briscoe..	86,794	1	4	Freeman	38,271	3	9
Graham & Sons....	46,628	3	1	J. G. White & Co...	37,656	11	3
J. Ewart	44,280	12	5	Pegg & Bailey.....	37,408	16	7
Dick, Kerr & Co....	41,847	13	1	George Law.....	36,747	7	11
W. Griffiths & Co...	40,937	19	10	M. Mollett & Co....	36,276	1	0
				Underwood Bros. ..	36,063	7	5

West Ham Corporation have accepted the following tenders for stores for the ensuing 12 months:—

British Insulated and Helsby Cables (Ltd.), cables; General Electric Co., incandescent lamps (100 volts); British Thomson-Houston Co., incandescent lamps (200 volts); Imperial Lighting Co., house cutout boxes; Ferranti Limited, meters; British Electric Transformer Co., transformers; Mosers Limited, ironmongery; Middleton Bros., engine-room stores.

Hammersmith Borough Council has accepted the following tenders for annual supplies.

General Electric Co., incandescent lamps and electrical goods (accessories and insulating materials); Johnson and Phillips, arc lamp accessories, arc lamp globes and shades; A. James, commutator brushes; Anchor Cable Co., insulated wires at £269. 7s. 10d.

The tenders of the National Telephone Co. have been accepted by the Scottish Office of the May-Oatway Fire Appliances (Ltd.) for wiring fire alarm installations (for direct connection with the fire brigades) on the premises of Fleming, Reid & Co., Greenock, and at the Theatre Royal, Edinburgh. The order for similar work at the Lyceum Theatre, Edinburgh, has been secured by Wm. Douglas (Ltd).

Mr. Bertram Thomas has secured the contract for the supply of bare copper accumulator connections to switchboard for Faversham Council; switchboard and gallery for Prestwich (Lancs.) Asylum; and feeder switchboard and short-circuit breakers for the Streatham tramway sub-station of the London County Council.

W. T. Henley's Telegraph Works Co. have received orders for paper-insulated electric lighting cables for Cape Town Corporation and Table Bay Harbour Board and for dry-core telephone cables for Cape Town Postal Department.

James Howden & Co. have obtained (through their Sydney representatives, McArthur & Co.) a contract for duplicate engines for the Ultimo power-house of the New South Wales Government tramways.

Ealing Town Council have accepted the tender of Siemens Brothers & Co. for a Siemens-Paxman steam alternator at £5,811, and that of Bertrams Limited for surface condenser plant at £2,360. 10s.

The tender of the Private Wire and Telephone Installation Co. has been accepted for installing a complete system of automatic intercommunication telephones in the new offices of "The Engineer," now nearing completion in Norfolk-street, Strand, W.C.

The Sir Hiram Maxim Electrical and Engineering Co. have secured a contract for one year's supply of incandescent electric lamps to the Heath Asylum of the London County Council.

Erith District Council have placed an order with the British Westinghouse Co. for a 50kw. three-phase engine-type alternator, to operate at 3,000 volts, 50 cycles.

Colchester Corporation have accepted the tender of Davey, Paxman & Co. for a boiler capable of evaporating 10,000lb. of water per hour at £840, less 2½ per cent. for cash after satisfactory test.

Salford Council have accepted the following tenders:—Pendleton Ironworks Co, steel rails and turnouts; Mather and Platt, motors; Chamberlain and Hookham, continuous-current meters.

Newport (Mon.) Electric Lighting and Tramways committee have accepted the tender of Dick, Kerr & Co., for ten tramcars at £5,046. 10s.

Brighton Corporation have accepted the tender of the Glasgow Electric Crane and Hoist Co. for a 20-ton four-motor electric crane for Southwick power house at £1,100.

Wigan Electric Light and Tramway committee have accepted the tender of J. G. White & Co. for the overhead equipment of additional tramways.

St. Annes-on-the-Sea Urban District Council have accepted the tender of Dick, Kerr & Co. for a 220kw. Willans-English Electric Mfg. steam dynamo.

Stothert and Pitt have secured an order for a 20-ton electric travelling crane for Natal Government.

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Camberwell (London) Borough Council have accepted the tender of the Electrical Engineering and Maintenance Co. to maintain the municipal telephones and electric bells for 12 months.

Leek District Council have accepted the tender of Mr. J. Richards for wiring the generating station.

BUSINESS NOTICES.

As stated in our last issue the business of the Rhodes Electrical Mfg. Co. has been converted into a company with limited liability. The administration of the new company will remain with the present partners, and the business continued as hitherto. The new company proposes to construct and standardise alternating-current motors from 1 H.P. up to 50 H.P. of single, two and three-phase types. It is intended to manufacture two distinct classes of single-phase machines: one a machine which will start up with full-load torque with normal full-load current or less, and the second an ordinary induction single-phase motor which will run up to synchronism as a split phase motor and then be thrown on the load running as a simple induction motor.

Messrs. Stegmann & Co., of Brighton Railway Approach, St. John's-hill, Clapham Junction, London, have acquired additional premises, and have opened new show rooms for electric lighting fittings, the demand for these goods in the South-Western district having greatly increased of late.

LIQUIDATIONS, BANKRUPTCIES, &c.

H. G. and G. L. Bastin, formerly trading as the Electrical Contracting and Maintenance Co. at 3 and 4, High-street, Ilford, have been adjudicated bankrupt.

The first meeting of creditors and contributories of the McGuire Mfg. Co. (Ltd.), 2, Queen Anne's-gate, London, S.W., will be held on 22nd inst. at 33, Carey-street, London, W.C.

A statement of affairs has been issued in the bankruptcy of Samuel Henry Thompson and James Edgar Thompson, electricians, trading as Thompson Bros. & Co., 6, East-street, Plymouth.

The statement shows 51 unsecured creditors £336. 9s. 5d., and three creditors for proportionate part of premiums paid under apprenticeship indentures £85. 10s. Assets are estimated to produce £188. 8s. 7d., and a total deficiency of £235. 3s. 2d. Debtors, very young men, commenced business in July last on a capital of £6 and a further borrowed £50. Insolvency is attributed to loss sustained under a contract with the Plymouth Football Club to illuminate the club's grounds at night, and to bad trade. The first meeting of creditors and the public examination took place on Tuesday.

The public examination of Charles Wallis, electrical engineer, 126, Cleethorpes-road, Grimsby, took place at Grimsby last week. Liabilities £107. 17s., deficiency £82. 17s. 1d. Debtor commenced business in 1902 with a capital of £40, and attributes his failure to bad trade, want of capital and losses on contracts.

A first and final dividend of 9½d. is payable at 47, Full-street, Derby, in the failure of H. J. Furness, electrician, Queen-street, Derby.

Claims against J. F. Worthington and Gerald Nuttall, electrical engineers, Foundry-street, Halifax, by 19th inst., to Mr. C. T. Appleby, 26, Corporation-street, Birmingham.

Claims against the Rapid Transit Co. (Ltd.) must be sent by March 31 to Mr. G. H. Homan, 86, Leadenhall-street, London, E.C.

Composition.—A deed of composition has been executed by W. C. Mercer (trading as W. C. Mercer & Co), electrical engineer, Newtown, near Wigan. Claims 11th inst. to Mr. J. Todd, 3, Winckley-square, Preston.

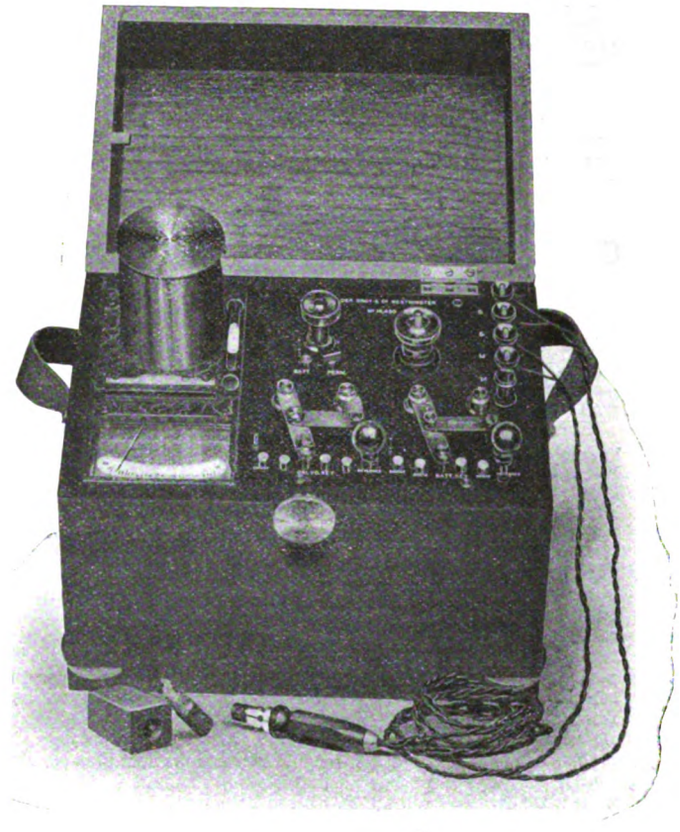
Plant for Sale —Govan Corporation invite tenders for three-wire Ediswan main switchboard, arranged for eight three-wire feeders, six dynamos, battery and balancer; also for three-wire booster by the British Thomson-Houston Co. The plant may be seen and full particulars obtained on application to the burgh electrical engineer, Mr. T. C. Parsons, Helen-street, Govan. Tenders to the town clerk (Mr. A. Macdonald), Town Hall, Govan, by March 29. See advertisement.

Premises to Let.—Messrs. Waring and Nicholson, 38, Parliament-street, Westminster, London, S.W., have premises to let in prominent corner position suitable for a factory or warehouse.

Concession in Spain.—An advertiser is willing to dispose of a concession for the construction in Spain of 85km. of railway, which would traverse two mountain ranges, where abundant water-power for electric generation of current is available.

Insulating Paints, Varnishes and Enamels.—The tendency in recent years has been to increase the voltages at which electrical energy is supplied, both for lighting and power, and the progress made in the development and use of polyphase and high-tension alternating-current systems for transmission of power for general industrial purposes has caused an increasing demand for good quality insulating materials, capable of withstanding the increased pressures and of securing electrical workers against risks from shock, &c. Among the leading firms who have essayed to supply this want is the well-known house of B. Paege & Co., 14, Kaiserin Augusta-Allée, Berlin, N.W. 87. The firm claim to have been the first on the Continent of Europe to make a special study of the manufacture and use of insulating paints, varnishes and enamels for commercial and industrial purposes, including suitable insulation for armature frames, boxes, windings, &c., for coating iron and overhead wires, the break-coils of tramway armatures and transformers, for sealing up and cementing battery cases, &c. The selection of a reliable and lasting insulating material is a matter of great importance to the manufacturer of electrical plant and apparatus, to electrical engineers and contractors, supply station engineers, &c., and Messrs. Paege & Co. claim that such has been the advance made in the production of these high-class varnishes that the insulating properties of a layer of their varnish are equal to those of mica of the same thickness, and that a thin layer of the varnish as now supplied will resist alternating currents at pressures of from 10,000 to 14,000 volts. It is further claimed for these materials that, owing to their general adaptability, they are specially useful for giving a final coating to difficult joints and junctions in installation work. Some of the e acid-proof paints and enamels may be enumerated as follows:—"Planté" enamel, quick drying, with highly polished surface, of any shade, for metals, stone, wood, &c.; "Elektro" enamel, a heat radiator, water-tight and perfectly acid-proof, especially suited for electrical plant and apparatus; "Elastic" varnish, smooth, flexible, acid, alkali and damp-proof, with high insulating qualities; "Franklin," insulating adherent, tested on canvas to 8,400 volts, used particularly for attaching insulating materials, as it will readily adhere to metals, celluloid, mica, fibres, oiled materials, &c. There are, in addition, a large number of paints, varnishes, enamels, &c. (42 in all), detailed and described in a comprehensive new catalogue issued by this firm, and these are applicable to an infinite variety of electrical uses. It should be added that an important series of tests have been made of these materials at the Imperial Physico-Technical Institute, Charlottenburg, and a complete list of the results is issued by Messrs. Paege. The voltages up to which the varnishes may be used are given with each variety of material supplied.

Catalogues.—An instructive and very complete catalogue of electrical testing and scientific instruments has been issued by Messrs. Nalder Bros. & Co., 12, Carteret-street, Westminster,



London, S.W. This is the eighth edition of this firm's catalogue, and covers electrical testing, engineering, mathematical, optical and other instruments. A special section is devoted to photometers. Several of the instruments shown in this section have been described in *The Electrician*. We have selected for illustration from the new list an example of Dr. Drysdale's patent permeameter, these instruments being specially designed to enable tests to be made of the magnetic qualities of iron or steel magnet castings and forgings under commercial conditions.

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The Sir Hiram Maxim Electrical and Engineering Co., Gillingham-street, Victoria, London, S.W., have ready a new list of Maxim patent lampholders and shade carriers.

A new list of distributing fuse-boards fitted in water-tight cast-iron cases is issued by Ernest F. Moy (Ltd), Greenland-place, Camden Town, London, N.W.

A well-illustrated catalogue of telephones and telephonic apparatus is to hand from Messrs. Ruoff and Jacques Delafon, 16, Rue Popincourt, Paris.

"Exide" Negative Battery Plate.—The Chloride Electrical Storage Co. notify that they are now supplying their new negative, known as the "Exide," which embodies several important improvements in design and detail. The company are also sending out a new type of board separator, which takes the place of the glass rod separators formerly employed, and entirely obviates short circuits from plate to plate.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from March 2 to 8, with the ports of destination:—

Africa—Alexandria, £110; Cape Town, £1,446 (including £957 telegraph material); Delagoa Bay, £1,458; Durban, £3,178 (including £2,184 telegraph material); East London, £193; Port Elizabeth, £45. *Australasia*—Adelaide, £117; Auckland, £371; Brisbane, £50; Fremantle, £88; Lyttelton, £19; Melbourne, £98 (including £31 telegraph material); Perth, £164; Sydney, £584 (including £125 telegraph material); Wellington, £129. *Brazil*—Rio Janeiro, £516 (telegraph material). *Canada*—Halifax, £90. *Ceylon*—Colombo, £161 (including £123 telegraph material). *China*—Shanghai, £102 (including £60 telegraph material). *Germany*—Hamburg, £74. *Gibraltar*—£65. *Holland*—Amsterdam, £124; Flushing, £20. *Hong Kong*, £850 (telegraph material). *India*—Bombay, £214; Calcutta, £283; Karachi, £103; Madras, £56. *Russia*—St. Petersburg, £110 (telegraph cable). *Spain*—Seville, £26 (telegraph apparatus). *Straits Settlements*—Singapore, £713 (including £650 telegraph material). *Sweden*—Gothenburg, £61; Stockholm, £33 (including £11 telegraph material). *Turkey*—Smyrna, £23 (telegraph material). Total £11,674, against £236,682 in the corresponding week last year (March 4 to 10).

Imports.—The following are the values of imports to this country during February last:—

Electrical machinery, £48,496 (a decrease of £16,697 compared with February, 1903); telegraph cables and apparatus, £2,985 (decrease £6,521); other electrical goods and apparatus, £64,756 (decrease £14,498). The totals for the two months ended Feb. 29 last were respectively £95,904 (decrease £31,879), £6,734 (decrease £10,302) and £139,430 (increase £36,395).

COMPANIES' MEETINGS AND REPORTS.

London Electric Supply Corporation (Ltd.)

The general meeting was held on Friday last under the presidency of Mr. Robert H. Benson.

The SECRETARY (Mr. H. C. Carter) read the notice calling the meeting and the auditors' certificate.

The CHAIRMAN then said: The gross revenue for 1903 was £77,190, compared with £78,344 in 1902, a decrease of £1,154, but the net revenue was £36,177, against £35,342, an increase of £835. The saving in expenses is entirely in the cost of generation, and practically all in coal. The past year was singularly free from fog—not an unmixed blessing to us—and the expansion of the company's lighting business has been less than usual, in common with the experience of the majority of the electric lighting companies in London. Notwithstanding this, it amounted to 9 per cent. in the number of lamps—from 201,487 to 219,364, or 17,877 lamps, while the units sold increased from 4,036,593 to 4,102,099. Some of you may be puzzled to understand why, with more lamps and more units sold, we took £1,154 less in gross revenue. The answer is, Competition. It was the same in 1901 as compared with 1899, when the units sold rose from 3,496,000 odd to 3,546,000 odd, but the gross revenue fell from £72,902 to £71,167. There was a time when we averaged 6d. per Board of Trade unit, now we are down to 4¼d. on the average. But we make more net money at a lower price for our product than we did at the higher, and that is the way with all healthy businesses. After paying the preference dividend (£14,952), we are able to put £6,000 to reserve and to carry forward £1,986, or a little more than was brought in. Last year I led you to expect some improvement in the company's net revenue, partly from the natural expansion of our business, but chiefly from our contract with the London County Council to supply them with power for their tramways in South London. The benefits from that contract did not begin until Jan. 17 this year, and therefore no benefit came into the past year. Our experience since that date is entirely satisfactory. It is tending to reduce cost of generation, and we expect it will more than double our units sold. We believe the result will be satisfactory not only to the County Council, but also to you as shareholders. Our capital expenditure last year was £36,198, which is small for a company with such an area and a growing business. We have about £45,000 of borrowing powers unexercised, but it is not prudent to run that too fine, and our best course will be to increase, by a moderate amount, the authorised issue of the preference shares, in accordance with the terms on which we originally issued them. In regard to the general progress of the company, taking the previous six years the units sold have risen from 3,250,000 odd to 4,102,000 odd, while the cost per unit sold has fallen from 3·19d. to 2·39d., and the net revenue has increased from £23,833 to £36,177. I have hopes that this rate of progress will be maintained. Having explained the absence of Lord Crawford and Sir W. H. Preece, the chairman moved the adoption of the report and accounts.

Mr. MAKINS inquired whether there would be a direct profit on the supply to the County Council tramways.

Mr. POPE asked whether it would not be better in the interests of the ordinary shareholders if 4 per cent. debenture stock instead of preference shares were issued.

Mr. R. STEWART BAIN, C.A., then seconded the resolution, and said: I should like to refer a little more fully to our capital expenditure during the year. It was necessitated by the expansion of the business and the contract with the London County Council to supply power for their tramways. The amount of £36,198 includes about £7,000 on account of five new boilers of 800 H.P. each which we have put down, and about £6,000 towards the new condensing plant, which is making good progress. It also includes payment on account of the new dynamo for our lighting plant and of new feed pumps and £10,623 for new mains, bringing the total length of mains laid up to 133 miles. Turning to revenue, in common with the majority of the London supply companies, our gross receipts this year do not show any increase over last year's figures—in fact, are about £1,000 less. This is accounted for chiefly by the fall in the average price received per unit sold, which arises from the keen—and sometimes unfair—competition with which we have to contend in our large area, as we have actually sold more units than during 1902. Against this, however, the total costs again show the satisfactory decrease of nearly £2,000, although we have sold nearly 70,000 more units. The coal consumption for 1903 was 14,469 tons, compared with 16,241 tons for 1902, 18,900 tons for 1901 and 26,710 tons for 1900—a very satisfactory decrease, especially when it is remembered that our engines are running non-condensing. The receipts per unit sold have shown a gradual diminution during the past 10 years, for while in 1894 the average was 6d., it has year by year shown a steady decrease, until last year it had come down to 4¼d., a decrease in 10 years of about 30 per cent. But in 1894 every unit we sold cost 6·30d., which has decreased in 1903 to 2·39d., a saving of 62 per cent. Taking, again, a 10 years' comparison, we find that in 1894 we sold only 52½ per cent. of the units generated, whereas last year we sold a fraction over 74 per cent., an increase of 22 per cent.—an efficiency which compares favourably with some continuous-current companies, although our current has to undergo two transformations. As to our future prospects, during the first two months of this year, we have received orders for a further 7,000 lamps, and the units generated on our lighting circuits have increased from 1,133,763 during 1903 to 1,302,989 for 1904, an increase of 15 per cent. We have sold over half a million units for power, against nil for the first two months of last year. We are therefore looking forward to the present year being a record one, and I hope we are nearing the time when the holders of our ordinary shares may expect the dividend which they have waited for so long and so patiently.

The CHAIRMAN, in reply to Mr. Makins, said their average cost of generation was 2·39d., and the contract with the London County Council was below that, but there was no loss on it. The average cost of production would be considerably diminished by the extra load. With regard to Mr. Pope's suggestion that the directors should issue debenture stock instead of preference shares, he (the Chairman) wished it were possible to issue 6 per cent. preference shares at a premium instead of 4 per cent. debenture stock at a discount.

The resolution was carried unanimously.

Sir William Pollitt and Mr. Robert D. Norton were re-elected as directors, and the official auditor, appointed by the Board of Trade under the Corporation's Electric Lighting Act, was elected as shareholders' auditor for the current year.

Power was then granted to the directors to increase the preference shares by the further issue of £100,000 as required.

A vote of thanks to the chairman terminated the proceedings.

The following table, showing the progress of the London Electric Supply Corporation since 1896, was read by the chairman. 1900 is omitted, as in this year the corporation had to purchase current from outside sources:—

Year.	Units sold.	Cost per unit sold.	Number of lights.	Gross revenue.	Net revenue.
1897	2,279,311	3·55d.	123,730	£50,357	£16,570
1898	3,250,650	3·19d.	154,950	67,100	23,833
1899	3,496,132	3·59d.	173,906	72,902	21,548
1901	3,546,461	3·10d.	182,878	71,167	25,220
1902	4,036,593	2·55d.	201,487	78,344	35,342
1903	4,102,199	2·39d.	219,364	77,190	36,177

South London Electric Supply Corporation (Ltd.)

The ordinary general meeting was held on Tuesday, Mr. George Ellis, J.P., presiding.

The SECRETARY (Mr. Herbert H. Boyer) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN said: During the past year we have increased the number of lamps connected by over 19,000. The report will have given you later figures, and at the moment, it is well over 99,000 lamps.

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The London County Council commenced running their electric tramcars in the middle of May last, since which time all the steam power required by them has been satisfactorily supplied by us. Now that the Company's earning capacity has arrived at a more satisfactory stage, the Directors think that the time has come for dealing with preliminary expenses on a fixed scale, and, as this matter is one of great importance to the shareholders, the Directors decided to take counsel's opinion upon the point. Counsel has advised that, provided adequate yearly provision is made for the payment of these expenses, so as to extinguish them within a reasonable period, dividends may be distributed as and when earned. In order, therefore, to give full effect to the opinion of counsel and make practical provision for the liability, the Directors have arranged a scale of gradual payments, commencing with the sum of £4,020 this year, which will annually decrease the liability and ultimately extinguish it in 10 years from this date. We now confidently recommend this scheme for the approval of the shareholders. You will observe at the end of the accounts a statement of electricity generated and sold during the year, which shows a great increase in the output, the units sold in 1902 being 1,093,029, and for the year ended Dec. 31, 1903, 4,805,481, the increase due to our own consumers being 36 per cent. in excess of sales in 1902, and the balance has been generated by the London County Council plant temporarily erected at the works, and to which we supply steam under contract. This increase has naturally improved the total cost per unit sold. The coal costs have no doubt been somewhat heavy, which is largely due to the fact of the peak of the traction load having coincided exactly with that of the lighting load each evening, and also to the fact that the greater portion of our units has been turned out non-condensing and our boiler plant has been severely taxed to cope with the load. The traction supply has to be maintained during the 24 hours each day, which a consequence that on light load the plant employed is not very economical. In order to improve the coal costs, we have this year put in operation additional condensing plant, and I am pleased to report that already there is a satisfactory decrease in the cost per unit generated. As next winter's load will require additional boiler plant, we have placed a contract for three more boilers, to be completed and in working order by August next. I think that we have all every reason to be satisfied with the success of the undertaking during the past year, and may look forward with satisfaction to the future. I have just heard that our estimated net profit since Jan. 1 last already amounts to more than that made in the first six months of last year, and in face of such a fact we may surely be sanguine of a successful year. Up to to-day the net profit amounts to £6,200, as against £5,210 for the first six months of last year. It will be seen on reference to the balance-sheet that at the end of the year our overdraft had amounted to £33,800, which, in the early days of January last, had increased to £35,000. In order to liquidate this overdraft the Directors conferred with their brokers, who undertook to find £50,000 on debentures bearing 5 per cent. interest, being part of an authorised issue of £100,000. Having regard to the depression in the money market and not caring to run the risk of a possible failure of a public issue, or of offering these debentures to the shareholders, the Directors deemed it in the best interest of the Company to close with the offer of the brokers, and we consider their terms reasonable. These debentures are to bearer, with coupons attached, interest at 5 per cent. being payable on April 1 and Oct. 1, and are repayable on April 1, 1907, but the Company reserve to themselves the right to pay off the bonds at par on or at any time after Oct. 1, 1905, by giving three months' notice by advertisement, and this option it may be desirable to exercise in the event of the money market being favourable to an issue to the public. No further capital issue is contemplated this year, but when the time does arrive the same will be first offered to the shareholders. With regard to the profit available for distribution, which will, I feel sure, be considered satisfactory, a glance at the net revenue account will readily explain how we propose to deal with this, and I need only remark that after making adequate provision for depreciation and reducing the amount of the preliminary expenses in accordance with the scheme already mentioned, there is an available balance of £10,160, out of which the Board recommend payment of a dividend of 3 per cent. for the year, payable March 17. I now move the adoption of the report and accounts.

Capt. E. IRONSIDE BAX seconded the motion.

Mr. CLAYTON asked how the company stood with the London County Council. He understood the Council were making preparations for generating their own electricity. If that were so the company would, of course, lose whatever profit there was in the present supply.

Mr. BRIGGS said he thought interest at the rate of 5 per cent. was rather high for debentures, especially as the Company was now beginning to show profits. He thought the shareholders should have been given the opportunity of taking up the debentures.

The CHAIRMAN: As to the Council contract, they are bound by a contract to us for a minimum period of 18 months and a maximum of three years. I have no doubt that the contract will run nearly, if not quite, the whole of the period. So far as the relationship between the company and the Council is concerned, there has never been an unpleasant word between us. As to the placing of the debentures at less than 5 per cent. interest, it was impossible, in the circumstances. The matter has been under consideration for a year, and we found that we could not get the money at a cheaper rate. It is for a very short period —a little over a year, and the short term of these debentures has to be taken into consideration in discussing the rate of interest.

The motion was then agreed to unanimously.

A resolution that a dividend of 3 per cent. be paid was then carried, and the two retiring directors (Mr. Ellis and Mr. J. Atherton) were re-elected, as were the retiring auditors.

A vote of thanks to the chairman and directors terminated the proceedings.

City of London Electric Lighting Co. (Ltd.).

The fourteenth ordinary general meeting was held on Wednesday, Mr. GEORGE HERRING presiding.

The MANAGER and SECRETARY (Mr. J. Cecil Bull) read the notice calling the meeting and the report of the auditors.

The CHAIRMAN then said: Gentlemen, our gross revenue has decreased by nearly £8,000, due principally to competition. Against this decrease our net revenue has increased slightly, and this is entirely owing to economies which have been made in generating expenses. In "coal" we have saved £7,560. Of that amount, only £1,105 is due to the reduced price of coal, the balance, some £6,400, is entirely due to economies effected by our engineer, Mr. Frank Bailey. Out of our receipts we have placed to reserve £45,000, and to leasehold redemption £500. Some shareholders may think we should have paid a higher dividend. We could have done so, but we are most anxious to place this company on an unassailable basis. We have had severe competition to go through. As fresh customers come on additional plant is required, and we also have to renew our old plant. We spent £41,000 on capital account in 1901, last year we expended £81,000, and this year we shall again have to spend a large sum in providing fresh plant and in renewing the old plant to make it in first-class condition. We have done all this without issuing any fresh capital. I think, therefore, you will regard it as wise that we put aside the large sum of £45,000, because that money is used for a most excellent purpose—providing plant so that we can deal with anything that may occur. Our future is, notwithstanding, I think, very hopeful, and I think this is the last time I shall have to ask you to be content with 5 per cent. We obtained in 1902 4·04d. per unit for our current, in 1903 only 3·72d. This ½d. difference means to us £17,681—that is, had we received the same price for our current last year as we obtained in 1902 it would have meant 2½ per cent. more dividend. The number of our customers has increased, and have also increased the number of equivalent 8 c.p. lamps by some 66,000. With regard to units sold in 1903, the increase was a little over 600,000 over the preceding year. Coming to accounts, we have issued £400,000 first debenture stock, and this has to be redeemed at 125. Therefore, when the company terminates, in something like 30 years, there will be £500,000 to pay for the £400,000 we received. We have, therefore, thought it better to put aside this sum of money, and after we get the figure up to £100,000 it will remain, and there will be the amount available with which to pay the premium. As to our contracts with the Corporation of London, I have nothing further to say except that we are getting on very much more comfortably with them, and I hope there will be no necessity to go back to the past. As to the competition with the Charing Cross Company, I must say for that company that they have fought very fairly and honourably, but, having said that, I do think it is a very ridiculous thing that we should go on fighting in the manner we do. I now move the adoption of the report and accounts.

Mr. J. BEVAN BRAITHWAITE, jun., seconded the motion, which was carried.

Resolutions approving the dividends and re-electing the retiring directors (Mr. J. B. Braithwaite, jun., and Mr. F. W. Reynolds), and re-appointing the auditors were then carried, and a vote of thanks to the chairman terminated the proceedings.

Brompton and Kensington Electricity Supply Co. (Ltd.).

The sixteenth ordinary general meeting of this company was held yesterday, under the presidency of Mr. H. R. BEETON.

The SECRETARY (Mr. Thomas J. Owens) read the notice calling the meeting,

The CHAIRMAN stated that nothing exceptionally eventful had arisen during the year to call for special notice. It was satisfactory to see that in the fourteenth completed year of the company's existence the increase in the number of lamps connected was larger than in any previous year, and it was also satisfactory to note that the growth in net revenue during the past year had been in spite of less fog. This was in part due to the growth of the demand for power, which from 18,000 units in 1902 rose to upwards of 100,000 in the past year, and they had every reason to hope that this would continue. Speaking generally, both capital and revenue account showed a normal increase in all items, due to the growth of the business, but in this connection it was satisfactory to note that, although the company had spent £56,000 during the last six years in new plant, the increase of capital had amounted to only £9,000 in that period, the balance having been met by appropriations to depreciation and by undivided profits, and it was also satisfactory to note that the total costs per unit generated were the lowest yet reached, notwithstanding that the cost of coal was not lower than in 1898, and notwithstanding also that the expenditure on repairs and maintenance had been exceptionally heavy, amounting to £1,961 as compared with £759 in the previous year. During the past 10 years the units sold had increased from 400,911 to 2,322,231, the efficiency of distribution (*i.e.*, the units metered as compared with the units generated) had risen from 42 to 83 per cent., the total costs per unit had fallen from 4·34d. to 2·17d., the load-factor (*i.e.*, the actual as compared with the possible use of the plant) had advanced from 10·46 to 15·44 per cent., the net receipts had risen from £6,264 to £29,234, the percentage of net profit had improved from 7·4 to 12·5 (and this notwithstanding that the average price obtained had fallen from 7·53d. per unit to 4·96d. per unit), and the annual appropriation for depreciation has steadily increased from 1·72 per cent. of the capital to 3·21 per cent. The grand result of this was that from distributing no profit they were to-day able to distribute 10 per cent. Roundly the directors had had at their disposal for distribution, from net profits and premiums on capital issues, about £220,000, and of

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his amount only about one-half had been disttributed as interest and dividend, the remainder having been invested in the undertaking in one form or another. With reference to the proposed appropriation of the balance of net revenue account, the directors recommended carrying forward the large balance of £4,179, which was rendered prudent by the fact that the price of current to consumers was being reduced in the present year. A circular had been issued announcing the reduction of the maximum price from 6d. to 5½d. with rebates according to quantity. This should materially reduce the price all round, and although the directors believed that this would inure to the ultimate benefit of the company, the immediate effect might be to introduce a slight element of disturbance into their accounts. In view of the substantial reserve, amounting to upwards of 22 per cent. of the capital, and the satisfactory rate of dividend now attained, the board propose, with the concurrence of the shareholders, to avail themselves, for the first time in the history of the company, of their rights in regard to remuneration under the articles of association. He concluded by proposing the adoption of the report and accounts and the payment of the dividends therein recommended—that on the ordinary shares at the rate of 11 per cent. per annum, making 10 per cent. for the year.

Mr. WILLIAM PAGE, in seconding the motion, observed that although the company had developed the enormous business referred to by the chairman, yet they still only supplied about 3,326 consumers in the district, so that there was abundant scope for extension, and the figures showed at present no sign of any falling off.

The motion was carried unanimously, and the retiring directors and auditors having been re-elected, a vote of thanks to the chairman, directors and staff brought the meeting to a close.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)—The directors' report for the year ended Dec. 31 shows that the capital expended during the year on the company's London districts was £133,772. 6s., bringing the total for these districts to £1,300,088. 19s. 11d. The net revenue (including balance from last account), after payment of all expenses, was £75,929. 3s. From this has to be deducted interest (£27,874. 16s.), interim preference dividend (£8,512. 10s.), interim ordinary dividend of 4 per cent. for half-year to June, less tax (£7,565. 13s. 4d), £10,000 to reserve for depreciation, repairs, renewals, &c , and £500, carried to contingency account, leaving £21,476. 3s. 8d. The directors recommend the payment of the balance preference dividend and a further dividend at the rate of 4 per cent, per annum (less tax) on the ordinary shares, making 4 per cent. for the year.

It is proposed to change the name of the company to the "County of London Electric Supply Co. (Ltd.)."

London Stations.—The profits derived from the company's London stations for 1903 were £73,423. 11s. 6d., against £61,698. 16s. 6d. for 1902, an increase of 19 per cent. Generation and distribution costs and working expenses showed an increase of 4·91 per cent. over 1902. The total applications received at Dec. 31 amounted to the equivalent of 528,856 8 c.p. lamps, an increase of 112,564 lamps for the year, against 90,314 lamps for 1902. Included in these figures are 595 users of motors, aggregating 5,837 H.P., an increase of 1,413 H.P. for 1903, of which 786 H.P. is in respect of the Wandsworth station. The total units sold were 5,754,633, against 4,868,285 for 1902. Additional generating plant for power purposes has been erected at the City-road station, and premises adjoining have been secured. At Wandsworth building extensions commenced in 1902 have been completed, and additional generating plant to a capacity 2,000kw. is now at work. The scheme of wiring premises on the rental and prepayment meter system introduced last year is working satisfactorily, and is found to be well adapted to the smaller class of premises which is so largely represented in the company's South London areas. The company's charges for supply of motive power have been revised, and a sliding scale of discounts is now in operation which meets with general approval.

Provincial Investments.—The progress of the Bournemouth and Poole Electricity Supply Co. continues to be satisfactory, a dividend on the ordinary shares of 8 per cent. per annum having been declared. The Scottish House-to-House Electricity Co. shows satisfactory progress. The Airdrie and Coatbridge tramways commenced running on Feb. 5, 1904, power being supplied under contract by the company from its Coatbridge station.

HADFIELD'S STEEL FOUNDRY CO. (LTD.)—In the report for 1903, the directors recommend a further dividend on the ordinary shares of 2s. per share and a bonus of 2s. per share, all tax free, making 3s. for the year. £15,000 is added to reserve and £15,240. 16s. 8d. forward. The capital of the company is to be increased by the issue of 50,000 ordinary shares of £1 each, which will be offered to existing shareholders.

HOVE ELECTRIC LIGHTING CO. (LTD.) The directors' report for the year 1903 states that the net profits have increased from £10,043 in 1902 to £11,215. 1,148 houses, representing an equivalent of 77,366 8 c.p. lamps, were connected to the mains, compared with 1,040 and 69,924 in 1902, the units sold being 779,985, against 735,316. There is £11,482. 12s. 1d. to dispose of, and after deducting interest and income tax, and the interim dividend at the rate of 7 per cent. per annum there remains £7,109. 2s. 4d. £3,000 is placed to reserve, £500 to maintenance reserve, and a dividend (payable April 15) at the rate of 10 per cent. per annum for the half-year is declared, making 8½ per cent. for the year, £250. 2s. 4d. is carried forward. During the year £5,000 in premiums was added to reserve. The 4 per cent. debenture stock now stands at £44,600. The amount annually set aside for repairs and maintenance (£600) in accordance with contract with Hove Corporation has proved insufficient to meet necessary outlays on this account during the year, and the excess (£13. 12s. 11d.) has been taken from maintenance reserve. The capital expenditure during the year amounted to £20,610. 18s. 4d., of which £4,655. 14s. 8d. was expended on land and buildings, £3,968. 17s. 5d. on extensions of mains, £12,478. 12s. 2d. on machinery and tools, and £379. 9s. 11d. on meters. The new generating station has been completed and set to work.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors' report for the year to Dec. 31 shows that the capital expenditure reached £2,090,763. 8s., an increase of £244,315. 3s. 2d. for the year. Of this £598,807. 14s. 3d. represents expenditure in Marylebone, which will be written off on completion of the purchase by the Borough Council. The gross revenue was £281,422. 5s. 8d,, compared with £261,073. 4s. in 1902, an increase of £20,349. 1s. 8d. Generation costs were £98,592. 10s. 8d., a decrease of £15,154. 6s. 10d. compared with 1902. The balance at credit of revenue, before providing for depreciation, is £142,872. 2s. £18,000 has been set aside as an addition to depreciation and reserve, which now amounts to £116,447. 5s. 10d., making the credit to net revenue £124,872. 2s., or, with balance brought forward, &c., £129,587. 2s. 8d. After deducting interest, preference dividend and other charges, there is a balance of £89,736. 3s. 6d. The interim dividend of 8s. per share on the ordinary shares absorbed £40,000, and the directors now recommend a further dividend of 9s. 6d. per share, making 17s. 6d. for the year, or 8¾ per cent. This will absorb a further £47,500, leaving £2,236. 3s. 6d. to be carried forward.

The total 8 c.p. lamps connected at Dec. 31 last was 823,000, an increase of 100,000 for the year. The number now connected is 838,000.

On Aug. 7 (as fully recorded in *The Electrician*) the company obtained judgment against Marylebone Council for payment of the £1,212,000 due under the recent award, and for the repayment of capital expended in Marylebone since 1901. The date originally fixed for these payments was Dec. 31 last, but an extension of time was subsequently granted until Feb. 29, 1904 (subject to payment on Jan. 31 of £60,000 on account of the capital expenditure), to enable the Council to promote a bill for the purpose of borrowing the required moneys. On Feb. 26 a further extension of time was granted till April 30, subject to payment on March 31 of a further £15,000 on account. Meanwhile it has been agreed that the company shall retain the profits in lieu of interest on the amount of the award, but interest is still payable to the company in respect of capital expended since 1901. The arbitration held in connection with the compulsory acquisition by the London County Council of the company's generating works at Sardinia-street resulted in the company being awarded £183,150. (See *The Electrician* for Sept. 4, 1903.) It is expected that this money will shortly be received, and the new site to be provided by the Council vested in the company.

The share capital of the company was increased during the year from £1,000,000 to £1,500,000 by the creation of 100,000 4½ per cent. cumulative preference shares of £5 each. 65,104 shares were taken up at par by holders of ordinary shares, and 7,919 shares were disposed of at a premium.

Loans from bankers were reduced during the year from £390,000 to £290,000, and now stand at £210,000.

The company have entered into an agreement with Acton District Council for the supply of electricity in bulk.

NATIONAL ELECTRIC SUPPLY CO. (LTD.)—The report for 1903 recently issued stated that 205 new customers, representing an equivalent of 12,520 8 c.p. lamps, were connected and various extensions of the mains (about 5¾ miles) carried out. Capital expenditure during the year was £10,588, gross profit £12,109. 16s. 8d , £12,355. 10s. 8d. was available for distribution. After providing for interest, depreciation, preference dividend, &c., a final dividend of 5s. 6d. per share on the ordinary shares (making 8s. 6d. per share for the year) was declared. A dividend of £4. 1s. 4d. was paid on the founders' shares and the balance (£305. 9s.) carried forward.

NEWMARKET ELECTRIC LIGHT CO. (LTD.)—The directors' report for 1903 states that 2,632 8 c.p. lamps have been connected during the year, making the total 16,453. Applications for a further 887 lamps have since been received. Important additions to works buildings and plant have been completed during the year. The profit, added to £126. 13s. 4d. from last account, amounts to £2,267. 8s. 8d. After providing for interest (£669. 3s. 10d.) there is £1,598. 4s. 10d. available for payment of a dividend of 4½ per cent., £500 is put to reserve and £312. 18s. 10d. carried forward.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—At the recent meeting the directors reported that the number of consumers at Dec. 31 last was 351, with an equivalent of 16,678 8 c.p. lamps (including 203·5 H.P. in motors) connected, against 325 consumers and 13,896 lamps in 1902. The chairman (Mr. J. A. Saner) said the policy of supplying power at a low price had been justified, as the increase of income from that source alone had been more than double the increase in working expenses. During the year a second cable had been connected across the river at Navigation Bridge and coupled up to the Leftwich main. They had now a very complete installation for its size, and when the additions proposed were carried out it might safely be said that the supply for either power or lighting would be absolutely certain, and at the prices now charged there were very few (if any) trades in the town which would not find it paid to throw out their old engines and boilers and put down electric motors. There was still some difficulty in persuading the ordinary user of power that electricity at the prices offered was cheaper than any other power. Another difficulty was to persuade them that it was true that some of their machines did not work more than one-third of a day's working hours, and that the majority of their tools were not working more than one-fifth of their full capacity. Personally, he was so satisfied with the results on the Weaver that he had no hesitation in recommending its adoption elsewhere. They had also decided to adopt a system of hire-purchase, by which the company would supply fittings in small houses.

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OXFORD ELECTRIC CO. (LTD.)—Sir H. C. Mance, presiding at the meeting on Monday said 1903 was the first time they had generated more than a million units. The profit, including £276. 3s. 1d. from last year, was £10,545. 3s. 1d. After providing £2,040. 17s. 2d. for debenture and other interest, and writing off £623. 15s. 3d. on account of hire-purchase instalments, the balance available was £7,880. 10s. 8d. A dividend at the rate of 6½ per cent. per annum on the share capital (including 2½ per cent. paid in September was recommended, as was the addition of £2,500 to reserve and renewal of plant account, the balance (£830. 10s. 8d.) being carried forward. The lamps added during 1903 was the equivalent of 9,747, making the total about 55,000 8 c.p. lamps. About 4,700 additional lamps had been installed in the colleges. Their customers had increased by about 100. Capital expenditure during the year was higher than they anticipated in consequence of the unusual increase in business. They had expended £3,549 more than they received. Capital expenditure during 1904 would, he presumed, need a call to be made towards the end of the year. He drew attention to the favourable coal figures. Although they generated some 100,000 units more than in 1902, their coal bill was about £30 less. The saving was due to some extent to the lower price paid, but more especially to saving effected by good management at the generating station. The total cost of production, distribution and management was about £250 in excess of 1902. The revenue had been £15,708, an increase of £1,743. Their load-factor was not a high one, indeed if they were to keep their machinery running for one month continuously, they could generate all the current required by Oxford during the year.

VICKERS, SONS AND MAXIM (LTD.)—The report for 1903 states that, after providing for depreciation, &c., the amount available is larger than in the previous year, but payment of a smaller dividend is recommended; also that £100,000 be placed to reserve, and £86,699. 3s. 7d. (an increase of about £16,000 on previous year) be carried forward. Interim dividends of 2½ per cent. on the preferred stock and preference shares, and 9d. per share on the ordinary shares were paid in August, and out of the disposable balance (£453,074. 3s. 7d.) the directors recommend (after the transfer to reserve) payment of balance dividends of 2½ per cent. on the preferred stock and preference shares, absorbing £35,781. 5s., and 1s. 3d. per share (tax free) on the ordinary shares, making 2s. per share, or 10 per cent. for the year, requiring £230,593. 15s. The return from the various investments in subsidiary companies has been satisfactory. The Wolsey Tool and Motor Car Co. and the holding in Messrs. W. Beardmore & Co. have given good returns, but the Electric and Ordnance Accessories Co. has been seriously handicapped by want of orders and also by foreign competition. The expectations with regard to the Wolsey Tool and Motor Car Co. have been fulfilled, and there continues to be a large demand for the motor cars manufactured by the company.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANIES.

HOVE AND WORTHING ELECTRIC TRAMWAYS (LTD.)—Reg. March 4, capital £100,000 in £5 shares, to carry on in the United Kingdom and elsewhere the business of carriers of passengers and goods, electrical and general engineers, electricians, manufacturers of and dealers in railway, tramway, electric and other apparatus, generators and accumulators, transmitters, users and suppliers of electricity, &c., constructors and owners of tramways, railways and other means of communication, manufacturers of cars and rolling stock, &c. Reg. office, Donington House, Norfolk-street, London, W.C.

MUSSELBURGH CONSTRUCTION SYND. (LTD.)—Reg. Feb. 29, capital £76,000 in £1 shares, to adopt an agreement with the National Electric Construction Co. (Ltd.) and to carry on the business of railway and tramway proprietors, electrical engineers, contractors for the supply of electrical plant, producers and distributors of electrical energy, makers of cables, wires, accumulators, dynamos, engines, lamps and meters, builders of stations and works, contractors, constructors and owners of telephone and telegraph lines, &c. Subscribers, R. Stewart Bain, C.A., L. B. Schlesinger, W. B. Cownie, C.A., J. T. Jervis, M Inst.C.E., F. E. Stanley, electrical engineer, R. Watson and E. A. Mitchell. First directors are R. Stewart Bain, L. B. Schlesinger, W. B. Cownie and J. T. Jervis. Reg. office, 34, Victoria-street, London, S.W.

MORTGAGES AND CHARGES.

EVERSHED AND VIGNOLES (LTD.)—Issue on Feb. 15 of £1,600 debentures, part of series created Feb. 11, 1902, to secure £15,000, charged on company's undertaking and property, present and future, including uncalled capital and a specific charge to extent of £2,500 in respect of shares issued since date of trust deed (Feb. 11, 1902). Trustees, Law Guarantee and Trust Society. Previously issued of same series, £12,000.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26 7/16d. per oz. (March 10). Consols 85¼—85⅜ for money, 85⅝—85¾ for account; 2½ per cent. annuities 85 – 85¼ (March 10). Consols Pay Day, April 7; Stocks and Shares Continuation Days, March 26 and April 12; Ticket Day, March 28; Pay Day, March 29; Mining Share Carry-over Days, March 25 and April 11.

CANADIAN ELECTRIC TRACTION CO. (LTD.)—This company, which has a capital of £120,000 in £1 shares, is issuing a prospectus inviting subscriptions for 53,000 shares, part of an issue of 78,000 shares.

DAVIS AND TIMMINS (LTD.)—The directors recommend balance payment of preference dividend and 12 months' dividend on the ordinary shares at the rate of 8 per cent. per annum.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The directors have decided to pay for the half-year ended Dec. 31, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, a dividend at the rate of 4 per cent., tax free, on the ordinary shares, both payable April 1.

NATIONAL TELEPHONE CO. (LTD.)—This company has issued a prospectus announcing an issue of £1,000,000 4 per cent. debenture stock at £95 per cent.

RAND CENTRAL ELECTRIC WORKS (LTD.)—During February 637,356 units were generated, yielding a gross revenue of £6,800, compared with 629,510 units and £5,115 in the corresponding month of 1903.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Mar. 5	1,104	+ 268	40	48,131	+ 9,569
Airdrie	Feb. 26	193	...	8	520	...
Ayr Corporation	,, 27	156	- 2	41	11,676	+ 177
Barnsley	,, 26	163	+ 5	8	1,206	- 43
Barrow	,, 26	140	+ 85	3	458	+ 283
Bexley District Council	Mar. 4	115	...	22	3,255	...
Birkenhead	,, 6	891	- 68	...	...	...
Birmingham Corporation	,, 5	279	...	9	2,685	...
*Birmingham Tramways Co.	,, 5	4,707	- 137	9	43,586	+ 2,481
*Blackburn Corporation	,, 4	693	+ 14	§19	40,963	+ 2,119
Blackpool Corporation	,, 3	277	- 35	§18	40,492	- 201
Blackpool and Fleetwood	,, 5	200	- 1	10	1,729	- 82
Blackp'l, St. Anne's & Lytham	,, 3	141	+ 141	‡18	2,637	+ 2,058
Bolton Corporation	,, 6	1,531	- 84	49	88,279	+ 8,893
Bournemouth Corporation	,, 2	784	...	48	48,745	...
*Bradford Corporation	,, 6	3,238	- 95	47	181,705	+ 35,536
Brighton Corporation	,, 6	653	- 81	48	43,382	+ 2,518
Brisbane Tramways	Jan. 20	2,925	+ 52	3	6,678	- 46
*Bristol Trams & Carriage	Mar. 4	4,198	- 14	15	67,165	+ 2,477
*Buenos Ayres & Belgrano	Feb. 7	3,311	+ 263	16	59,892	+ 2,976
Burnley Corporation	Mar. 5	881	+ 214	49	47,786	+ 9,225
Burton Corporation	,, 6	275	...	31	10,553	...
Calcutta Tramways Co.	,, 5	a35,835	+ a3,031	10	a348,110	+ a63,392
Camborne-Redruth	,, 7	85	...	18	1,992	...
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 5	7,248	+ 270	10	70,365	+ 750
Chatham & Dist. Lt. Rys.	,, 3	443	+ 35	9	4,450	+ 903
City & South London Rly.	,, 6	3,285	+ 47	10	32,176	- 530
Cork Electric Trams Co.	,, 3	355	- 39	9	3 472	- 12
Darwen Corporation	,, 4	189	- 26	49	10,969	- 253
Devonport & Dist. Trams	Feb. 26	423	+ 65	8	3,658	+ 629
Dover Corporation	Mar. 5	150	- 33	†49	10,616	- 6
Dublin & Lucan Railway	,, 6	77	- 5	10	857	+ 55
Dublin Southern District	,, 4	661	- 3	¶9	31,257	+ 957
Dublin United	,, 4	3,411	- 129			
Dudley—Stourbridge	Feb. 26	760	+ 74	8	5,818	+ 373
Dundee Corporation	Mar. 2	777	+ 11	41	85,015	+ 2,176
East Ham Council	,, 5	557	+ 78	†49	32,023	+ 8,655
Gateshead & Dist. Trams	Feb. 26	833	+ 3	8	6,965	+ 472
Glasgow Corporation	Mar. 5	12,907	+ 778	40	513,103	+ 54,124
Gravesend—Northfleet	Feb. 26	205	+ 30	8	1,661	+ 274
Gt. Northern & City Rly.	Mar. 5	949	...	3	2,689	...
Greenock & Port Glasgow	Feb. 26	416	+ 35	8	3,753	+ 593
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 23	236	+ 15	8	1,977	+ 270
Huddersfield	...	...	...	...	...	...
Hull Corporation	Mar. 5	1,954	+ 264	†49	93,538	+ 7,543
Ilkeston Corporation	,, 2	120	...	16	1,913	...
Ipswich Corporation	,, 5	172	...	9	4,415	...
Isle of Thanet Co.	,, 5	190	- 64	...	...	...
Kidderminster & District	Feb. 26	92	- 6	8	741	- 47
Kirkcaldy Corporation	Mar. 2	191	...	1	191	...
Lanarkshire Trams Co.	,, 3	558	...	9	5,189	...
Leeds Corporation	,, 5	4,628	- 108	49	264,446	+ 15,403
Liverpool Corporation	Feb. 27	9,208	+ 234	9	85,318	+ 8,119
*Liverpool Overhead Rly.	Mar. 6	1,449	- 45	10	15,143	+ 311
*London County Council	Feb. 27	9,580	+ 1,645	†48	458,450	+ 81,972
Lowestoft	...	...	...	...	...	...
Manchester Corporation	Mar. 5	10,422	+ 2,330	37	435,154	+ 191,444
Mersey Railway	,, 5	1,359	+ 317	9	12,808	+ 3,157
Merthyr	Feb. 23	188	+ 13	8	1,512	+ 161
Middleton	,, 23	236	+ 37	8	1,936	+ 196
Newcastle-on-Tyne Corp.	Mar. 5	3,895	+ 400	9	31,065	+ 4,384
Newport (Mon.)	,, 5	410	+ 155	28	10,059	+ 6,101
Oldham, Ashton & Hyde	Feb. 26	473	- 29	8	3,927	- 172
Perth (W. A.) Elec. Trams.	Mar. 4	1,382	+ 204	9	12,655	+ 1 699
Peterborough	Feb. 26	104	- 4	8	881	- 155
Poole and District	,, 26	2.0	+ 1	8	1,708	- 33
Portsmouth Corporation	Mar. 5	1,245	- 55	†19	83,220	+ 5,533
*Potteries	Feb. 26	1,625	+ 64	8	12,993	+ 992
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 26	42	+ 8	8	350	+ 39
Salford Corporation	Mar. 7	3,455	+ 449	49	195,807	+ £0,793
Sheerness	Feb. 24	43	...	8	358	...
Sheffield Corporation	Mar. 6	3,909	+ 168	†50	22,536	+ 18,671
*Southampton Corporat'n	,, 3	784	- 64	9	7,571	+ 232
Southend Corporation	,, 2	172	- 13	48	14,798	+ 2,242
Southport Tramways	Feb. 26	217	+ 15	8	1,893	+ 215
S. Staffordshire Trams.	,, 6	718	+ 9	8	5,856	+ 443
Sunderland Corporation	Mar. 6	1,017	+ 46	49	57,553	+ 2,794
*Swansea Trams	Feb. 26	448	+ 11	8	3,703	+ 206
Taunton Trams	,, 26	42	- 9	8	374	- 14
Tynemouth and District	,, 26	193	- 21	8	1,690	+ 6
Tyneside Trams Co.	Mar. 2	209	+ 35	9	2,129	+ 478
Wallasey District Council	,, 5	551	+ 31	†49	32,968	+ 3,919
West Ham Corporation	,, 3	207	...	1	207	...
Weston-super-Mare	Feb. 24	24	- 2	8	180	- 11
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 26	832	- 22	8	2,630	- 67
Worcester	,, 23	250	+ 112	3	796	+ 377
Wrexham	,, 26	96	...	8	778	...
Yorkshire Woollen District	,, 26	514	+ 387	8	4,002	+ 809

(a) These comparisons are with the corresponding period last year.
Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name	Price Wed., Mar. 9.	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business, Week to Mar. 9 Highest.	Business, Week to Mar. 9 Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅞–4¾	5 2 6	April, Oct	4⅛	4⅛
St.	6%	Do. Permanent 6% Deb. Stock	125 –130	4 12 4	..	..	..
St.	34 2	Auckland Elec. Trams 5% Deb. (red.)	98 –100	..	..	..	..
10	10/0	Barcelona Tramways Ord.	6 –8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 –95	4 14 9	..	95	..
100	5%	Do. 5 per Cent. Debs.	95 –98	5 2 0	..	93½	93
5	..	Brisbane Electric Trams. Invest. Ord.	2 –3	..	..	2	..
5	2 6	Do. 5 per Cent. Cum. Pref.	3¾–4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 –102	4 8 3	..	98	..
10	8%	†Bristol Tramways and Carriage Ord.	19½–20½	4 10 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼–10¾	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	103 –108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	82 –85	3 11 5	..	..	..
St.	5%	Do. Pref. Ord. Stock	96 –99	5 2 3	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10¼–10¾	4 13 0	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝–105⅞	4 7 0	..	..	..
100	4½	Do. Vancouver Power Debs.	98 –101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9 –10	8 0 0	..	9⅜	9⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	10 –11	5 9 1	Feb, Aug	10⅜	9⅝
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –123	4 1 4	..	121½	120⅛
5	..	Buenos Ayres and Belgrano Ord.	2⅝–3⅛	..	..	3⅛	2⅝
5	3/0	Do 6 per Cent. "A" Cum. Pref.	5¼–5⅝	5 4 0	..	..	..
5	3/0	Do. "B"	4⅜–5⅛	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 –107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 –101	4 19 6	..	..	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 –100	5 0 3	..	..	..
5	2 6	Calcutta Tramways	6¾–7¼	4 9 8	..	6⅛	6⅜
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 –107	4 4 2	..	..	..
1	1/0	Cape Electric Tramways Shares	1⅞–2	8 10 0	..	1⅞	1⅞
St.	4%	Central London Ordinary Stock	92 –95	4 4 4	June, Dec	92⅜	..
St.	4%	Do. 4 per Cent. Pref. Stock	98 –101	3 19 9	..	..	..
St.	4%	Do. Deferred Stock	86 –89	4 9 11	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 –113	3 11 8	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾–5¼	4 15 3	..	5	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	100¼	99⅜
St.	2%	City and South London Rly. Con. Ord.	49 –52	4 11 4	Feb, Aug	49⅜	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 –126	3 19 4	Feb, Aug	..	..
St.	5%	Do. (1896)	119 –122	4 2 0	..	..	..
St.	5%	Do. (1901)	118 –121	4 2 8	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 –112	3 11 7	May, Nov	109	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	102 –105	4 16 5	..	102½	103
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12¾–13¼	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract.ofAust.6%Cm.Prf.	3 –4	7 10 0	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 –97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	7 –8	3 15 0	..	7	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., 8pever Bros. Scrip Certs.	9 –10	..	..	..	..
10	9%	‡Imperial Tramways Ord	19½–20½	4 7 10	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 –14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	..	..	..
10	15%	†Liverpool Overhead Railway Ord.	4⅛–4⅜	2 16 5	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	9⅞–10¼	4 17 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98⅜–100½	3 19 10	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref..	11 –11½	4 7 0	..	11⅜	11⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 –103	3 18 5	..	103	101
St.	..	Mersey Con. Ord. Stock	6 –9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	12½	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	..	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅜–⅝	4 8 11	..	1⅛	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	101 –103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	104 –106	4 4 11	..	105	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1¼–2½	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1st Mt.Db.Stk.	99 –102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½–9½	5 5 3	..	8⅝	8⅞
10	5 0	Do. 5 per Cent. Cum. Pref.	9 –10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 –106	4 5 11	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	83 –91	3 8 8	June, Dec	88½	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 –102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2½–3½	..	Jn, Dec	..	..
10	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	16/0	Anglo-American	48 –51	5 18 8	F,My,Ag,N	49	..
St.	30/0	Do. Preferred	91 –93	6 9 0	F,My,Ag,N	93	91½
St.	2/0	Do. Deferred	7 –7½	1 6 8	F,My,Ag,N	7⅞	7
100	$2	Commercial Cable Capital Stock	180 –190	4 4 5	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 –91	4 8 3	Jn Ap,Jy,O	91	90
10	7/0	Cuba Submarine Ord.	7 –8	10 0 0	Feb, Aug	7⅛	7⅜
10	10/0	Do. Preference 10 per Cent.	16 –17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½–8½	5 17 8	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅝–101⅞	4 9 1	Jan, July	..	..
20	3/0	Direct United States Cable	9¼–10¼	6 6 10	Ja,Ap,Jy,O	10⅜	9⅛
100	4½%	Direct West India Cable 4½% Rg.Db.(rd.)	98 –101	4 9 1	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	117 –122	5 14 9	Ja,Ap,Jy,O	120	119
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 –90	3 17 10	Ja Ap,Jy,O	88⅛	..
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 –107	3 15 8	May, Nov	104	..
10	2/6	Eastern Extension	10¾–11¼	6 4 5	Ja,Ap,Jy,O	11⅛	10⅝
St.	4%	Do. 4 per Cent. Deb. Stock	104 –107	3 14 9	Feb, Aug	105	104
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	98 –101	4 0 0	Feb, Aug	98⅛	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝–102⅞	3 18 11	May, Nov	..	..
10	5/0	Great Northern of Copenhagen	23½–24½	5 2 1	Jan, July	..	..
100	4½%	Halifax & Bermuda4½% 1st Mt.Db. (rod.)	98 –101	4 9 6	June, Dec	..	..
25	12 6	Indo-European	38 –41	6 1 11	May, Nov	38⅛	..
100	4%	Pacific&Europe'n Tel.4% Guar.Dbs.(rd.)	97 –100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 –6	1 13 4	..	..	..
2½	..	West Coast of America	⅜–¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 –98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜–½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 –8½	9 4 8	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	11⅜–12½	5 14 3	Mr,Jn,O,D	12⅜	11⅛
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 –103	4 18 2	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 –101	3 19 3	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	5 –5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8¼–8½	4 11 5	Ja Ap,Jy O	8⅜	8⅛
10	3/0	Do. 6% per Cent. Pref.	12 –12½	4 16 0	Ja Ap,Jy,O	12⅝	12⅛
8	4/0	Reuter's	6½–7½	5 6 8	April, Oct	7⅛	..
100	6%	Submarine Cables Trust (Cert.)	115 –120	5 2 2	April, Oct	..	..
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	4⅜–5½	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	99 –101	5 19 2	..	100½	99½
St.	5%	Do. Def. Stock	73 –76	6 11 8	..	74⅜	73
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 5 9	Feb, Aug	..	..
10	6,0	Do. 6 per Cent. Cum. 2nd Pref.	13½–14½	4 2 9	Feb, Aug	..	..
5	2.6	Do. 5 per Cent. Non-Cum. 3rd Pref...	5 –5½	4 15 3	Feb, Aug	5	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.) ...	95 –97	3 12 2	June, Dec	95⅜	94⅝
St.	4%	Do 4 per Cent. Deb. Stock (red.)	99 –101	4 0 0	..	101	98½
1	0/7½	Oriental	¾–1	6 13 4	April, Oct	..	..
		Do. 6 per Cent. Cum. Pref.	1 –1½	..	..	..	..
5	3/0	United River Plate	5½–6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝–5⅞	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 –105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
		Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅜–½	..	..	..	..
		Do. 7% Cum. Pref.	1⅛–1⅜	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts.(rd.&con.)	115 –118	3 17 4	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½–13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10¼	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¼–11¼	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.) ...	101 –104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 –103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord	10 –10¼	4 15 3	..	10½	..
5	3/6	Do. 7 per Cent. Pref.	9⅝–10¼	3 8 4	Mar, Sept	..	..
5	3.0	Calcutta Electric Supply Ord.	6 –7	4 12 10	..	6⅛	6½
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	106 –109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup...	7½–7⅝	5 3 2	Feb, Aug	7⅝	7⅜
5	2/3	Do. 4½ per Cent. Pref.	5¼–5½	4 5 0	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅞–5	4 10 0	..	..	..
5	1/7	Do. Do. (19.3)	4⅜–5	..	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –103	3 18 5	..	102	..
5	2.0	Chelsea Electric Supply Ord.	5½–6	4 11 8	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	106 –109	4 8 1	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¾–11¼	6 13 4	Feb, Aug	11⅛	10⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	13⅜	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7½–8½	4 14 2	..	7⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 –12	5 0 0	Mar, Sept	11½	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	103 –109	4 2 11	..	..	..
St.	27/6‡	Do. Second Deb. Stock Prov. Certs..	99 –102	..	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5¾–6¼	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 8	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	7⅞	..
St.	..	I of W.Elec Lt.& Power4½%Db St (red.)	100 –105	..	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	⅜–⅝	..	..	..	..
5	7 0	Kensingtn&Knghtsbdge Ord xd&bonus	10½–11½	5 4 4	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾–7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck.(red.)	103 –106	3 16 2	..	..	..
3	..	London Electric Supply Ord.	1½–1⅝	..	..	..	..
5	8/0	Do. 6 per Cent Pref.	4⅝–5½	5 0 0	..	5	4⅞
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 –98	4 2 1	Mr,Jn,S,D	97⅜	..
10	8 0	Metropolitan Electric Sup. Ord.	17½–18½	4 3 9	April, Oct	18¼	17⅞
5	..	Do. 4½ per Cent. Cum. Pref.	5⅜–5⅝	..	..	5⅛	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	3 19 6	Jn, Dec ..	110	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –98	3 11 9	..	96⅛	95
100	4½	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 –98	4 11 9	..	..	..
10	6/0	Notting Hill Electric Ord.	13 –14	4 5 9	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
St.	4%	Oxford Electric Ord.	5½–6	4 11 8	March ..	5⅜	..
St.	4%	Do. 4% Deb. Stock	96 –99	4 0 9	..	97⅛	..
1	..	Rand Electric	⅞–1	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 –102	4 8 11	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 –15	4 16 8	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	97 –100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord...	3 –3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	..	..
5	1/9	South London Electric Supply Ord.....	3½–3¾	2 6 8	..	3⅝	..
5	2/6	Urban Electric Supply Ord.	4¾ 5	5 0 0	..	4⅛	..
5	2/6	Do. 5% Cum. Pref.	4⅜–5⅛	4 17 7	..	..	..
5	7/0	Westminster Electric Supply Ord.	12½–13¼	5 0 0	Mar, Sept	13⅛	12⅞
5	z/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING &c.					
5	6d.	Alliance Electrical Co. 5% Cum. Pref...	⅜–½	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.....	1/16–⅛	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 –6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5¼–5½	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 –103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3⅜–4½	7 1 2	..	3⅛	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock ...	93 –96	4 3 4	..	..	..
½	..	Brush Electrical Engineering	½–1	..	March ..	..	..
½	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾–1½	0 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	72 –77	3 18 4	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord. ...	10¾–11¼	6 10 5	Jan, July	10⅞	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5⅞	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs.(rd.	104 –108	4 3 3	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝–¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 14 9	..	..	..
1	0,7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000) ...	1½–2	7 10 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.	96 –99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8 –8½	..	..	..	..
5	..	Do. 6% Cum. Pref.	5½–5⅝	..	..	..	..
St.	4½%	Do. 4½ Deb. Stock	102–104	4 7 2	..	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	½	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	¾–1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 –77	5 3 11	June, Dec	77	73½
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 –81	6 3 5	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜–6½	5 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜–6½	4 16 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 –106	4 4 11	..	105	103½
2	1/2½	Electric Construction Co.	1½–1⅞	6 7 1 2	Jan, July	..	..
2	2.9½	Do. 7 per Cent. Cum. Pref.	2⅜–3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅜–½	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾–1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	9½–9¾	5 2 7	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 –98	4 2 6	..	..	..
5	6/0	Henley's Telegraph Works Ord.	12 –13	7 13 10	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	106 –110	4 1 10	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18½–19½	5 2 7	Feb, Aug	19⅛	19⅜
100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 –103	3 17 4	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½–11	4 10 11	Mar, Sept	..	..
12	12/0	Telegraph Construction & Mainten'ce.	34 –37	6 9 8	Mar, July	36	34½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909.....	101 –104	3 17 8	Jan, July	..	..
5	8/0	Willans and Robinson Ord.	3½–4½	7 4 5	Apr, Oct	4	..
5	8/0	Do. 6 per Cent. Cum. Pref.	5–5¾	5 9 1	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	97 –101	4 0 3	May, Nov	..	..

* In calculating the yield, allowance has been made for accrued interest, but not for redemption. † x Dividend. ‡ The London Stock Exchang Commi... refused to quote these...

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NOTES.

MR. HOBART read an interesting Paper on electric motors at the Institution of Electrical Engineers last week, and it is to be regretted that it was not accorded a better discussion. Of the four speakers who took part in it, one only offered any serious criticisms, although the Paper bristled with controversial questions. Mr. HOBART'S comparison of continuous and alternating-current machines was not quite as favourable to the former as it might have been, the efficiencies which he gave them being rather lower than is customary nowadays. The result of this was that the intersection of the efficiency curves of the two types of machines occurs at the very low speed of 250 revolutions, whereas at much higher speeds than this the continuous-current machine might still be more efficient than its rival. This may partly be accounted for by Mr. HOBART'S assumption of rather too high a friction and windage loss for the continuous-current machines in comparison with the values for alternating. They must certainly be larger on account of the larger armature, but the difference appears rather exaggerated. In general, however, Mr. HOBART'S Paper is one of the most valuable of recent contributions to the subject of motor design.

THE second Paper read at the Institution of Electrical Engineers last week was by Mr. F. F. BENNETT of Manchester, and surprise is being expressed on all sides that the Council of the Institution should have accepted it for reading at one of the London meetings. Its chief value is in demonstrating the fallacy of attacking an engineering problem entirely from the standpoint of averages and official returns. Three gentlemen only (Mr. H. M. SAYERS, Mr. JACOMB HOOD, of the London and South-Western Railway, and Mr. G. J. MORRISON) took part in the discussion, and their remarks, which we shall publish next week, clearly showed the lines upon which practical engineers and railway managers must consider the question of railway "electrification." It is not our policy to condemn any man unheard, and we, therefore, publish an abstract of Mr. BENNETT'S Paper in this issue; it will also serve as a preface to the interesting remarks made by the three engineers, who spoke with authority on a subject upon which they, at any rate, are qualified to speak.

THE evil effects of Standing Order 22, relating to the consent of the local authority in respect to tramway schemes, has been emphasised in quite a new direction this week. In our Parliamentary columns will be found a report of the proceedings before the House of Commons Committee which has been considering the Torquay Tramways Bill, promoted by the Dolter Electric Traction Co. In order to obtain the consent of the Torquay Corporation, the company had to insert a special clause giving protection against electrolytic action in connection with the Corporation gas and water mains additional to the protection afforded by the Board of Trade regulations. This clause has been allowed in one or two instances, but in most cases it has been refused, as the Board of Trade authorities consider it to be unnecessary. The Corporation, however, only supply gas over a small portion of the town, the remainder being served by the Torquay Gas Co., who sought a similar protective clause. Counsel for the promoters frankly stated to the Committee that, had they had a free hand, this special clause would not have been granted to the Corporation, but that it had been forced upon them, in the phrase of Mr. BAGGALLAY for the gas company, "with the pistol at their heads." In spite of this, however, the Committee allowed the gas company's claim, and gave them the clause asked for; but in making this announcement the Chairman made the important comment that a precedent would not be created by this action, as the clause to the gas company was granted owing to the promoters having given similar protection to the Corporation. It was clearly understood that the technical question had no bearing upon the decision of the Committee; in fact, they decided not to hear Prof. AYRTON and the other witnesses whom the gas company had ready to give the usual evidence as to the effect of electrolytic action upon gas pipes.

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In the course of his second Cantor lecture at the Society of Arts, on Monday evening, Mr. Bertram Blount called attention to the use of sodium as a means of storing energy. He said that, if used in some form of primary battery, it would be even more efficient than petrol, and that if only this form of battery could be devised the traffic question would be solved. The problem, however, is by no means an easy one, and the effect of sodium coming into contact with water is one that constitutes a serious objection. Acetylene is very excellent in its way; but there is, nevertheless, a very distinct element of danger in the manufacture of the gas from calcium carbide. Similarly, sodium is a substance that should not be treated without due respect, and any attempts to solve the problem propounded by Mr. Blount should not be undertaken without wide knowledge of the subject and a familiarity with the curious vagaries of sodium. We are inclined to think that the lecturer did not intend his proposition to be taken too seriously.

The X-rays are developing new qualities with a somewhat bewildering rapidity. M. Blondlot has made two observations which partly explain and partly complicate matters. The change in the luminosity of a feebly illuminated screen appears to be due to a change in the direction rather than the intensity of the emission or reflection. This fact would get rid of some of the theoretical difficulties which lie in the way of an explanation of these delicate and elusive effects. The other observation which we report this week is that there is a kind of X-rays which reduces the intensity of phosphorescence, emission, or reflection, instead of increasing it. This, we suppose, means that the emission of light becomes more tangential than normal to the surface, since the latter is supposed to be looked at along the normal. But the discovery which will create the greatest interest is undoubtedly that of M. H. Bagard, who has succeeded in reproducing the rotation of the plane of polarisation in a magnetic field which was first produced by Faraday in the case of ordinary plane-polarised light, and is usually known as the Faraday effect. Since ordinary light consists of waves about 100 times as long as those which make up X-rays, and since according to Faraday, the rotation increases as the waves become smaller, it was natural to expect the Faraday effect to be very large in the latter. This has been fully verified by M. Bagard, who obtained rotations in aluminium and in carbon bisulphide such as can in ordinary light only be obtained in quartz. By the time that all the other optical analogies of X-rays are worked out, we may expect some very interesting developments.

Of the three kinds of rays given off by radio-active bodies, the γ-rays have appealed least to the physicist, and there has been some doubt as to their proper position in connection with the disintegration theory of radio-activity. While on the one hand their properties resembled those which could be ascribed to Röntgen rays of greater penetrating power than those produced hitherto, it was noticeable that they differed from Röntgen rays in one important particular. Experiments made by the Hon. R. J. Strutt had shown that the conductivity in gases by γ-rays varied approximately with the density of the gas, while in the case of Röntgen rays there is a wide divergence from this law. Mr. A. S. Eve, in a letter to last week's *Nature*, describes some experiments he has made with Röntgen rays of high penetrating power at the suggestion of Prof. Rutherford. These rays, produced by a particularly "hard" X-ray tube and a powerful induction coil, were found to impart to gases conductivities that did not follow the density law and were more nearly in accordance with the relative conductivities obtained for the γ-rays. This, as Prof. Rutherford points out in a letter accompanying that of Mr. Eve, removes the strongest objection to the view that γ-rays are nothing more than an extremely penetrating type of Röntgen ray. It is thus reasonable to expect that these rays are set up as a result of the sudden expulsion of the β-particle from the atom of a radio-active body. On this hypothesis, in accordance with the theory of the nature of Röntgen rays developed by Sir George Stokes and Prof. J. J. Thomson, "soft" Röntgen rays should arise at the point of incidence of the β-rays. Mr. Eve's results, together with Prof. Rutherford's deductions from them, give us an important link in the chain of experimental evidence supporting the disintegration theory for the explanation of the radio-active phenomena.

An attempt to insert the famous "Bermondsey" clause in the Marylebone Borough Council's Electric Lighting Bill, by means of an instruction to the Committee, was decisively negatived in the House of Commons on Tuesday. The debate on it (briefly reported in our Parliamentary Intelligence columns) was interesting for the fact that it elicited from Mr. Bonar Law, as representing the Board of Trade, a statement that the Board refused to insert this clause in any Electric Lighting Provisional Orders, and were opposed to it on principle. The Parliamentary Committees, who are sometimes influenced by the oratory of those representing the gas interests, should take due note of Mr. Law's statement, and remember that the insertion of the clause in question would in all cases be distinctly in opposition to the views of the Government Department in question. The "Bermondsey" clause, it will be remembered, makes it obligatory for a municipal electricity undertaking to raise the price charged for electrical energy if a loss is shown on the first year's working. In the case of Marylebone, such a condition would irrevocably damn the undertaking, for, saddled as the Borough Council will be with a large capital expenditure, it will only be by maintaining a comparatively low tariff, and doing their utmost to popularise electric light and power and improve the load-factor, that they will be able to make the undertaking pay its way within the first few years.

At the first meeting of the newly-elected London Council, which was held on Tuesday, an important letter was read from the Board of Education. It will be remembered that the old Council prepared a draft scheme for an Education Committee, and that exception was taken to it by numerous educational authorities, on the ground that no provision was made for the inclusion in the Committee of authorities on higher and techni-

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cal education. Petitions in great numbers were prepared and submitted, praying that the scheme might not be sanctioned, and a question was asked in the House of Commons; in spite of all, however, the Board of Education has approved the draft scheme. It was thought that, in view of the recent election, the Board would have delayed their approval, and thus have given the new Council time to re-model the scheme, but matters seem to have been rushed through with undue haste, and the present position is undoubtedly serious. Even the Board of Education seems loth to accept responsibility, and shelters itself by saying that, owing to the grave duties imposed upon the London County Council by the London Education Act, it is unwilling to press for modifications in a scheme framed by the Council. Thus, it is clearly pointed out that the scheme ought to have been modified, and although the Council is largely responsible for the blunder, yet it is obvious that the Board of Education is also to blame for having given its approval, even under protest.

ANOTHER event at the London County Council meeting will not be without interest to our readers. We refer to the election of Mr. J. W. BENN as Chairman of the Council. Mr. BENN'S name has long been familiar as Chairman of the Highways Committee, a responsible position which he has occupied during the construction of the South London tramways. During his long tenure of this office, and as one of the first members of the Council, he has earned considerable distinction; but it is nevertheless surprising that the Council should have elected so essentially a party man—and one with extreme radical if not socialistic views—as their Chairman. Although many miles of an excellent electric tramway system have been built by the Highways Committee, yet this Committee, under the guidance of Mr. BENN, has been instrumental in opposing every other electric traction scheme in the metropolis. Moreover, considerable delay and unnecessary expense was occasioned by the lavish use of the conduit system of traction on many routes where the ordinary trolley system would have been quite suitable; the ultimate result being that some Borough Councils to the north of the Thames expressed their intention of refusing their sanction to electric tramways in their areas unless they, too, were to have the conduit system instead of the overhead. In the manner in which Mr. BENN treated requests for information with respect to the Belgian rail contracts and the working of the "Fair Labour Clause" of the Council's specifications, he has laid himself open to severe criticism. While admitting that Mr. BENN has worked hard as a member of the London County Council, and while honouring him for upholding his opinions against all comers, we cannot but regret that a Chairman has not been chosen who had shown himself a better friend to the electrical engineering industry.

IN *The Electrician* of February 19th we called attention to the fact the American Society of Civil Engineers had not decided whether to accept Mr. CARNEGIE'S offer of the use of a temple of engineering, common to all the American engineering institutions. Some of the "Civils" of America were of the opinion that they would suffer loss of dignity by associating so intimately with the other branches of the profession and, therefore, decided to put the matter to the vote. The result of this vote has just been published. It appears that 1,134 members were against the acceptance of Mr. CARNEGIE'S offer and only 662 in favour of it, while no less than 700 members either abstained from voting or expressed themselves neutral. This means that nearly half the total number of members expressed their actual disapproval of the scheme. It is difficult to understand why the American Society of Civil Engineers have seen fit to adopt this attitude, especially as their present quarters are not sufficiently large to accommodate an annual general meeting. Their membership roll is not likely to decrease, and it will, therefore, be necessary to provide further accommodation without delay. Whatever disadvantages or benefits may accrue to the Society by this action, it is obvious that the respect in which they are held by sister institutions will not be increased. The American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the Institute of Mining Engineers, and the Engineers' Club of New York, have already accepted Mr. Carnegie's offer.

An Unseasonable Thunderstorm.—A severe thunderstorm occurred at Weybourne, Norfolk, on the afternoon of March 8th, when a house was considerably damaged and one of its inmates injured. A local newspaper observes that all the glass and metal work in one room was broken and twisted, and that another house which was connected to the first by an overhead electric bell wire was also damaged.

Royal Society.—Among the Papers down for reading yesterday were the following:—On "The Construction of some Mercury Standards of Resistance with a Determination of the Temperature Coefficient of Resistance of Mercury," by F. E. Smith, communicated by Dr. R. T. Glazebrook, F.R.S.; on "The Effect of a Magnetic Field on the Rate of Subsidence of Torsional Oscillations in Wires of Nickel and Iron, and the Changes produced by Drawing and Annealing," by Prof. A. Gray, F.R.S., and A. Wood.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
New York—Hayti	Apr. 13, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Oran—Tangier	Feb. 3, 1904 ..	Mar. 11, 1904
Cape St. Jacques—Haiphong	Mar. 7, 1904 ..	—

Electricity and Therapeutics.—In the course of a lecture on "Physics Applied to Medicine," delivered before Birmingham medical practitioners, Sir Oliver Lodge said he believed that lightning or Leyden jar discharge effects were not necessarily fatal, but only of the nature of temporary paralysis, and that artificial respiration, if continued long enough, would cause the heart to start again, unless there was actual destructive damage from explosion. He had given his assistants instructions that if one received a Leyden jar discharge he was to be subjected to treatment identically similar to that for drowning for at least three or four hours.

The c.s. "Scotia."—News was received in London late on Thursday last week that the submarine cable-laying and repairing steamer "Scotia," recently purchased from the Telegraph Construction and Maintenance Co. on behalf of the Commercial Pacific Cable Co., had gone ashore on the Catalan Shoal at the entrance to Guam Harbour, in the Ladrones. She was on her way to Guam to make some alterations in the dispositions of the shore ends of the Commercial Pacific Company's cable at that place. The "Scotia," which is a total wreck, was one of the oldest of the cable steamers in the world's

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cable fleet, having been built by R. Napier & Sons as far back as 1862. She was an exceptionally well-built vessel, and notwithstanding her age held the highest certificate. She had on board a quantity of valuable cable, and the work of salving this cable is to be carried out by the Eastern Extension Telegraph Co.'s c.s. "Patrol."

The Forthcoming International Electrical Congress at St. Louis.—Mr. Bion J. Arnold, President of the American Institute of Electrical Engineers, has appointed the following general reception committee for the International Electrical Congress :—

John W. Lieb, jun. (chairman), Calvin W. Rice (vice-chairman), E. G. Acheson, E. K. Adams, William A. Anthony, A. H. Armstrong, J. C. Barclay, Alex. Graham Bell, Louis Bell, Charles S. Bradley, N. F. Brady, C. F. Brush, H. W. Buck, George Bullock, H. S. Carhart, J. J. Carty, C. A. Coffin, C. D. Crandall, F. B. Crocker, H. L. Doherty, Alex. Dow, Louis Duncan, Gano S. Dunn, Thomas A. Edison, Charles L. Edgar, W. C. L. Eglin, R. A. Fessenden, S. D. Field, Frederick P. Fish, B. Gherardi, W. E. Goldsborough, Hammond V. Hayes, Carl Hering, Peter Cooper Hewitt, J. W. Howell, C. R. Huntley, Samuel Insull, D. C. Jackson, William J. Jenks, Francis W. Jones, John F. Kelly, A. E. Kennelly, W. A. Kreidler, H. Ward Leonard, Herbert Lloyd, T. D. Lockwood, John Martin, T. C. Martin, J. H. McGraw, E. L. Nichols, R. B. Owens, F. S. Pearson, W. A. Pearson, F. A. C. Perrine, Ralph W. Pope, W. V. N. Powelson, Charles W. Price, M. I. Pupin, Samuel Reber, E. W. Rice, jun., A. L. Riker, E. B. Rosa, Charles F. Scott, Samuel Sheldon, Frank J. Sprague, William Stanley, C. P. Steinmetz, L. B. Stillwell, H. G. Stott, F. H. Taylor, Charles A. Terry, Nikola Tesla, Elihu Thomson, Calvert Townley, W. D. Weaver, George Westinghouse, Edward Weston, Schuyler S. Wheeler, J. G. White, W. F. White.

Speed Regulation on the Cascade System.—In a recent issue of the *Elektrotechnische Zeitschrift*, Mr. E. Danielson describes a three-speed, three-phase induction motor installed at the iron works at Sandviken (Sweden). These works are supplied with electric energy (2,700 H.P. at present) at 20,000 volts pressure and 50 ~ per second from a waterfall 33·5 miles distant. The motor in question is really a combination of two motors, which are mounted on one bedplate, and possess a common shaft supported by three bearings. While the main motor has 14 poles, a rotor of a diameter of 41·3 in. and an air-gap of 0·059in. the smaller and auxiliary one, possessing a rotor diameter of 21·5in. and an air-gap of 0·049in., may be run at will as a bipolar or 4-pole motor. Starting is effected by resistances placed in the rotor circuit of the main motor. When the latter alone is supplied with energy, the speed of the set is 428 revs. per min., but if the auxiliary motor is electrically connected to the main motor in cascade fashion, the speed is 375 and 333 revs. per min. respectively, according to the auxiliary machine being run with two or four poles. At all speeds the maximum output remains the same, but the efficiency and power-factor vary somewhat, as may be gathered from the following table, in which η = efficiency and $\cos\phi$ = power-factor of the combination :—

Output	50 H.P.		100 H.P.		150 H.P.		200 H.P.	
Revs per min.	η.	Cos ϕ.	η.	Cos ϕ.	η.	Cos ϕ.	η.	Cos ϕ.
428	80	77	87	89	90	92	90	92
375	76	60	86	78	88	82	87	83
333	80	58	86	76	88	81	84	80

The rotor of the auxiliary motor is of the squirrel-cage type, and since the frequency in this motor never exceeds 12 cycles per sec., the corresponding iron losses are small.

High-tension Continuous-current Power Transmission.—Mention was made in *The Electrician* of January 1st, p. 405, of a 22,000-volt continuous-current generator, built by the Compagnie de l'Industrie Électrique et Mécanique of Geneva, for testing the St. Maurice–Lausanne transmission line. A similar dynamo, generating 1 ampere at 20,000 volts when running at a speed of between 600 and 700 revolutions, has recently been supplied by the same firm to the Imperial Technical College of Vienna. Exciting current is supplied by a small 110-volt generator, the armature of which is mounted on the same shaft as that of the main dynamo. The armature has open slots, and the coils are former-wound. A fixed commutator, having 96 segments, is employed, and condensers are suitably connected up to it so as to diminish the sparking. Some further interesting data on the subject, the outcome of experiments upon the line by the contractors, are recorded below. The earth was used first as a return conductor in the ordinary sense, with the transmission voltage equal to the maximum pressure allowable between line and earth, and then as the middle wire in a three-wire system with a voltage between the outers equal to double the voltage between earth and either of the outers. On September 10, 1902, during damp and partially foggy weather, the transmission line St. Maurice–Lausanne was fed with continuous current at 20,000 volts, and the total leakage amounted to 0·01299 ampere, which corresponds to a loss of 0·0866 watt per insulator. When the earth was substituted for one conductor during the ordinary service of the power transmission, the drop of volts at the earth plates at Lausanne was observed to be 25 volts, and that at St. Maurice 185 volts, the resistance of the earth being negligible.

Single-phase Traction in America.—The first American railway lines to be converted to single-phase electric traction are the interurban railways connecting Fort Wayne (Ind.) with Springfield (Ohio) and Indianapolis with Connersville (Ind.) respectively. While the former is about 110 miles long, the second line has at present a length of 53 miles, but it is intended to lengthen it eventually to Hamilton, the total distance electrified being then 93 miles. It was at first decided to work the Indianapolis and Connersville line on the continuous-current system, but after a subsequent investigation with regard to initial cost and running expenses, the manager and the consulting engineers decided to abandon their first scheme in favour of the single-phase system. The power station, as far as the engines and generators (which had already been ordered) were concerned, is to remain as first laid out. Electric energy will be generated at a pressure of 2,300 volts by two 500kw. three-phase generators. The pressure is to be increased to 16,500 volts by step-up transformers, and energy will be transmitted on the Scott two-phase system to six sub-stations equipped with stationary transformers and located about every 10 miles along the line. Half of these sub-stations are connected to the one-phase, and the other half to the other, the pressure being reduced to a line voltage of 3,300 volts. On the car, again, the voltage is reduced to suit the working conditions. The trolley wire is to be of No. 000 B. & S. gauge. On the Fort Wayne and Springfield line induction control (by means of a rotatable-core transformer) is to be employed, but on the Indianapolis–Connersville line rheostatic control is to be used, because the cars, in this case, have to be worked with continuous current within the confines of the city of Indianapolis. Each of the 10 cars which have been ordered will be equipped with four 75 H.P. motors, the gearing being such as to correspond to a normal train-speed of 42 miles per hour. The conversion will be carried out by the Westinghouse Company of Pittsburg.

Electrical Methods of Measuring Temperatures.—In the third and last of his lectures on the above subject at the Royal Institution on Thursday of last week, Prof. Callendar demonstrated the applicability of electrical methods for taking indicator diagrams. For this purpose a motor cycle had been rigged up in the lecture room, and five thermo-couples had been screwed from the outside into the cylinder wall of its small internal combustion engine. Since the thickness of the cylinder casting is but about $\frac{1}{8}$in., the temperature indications of the thermo-couples could be taken to represent also the internal temperatures. One couple was placed near the exhaust, another near the inlet, and the remaining three were fixed near the top, the middle and the bottom of the stroke respectively. First of all, Prof. Callendar determined the temperatures at these various points. He proved experimentally that the temperature at the exhaust side of the cylinder was considerably higher than at the inlet side, but that, by directing a blast of air from a small fan against the exhaust, this order of things might be reversed and the engine rendered more powerful in consequence. The measurement of the temperatures at the three points of the stroke brought out the interesting fact that these temperatures—contrary to expectation—differed but little, the explanation being that the heat generated in the combustion chamber was rapidly transported to all points of the stroke by the piston. Most interesting and instructive were the indicator diagrams of the

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engine, which were made visible to the appreciative audience by means of a beam of light thrown by an oscillating mirror on the screen. The diagrams were perfectly continuous at the very highest speeds (about 2,000 revs per min.), and with their aid the influence of a retarded or advanced spark and of various compositions of the gaseous mixture and so on could be studied to a nicety. It is to be regretted that want of time prevented the lecturer from fully carrying out his programme, as the syllabus included several items, chiefly connected with steam engine practice, which cannot be studied with the same ease and accuracy by other methods.

Messrs. Graham, Morton & Co.'s New Works.—A visit of inspection was paid to the new Hunslet Works of Messrs. Graham, Morton & Co. (Ltd.) on Friday last. While there is comparatively little that appeals to the purely electrical engineer, there is, on the other hand, much of general engineering interest about the works. The ground on which the works now stand was an unoccupied field so late as May, 16, 1903; on that day, however, an army of Messrs. Graham, Morton's employés arrived, and work was commenced immediately. The works were in full swing on November 2nd, only 5½ months having been required to complete the task. The main floor of the works is 420ft. in length overall, and its width is 150ft.; the roof and side walls are of glass, supported by massive steel girders, which were punched, drilled and fixed on the spot. The offices are well built and handsomely furnished and decorated, and it is clear that no expense has been spared in equipping both works and offices with the most modern plant obtainable. Electric driving has been adopted, the power house containing two 150kw. and one 50kw. generators directly connected to Belliss high-speed vertical engines. There is also one double-acting hydraulic pump, working at a pressure of 1,200lb. to the square inch. The motors are 220-volt semi-enclosed machines, and were supplied by the Phœnix Dynamo Mfg. Co. Their aggregate horse-power is 234, of which 84 H.P. is required for driving the four overhead travelling cranes, each equipped with three motors. These crane motors run at a speed of 400 revs. per min., and the rest at 600 revs. per min. Sturtevant "Cutler-Hammer" switches are employed on the shop motors, and are fitted with overload and no-voltage release. The 50kw. generator, referred to above, was supplied by the Phœnix Dynamo Co., and, together with all the motors, was tested on full load for a six hours' run, with a temperature rise not exceeding 70°F. Messrs. Graham, Morton & Co. are to be congratulated on the enterprise which they have shown in erecting such works, and on the fact that the entire building was carried out by their own employés. Their manufactures, such as conveying, screening and crushing plant are too familiar to need further description here.

Recent Advances in Electro-Chemistry.—The second of a course of three Cantor lectures on this subject was delivered by Mr. Bertram Blount, at the Society of Arts, on Monday evening; the first lecture was reported in our notes columns last week. In dealing with the preparation of metals from fused electrolytes, the lecturer said that aluminium was now made electrolytically and in no other way. It was obtained from bauxite, which possessed impurities in considerable quantities, silica being the most troublesome. The raw material, alumina, was produced from bauxite, and the cost of the process of extraction was about one-third of the total manufacturing cost of the resultant aluminium. He then described the Héroult process as worked by the Aluminium-Industrie-Aktien-Gesellschaft at Neuhausen, and by the British Aluminium Co. at Foyers. Attention was called to the fact that early efforts were devoted to the production of aluminium bronze, whereas the present demand was for hardly anything else than pure aluminium. In describing the Héroult process, Mr. Blount said that the electrolyte consisted of alumina dissolved in cryolite or in an artificial mixture of aluminium fluoride with sodium fluoride; and the electrolyte was kept fused by the heat generated by the electric current. This method of heating was superior to that in which heat was supplied externally, as the heat was applied where needed and the walls of the containing vessel were protected by a congealed crust of the electrolyte. The anode was of carbon. Bauxite for the Foyers works was obtained at Larne, but was rich in silica and took up a large amount of soda in the extraction of alumina; this made the process rather expensive. Aluminium was about as mechanically adaptable as zinc; its production was hampered to a certain extent by the difficulty in obtaining pure materials. The output was very considerable, that for 1897 being 3,394,000kg., while for 1901 it was 7,571,000kg., and there was a very hopeful outlook for aluminium. Referring to sodium, the lecturer said it was very useful for certain purposes, but the demand for it was limited. It was now produced solely by electrolysis, and the only process employed was that devised by Castner, which he proceeded to described by the aid of diagrams. Sodium was used in the manufacture of sodium peroxide and the production of cyanides. With regard to alkali and bleach, Mr. Blount thought the difficulty was in the selling and not in the making. There was a big field for potassium chlorate as an explosive. He then said that the electrolysis of water might be divided into two general classes: one in which lead plates in an acid solution were employed, and the other in which iron plates in an alkaline solution were used. There had been a difficulty in keeping the evolved gases apart by means of septa until some ingenious individual hit upon the idea of employing a metallic septum and at the same time keeping the volts below 3. The third and last lecture will be given next Monday.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, March 19th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture V. on "The Life and Work of Stokes," by the Right Hon. Lord Rayleigh, F.R.S.

JUNIOR INSTITUTION OF ENGINEERS.

7 p.m. Conversazione at the Westminster Palace Hotel.

MONDAY. March 21st.

FARADAY SOCIETY.

8 p.m. Ordinary Meeting in the Library of the Institution of Electrical Engineers. Papers to be read: (1) "The Electrolytic Analysis of Gold," by F. Mollwo Perkin, Ph.D., and W. C. Prebble, (2) "Thin Film Electrolysis, with an Application to Printing," by Chas. R. Darling.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture III.: "Recent Advances in Electro-Chemistry," by B. Blount.

WEDNESDAY, March 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7:30 p.m. Joint Meeting with the Liverpool Engineering Society at the Royal Institution, 20, Colquitt-street, Liverpool. Paper to be read: "Notes on the Design of Electrical Machinery," by J. L. Hunt.

THURSDAY, March 24th.

INSTITUTION OF ELECTRICAL ENGINEERS: LEEDS LOCAL SECTION.

7:30 p.m. Meeting at the Yorkshire College. Mr. W. B. Woodhouse will open a Discussion in favour of Electric Power Schemes, and Mr. W. Emmott will speak from the opposite point of view.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER STUDENTS' SECTION.

7:30 p.m. Meeting in the School of Technology. Paper to be read: "Photometric Testing," by D. Livingston Sands.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Direct-reading Measuring Instruments for Switchboard Use," by K. Edgcumbe and F. Punga.

FRIDAY, March 25th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "Note on the Measurement of Small Inductances and Capacities and on a Standard of Small Inductance," by Prof. J. A. Fleming, F.R.S. (2) "A Hot-Wire Ammeter for measuring very small Alternating Currents," by Prof. J. A. Fleming, F.R.S. (3) "The Energy of Secondary Röntgen Radiation," by C. G. Barkla.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Ordinary Meeting. Paper to be read: "The Relative Advantages of Continuous and Alternating Current for Traction Purposes," by J. M. Kennedy.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Liquid Hydrogen Calorimetry." by Prof. Dewar, F.R.S.

SATURDAY, March 26th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture VI.: "The Life and Work of Stokes," by the Right Hon. Lord Rayleigh, F.R.S.

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THE LIVERPOOL–SOUTHPORT ELECTRIC RAILWAY.

The electrical equipment of the Liverpool–Southport section of the Lancashire and Yorkshire Railway (a brief description of which appeared in our issue of January 1st) is now practically complete, and the new trains will probably run for regular passenger traffic next week. This will be the first section of a main line of railway to be worked electrically in this country, although the first electric railways in the United Kingdom were opened as long ago as 1883. A few historical notes with regard to the history of British electric railways will be found in our leading article this week. By the courtesy of Mr. J. A. F. Aspinall, general manager of the Lancashire and Yorkshire Railway Co., and Messrs. Dick, Kerr & Co., the contractors, we have had the opportunity of inspecting the line, rolling stock, power-house and one of the sub-stations, and the engineers of both companies have given us every facility and supplied us with all the information necessary for making our description as complete as possible.

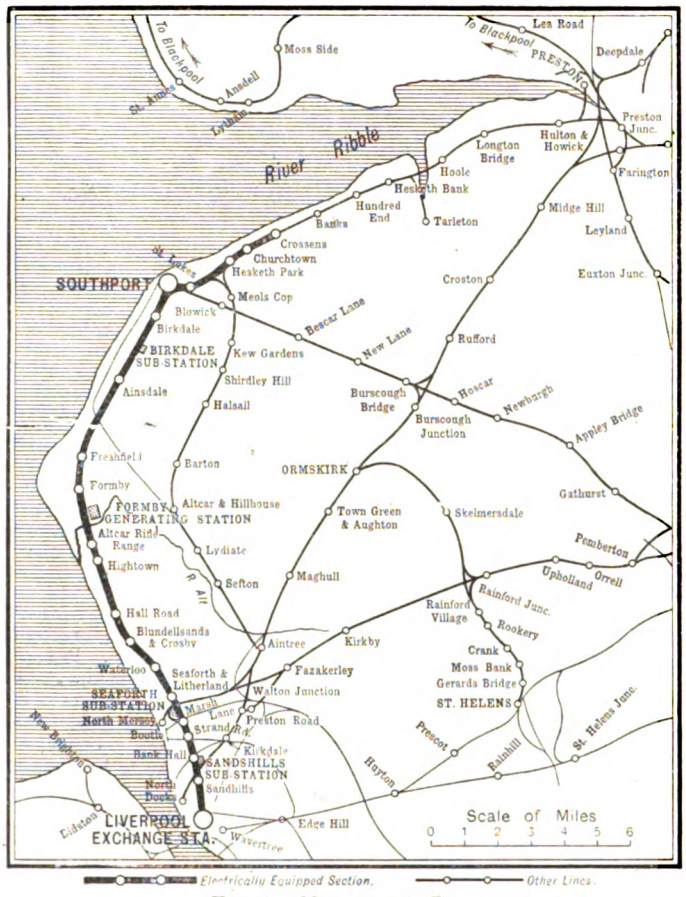

FIG. 1.—MAP OF THE LINE.

The scheme for replacing steam traction by electric traction on the Liverpool–Southport line had been maturing for a considerable time before any public announcement was made on the subject. The idea generally originated with Mr. Aspinall, who long ago realised the possibilities of great traffic development in the excellent residential districts which lie between Liverpool and Southport, and on the north side of the latter town. The new service, with its greater facilities, will, no doubt, lead many Liverpool business men to take up their residence on the north side of the city, and particularly in the charming suburbs on the further side of Southport. As the re-modelled line extends to Crossens, this district will now rival the residential neighbourhoods of the Wirral peninsula, on the south side of the river, in their convenience of access for Liverpool.

The decision to "electrify" having been made, no time was lost in putting the work in hand. The complete contract, with the exception of the rolling stock, which was made at the Horwich and Newton Heath works of the railway company, was entrusted to Messrs. Dick, Kerr & Co., and the work of electrifying the line has been completed in a remarkably short time. Twelve months ago the work of construction had not been begun, yet a scheme embracing 47 miles of permanent way, a transmission plant of 12,000 H.P. and a complete train system has now been carried out. It is further to be remembered that this has been achieved without interference with the running of the steam service. The work reflects great credit upon all concerned.

The distance between Liverpool and Southport is nearly 18½ miles, the total length of track equipped being practically equivalent to 47 miles of single line. The gradients on the road are slight, and there are but few curves, the steepest gradient being a short length of 1 in 85 near Waterloo, and the sharpest curve one of 7 chains at Southport. With these exceptions, the line is level and straight. As seen in the map (Fig. 1), there are 14 intermediate stations, which lie at an average distance of about 1 mile apart on the southernmost portion of the route, but are more widely separated on the northern portion. The traffic is almost wholly passenger, business people going to and returning from Liverpool in the morning and evening, with a considerable shopping and miscellaneous traffic during the daytime.

Under steam conditions there are about 36 trains per day in each direction between Liverpool and Southport; a similar number running in each direction between Liverpool and Hall-road, a station some 7 miles from Liverpool. The majority of these trains stop at every station, a few expresses being run in the morning and evening for the accommodation of the business men. The running times are at present as follows:—Express trains 25 minutes, stopping trains 54 minutes, Hall-road stopping trains 25 minutes. The total train-mileage per diem is about 1,900. Under the new conditions the train mileage will be increased to 3,200. The number of trains in each direction between Liverpool and Southport will be increased from 36 to 65, and between Liverpool and Hall-road from 38 to 54. Moreover, the running time from Liverpool to Southport will be decreased from 54 minutes, at present, to 37 minutes, and from Liverpool to Hall-road from 25 minutes to 17 minutes; the schedule time of the fast trains will remain unaltered, but there will be an express in each direction hourly, instead of only rarely. In addition to this, the express trains will run on to Crossens, giving that suburb a service of 17 trains each way during the day. A portion of the new time-table is given in Fig. 3. These arrangements, however, do not represent the ultimate capacity of the line, and if the traffic in the course of a year or two were to demand it, there would be no difficulty in running an even more frequent service. It is intended to shorten the stops at the intermediate stations, and as this will make fresh arrangements necessary to deal with heavy luggage and parcels, a special baggage car has been built to deal only with this service. This car will make numerous trips between Liverpool and Southport, and will immensely increase the ease and rapidity with which parcels can be delivered in the residential districts between Liverpool and Southport.

Electrical energy is generated as three-phase alternating current of 7,500 volts pressure, and transmitted to sub-stations, where the voltage is stepped down by stationary transformers and converted by rotary converters into continuous current of 650 volts pressure, the maximum voltage at the train being 600. The power house is situated approximately at the centre of the line, near Formby, directly on the River Alt, being thus favourably situated as regards economical distribution and a plentiful supply of water. In addition to some rotary converters at the main power house, the scheme embraces three sub-stations, the first being at Sandhills, the second at Seaforth, and the third at Birkdale. The distances of these sub-stations from Liverpool are as follows: Sandhill railway station 2 miles, Seaforth 3¾ miles, Formby (power house and sub-station) 10¼ miles, Birkdale 16⅛ miles. Near Liverpool it has been necessary to arrange the sub-stations closer together than on other parts of the line, in order to cope with the heavier traffic of the local trains running between Liverpool and Hall-road. The extreme ends of the line—from Sandhills sub-station towards Liverpool, and from Birkdale sub-station towards Southport and Crossens—are each fed by one sub-station only, whilst for the intermediate sections of the line energy is sup-

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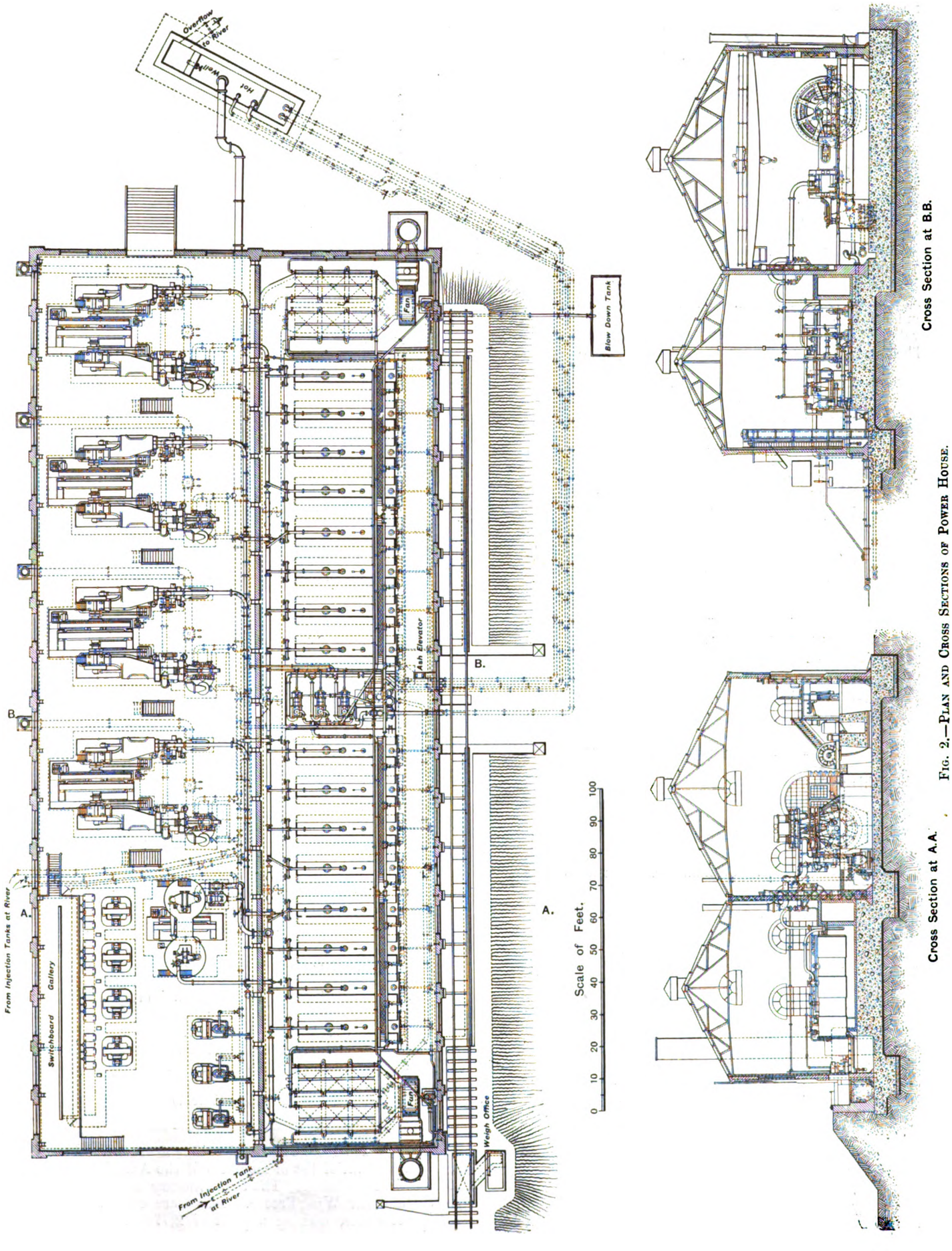

FIG. 2.—PLAN AND CROSS SECTIONS OF POWER HOUSE.

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plied by the two remaining sub-stations in parallel. The sub-stations are situated near the track, and the system is arranged so that any sub-station can be disconnected if required.

The power house has been laid down on simple lines, with no unnecessary luxuries or refinements. The building, a plain and substantial one, with no ornamentation, has been erected by Messrs. Thomas Croft & Sons, to designs prepared by Messrs. Dick, Kerr & Co., and upon elaborate foundations which were constructed by Messrs. Monk and Newell under the immediate supervision of the engineers of the Lancashire and Yorkshire Railway Co. As shown in the plan (Fig. 2), it consists of two divisions, the engine room being 280ft. long by 65ft. wide, and the boiler house 50ft. wide. The building is protected by a steel roof in two bays, carried upon steel columns, all of which are independent of the brickwork. These have been made by Messrs. Head, Wrightson & Co. Electrically-driven overhead cranes in the engine room (by Messrs. Jessop and Appleby) are capable of dealing with pieces of machinery up to 20 tons. An examination of Fig 2 will show that four 1,500kw. units are placed next to one another in the engine room, and next to these a 750kw. set is to be put in. The rotary converters occupy one end of the engine room, and overlooking these, on the outer wall away from the boiler house, is the switchboard gallery. The main high-tension switches are on the ground floor

Distance between Stations. Miles.	Yards.	Stations.
		Liverpool ... ...
1	1,068	Sandhills ... ...
—	1,004	Bank Hall ... ...
—	1,222	Bootle ... ...
—	754	Seaforth ... ...
1	307	Waterloo ... ...
1	93	Crosby ... ...
—	1,018	Hall Road ...
1	1,645	Hightown ... ...
—	744	Altear... ... ...
1	1,087	Formby ... ...
—	1,553	Freshfield ... ...
2	1,518	Ainsdale ... ...
2	264	Eastbourne Road..
—	664	Birkdale ... ...
—	805	Duke Street ...
—	810	Southport ... ...
—	1,507	St. Luke's ...
—	1,592	Hesketh Park ...
—	1,383	Churchtown ...
—	1,188	Crossens ... ...

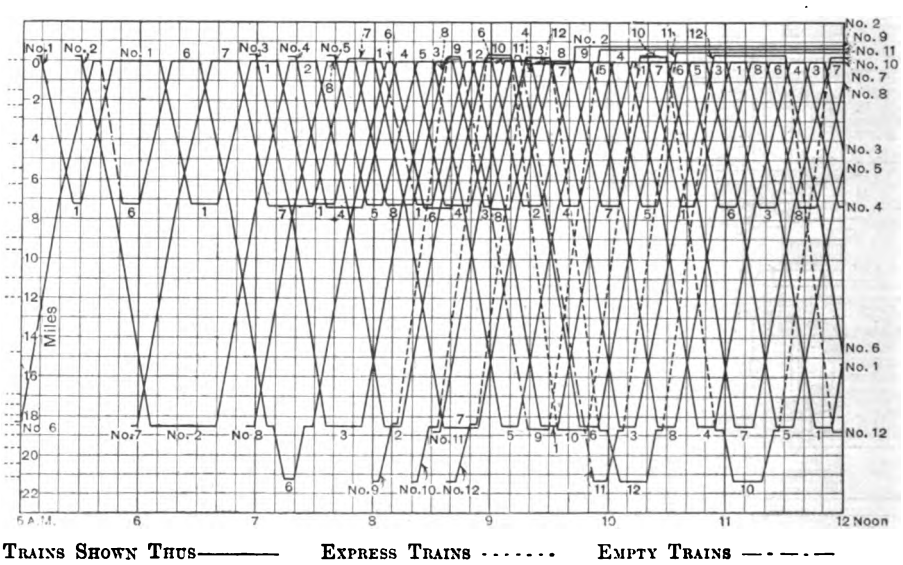

FIG. 3.—STOPPING TRAINS SHOWN THUS———— EXPRESS TRAINS ------- EMPTY TRAINS — - — - —

below this gallery, being controlled by handles on the switchboard. The feed pumps are in the boiler house and the condensing plant in the basement below the engine room.

There are 16 Lancashire boilers, made by Messrs. Yates and Thom. Each boiler is 32ft. long by 8ft. 6in. diameter, with two flues each 3ft. 5in. diameter, constructed for a working pressure of 160lb. per square inch, the shell plates being $\frac{13}{16}$in. thick, flue plates $\frac{9}{16}$in. thick, and the end plates $\frac{3}{4}$in. thick; each shell is in five rings of one plate each. The boilers were tested satisfactorily to 260lb. per square inch. They are hand-fired and are arranged in two batteries of eight each in one row. In each of the downtake flues at the back end of the boilers is fitted a superheater of the Galloway type. The feed pumps placed between the two batteries of boilers were supplied by Messrs. Mather and Platt.

Induced draught is employed, there being two fans for this purpose, one at either end of the boiler house. Each fan, when running at 175 revs. per min., can furnish sufficient air for the consumption of 10,000lb. of coal per hour, assuming the temperature of the flue gases after passing through the economisers to be 400°F. The fans are of the three-quarter housing over-hung blast wheel type, and are directly connected to horizontal side crank engines. The housings are built on an angle-iron framework, and the side plates are stiffened by angle-iron braces both on the engine and inlet sides of the fans. The inlets are 6ft 2in. in diameter and the outlets 4ft. 11¾in. square. The blast wheels are constructed on three spiders formed by T-iron arms fixed into heavy cast-iron hubs. One of these spiders is off-set, and the hubs of the blast wheels are off-set and brought as near to the main bearings as possible. In order to give the fans their maximum capacity, the blast wheels, each of which has eight wings of the curved pattern, were built the same width at the periphery as at the centre. The blast wheels are carried on steel shafts 5in. in diameter, and supported by self-oiling water-cooled bearings. After leaving the fans, the flue gases are discharged in each case through an underground brick duct to the base of a 60ft. chimney located just outside the building. The whole of the induced draft apparatus was supplied by the Buffalo Forge Co.

The economisers, by Messrs. Green & Son, are arranged in two batteries, one in each of the flues at the corresponding end of the boiler house. Each battery consists of 720 tubes, representing 7,200 sq. ft. of heating surface. These are again sub-divided in two separate apparatus of 360 tubes, in sections of tens, so that both can be worked together or independently as required. Each group of 120 tubes is coupled together by expansion elbows at top and bottom. The scrapers are actuated by a double set of gearing on the top of the economisers, and the whole is driven by a direct-geared electric motor. The economisers are specially constructed to work at high pressures, and the top boxes are fitted with internal lids of the latest pattern. The total water capacity of the economisers is some 9,000 gallons. No special coal conveying plant is employed; the coal trucks will be taken up an incline to the level of the coal bunkers and tipped directly into them, the boiler house being parallel to the railway line.

The whole of the steam-feed, exhaust, and injection, main and auxiliary piping was fitted and prepared by Messrs. Dick, Kerr & Co. at their Kilmarnock works. The feed ring (6in. diameter) runs the whole length of the boilers, branches to each boiler being taken through check valves. The ring is supplied from pumps in triplicate. The feed water can be passed either through the economisers or direct to the boilers by a duplicate system. The main steam piping, which is 12in. in diameter, is a combination of the ring and by-pass systems. The steam is taken from the boilers, passed through superheaters and then into the main ring or direct through a by-pass to the engines. The steam pipes are entirely on the duplicate system, and are of steel.

(To be continued.)

American Institute of Electrical Engineers.—We have just received the official list of members of the American Institute of Electrical Engineers. The two honorary members are Lord Kelvin and Sir Wm. Preece. There are 457 members and 2,317 associates, making a total of 2,776, there being no associate member grade.

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THE RATED SPEED OF ELECTRIC MOTORS AS AFFECTING THE TYPE TO BE EMPLOYED.

The following is an abstract of the discussion which followed the reading of Mr. Hobart's Paper on the above subject before the Institution of Electrical Engineers on Thursday, March 10th. The Paper itself appeared in our last issue (p. 814).

Prof. SILVANUS P. THOMPSON, F.R.S., said that the contrast between the designs of a number of machines of the same rated output emphasised several very important features of design. In comparing machines of one kind with those of another, it was useful to go back to first principles, and to put aside for the moment empirical rules and formulæ and to deal with rules and formulæ that could be looked upon as applicable to all cases. Such a formula which he had found extremely convenient for comparing all kinds of electric motors and generators, whether continuous-current, alternating, three-phase or single-phase was $KVA/RPM = N k d q p \div (1{\cdot}91 \times 10^{12})$, where KVA = the output of the machine, RPM = revs. per min., N = the magnetic flux, k = a coefficient which varied with the type of machine (for continuous-current machines $k = 1$ and for alternating-current machines k was theoretically = 1·11), d = diameter of armature, q = amperes per inch of armature and p = number of poles. When considering machines of a given output and a given speed, it could be seen there were a large number of variables in the above equation. For alternating-current machines the number of poles was not, however, a variable. It was fixed by the revolutions per minute and by the frequency, whatever it might be, but it was quite apparent that there might be all manner of variations between the other values. In continuous-current machines the specific load was that which was mainly responsible for good commutation. If the armature was loaded with more than 600 amperes per inch, then sparking occurred. It was necessary to keep the load down if one wished to be on the safe side. For alternating-current machines there were other considerations which compelled us to keep within a certain range with respect to the flux per pole, and there was also the question of armature reaction, governed mainly by the flux per pole and the number of turns round that pole. In comparing Mr. Hobart's 11 machines by the light of the formula given above, some rather curious and interesting variations were discovered. Taking, first, the five continuous-current machines, he noticed that the largest of them had a flux of about 15½ millions of lines from each pole, whilst the smallest had only about four million lines, so that the former poles were about four times as large as the latter. The diameters, however, did not vary very much, the largest having a diameter of a little more than 2½ times that of the smallest. The loading of the armature per inch varied from about 560 to 415 amperes, so that they were not very different in that respect. But they differed mainly in the number and size of the poles. The six induction motors were in two lots, one for a frequency of 21 periods per second—practically unknown in this country—and the other for a frequency of 63 cycles per second, and here the number of poles differed enormously. Of the first three motors for a frequency of 21 ~ per second (Nos. 6, 7 and 8), the largest one had 36 poles and the smallest only four. The 36-pole machine had only about 1⅛ million lines for each pole, whereas the smaller one had five million lines, so that the operation of choosing sizes had gone inversely. With regard to the three induction motors for 63 ~ per second, the largest one had 12 poles with a flux of 1,190,000 lines, whilst the smallest one, with only half as many poles, had 2,380,000, so that the size of the poles increased as the number diminished. This was a point that had not come out with any series of machines before. The specific loading on the armature did not differ very much. There were several other points which might be gone into, particularly if one translated the formula so as to give the output in terms, not of the number of revolutions per minute, but of the peripheral speeds. He supposed that the builders of dynamo machinery would be agreed that a better use could be made of copper and iron the higher the surface speed. The specific utilisation of materials was much more a question of surface speed than of revolutions per minute. With laminations and copper conductors laid in the slots, the surface speeds were usually seldom below 2,500ft. or 3,000ft. per minute, and, except in very large machines, did not very often go beyond 7,000ft. per minute; that was leaving turbine machines out of the question. Taking the five continuous-current machines mentioned by the author, the first one had a surface speed of only 1,040ft. per minute, which showed that, however good the design might be in other respects, it was not fully utilised in this respect. The other four continuous-current motors had speeds of 3,120ft., 6,400ft., 7,700ft. and 7,900ft. per second, so that with the smaller machines a much higher surface speed had been obtained. No doubt, Mr. Hobart would reply that it could not be anything else, and that any other design would have involved other difficulties, especially the difficulty of the big commutator. The other machines instanced in the Paper were more reasonable in this respect. The largest had a surface speed of 2,040ft. per minute and the smallest 5,720ft. The others were intermediate.

Dr. C. V. DRYSDALE said he felt that the size of motor which Mr. Hobart had chosen did not seem sufficiently representative of everyday practice. Smaller machines formed such a large proportion of the output of motors that information concerning them would have been of great value. He thought that Mr. Hobart had not done the right thing, in determining the cost of the machines, to take as a unit upon which to base his comparisons the product of the diameter and length of the rotating part of the armature, and it was a little unfortunate that he had also taken the dimensions over the windings. Hitherto it had been the custom to consider the core dimensions in this respect. This policy was always adopted when making use of the Steinmetz coefficient, which was so valuable in dynamo design. If Mr. Hobart had adopted the same principle in expressing the cost of the machine it would have helped considerably towards uniformity. Within the last few days he had had an opportunity of looking over some alternating and continuous-current machines in the Northampton Institute, where there were 25 motors of various sizes, and he had examined the question of cost. Mr. Hobart's result might very well be expressed by saying that the cost was about 1s. per square centimetre of core area. He himself had found that the small machines of from 2 H.P. to 10 H.P. gave a surprisingly uniform value of 2s. 6d. per square centimetre of core area, and he thought this was rather a valuable basis of comparison, because, when taken into consideration with the Steinmetz coefficient, it afforded a considerable help in design. The general conclusion from Mr. Hobart's Paper seemed to be that the induction motor was, on the whole, preferable at high speeds, whilst at low speeds the continuous-current motor was the best. The gaining of low-speeds by electrical means was very expensive, but if high-speeds, and, therefore, inexpensive motors, coupled with satisfactory reduction gears were used, it would be far more practicable.

Mr. H. S. MEYER thought he could only consider all the facts brought forward by the author as of a theoretical nature. He had devoted some time to an investigation of Mr. Hobart's figures, and the results which he had obtained were disappointing. The author had attempted to cover too wide a range of speed, and thereby he had naturally detracted from

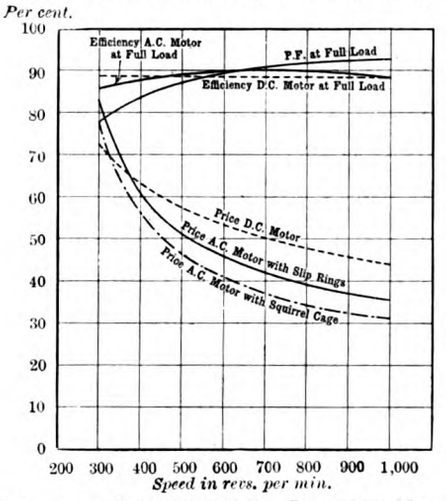

FIG. 1.—COMPARISON BETWEEN 45 H.P. INDUCTION MOTOR AND 45 H.P. DIRECT-CURRENT MOTOR.

the value of his conclusions. Whilst it was quite possible to compare continuous-current machines with alternating-current machines of commercial speeds, it was very difficult to extend this comparison beyond the normal speeds. Dealing first with Mr. Hobart's cost formula for induction motors, he was very sceptical about it, since the commercial

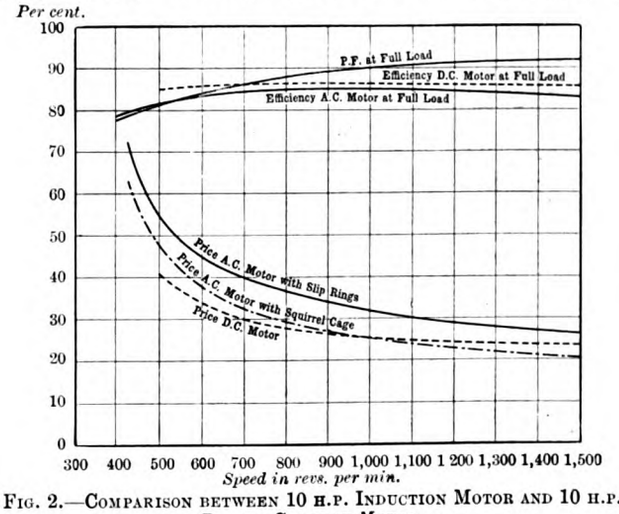

FIG. 2.—COMPARISON BETWEEN 10 H.P. INDUCTION MOTOR AND 10 H.P. DIRECT-CURRENT MOTOR.

cost of the design was a function also of the equipment of the shops and of the special plant which was necessary for different sizes. It required very much more money to handle the parts of larger-sized machines, and this could not be expressed as a function of the diameter. Cranes and other large tools were required, and the capital invested was considerably larger and less frequently used, and the works costs were consequently higher than in the case of smaller machines. He had used Mr. Hobart's formula for induction motors, assuming a diameter of 20in. and a length of 5in., and the figure for a six-pole machine came to 247, and for a 12-pole machine to 173, the same carcase being used in both cases. The conclusion would be that the six-pole machine ought to be 30 per cent. cheaper than the 12-pole machine, which was obviously wrong. From a

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number of designs he had come to the conclusion that a better approximation to the factory costs of standard and semi-standard motors was obtained by using a formula where the cost was equal to $D^{1\cdot8} \times L$. This takes into account the greater difficulties in handling larger machines, and avoids the contradictory results for different numbers of poles. He did not claim accuracy for this formula over a very wide range of designs, nor for machines of different make. A motor of 50 H.P. was a size much more suited for comparison than one of 150 H.P. Comparison should be limited to speeds from 300 to 1,000 revs. per min., whilst in a motor of 10 H.P. speeds of from 400 to 1,500 revs. per min. were the speeds mostly used. He had compiled the curves (Figs. 1 and 2) from actual figures. With regard to a statement made by Mr. Hobart as to slip ring motors and squirrel-cage motors, he thought it was hardly correct in the way in which it was made, because the difference in the price of squirrel-cage and slip-ring motors was a variable function, and he had compiled the curve shown in Fig. 3, which showed this difference to

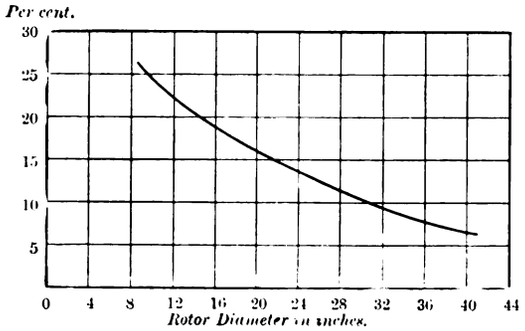

Fig. 3.- REDUCTION IN COST FOR SQUIRREL CAGE MOTORS IN PERCENTAGE OF THE COST OF THE SLIP-RING TYPE.

vary between 5 and 35 per cent. He had found that with small diameters the cost must be very much more than in large diameters, where bare windings were usually used. Sizes of 100 H.P., therefore, differed by 25 per cent. instead of 8 per cent. He also thought that Mr. Hobart had a little too much faith in the slow-speed continuous-current machine, for with our present knowledge of design it was quite possible to make a continuous-current machine for higher speeds.

The following additional remarks by Mr. Meyer have been communicated:

Fig. 1, representing the comparison of 45 H.P. motors, shows a difference in price of 24 per cent. in favour of the slip-ring induction motor, and of 42 per cent. in favour of the squirrel-cage induction motor, or, on an average, 33 per cent., against Mr. Hobart's 50 per cent. The intersection of the costs curves for direct current and alternating current occurs at 375 revs. per min., while in Mr. Hobart's Fig. 12 the curves seem to diverge for lower speeds, which certainly is wrong, and from this point of view the curves in Fig. 12a seem more to approach the actual facts. The efficiency curve given in my Fig. 1 shows a maximum at about 700 revs. per min. and drops already 2 per cent at 1,000 revs. per min. Quite different from Mr. Hobart's statements are the results contained in my Fig. 2, where the same comparison is made for 10 H.P. motors. Here the direct-current motor is about 10 per cent. cheaper when compared with the slip-ring motor, an intersection of the curves occurring somewhere near 1,800 revs. per min., and of the same cost when compared with the squirrel-cage motor. The intersection occurs here at about 1,000 revs. per min. The maximum efficiency of this size occurs at about 1,000 revs. per min., a drop of 2 per cent. being noticeable at 1,500 revs. per min.

The next point to which I wish to refer in a few words, is the formula for leakage on induction motors, to which Mr. Hobart refers in his Paper. Here, again, I must say that experience shows that it is impossible to represent the actual leakage in induction motors by a simple formula such as given by Behrend and modified by Hobart. I have checked his recommendations on a great number of designs, and find results of hardly any practical value. The problem is of such a nature that a general law—while it may happen to approach the conditions in a number of normal machines—will mostly fail in abnormal machines, and it is here where it is more necessary to foresee the performance. I, further, cannot quite agree with conclusions I. and II. in Mr. Hobart's Paper. Conclusion I., as shown by the curves, based on actual costs, cannot be substantiated in the broad sense expressed in the Paper, but will entirely depend on the sizes used. As to conclusion II., the general performance and the mechanical construction of induction motors improves with increased in rated speeds, as long as the above given range in speed is not surpassed, but with excessive high speeds, the efficiency as well as the mechanical construction, particularly of slip-ring motors—decreases rather than increases. To the fourth conclusion, I must agree as long as the excessive range in speed is considered; but within the commercial limits referred, the direct-current motor at moderate speeds and the alternating current motor at slow speeds will be entirely satisfactory. In regard to cost, the high speed will be always more favourable, both for alternating-current and direct-current machines, and I think Mr. Hobart goes somewhat too far in his preference for the very slow-speed direct-current machine. While it must be admitted that it is easier—as far as commutation goes—to design a good direct-current machine at a slow speed, it is, on the other hand, with our present experience, readily possible to design a good direct-current machine for high speed. As an example, I need only refer to the turbine-driven direct current machines, where 300kw. dynamos and more have been designed to run sparklessly at 1,800 revs. per min. without the use of compensating windings. Of course, this must be considered a special case, but the tendency for high-speed direct-current apparatus, and thereby reduced cost cannot be stopped on the ground that greater care and experience in the design is required. An analagous case has been experienced with the steam engine, where the question of high speed versus slow speed presents a similar problem.

Mr. GERALD STONEY (chairman of the Newcastle Local Section) said, in order to get fixed commutation there must be a compensating winding for armature reaction. By this means fixed commutation could be obtained up to 100 or 150 per cent. overload. Quite recently he had made large turbo-dynamos for traction work, which stood heavy overloads without necessitating any movement of the brushes whatever.* Voltage drops of only 2 or 3 per cent. had been obtained in many alternators manufactured by Messrs. Parsons from full load to no-load with constant speed and excitation. He knew of one case where it was only ½ per cent.; in fact, it could hardly be measured. Regulation was rather easier in high-speed alternators than in low-speed ones.

Mr. H. M. HOBART, in reply, said that Dr. Thompson had spoken of the loading of the periphery of the armature as affecting commutation, but he was not quite in agreement with Dr. Thompson on this point. He believed it was exactly on these lines that the continuous-current dynamo and motor could be much cheapened. He was perfectly sanguine that motors possessing approximately the same $D \times L$ as given in the Paper—at least, in the lower-speed ranges—could be obtained with a high value of ampere-turns per centimetre of periphery without running into any commutation trouble whatever. If it were only a question of the nature of the effective material, he should agree with Dr. Thompson that the higher the peripheral speed the cheaper the machine, but the use of the highest practicable peripheral speed led to a tremendously narrower machine. The mechanical cost constituted a large percentage of the total cost of the machine, and very often a low peripheral speed would be the cheapest and would make the best use of the total material required. Dr. Drysdale had remarked that it would be useful to have had smaller sizes, and he himself also hoped to see some investigations worked out for, say, a series of 75 H.P. and 25 H.P. motors. His use of the length over the windings instead of the length over the core had also been criticised. He had adopted this course without any special theoretical justification, but simply because it was impossible to escape from the fact that the product of the diameter of the rotor and the length over the winding multiplied by the constant gave the total factory cost of the machine, and this was true for motors from 5 H.P. to 500 H.P. He did not think that any such agreement could be found by using the core length, and he was not specially surprised that Dr. Drysdale found pretty good agreement between 10 H.P. and 30 H.P. Mr. Stoney had referred to some good results which he had obtained with high-speed dynamos by means of compensating windings. Such windings involved a considerable increase in the labour cost of the machine, and they were not in common use.

ELECTRICITY IN MINES.

An esteemed correspondent has sent us the following suggestions relating to the draft regulations issued by the Departmental Committee on the Use of Electricity in Mines. The regulations were given in full in *The Electrician* of February 19th, p. 689, and some suggestions as to their amendment were also made in the editorial notes and correspondence columns of our issue of March 4th:—

Sec. I., para. 3.—That it would be better that the rise of temperature should be indicated in actual degrees Fahrenheit.

Para. 4.—That the last words, "where the pressure exceeds the limits of low pressure" should be eliminated.

Para. 5, *rule* 1.—That in this rule, and in all others similarly expressed, the connection with earth should mean connection with the armouring or lead covering of the main cables of the system, which armouring, where it ceases on main cables or elsewhere, should be continued in the form of a substantial copper conductor, which should be taken to all fittings of any kind, such as holders, motor frames, &c., and connected thereto. It is particularly difficult in some cases to find what is called good "earth" in mines. This suggestion, it will be found, applies to a very large number of the subsequent rules, and it need, therefore, not be again referred to.

Rule 11.—That the reading of these instruments should be recorded at each change of shift in order to fix more accurately responsibility for the non-observance of a fault.

Rule 22.—That after the word "duty" the following should be inserted:—"and in the action to be taken in the event of the chief accidents that may happen to the machinery under his charge."

Rule 28.—That three months is far too long a period; any mine could keep its plans up to date within a fortnight.

Rule 29.—That no glass cells be allowed for storage batteries when placed underground.

Sec. II., Rules 3 *and* 4.—That all references to "wood" be eliminated as events show that it is dangerous in the case of cable or switchboard accidents.

* We have written to Mr. Stoney for further particulars concerning these machines, but he is unable to supply them at present.—ED. *E.*

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Rule 7.—That the words "above the limits of low pressure" should be eliminated, as there is practically as much danger of accident from work in this as in any other case; in fact, the effects of short circuits may be even greater.

Rule 8.—That no lightning arresters will ever make it quite certain that a flash will not get into the cables in the pit and cause trouble. I therefore think that all lines from the generating room to the pithead should be underground,

Sec. III., Cables, Rule 2.—That the phrase "the electric heating is almost nil" should surely be made definite, as, for instance, "that the maximum temperature of the cable when working continuously at full load in its position shall not exceed .... degrees Fahrenheit.".

Rule 7.—That No. 18 is far too small, especially for work in a mine, and No. 20 for a flexible cord is still worse, as it is an extremely small wire. No solid wires should be allowed at all, even the smallest section being stranded.

Rules 11 *and* 12.—That no joints be allowed in any conductor; certainly not above a very small size, such as equivalent of the No. 16 S.W.G.

Rule 14.—That overhead wires should be prohibited.

Rule 17 (*e*).—That it is not advisable that trailing cables should be repaired after being damaged. They would always be worth a good percentage of their original cost for the copper alone.

Sec. IV., Rule 2.—That the mere lining of rigid metal covers would not suffice, as experience has shown that the flame of a short-circuit arc will penetrate through even a close joint at the angles. It will be necessary for the lining to be absolutely continuous, either moulded in the metal casing or in some other way.

Rule 3.—That the various fuses for different leads should be made slightly different in the centres for clamping on studs or otherwise, in order to make it impossible for the wrong fuse to be inserted.

Rule 4.—See Rule 2 above.

Sec. VI., Rule 3.—That it be arranged that when the roads are being used for electric traction that a circuit of red lamps along the said road at fair intervals be automatically connected by the switch which feeds the trolley wire.

Sec. VII.—That the lighting circuits be kept absolutely distinct from the power circuits in the generating room and throughout, and, if possible, the mine should be fed as regards lighting from both shafts.

ALTERNATORS IN PARALLEL.*

BY H. BOHLE.

(*Continued from page 785*).

Let us consider a single-cylinder double-acting steam engine. Each inlet of steam produces a knock upon the piston, which will be communicated to the inductor of the alternator, accelerating it,

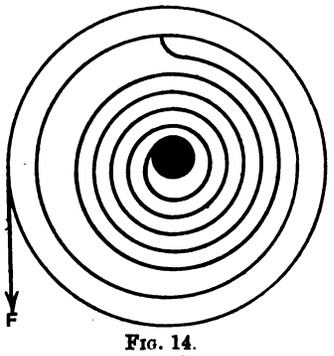

Fig. 14.

and this happens twice in a revolution. The velocity curve of the inductor will, therefore, not be a straight line, but wavy, showing two peaks in each revolution (see Fig. 15). A double-cylinder steam

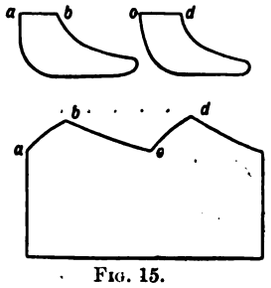

Fig. 15.

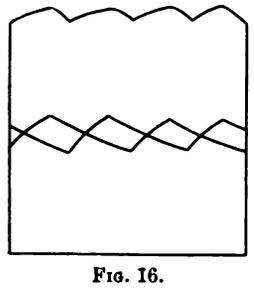

Fig. 16.

engine, with cranks at 90deg., will show four velocity peaks in one revolution, but which, however, are less pronounced. The ratio maximum velocity – minimum velocity: mean velocity is called the "coefficient of speed variation." We see, then, the ratio decreases with decreasing difference between maximum and minimum velocity. Expressed by a formula, we have

$$q = \frac{V_2 - V_1}{V}, \quad \ldots\ldots\ldots \quad (6)$$

q may evidently be decreased by increasing the moment of inertia. The knocks upon the piston produce, as we have seen, variations in the speed within a revolution. These variations may be considered

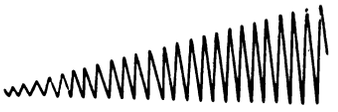

Fig. 17.

regular oscillations, occurring periodically, and which are impressed upon the inductors. The time of an oscillation for a single-cylinder double-acting engine is given by $t_e = 30/n_1$; for a twin engine, with cranks at 90deg., $t_e = 15/n_1$; and for three-crank engines, with cranks at 120deg., $t_e = 10/n_1$.

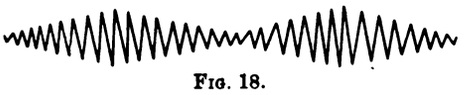

Fig. 18.

It will now be obvious that if, in any system, the time of a forced oscillation is equal or nearly equal to the time of a free oscillation, in other words, if we have "resonance," the oscillations grow indefinitely, and the alternator will get out of step with the 'bus bars in a very short time. When $t^e/t_e = 1$, the oscillations will grow as shown in Fig. 17. Good results are obtained when $t^e/t_e = 3/2$

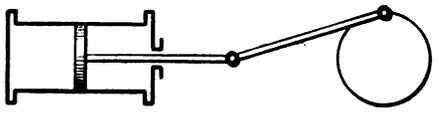

Fig. 19.

and when the oscillations look more like Fig 18. The relative crank positions of two sets, working upon the same network, influence also the proper working. Consider at first, two similar sets. In Figs. 19 and 21 we have evidently greater velocities than in Figs. 20 and 22, so that if two machines are joined in parallel, when the crank of one is in a position as shown in Fig. 19, while

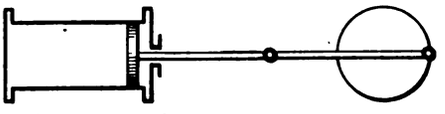

Fig. 20.

that of the other engine is in a place as shown by Fig. 20, the E.M.F.s will vary, causing a synchronising current to flow. Better results are obviously obtained if the machines are brought into "tact-synchronism," which may be effected by means of bells, which are struck by the crank once in a revolution. When the two

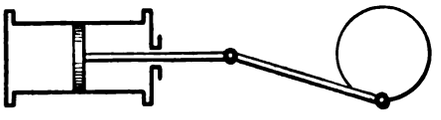

Fig. 21.

bells, of two different sets, are struck at the same time, the machines are in tact-synchronism. This makes, however, the proceeding of joining machines in parallel more complicated still, as besides the phase lamps, respectively phase meters, a couple of bells have to be observed.

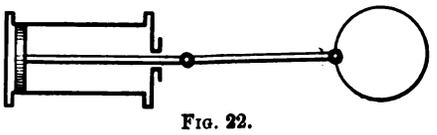

Fig. 22.

If machines which run in parallel are not of the same type, a synchronising current will always result, its value being given by:

$$C_1 = \frac{E_d}{\sqrt{R^2 + (2\pi n L)^2}}. \quad \ldots\ldots\ldots \quad (7)$$

This current is the smaller, the smaller E_d, and the larger R and L. E_d increases, with increasing divergence, from uniform rotation, the resistance R is limited by the heating of the machine, whilst the coefficient of self-induction is limited by the drop. The denominator of equation (7) being thus fixed, or at least limited, we must reduce

* Paper presented at the Leeds Local Section of the Institution of Electrical Engineers, Jan. 21st. (See *The Electrician* of Jan. 22nd, p. 511.)

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E_d, to which the synchronising current is directly proportional, and for this purpose we require the crank effort diagram as shown in Fig. 23. The largest of the areas lying above or below the mean effort line is called the fluctuation of energy, and the ratio of this quantity to the total work done in one revolution the coefficient of fluctuation of energy. The question of weight of a flywheel to fulfil certain conditions may be expressed by a formula:—

Let G be the total energy stored in a flywheel when rotating uniformly, dG the fluctuation of flywheel energy, W the work done by the engine in one revolution, and q the coefficient of speed variation.

$$G=\frac{V^2I}{2},$$

where I is the moment of inertia.

$$dG=\frac{I}{2}(V_2^2-V_1^2)=\frac{I}{2}(V_2+V_1)(V_2-V_1)$$

now $$\frac{V_2+V_1}{2}=V,$$

hence $$dG=\frac{I}{2}\times 2V(V_2-V_1)=I\times V(V_2-V_1),$$

$$=IV^2\times\frac{V_2-V_1}{V}=IV^2q=2Gq.$$

But $dG/W=K=$coefficient of fluctuation of energy,

$\therefore$ $K=2Gq/W$, or $2G=KW/q$, or $IV^2=KW/q$,

or $$I=\frac{KW}{qV^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

From this equation it follows that the mass of a flywheel should be directly proportional to the coefficient of fluctuation of energy and the work done by the engine, and, inversely, proportional to the coefficient of speed variation and the square of the speed.

Fig. 23.

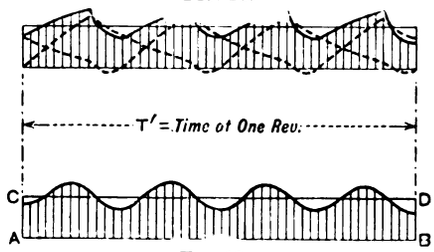

Fig. 23A.

Replace now the curve of Fig. 23 by a true sine curve, such that its upper and lower lying areas are equal to the upper and lower lying areas of the original curve (see Fig. 23A). (We have here the diagram of a twin engine.) This may, however, be objected to. With gas engines it would certainly be very risky, but with steam engines the fault is not greater than assuming the current curve of an alternator to be a sine curve. The area included in the figure ABCD, giving as it does the integral of the product effort into the space, will be the measure of the total work done in a revolution. Of this curve now consider one cycle (in a twin engine there are

Fig. 24.

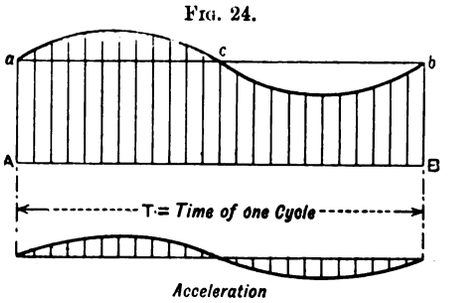

Fig. 25.

four cycles in a revolution), and, as shown in Fig. 24 (see also E. Rosenberg, *E.T.Z.*, 1902), the ordinates of the curve, the tangential pressures, may be considered to consist of a mean pressure, which is constant, and a variable pressure, which is alternately positive and negative. With the latter quantity we have to deal here. As long as it is positive we have acceleration, when negative retardation. The ordinates of this sine curve with ab as base will be a measure (assuming the proper scale) of the acceleration, the curve of which is shown in Fig. 25. It will now be obvious that, as long as the acceleration is positive, the velocity keeps on increasing, being a maximum at the instant the acceleration is zero. The velocity may also be the resultant of a mean velocity, represented by CD and a variable velocity, EFGHI (Fig. 26). The ordinates of the acceleration curve will be a measure of the velocity. On account of the variable velocity, a point of the rotating system will sometimes lag, sometimes lead, in regard to a supposed uniformly rotating system, or we have alternately negative and positive lead. The actual space traversed may, therefore, be considered to be the resultant of a mean space ABCD (see Fig. 27) and a variable distance shown by the sine curve CEFGD. We see, therefore, that the lead is nil when the variable velocity is a maximum or a minimum, and that the lead is a positive or a negative maximum when the variable velocity is zero. In other words, with a positive acceleration there is a negative lead, and vice versa.

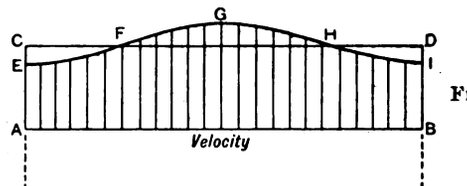

Fig. 26.

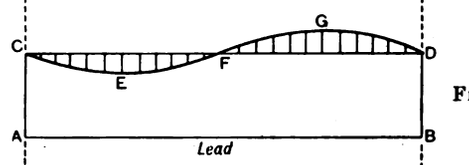

Fig. 27.

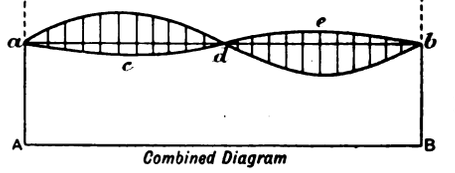

Fig. 29.

Treating the subject analytically, we have the following relations between the various quantities:—

Let P_t be the total tangential pressure, consisting of a mean pressure P, and a variable pressure p, or

$$P_t=P+p. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Let, further, p vary according to the sine law, so that

$$p=p_m\sin\left(\frac{2\pi}{T}\times t\right),$$

when p_m is the maximum value of the variable pressure, T the time of a cycle, and t the variable time. Let p be attached at radius R, and I be the moment of inertia, then the angular acceleration at any time t is given by

$$\sigma=\frac{pR}{I}=\frac{p_mR}{I}\sin\left(\frac{2\pi}{T}\times t\right). \quad . \quad . \quad . \quad . \quad . \quad (10)$$

The maximum value of the acceleration is $\sigma_m=p_mR/I$, from which it follows that

$$\sigma=\sigma_m\sin\left(\frac{2\pi}{T}\times t\right). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Let V^1 be the instantaneous value of the angular velocity, then

$$\sigma=\frac{dV'}{dt} \quad \text{or} \quad V'=\int\sigma dt=\sigma_m\int\sin\frac{2\pi}{T}t\times dt,$$

or $$V'=-\sigma_m\times\frac{T}{2\pi}\cos\frac{2\pi}{T}\times t+C.$$

It will now be evident that the integration constant C is here the mean velocity = V, so that

$$V'=V-\sigma_m\frac{T}{2\pi}\cos\frac{2\pi}{T}\times t,$$

or $$V'=V+\sigma_m\frac{T}{2\pi}\sin\left(\frac{2\pi}{T}t-\frac{\pi}{2}\right), \quad . \quad . \quad . \quad . \quad . \quad (12)$$

or $$V'=V+v=\text{mean}+\text{variable velocity}.$$

The maximum value of the variable velocity is

$$v_m=\sigma_m\times\frac{T}{2\pi},$$

hence $$V'=V+v_m\sin\left(\frac{2\pi}{T}t-\frac{\pi}{2}\right), \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

and $$v=v_m\sin\left(\frac{2\pi}{T}t-\frac{\pi}{2}\right). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

Now the coefficient of speed variation is

$$q=\frac{V_2-V_1}{V}=\frac{(V+v_m)-(V-v_m)}{V}=\frac{2v_m}{V},$$

or $$v_m=qV/2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

The amplitude of the lead is the integral of velocity and time, or

$$S=\int vdt;$$

with these assumptions we obtain

$$S=S_m\sin\left(\frac{2\pi}{T}t-\pi\right),$$

where S_m is the maximum lead.

$$S_m=v_mT/2\pi. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

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From equations (15) and (16) it follows that

$$S_m = \frac{q}{2} V \times \frac{T}{2\pi}. \quad \ldots \quad (17)$$

Now T is the time of a cycle, hence VT is the distance traversed in a cycle. Let n_c be the number of cycles per revolution, it follows that $VT = 2\pi/n_c$, and thus

$$S_m = \frac{q}{2n_c}. \quad \ldots \quad (18)$$

Expressing the maximum lead in electrical degrees

$$S_m = \frac{q}{2n_c} \times \frac{360}{2\pi} \times p_1, \quad \ldots \quad (19)$$

where p_1 is the number of pairs of poles.

From equation (19) we see that the maximum lead is directly proportional to the coefficient of speed variation and the number of poles, and inversely proportional to the number of cycles per revolution. Or, with a given lead and a fixed number of poles, the coefficient of speed variation should decrease proportionately to the number of cycles per revolution. This would mean that, for a given lead and a fixed number of poles, a double-acting twin engine with $q = \frac{1}{30}$ could only be replaced by a single-cylinder engine with $q = \frac{1}{15}$. This is, however, far from being the case, as we have not taken the reaction of the alternator upon the prime mover into account.

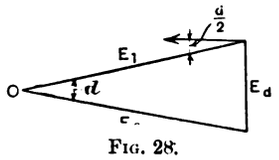

FIG. 28.

The synchronising current, standing practically perpendicular upon its own E.M.F., is given by

$$C_1 = \frac{E_d}{\sqrt{R^2 + (2\pi n L)^2}},$$

where R is the resistance and L the coefficient of self-induction. Assume now that the machine is short-circuited, which would take place if its E.M.F. E_1 and that of the 'bus bar E_2 lagged by 180deg. with regard to each other, the short circuiting current would then be given by

$$C_c = \frac{E_1 + E_2}{\sqrt{R^2 + (2\pi n L)^2}},$$

or

$$\sqrt{R^2 + (2\pi n L)^2} = \frac{E_1 + E_2}{C_c}$$

from which it follows that the synchronising current =

$$C_c \times \frac{E_d}{E_1 + E_2}$$

Assuming, now, for the sake of simplicity, that $E_1 = E_2$ (see Fig. 28), then

$$\frac{E_d}{2E_1} = \sin \frac{A}{2},$$

hence,

$$C_1 = C_c \times \sin \frac{A}{2}.$$

The power of this current

$$P_1 = E_1 C_1 \cos \frac{A}{2} = E_1 C_c \sin \frac{A}{2} \times \cos \frac{A}{2}.$$

But

$$\sin \frac{A}{2} \times \cos \frac{A}{2} = \frac{1}{2} \sin A,$$

hence

$$P_1 = \frac{E_1 C_c}{2} \sin A. \quad \ldots \quad (20)$$

The normal load power of a machine is given by $P_n = E_1 C \cos \phi$, where C is the normal load current, and $\cos \phi$ the power-factor.

The synchronising power may then be expressed as follows

$$P_1 = \frac{E_1 C_c}{2} \sin A = E_1 C \cos \phi \times \frac{C_c}{2C \cos \phi} \times \sin A.$$

In words:—The synchronising power is equal to the product of the normal power in the short-circuiting current into the sine of the lead, divided by double the watt current at full load. But the moments are proportional to the powers, so that the synchronising moment may be expressed by the normal turning moment, or

$$M_s = M_1 \times \frac{C_c}{2C \cos \phi} \times \sin A. \quad \ldots \quad (21)$$

With a short-circuiting current equal to $2\frac{1}{2}$ times the full-load current,

$$M_s = 1{\cdot}56 M_1 \sin A, \quad \ldots \quad (22)$$

or

$$M_s = M_1 \quad \text{when} \quad A = 40^0 \text{ (electrical)}.$$

We see that, under ordinary working conditions, there is a reaction upon the prime mover which cannot be neglected. The line of the back pressure will, therefore, not be given by the straight line *ab*, but by a wavy line *acdeb*, as represented in Fig. 29. The former diagrams (Figs. 24 to 27) are, therefore, not quite correct, and should be rectified on the basis of the combined diagram of Fig. 29. The rectified diagrams obtained in this way should then be used to rectify the combined crank effort and back-pressure diagram of Fig. 29, and so on. The acceleration velocity and lead diagrams of Figs. 25 to 27 would then become larger and larger, unless the synchronising force is very small in comparison with the variable pressure *p*. It is, therefore, of the greatest importance that synchronising force ÷ initial variable pressure (p) is small, as otherwise the lead will keep on increasing, causing the machine regulator before long to jump, which is one of the greatest dangers for alternators in parallel. The original lead, as represented in Fig. 27, is of little importance as long as the final lead, determined on the basis of the rectified diagrams, remains within workable limits, or as long as the above ratio synchronising force ÷ initial variable pressure is small.

It should further be mentioned that the crank effort and back-pressure diagrams suffer continual changes, which are due to variations in the steam pressure, changes in the composition of the gas, varying loads, &c. The fluctuations of energy, due to these changes, may be larger than those of the normal diagram, but they are not in any way connected with the coefficient of speed variation. Which machine will now be the most sensitive in regard to these changes? It is obvious that a gas engine with a large coefficient of speed variation will take scarcely any notice of these fluctuations. Its flywheel mass will be sufficient to store the excess of energy without the least trouble. But in a multi-crank engine, set with a high degree of uniformity, the mean tangential pressure will differ comparatively little from the maximum pressure, and the flywheel mass will, therefore, be comparatively small, and the above-mentioned irregular changes may produce unstable light. For these reasons it is essential that multi-crank engines should be given a smaller coefficient of speed variation than single cylinder sets. There is absolutely no reason whatever why alternators driven by single-crank prime movers should not give first-class results when running in parallel.

Where trouble occurs it is almost always due to resonance. It will in some cases be even possible to obtain better results by decreasing the flywheel mass, supposing forced and free oscillations are of the same or nearly the same duration. This is, however, not always advisable, especially with multi-crank sets, as the light may become pulsating on account of irregular changes, unless the coefficient of speed variation is less than $\frac{1}{300}$.

Gas engines give even more trouble than steam engines, which is usually put down to their low degree of uniformity. The trouble lies, however, very seldom with q, but chiefly with interrupted explosions or irregular gas supply, so that now one, then the other, alternator is leading. These irregularities produce also oscillations which interfere with the free and forced oscillations, and are especially troublesome if we have nearly resonance. The latter is the original evil, interference of the oscillations makes it worse. The importance of q is, however, often overrated.

The preceding remarks may be summed up in the following terms:—

Trouble occurring with single-crank sets, and being due to resonance, is made worse by interference of oscillations, and can be avoided by decreasing the flywheel mass if the coefficient of speed variation is as low as $\frac{1}{300}$. The flywheel mass will still be large enough to account for any irregular changes. The coefficient of speed variation should, however, never be larger than $\frac{1}{100}$. In multi-crank sets, working under similar conditions, q should not be less than $\frac{1}{150}$, so that, whenever we have nearly resonance, the flywheel mass should be increased. $\frac{1}{300}$ should, however, be the limit in the other direction, otherwise the machines become unnecessarily expensive.

(To be continued.)

THE RAILWAY ELECTRIFICATION PROBLEM AND ITS PROBABLE COST FOR ENGLAND AND WALES.*

BY F. F. BENNETT.

The opinion held by the large majority of electrical engineers on railway electrification is, that for suburban traffic only is it justified. It has been suggested that the electrification of main or trunk lines might result in a loss to the undertakers, as the load-factor at the power station would be a very poor one owing to the infrequent headway of traffic; but I shall endeavour to show otherwise. On the other hand, the suburban traffic existing in thickly populated areas calls for a more frequent headway and a greater acceleration of speed. This is not only desirable, but is quickly becoming a necessity, if the suburban railway system is to hold its own with municipal tramway competition; and it can be best attained by electrical methods.

The contention relative to main-line electrification is true if the separate railway companies only considered their own systems, and made electric power provision to meet each individual section of their own lines. If on 50 miles of railway, no matter where located, one power station were placed in the centre to work that section only, it stands to reason that the expenditure for electrification would not be justified. But, if the plant were competent to work the said section 25 miles north and the same distance south of the centre of power, it would also be competent to work all the network of lines within a radius of 25 miles, including even those belonging to other companies.

In 1901 there were 15,308 miles of railway open in England and

* Paper read before the Institution of Electrical Engineers on Thursday, March 10th. Abridged.

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Wales; consequently, if the companies provided one power station to work every 50 miles of their systems, there would be required $\frac{15,308}{50}$ = 306 power stations for England and Wales. Each company would probably have a separate technical adviser, therefore many and various systems of electric traction would obtain, making it impossible to have in the future a free and easy interchange of traffic, and chaos would reign supreme.

Now, assuming that the country could be divided into areas of 900 sq. miles, and a central power station were placed in the centre of each area to supply power to all railways, irrespective of whether they are separate companies or not, within such area. With the object of organising a uniform electrical system common to all companies, I would recommend the formation of a central directing Board consisting of members appointed by the railway companies, one representative for every 500 miles of railway or part thereof. After a period of investigation, this Board could finally select and adopt the system of electrification which they deemed to be the best one to be common to all the companies alike.

England and Wales contain 58,370 sq. miles; if we average the area required for each power station at 900 sq. miles (30 × 30), the total number of power centres required would be $\frac{58,370}{900}$ = say 65. Each railway company could subscribe towards the capital cost of erecting the power centres and sub-stations, in the direct proportion or ratio of their respective train mileage recorded in the complete previous year's working. If the system ultimately adopted should be one of polyphase generation, serving direct current to the trains through sub-stations, I would advocate one such sub-station to every 36 sq. miles, making a total of 25 distributing stations for each power centre. The companies could provide their own equipment such as rolling stock, feeders high and low tension, third rail or trolley wires—in fact, all the plant necessary outside the power stations and sub-stations. The current taken by each company for their purposes could be measured by meter, and the payments due from each individual company could be ascertained and adjusted by the Railway Clearing House.

To discover the total power required for working one section of 900 sq. miles, it is necessary to calculate the mean weight of each train along with the mean speed. In order to obtain the former, I have made inquiries from several reliable authorities, with the result that 200 tons per passenger train, and 350 tons per goods and mineral train, are safe figures to take. For passenger trains I have based the mean speed upon the time taken by 34 long-distance trains and 15 short-distance trains, taking Manchester as a centre. This I consider to be a fair average speed by passenger trains in England and Wales. The short-distance trains are taken to be within a 15-mile radius of Manchester at an average distance of 7½ miles. The long distance trains are taken to be without the 15-mile radius, at an average distance of 68 miles. There is no certain information to be ascertained as to the mean speed of goods and mineral trains, and for the purposes of this Paper I have taken this speed to be 15 miles an hour; with this traffic very considerable delays occur, such as shunting at stations to drop and take up waggons, running into sidings to clear for passenger trains, &c.

By aggregating the times occupied by the first five trains every day in running to 15 stations from four to 13 miles from Manchester, it appears that five hours 52 minutes are taken to cover a distance of 114 miles This is equal to a speed of 19·45 miles per hour. Similar figures for the first five trains every day in running to 34 stations from 17 to 222 miles from Manchester show that 81 hours and 29 minutes are taken to cover a distance of 2,322 miles. This is equal to a speed of 28·52 miles per hour. Owing to the more frequent headway of service on suburban lines there is not much difference in the number of train miles run per annum by suburban trains and main line trains, consequently the mean number of miles between the two services would be a fair indication of the mean speed of trains throughout England and Wales. I therefore take (28·52 + 19·5)/2 = say, 24 miles as the mean speed for the purposes of my calculations.

Taking the figures given in the blue book published by the Board of Trade on railway returns for England and Wales for the year 1901, and dividing by 65, we get for the mean passenger traffic obtaining on 900 sq. miles:—

Passenger train-miles	2,859,271
Number of passengers carried	15,710,443
Receipts from passengers	£609,365
Number of engines (half)	142
Number of coaches	637
Miles of railway	235

We can further deduce from these figures that there are:—

Passenger train-miles per day	7,835
Passenger train-miles per hour (18 hours per day)	436
Number of passengers per day	43,042
Number of passengers per hour (18 hours per day), say	2,400
Receipts per day	£1,670
Receipts per hour	£93
Receipts per train-mile	4s. 4d.
Receipts per passenger	9·3d.

The result of careful inquiries has elicited that the mean fare per passenger-mile can be estimated at 1d., that being the amount of the third-class fare. The excursion fares are much lower, but are counterbalanced by the first and second-class fares, which are higher. If the receipts are 1d. per passenger train-mile, and the train-mile receipts are 4s. 4d., the mean number of passengers per train must be 52, and the mean distance travelled by each passenger is 9·3 miles. The main line and suburban trains are made up of 10 coaches, having a mean carrying capacity for 500 passengers; the passenger load-factor is therefore only 10 per cent.

The number of trains required to be actually running—that is to say, consuming power—on each 900 square-mile section would be the number of train-miles per hour, 436, divided by the mean speed of each train, 24—viz, 18 trains. I have therefore to estimate for 18 trains, each weighing 200 tons, travelling at a speed of 24 miles per hour In Mr. W. Langdon's Paper, read before the Institution of Electrical Engineers on November 29, 1900, he recommends the following formula:—

Tractive effort per ton = $3 + \frac{V^2}{250}$, where V = speed in miles per hour.

$$\text{H.P.} = \frac{\text{tractive effort lbs.} \times \text{miles per hour}}{375}.$$

The power necessary for 18 trains, each of 200 tons, and making a speed of 24 miles per hour, according to this formula would be 68 M.H.P.

Assuming the total losses to be 100 per cent., which is rather an extravagant figure to take, we have a total power required for 18 trains of 2,448 M.H.P. In addition to this, allowance must be made for extraneous power, such as for shunting empty carriages, transit of empty carriage trains, transit of light engines, &c. If 50 per cent. is added for this, I think that it will leave a margin of safety. The total power would therefore be:—

3,672 M.H.P.

3,672 × 365 × 18 = 24, 125,040 M.H.P. hours per annum.

2,739kw.

2,739 × 365 × 18 = 17,995,230kw.-hours per annum.

Goods, Minerals, Cattle and Miscellaneous Traffic.

Taking the Board of Trade returns for 1901, and dividing as before by 65, we get—

Goods train-miles	2,254,500
Number of tons carried	5,401,798
Receipts	£690,691
Number of engines (half)	142
Number of waggons	8,426
Miles of railway	236

We can further deduce from these figures:—

Goods train-miles per day	6,176
Goods train-miles per hour	256
Receipts per day	£1,892
Receipts per hour (24 hours)	£79
Receipts per train-mile	6s. 3d.
Receipts per ton-mile	¾d.

After making numerous inquiries from all sorts and conditions of railway people, I have come to the conclusion that ¾d. per ton-mile would not be far out in expressing the mean revenue obtaining for all classes of goods and minerals. If 6s. 3d. is the amount of the receipts representing a train-mile, and ¾d. the receipts per ton-mile, the number of tons carried by each train must be 100. The revenue per hour being £79, the number of ton-miles would be £79/¾d. = 25,280.

The next point to arrive at is the mean speed of goods and mineral trains. Railway expert opinion being again resorted to, and the outcome of my investigations was that it would not be safe to allow a mean speed of more than 15 miles an hour. The number of trains to work this traffic on the 900 square-mile section would therefore, be $\frac{25,280}{15 \times 100}$ = 16·86, say, 17 trains. Where 25,280 represents ton-miles and 15 × 100 represents miles per hour × tons per train.

The gross weight of the train I put as follows:—

Goods and minerals	100 tons
Waggons to carry same	100 ,,
Locomotive and brake vans	100 ,,
Empty waggons on transit	50 ,,
Total weight	350 tons

The power necessary for 17 trains, each of a gross weight of 350 tons, with a mean speed of 15 miles, would be:—

$$\text{Tractive effort per ton} = 3 + \frac{15^2}{250} = 3{\cdot}9\text{lb.}$$

3·9 × 350 = 1.365 tractive effort per train.

$$\frac{1,365 \times 15}{375} = 54{\cdot}6, \text{ say, } 55 \text{ M.H.P.}$$

Assuming the total losses between the power centre and the train wheels to be 100 per cent. the total power required would be 55 × 17 × 2 = 1,870 M.H.P. The extraneous power absorbed in goods and

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mineral shunting at the various depots and at wayside stations would greatly exceed the extraneous power required for passenger service, therefore I consider an additional 100 per cent. none too much. $1,870 \times 2 = 3,740$ H.P. would be the total required for the locomotion and shunting of 17 trains.

$3,740 \times 24 \times 365 = 32,762,400$ H.P. hours per annum.
Converted into electrical (3,470 H.P. = 2,790kw.).
$2,790 \times 24 \times 365 = 24,440,400$ kw.-hours per annum.

The total for both passengers and goods is 42,435,630 kw.-hours per annum. The power plant required for this would be one of 5,529kw. capacity, but allowance must be made for duplication. In the Paper read by Mr. Langdon he considers 100 per cent. necessary for this, so I have based the following estimate on plant of 11,000kw. capacity.

ESTIMATE OF COST OF POWER STATION OF 11,000KW. CAPACITY.

Land and buildings	£50,000	
Steam generating plant for 11,000kw. at £20 per kilowatt	220,000	
		£270,000
Sub-Stations.		
25 stations, each of 1,000kw. capacity, land and buildings	50,000	
25 converters, each of 1,000kw. capacity at £7 per kilowatt	175,000	
		225,000
Distribution.		
Cables, including laying, £700 per mile for two tracks, 235 miles	164,500	
Extra required for sections of the route where four tracks exist, also for termini and sidings: these track, calculated to be equal to one additional or £350 per mile	82,250	
Contact rail and bonding, £700 per mile for two tracks	164,500	
Ditto for termini and sidings and where four tracks exist	82,250	
		493,500
Rolling Stock.		
285 motor carriages and electric locomotives at £3,000	855,000	
Less credit for 285 existing locomotives at £1,500	427,500	
		427,500
Total cost of electrification		£1,416,000

The above estimate being the cost of one section of 900 square miles, the cost of electrification of the whole railways in England and Wales would be $£1,416,000 \times 65 = £92,040,000$, or say £100,000,000.

The question now arises, would the saving in the working expenses justify this enormous expenditure? I shall endeavour to show that it would, but only on well-organised lines similar to those I have suggested.

In the Board of Trade returns for 1901 the total train-mileage is put at 332,808,431, made up as follows: Passenger, 185,852,615; goods and minerals, 146,520,704; mixed, 435,112. In the following calculations I base the cost of the goods and mineral traffic and the passenger traffic only. The total cost of locomotive power (including stationary engines) was £16,786,262. The cost of stationary engines as compared to the cost of the locomotive engines could only be infinitesimal, as they are used primarily for electric lighting and pumping purposes, and as the installation of the proposed electric power-stations would render the further existence of these engines unnecessary, I have not taken them into consideration for the purposes of this estimate.

$£16,786,262 \times 240\ 332,808,431 = 12{\cdot}105$d. per train-mile,

as at present shown by the Board of Trade returns.

From Mr. W. Langdon's excellent Paper, before mentioned, I extract the following points, and include them in my calculations. I am sure that the care that has been exercised in compiling them proves their accuracy:—

Coal	7 11½d. per ton.
Cost of staff at power station	0·0245d. per kilowatt.
Water	0 0050d. „ „
Sub-station.	
Staff	0·0299d. „ „
Outdoor service	0·0041d. „ „
Oil, waste and sundries	0·0109d. „ „
Locomotive drivers and assistants	2·6500d. per train-mile.
Repairs and renewals of machinery	2·0000d. „ „
Renewals of cables and contact rail or trolley wire	0·2590d. „ „

The total kilowatts required to be generated to meet the working of the whole system for one year would be:—

$42,435,630 \times 65 = 2,758,315,950 = 8{\cdot}288$kw. per train-mile.

The saving thus effected is £2,846,616, but it should be noted that this amount includes £3,500,000, the 3½ per cent. interest on the new capital necessary for the conversion. The difference in the cost per train-mile is 2·0571d. in favour of electricity, but excluding the interest on new capital the saving is 4·5844d. per train-mile.

Estimate of Annual Expenditure of Working by Electricity the Railway System of England and Wales.

—	—	Cost per train-mile.	Cost per kilowatt.
Capital outlay, £100,000,000— Interest at 3½ per cent.	£ 3,500,000	d. 2·5273	d. 0·3049
Generating stations staff	281,576	0 2031	0·0245
Coals, 4lbs. per kw.-hour at 7s. 11½d. per ton, 4,930,028 tons	1,961,740	1·4131	0·1705
Water, 25lb. per kw.-hour at 2d. per 1,000 gallons	57,465	0·0415	0·0050
Sub-station staff	343,640	0·2477	0·0299
Outdoor service	47,121	0 0339	0·0041
Oil, waste and sundries	125,273	0·0904	0·0109
Total estimated cost of generation and distribution	2,811,815	2·0297	0·2449
Locomotive drivers and assistants the same as at present	3,669,955	2·6465	0·3193
Repairs and renewal of machinery	2,769,777	1·9973	0·2409
Renewals of cable and contact rail	358,686	0 2580	0·0311
Locomotive oil, waste and sundries	123,334	0·0891	0·0107
Rates, taxes, office, insurance, &c.	692,444	0·5000	0·0603
Mixed traffic, 435,112 train-miles at 7·5206 per train-mile, electrical cost	13,635	—	—
Total cost of locomotion	7,627,831	5·4909	0·6623
Total cost of the whole	13,939,646	10·0479	1·2121

The paid-up capital, including loans, for 1901 was £986,646,782, and the saving obtaining from electrical working is equal to 0·29 per cent. The percentage on the cost of conversion is 2·85 per cent., in addition to the 3½ per cent. included in the estimate of cost.

Would this extra profit of 0·29 per cent. be a sufficient incentive for the companies to undertake this revolutionary departure? I am inclined to think that it would not, and yet to yield even this small amount of profit it is essential to treat, for purposes of electrification, the railway system as a whole, and in a properly organised way jointly, otherwise I feel pretty confident that the alteration or conversion could only be brought about by incurring a very heavy loss.

The point now to consider is in what way could electrification be introduced to justify not only this large amount of expenditure, but to benefit the shareholders and all classes of the public alike. It has been proved beyond a doubt that where an accelerated and a more frequent service has been given, along with a generous reduction in fares, the traffic has increased fourfold. In this country and in Italy I believe this to be the case. If this large increase has been obtained with passengers, is it not likely to obtain also with goods and minerals? My opinion is decidedly in the affirmative.

Now, assume that by gradual steps the railway companies were to reduce the passenger fares to one-half of the mean obtaining to-day—viz., to ½d. per passenger-mile, and the goods and minerals to 3d. per ton-mile, and to increase the long-distance speed to a mean of 50 miles an hour and the short-distance speed to 30 miles an hour, while at the same time doubling the train-miles by giving a more frequent service. The alteration would lead to an increase of traffic to at least threefold, if not more. The passenger load-factor at present of only 10 per cent. appears to be so ridiculously low that I think with a little differentiation it could be materially improved. It seems absurd to supply a conveyance weighing 200 tons to convey 2½ tons of people about, and that is what it really amounts to. The high peak of the suburban passenger load is when people are going and returning from business, consequently, for 10 or 12 hours out of the 18 the trains are running practically empty. Under these conditions one motor coach and perhaps a trailer would amply suffice during these periods of little traffic, instead of the 200-tons trains in use at the present time; therefore, with double the headway and an accelerated speed a far better passenger load-factor could be obtained. An alteration of this nature would solve many problems, the housing question being one of them. The alteration in the goods and mineral services would lead to the revival of many industries, besides bringing into being many new ones. It would be a boon of incalculable value to the agricultural interest. No longer would it be possible to send fruit and vegetables from the Continent to large Midland towns at a lower rate than from our own producing counties; nor would it be probable that finished articles of commerce would be sent from New York via Liverpool to London at a lower rate as from Manchester to London, as the railway freights to London would be less, which is not so at the present time.

With the view of ascertaining how the result would be likely to work out if this idea were entertained, I have made estimates showing the probable cost of new plant and the cost of running under these circumstances; I have calculated the increased traffic to be threefold under the conditions I have named.

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Allocation for 900-mile section :—

Passenger train-miles	5,718,542
Number of passengers carried	47,131,329
Receipts from passengers	£914,047
Number of engines	142
Number of coaches	873
Miles of railway	235

I deduce the following from these figures :—

Passenger train-miles per day	15,667
Passenger train-miles per hour (18 hours)	870
Number of passengers per day	129,126
Number of passengers per hour	7,174
Receipts per day	£2,505
Receipts per hour	£139 10s.
Receipts per train-mile	38·4d.
Receipts per passenger	4·65d.

If the receipts are 38·4d. per train-mile at ½d. per mile per passenger, there would be 77 passengers on each train. If we differentiate in the way suggested, and run trains of sufficient capacity during the day calculated to meet the different press of traffic, the mean weight of train might materially be reduced. By the adoption of a train of 150 tons weight, with a carrying capacity of 300, instead of a 200-ton train, we should have a passenger load-factor of 26 per cent., which, under the circumstances, I consider none too large. Taking the average of speed to be 40 miles an hour, the number of trains required to serve one area would be 870/40 = say 22 trains; in fact, owing to the acceleration of speed from 24 miles per hour to 40 miles, only four additional trains are required.

I estimate the power essential to supply this system to be as follows :—

$$3+\frac{40^2}{250}=9\cdot4 \text{ tractive effort per ton.}$$

$$9\cdot4\times150=1{,}410 \text{ tractive effort per train.}$$

$$\frac{1{,}410\times40}{375}=150 \text{ M.H.P. per train.}$$

Allowing for a loss of 100 per cent. between the prime motor and the train wheels, we have a total power required for 22 trains of $150\times2\times22=6{,}600$ M.H.P. To add 50 per cent. to this for extraneous power required, a total of 9,900 M.H.P. would be reached, this being equivalent to 7,365 kw.-hours. $7{,}365\times18\times365=48{,}388{,}050$ kw.-hours per annum.

We have now to consider the question of goods and minerals. By the reduction of 50 per cent. in the freight, the big towns in the north would be brought into closer commercial relation with the towns in the south, the interchange of mechandise would be more self-contained, consequently more independent of foreign supplies. The reduction would also lead to a greater demand for express traffic, and it would, in my opinion, be safe to base the mean speed of trains at 25 miles an hour. The mean net weight of merchandise carried I increase from 100 to 150 tons per train, the merchandise on a 900 square mile section under these conditions would, therefore, be :—

Number of tons carried per annum	16,204,394
Receipts	£1,036,036
Goods train-miles per annum	4,380,000
Goods train-miles per day	12,000
Goods train-miles per hour	500
Number of tons per day	44,395
Number of tons carried per hour	1,850
Receipts per day	£2,838
Receipts per hour	£118
Receipts per ton-mile	⅜d.
Receipts per train-mile	4s. 8½d.

The receipts per hour divided by the receipts per ton-mile, £118 ÷ ⅜d. = 75,520 ton-miles per hour.

The weight of merchandise, 150 tons × 25 speed in miles per hour = 3,750 ton-miles per train per hour. 75,520 ÷ 3,750 = 20 trains actually requiring power.

Gross weight of train :—

Merchandise	150 tons
Waggons to carry same	150 ,,
Locomotive and brake vans	100 ,,
Empty waggons on transit	75 ,,
Total	475 tons

Power :—

$$3+\frac{25^2}{250}=5\cdot5 \text{ tractive effort per ton.}$$

$$5\cdot5\times475=2{,}612 \text{ tractive effort per train.}$$

$$\frac{2{,}612\times25}{375}=174\cdot1, \text{ say, } 175 \text{ M.H.P. per train-mile.}$$

Add to this 100 per cent. to cover total losses, and the power required to run 20 trains would be $175\times2\times20=7{,}000$ M.H.P. per hour. Add 100 per cent. for extraneous power required, such as for shunting, empty waggon trains, light engines, &c., and we have a total of 14,000 M.H.P. to provide for, which is equivalent to 10,444 kw.-hours and 0·069kw. per ton-mile. The total required for both passsenger and goods traffic is, therefore, equal to 17,800kw. per hour. To allow for duplication of plant, I consider that the station should be of a capacity of 36,000kw. The annual demand of power would be for passengers, 48,388,050; for merchandise, 91,489,440; total, 139,877,490 kw.-hours. The total for the 65 stations embracing the whole of England and Wales would be 9,092,036,850 kw.-hours and 12,187,716,905 M.H.P.-hours.

The passenger train-miles for the whole system would be 371,705,230; the merchandise train-miles 284,700,000. The total is thus 656,405,230 per annum = 13·85kw. per train-mile.

Estimate of Cost of Power Station 36,000kw. capacity.

Land and buildings	£50,000	
Generating plant at £20 per kilowatt	720,000	
		£770,000
Sub-stations (25) 2,000kw.		
Land and buildings	50,000	
Converting plant at £7 per kilowatt	350,000	
		400,000
Distribution cables, including laying for two tracks at £700 per mile	164,500	
Extra required for sections of line where four tracks exist, also for termini and sidings—these are calculated as being equal to one additional track, £350 per mile	82,250	
Contact rail or trolley wire and bonding, £700 per mile for two tracks	164,500	
Ditto for termini, sidings, and where four tracks exist, £350 per mile	82,250	
		493,500
		1,663,500
Rolling stock the same as in other estimate		427,500
Total cost		£2,091,000

The total cost of electrification for the whole of England and Wales would therefore be £2,091,000 × 65 = £135,915,000, say £150,000,000.

Estimate of Annual Cost of Running.

—	—	Cost per train-mile.	Cost per kilowatt.
	£.	d.	d.
Capital outlay £150,000,000 at 3½ per cent.	5,250,000	1·919	0·1385
Power Station.			
Staff	464,073	0·183	0·0122
Staff (sub-station)	568,252	0·207	0·015
Coals 4lb. per kw-hour at 7s. 11½d. per ton, 16,236,780 tons	6,460,487	2·362	0·1705
Water 25lb. per kw. at 2d. per gallon	189,417	0·069	0·005
Out-door service	94,708	0·035	0·0025
Oil, waste and sundries	189,417	0·069	0·005
Total	7,966,354	2·925	0·2102
Locomotives.			
Wages to drivers and assistants. (As the mean speed has been increased by 60 per cent., the wages per train-mile has been reduced by 40 per cent. in these calculations—viz., to 1·59d.)	4,348,684	1·590	0·1148
Locomotive oil, waste and sundries	189,417	0·069	0·005
Repairs and renewals of machinery, 2½ per cent. on capital outlay of £150,000,000	3,750,000	1·188	0·0857
Office, rents, rates and taxes	1,094,008	0·400	0·0288
Grand total of expenditure	£22,598,463	8·091d.	0·5830d.

The question now arises as to what additional capital would be required to provide the extra accommodation necessary to cope with three times the traffic to that obtaining at the present time. The great bulk of the through stations would require very little additions to their size and accommodation to meet this increase in the traffic, but I see that great congestion would take place at termini and on the main trunk lines, some sections of which would necessarily have to be widened. There would also be some considerable additions to be made to the rolling stock, also in the extension of collecting and delivering vans. Time will not allow me to enter in full detail into the cost, but, roughly speaking, I think that an additional sum of £150,000,000 would go a long way to cover it. If I am right in this supposition, an increase of capital equal to £300,000,000 would be necessary to cope with the proposed greater train-mileage and the trebled traffic.

The total receipts for 1901 were £90,703,770, and the total working expenses were £58,349,606, being 64 per cent. of expenditure to receipts. We have ascertained the additional cost of locomotive working, but what would be the additional cost of dealing with the increase of traffic in other departments? A large increase in the subordinate staffs would be imperative, but only in those staffs, as the chief officials would be a standing charge and require no increase. I think that an increased expenditure of 25 per cent. in all other

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departments except that of locomotion would meet the requirements of the additional traffic. Now deduct the cost of locomotion, £16,786,262, from the total expenditure of £58,349,606 = £41,563,344, add 25 per cent. = £52,954,177, and also add to this the cost of locomotion under the new conditions, £17,348,463, and we obtain the figure £70,302,640, which is. therefore, the estimated cost of working the whole system under the new conditions.

The gross revenue obtaining would be increased from £90,703,770 to £136,055,655, and the result in the percentage proportion of expenditure to total receipts would be 51·6 per cent. as against 64 per cent., the figure obtaining at the present time.

The proportion of net receipts to paid-up capital in 1901 was 3·279 per cent.; the same proportion under the new proposed conditions would, after increasing the capital by £300,000,000 (viz., to £1,286,646,782), be 5·1 per cent., or an increase in the profits of 1·831 per cent., which would represent an additional profit of £23,558,421 per annum.

In a little pamphlet entitled "Should Railways be Nationalised," by Mr. W. Cunningham, he claims that under State management a saving of £30,000,000 would obtain. While not quite sharing this sanguine conclusion, I feel convinced that, either by State control or combination of the companies, a very great economy in expenditure might be looked for. A saving equal to £11,446,787 might easily result under such joint and direct management, and this would make the expenditure exactly 43 per cent. of the gross revenue, the result being a profit equal to 6 per cent. on the whole of the capital invested. If the State were to obtain control and absorb the companies at par value, the whole could be paid off in 24 years by adopting a sinking fund of 3 per cent. while paying 3 per cent. interest.

In conclusion, I wish to warn the railway companies from continuing in their present policy with regard to electrification. Indiscriminate installations are useless for proving whether electrification is economical. The only way by which electrical working can be made cheaper than the present method is by adopting one system common for all companies, controlled by one central body like the Railway Clearing House. There are six or seven railway systems in Manchester: would that centre not be a good one to test the system I advocate? Assuming that Manchester and 15 miles round were electrically equipped, the experiment could be made by reducing all the passenger fares to one-half within that radius; and if treble traffic resulted, my theory will have been proved to be correct. The next course to be pursued would be to electrify the whole of Lancashire in the same way, reduce the present fares and freights to one-half within the county, and if the expected results are realised, then the whole of England and Wales could be proceeded with. To show how British internal trade is handicapped by heavy railway rates, the following list will demonstrate the advantages possessed by the foreign producer over the British:—

1. Carriage of a ton of apples, Folkestone to London, £1. 4s. 1d.; California to London, 15s. 8d.

2. Carriage of a ton of British meat, Liverpool to London, £2.; ton of foreign meat, Liverpool to London, £1. 5s.

3. Carriage of a ton of eggs, Galway to London, £4. 14s.; Denmark to London, £1. 4s.; Russia to London, £1. 2s.; Normandy to London, 16s. 8d.

4. Carriage of a ton of plums, apples, and pears Queensborough (Kent) to London, £1. 5s.; ton of the same from Flushing (Holland), 12s. 6d.

5. Carriage, per ton, of English pianos, Liverpool to London, £3. 10s.; of foreign, £1. 5s.

6. British timber, per ton, Cardiff to Birmingham, 16s. 8d.; foreign, 8s. 10d.

7. Carriage of nails, wires, tubes, per ton, from Birmingham to London, 10s. 9d.; from Germany, 4s. 9d.

Carriage of English spades, per ton, £1. 1s. 9d.; of German, 6s. 6d.

In the carriage of iron ore and steel rails the American railway charge 6s. 3d., where the British charge £1. 9s. 3d.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Charge of an Electron.—J. S. Townsend compares the various values found for the charge of an electrolytic ion and an electron, and finds that the difference lies well within the limits of the probable experimental error. If E is the charge on a hydrogen ion or atom in a liquid electrolyte, N the number of molecules per cubic centimetre of a gas under normal conditions, then, since a known volume of hydrogen is evolved at the negative electrode when unit quantity of electricity passes through the liquid, the formula

$$N \times E = 1{\cdot}22 \times 10^{10}$$

is established, E being measured in electrostatic units. In this formula the most probable value for N, according to Lord Kelvin, is 10^{20}, and $1{\cdot}22 \times 10^{-10}$ is not improbably an upper limit to the value of the charge in electrostatic units. Of the values determined from electrons liberated by Röntgen rays, that of H. A. Wilson is probably the most reliable. By the method which he used he avoids the necessity of finding the number of drops in the cloud formed by the expansion of the conducting gas, and a very uncertain quantity is thus eliminated from his calculations. He concludes from his experiments that "it may be considered established that e lies between 2×10^{-10} and 4×10^{-10} electrostatic units." The lower limit is in fair agreement with the value $1{\cdot}2 \times 10^{-10}$ found for E by taking $N = 10^{20}$. Therefore, the value 2×10^{-10} does not differ by more than the factor 2 from the most probable values which can be obtained from the electrolytic and electron methods.

[J. S. TOWNSEND, *Phil. Mag.*, March, 1904.]

New kind of N-Rays.—R. Blondlot has found that besides the kind of N-rays already described, there exists another kind which reduces the luminosity of a feebly luminous surface instead of increasing it. The new kind, which he designates by N′, is specially abundant in the least refrangible part of the N-ray spectrum. On re-examining that part by means of an aluminium prism having a refracting angle of 60 or even 90deg., he found an alternation between the two different kinds of rays in the spectrum. The following is a table of refractive indices (for aluminium) and wave-lengths:—

	Index.	μμ		Index.	μμ
N′	1·004	3·0	N′	1·0125	7·4
N	1·0064	4·8	N	1·029	8·3
N′	1·0096	5·6	N	1·041	8·1
N	1·011	6·7			

On plotting these results in a diagram, it is found that the first five values lie close together on a simple curve. Certain sources appear to emit N′-rays only, or predominantly. Among these are wires of copper, silver and platinum. Bichat has found that ethyl ether, brought into a state of forced extension by Berthelot's process, emits N′-rays. When that state is ended, either by a slight shock or spontaneously, the emission of N′-rays ceases instantly. N′-rays, like N-rays, may be stored up. Thus, if a piece of quartz is brought near a stretched copper-wire, it emits N′-rays for some time after.

[R. BLONDLOT, *Comptes Rendus*, February 29, 1904.]

Faraday Rotation in Polarised N-rays.—The extreme smallness of the wave-length of N-rays makes it reasonable to expect a very pronounced magnetic rotatory polarisation. Such rotation has been foreseen and actually verified by H. Bagard. He used a prism of aluminium to separate out the various beams of N-rays, and polarised them by means of a glass plate held at an angle ranging from 59 to 71deg. The source of the rays was a Nernst lamp, and the polarised rays were transmitted either through aluminium or through carbon bisulphide placed in a magnetic field of about 50 units. Even with such a feeble field, the rotation observed was very large, amounting to a maximum of 45deg. in the case of aluminium and to 54deg. in the case of carbon bisulphide. These rotations would, in the case of ordinary light, require fields of great intensity. They are of the order of those observed in quartz with ordinary light. The rotation increases as the wave-length becomes smaller. On repeating the same experiments with ordinary light, the author only obtained rotations of some 4 minutes.

[H. BAGARD, *Comptes Rendus*, February 29, 1904.]

Luminous Emission under N-Rays.—R. Blondlot has found a probable explanation of the failure of many other physicists to repeat his observations. It lies in the fact that the emission of light is affected by the N-rays in the sense of being concentrated upon the normal rather than upon the tangent plane. Thus, an observer watching the surface perpendicularly sees it brighten up, while, if he watches it along the edge, it appears to become duller. In the case of the N′-rays, the reverse is the case. The influence of sound-waves discovered by de Lépinay, and that of the magnetic field observed by Gutton, act in the same manner.

[R. BLONDLOT, *Comptes Rendus*, February 29, 1904.]

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ELECTRIC RAILWAYS.

The completion of the electrical equipment of the Liverpool-Southport line of the Lancashire and Yorkshire Railway is an event of some considerable importance. Although this line is by no means the first electric railway to be opened in this country, or indeed the first line of steam railways to replace its locomotives with electric motor cars, it is perhaps more significant of the progress of electric traction than any other. The first electric railway in the United Kingdom, between Portrush and the Giant's Causeway, was opened in 1883. This was built on the third-rail system, but was altered into an ordinary overhead trolley system in 1899. Another short electric railway on the third-rail system was opened by Mr. MAGNUS VOLK at Brighton in 1883, and this is still running. These lines were both very light railways—practically tramways. They were pioneers, but electric traction in this country did not make much progress for some years after this; experimental work on tramways was much impeded by the 21 years' purchase clause of the Tramways Act of 1870, and by the outcry raised against overhead wires. Two conduit tramway lines were built, one between Gravesend and Northfleet, the other by Mr. HOLROYD SMITH at Blackpool; but, as in the case of many other engineering developments, England took the initiative and then paused, America worked further at the problem, and the fully-developed American systems were then brought over here. Trolley traction when it started in this country was practically an American industry. In the meantime, however, a good solid piece of English electric railway engineering was carried out by the City and South London Railway Co., and this railway—the first "tube" line—was opened in 1890. In 1893 the Liverpool Overhead Railway was opened (a system which was immediately approved and imitated in America), in 1898 the Waterloo-City "tube," and the Central London Railway in 1900. The first steam railway to be "electrified" in this country was the Mersey Railway, which was opened under the new conditions last summer, the second is the Liverpool-Southport section of the Lancashire and Yorkshire Railway, and the third will be the Tyneside lines of the North-Eastern Railway, the electrical equipment of which is in an advanced state. The case of the Liverpool-Southport line (and also of the Tyneside lines) differs considerably in character from the Mersey Railway. Both the Liverpool-Southport line and the Mersey Railway are, it is true, essentially passenger lines, both carry a suburban traffic and both are full-gauge heavy lines. The Mersey Railway is, however, self-contained, while the Liverpool-Southport line, although three times its length, is but one section of the large net-

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work of suburban lines owned by the main railway companies serving Liverpool. The success of this section, therefore, will doubtless mean the electrical equipment of all the other suburban lines of the Lancashire and Yorkshire Railway. The London and North-Western Railway will then, in all likelihood, follow suit, and it may even be conjectured that the latter company would then adopt a similar system in the Manchester district, and ultimately on its suburban lines around London.

Standardisation of track and working voltage is, therefore, important, and as a result of the conference last year at the Railway Clearing House in London, a third-rail system has been chosen with the third rail outside the running rails, and 3ft. 11½in. from the centre of the 4ft. 8½in. gauge. The line voltage has been fixed at 600. In the Lancashire and Yorkshire system a fourth rail is employed in the centre of the track, but it is not used as a contact rail, being simply bonded to the running rails to decrease the resistance of the return conductor. Many engineers are in favour of an overhead conductor system for railways as well as tramways, and it has many points in its favour, one of which is cheapness. On the other hand, there are many difficulties in the way of its adoption as the standard practice for the "electrified" main lines. Among these are the complications that would necessarily be introduced in tunnels and under low bridges, but probably the greatest difficulty would be the actual collection of the current. Large currents are required for heavy trains, and on some of the comparatively light railways that have already been built on the overhead system the trolley or collector-bow has had to be duplicated in order to afford sufficient contact surface. Of course, it is now the custom to put forward a single-phase system with high-tension distribution as a panacea for these troubles; but much experiment is still needed before such a system will be sufficiently perfect to standardise, and there is no need to wait in order to obtain what can at best be but a small gain in efficiency and first cost, when we have an excellent standard system ready to hand—for the "electrification" of our suburban lines is urgently needed.

In the methods of generation and distribution, the Lancashire and Yorkshire Company has followed standard practice —three-phase generation at high pressure, with conversion by means of stationary transformers and rotary converters in sub-stations to 600 volts continuous current. The train equipment necessitated the employment of trains made up of units which can be separated at times of light traffic. In choosing between direct control and indirect control by means of electro-magnetic or electro-pneumatic switches, the company has decided in favour of the former. A double-unit system has been adopted, with a motor car at each end of the train and two trailers in the middle. This has necessitated the employment of no less than eight cable couplings from one end of the train to the other, two main cables, four auxiliary cables for the series-parallel control, and two cables for working the reversing switches at the motors. There are thus two controller barrels worked by one handle in the cab of each motor car, each barrel controlling the four motors under one of the motor cars.

By this method the "contactors" or the electro-pneumatic devices of the usual multiple unit systems are dispensed with, and the control is direct, although these advantages have to be paid for by the employment of couplings carrying the main current, as already explained. In spite of the fact that reversing switches with their indirect control have still to be used, many engineers will give preference to the system adopted on this line, for it reduces the number of automatic devices considerably.

Enough has been said to indicate the general lines upon which the system has been laid down. They are good sound engineering principles, worthy of adoption by the first main line of railway to be electrically equipped in this country. We had the opportunity of riding in the cab of the front motor-car during a most successful trial run from Liverpool to Southport last Saturday, and also of inspecting the line, power house, sub-stations and rolling stock. A detailed illustrated description is commenced on another page of this issue. We may add one more fact in this place, however. The work has been carried out by a British firm, with plant and material manufactured in this country and to the specification of British engineers. The whole of it reflects great credit alike on the Lancashire and Yorkshire Railway Co. and on the contractors.

THE NATIONAL PHYSICAL LABORATORY.

The annual meeting of the general board of the laboratory will be held at Bushey House, Teddington, this (Friday) afternoon. The report, which is to be presented at the meeting, contains an account of the work done at Bushey House during the year 1903. In the department of electricity and magnetism the following tests have been made:—Resistance coils (128), resistance boxes (4), condensers (11), conductivity tests (7), permeability and hysteresis tests (8), inductance tests (3), permanent magnets (10), supply meters (10), miscellaneous (14); a total of 195, as against 31 during the nine months in 1902. In addition to the above, applications have been received for a number of tests which it has been found impossible to carry out owing to the incomplete equipment of the laboratory. Among such applications were some for electrical tests involving heavy currents, tests on alternate-current instruments of all kinds, and extremely high voltage tests on insulators. The equipment is, however, being extended in various directions; the alternating set given by Messrs. Siemens Brothers is now at work, but the transformers and certain of the alternating-current measuring instruments still remain to be installed. A number of important photometric tests are in progress for the Admiralty and War Office. The need of a powerful testing machine is greatly felt in the engineering department, and inquiries have been received from the Eastern Telegraph Co. for tests on ropes used for submarine cable work. Towards the end of the year arrangements were made whereby much of the electrical apparatus which is to be sent to the St. Louis Exhibition will pass through the tests of the laboratory, and, if approved, will receive certificates. The committee hope in this way that their aid may prove of value to the English exhibitors. One large firm has arranged to issue all its standard resistances through the laboratory. Thanks to the assistance of the Manchester Steam Users' Association, who voted £150 to the funds of the laboratory for the purpose, apparatus has been constructed for measuring the specific heat of superheated steam up to a pressure of 200lb. to the square inch, and the preliminary experiments made with it have shown that there is every reason to hope it will work satisfactorily. The method, due to Mr. Jakeman and Dr. Harker, consists in superheating the steam by means of an electrical current, and determining the rise of temperature produced and the watts required. The present apparatus is capable of dealing with a flow at the rate of 600 grammes of steam per minute, or about 80lb. of steam per hour, but it is hoped to construct apparatus which will permit of higher temperatures and pressures being used.

In the electrical division Mr. Smith has completed his research on the mercury standards of resistance, and has constructed 11 mercury tubes. The results obtained from these tubes agree among themselves to some two or three parts in 100,000, while the final result agrees with that obtained at the Reichsanstalt to one part in 100,000. A preliminary account of these experiments was communicated to the British Association at Southport, and a Paper, dealing with the whole, is ready for presentation to the Royal Society. Incidentally, Mr. Smith has compared a large series of standard resistances, and has re-determined the coefficient of change of resistance with temperature of mercury. The whole of the work is marked by a very high degree of accuracy. Another electrical research, undertaken at the request of the Engineering Standards Committee, is one on the effect of temperature on the insulating properties of materials used in dynamos, motors and transformers. This has been carried through by Mr. Rayner, who volunteered for the work; the results have been communicated to the committee and will be published in due time.

While the work of the laboratory has prospered, the financial position is one which gives rise to grave anxiety. The receipts for the year amount to £10,200. 4s. 3d. while the expenditure has been £10,306. 14s. 6d., thus leaving a deficit of £106. 10s. 3d. Last year the corresponding figures were £9,314. 19s. 3d., and £9,235. 9s. 8d., giving a balance of £79. 9s. 7d. In addition to this a sum of £1,036. 6s. 11d. has been spent on equipment out of the accumulations of income transferred from the Kew Committee. The balance* is now £2,379. 9s. 11d., as against

* This balance includes in addition to the cash at the bank the difference between the sums due to the committee and the debts due from the committee.

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£3,522. 7s. 1d. at the beginning of the year. The increase in income is due to the increase in the fees for test work, &c. The increase in expenditure arises mainly from the additions to the staff and to the working expenses, and from the fact that the laboratory was working fully for only nine months in 1902. Thus the laboratory is spending more than its income, and in the opinion of the committee a further increase in expenditure will be necessary in the present year. To meet this a considerable increase in income is urgently required. By drawing on the balance it will be possible to continue for another year, but the time has come when the financial position must be reconsidered. This is the more necessary since the period for which the grant of £4,000 was originally made ends in September, 1904. In consequence of this, the President and Council of the Royal Society have been in communication with the Treasury, and it has been arranged that the grant of £4,000 shall be continued to April, 1905—*i.e.*, for the financial year 1904-5—and that the committee should prepare a scheme for the consideration of the Treasury. The Treasury have been asked when the scheme of the Executive committee is received to carefully consider "the work and organisation of the National Physical Laboratory, with a view to laying down the lines that ought to be followed in the future," and have stated in reply that they "will be prepared to give careful consideration to the statement and proposals with regard to the future." It appears, from what has been already stated, that an increase of funds is required even to maintain the work of the laboratory as at present; a further increase is necessary if it is to carry out all the work for which there is a demand. Again, it is important for the sake of permanence that the positions of the senior members of the staff should be made more secure. The stipends now paid to the assistants—with one exception, £200 a year—are not commensurate with the work, and are insufficient to retain for long the services of men of the calibre required for that work, while the number of the staff is too small and should be increased. Again, in many branches the equipment is wholly inadequate. The divisions of electrotechnics and metrology must be extended, and more apparatus provided to meet the varied nature of the tests asked for, and the staff increased to carry out the work.

The following is a list of subscriptions received in 1903 towards the proposed annual fund of £2,500:—Institution of Civil Engineers, £500; Iron and Steel Institute, £200; Railway Companies' Association, £200; Society of Chemical Industry, £100; Eastern Telegraph Co., £50; Sir E. H. Carbutt, Bart., £25; Sir Bernhard Samuelson, Bart., £25; Messrs. Hadfield's Steel Foundry Co., £10. 10s.; Messrs. Vickers, Sons and Maxim, £10. 10s.; Messrs. J. J. Saville & Co., £3s. 3s.

The particulars given below are taken from the statement of work for the year 1904, to be submitted to the general board at their meeting.

ENGINEERING DEPARTMENT.

Steam Research.

The experience gained with the apparatus at present set up is sufficient to show that the method works and to give preliminary values for the specific heat of superheated steam. The next step will probably be to rebuild part of the apparatus on a larger scale so as to admit of larger flows and higher pressures. The present apparatus will stand over 200lb. pressure, and will condense about 80lb. of steam per hour; in any one of Regnault's experiments the maximum amount of steam condensed was 10 grammes. In an experiment of the present series, lasting for 5 minutes, 3kg. of steam are condensed. When this work has been completed the same apparatus will be utilised to determine the latent heat of evaporation of water at high temperatures; and finally it is proposed to determine the relation between the pressure and temperature of superheated steam.

PHYSICS DEPARTMENT.

Electricity Division.

The experiments made up to the present on standard cells seem to show that differences remaining in the mercurous sulphate obtained from different makers, even when re-purified in the standard manner in the laboratory, are the main cause in the differences observed between different standard cells. It is hoped that it may be possible to prescribe a standard method of preparing the sulphate, which will eliminate these differences. At present, the electrical test of purity is more sensitive than the chemical.

At the request of the Electrical Standards Committee of the British Association, the laboratory has undertaken the construction of a standard ampere balance, designed by the late Prof. Viriamu Jones and Prof. Ayrton. The coils of the balance consist of helices of bare copper wire wound on marble cylinders, and its working depends very greatly on the accuracy with which these coils are wound and measured; for this work the laboratory is well equipped, and an experimental coil has been successfully wound and tested. The funds for this work are found by the British Association. When this work is completed it will be possible to go on with the construction of the Lorenz machine, which is to be given by the Drapers' Company.

The tests on insulating materials for the Engineering Standards Committee will be continued; the invesigations now in progress relate to the distribution of temperature within the layers of the field coil of a dynamo or motor. Tests, as ordinarily made, give the mean temperature of the coils; it is desired to know by how much the maximum temperature may in practice differ from the mean. These experiments are being conducted in co-operation with Messrs. Cromptons, Messrs. Johnson and Phillips, Messrs. Mather and Platt, Messrs. Siemens Brothers, the British Westinghouse Co., and other firms.

Much requires to be done to complete the equipment for general testing work. Large currents are frequently needed for testing meters, &c., both direct and alternating. For this it will be necessary to supply some large storage cells and a set of step-down transformers for use with Messrs. Siemens Brothers alternator. The question of the automatic regulation of the current used for testing meters and similar apparatus is one of some difficulty, especially when the supply station is a small one and the load very variable. Considerable progress, however, has been made towards its solution, and it is hoped that the difficulty may shortly be overcome. The testing of electrical instruments has increased greatly during the past year, and there seems every reason to anticipate a continued increase; the accommodation provided is already becoming too small.

THERMOMETRY DIVISION.

The work proposed includes:—

Study of the thermo-electric force of junctions of platinum, platinum-rhodium and platinum, platinum-iridium, and of the effects of small impurities. For this research a good deal of material is in hand.

In conjunction with the engineering department, an investigation into the properties of steam, involving determinations of (*a*) the specific heat of superheated steam, (*b*) the latent heat at various pressures, (*c*) the variation of pressure with temperature.

METROLOGICAL DIVISION.

The work in prospect includes the following:—

1. The erection and standardisation of the two comparators referred to in the director's report. One of these is for lengths up to 10ft., the other is arranged for the rapid inter-comparison of the divisions on a given bar.

2. The completion of the standardisation of the steel yard and nickel metre. The yard is primarily intended for the standard leading-screw lathe, which is being laid down for the Standard Leading Screw Committee of the War Office, and when this is installed the measurement of the screws cut upon it will be undertaken by the department.

3. A comparison of an "end" yard and an "end" metre with the "line" standards and a calibration of the subdivisions of each. This work is urgently needed. A firm of engineers recently sent the same series of English-measure gauges to four different authorities for measurement, with the result that in the case of more than one gauge there were discrepancies amounting to as much as $\frac{1}{1000}$in.

4. The standardisation of a 4-metre and a 10ft. standard, which it is hoped to acquire.

5. The construction of an apparatus for measuring steel tapes and wires, also a machine for comparing "end" standards automatically.

6. A determination of a number of coefficients of expansion of nickel steels, in connection with the research mentioned under the head of "Metallurgy."

7. The inter-comparison of a series of weights from 1lb. to 56lb., and from 1kg. to 20kg.

METALLURGICAL DIVISION.

Nickel Steel Investigation. (Jointly with Mr. Hadfield.)

A series of eight medium carbon-nickel-iron alloys, having each about 0·45 per cent. of carbon and 0·8 per cent. of manganese, and varying in nickel content from 0 to 20 per cent., have been prepared by Mr. Hadfield. Specimens of each of these are, as far as possible, to be subjected to electrical conductivity, permeability and many other tests.

OPTICAL DIVISION.—*Photometry.*

The first piece of research is an investigation into the conditions under which the pentane lamp may be treated as standard. It is known that its intensity varies greatly with the quantity of aqueous vapour present, and also with the barometric pressure and with the carbonic acid. An examination into these causes of variation is now in progress; on its completion it will be possible to define the conditions under which the lamp may be used. The pentane lamp can only be treated as a secondary standard; the next series of experiments will relate to the establishment of some primary standard—*e.g.*, the radiation from a square centimetre of glowing platinum at a definite temperature, or that from a perfectly black body at a definite temperature. A considerable amount of work and expenditure is required before the life-testing equipment can be considered as completely satisfactory, and various important questions connected with the life and most efficient working of lamps have been raised by the electrical adviser to the Admiralty and by others. Some of these are now being attacked.

OBSERVATORY DEPARTMENT.

There are a number of investigations required connected with the magnetic instruments and the apparatus for recording the variations in atmospheric electricity which will be necessary for the observatory at Eskdale Muir. These Dr. Chree hopes to carry out. He is also engaged on the reduction of the Kew magnetic records, and has already obtained from them results of great interest.

(*To be concluded*).

Electric Traction in Sweden.—According to *Elektrische Bahnen*, the government of Sweden has been approached by the directors of the State Railways with a view of obtaining 425,000kr. (£13,500) for conducting experiments with electric traction. It is suggested that the trials should take place on the Stockholm–Värtan and Stockholm–Järfva lines, each about 5 miles long. Traffic is light on the first line, but heavy on the second. After studying the subject in Europe and America, Mr. Dohlander, the expert to the railways, issued a report on the question, recommending single-phase current for the trials.

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ELECTRIC WINDING MACHINES.*

BY MAURICE GEORGI.

Up to the present time electrical winding machines are practically unknown in this country, although on the Continent, especially in the mines of Silesia and Westphalia, they have made rapid headway during the last few years. The modern steam winding engine is well adapted to all the demands of the service; it, nevertheless, absorbs an immense quantity of steam, as the effort exerted is irregular, and, therefore, the admission of steam to the cylinders is essentially varying. For instance, in starting his machine the driver has to open his stop-valve completely, giving full admission in order to shorten the acceleration period. After a certain number of revolutions the haul is finished, and he has to stop his machine by using brakes or reversing; thus the whole of the kinetic energy of the system is lost. In lowering a load there is no means of turning to any practical use the work done, the liberated energy having to be constantly absorbed by the brakes.

The first advantage of electric winding is to diminish very considerably the coal consumption, which can be brought down to about one-third of its original value if a modern generating plant is adopted. Considering that the work done by winding machinery is of the most intermittent character, the torque to be overcome at the beginning being sometimes more than double that during the haul, it will be necessary, should no special contrivance be used, to design the steam engine driving a dynamo so that it can, when starting up, overcome the corresponding torque; and, on the other hand, it must work with an economical admission during the haul and whilst the winding machinery is at rest. The conditions are, as a rule, incompatible, so that engineers have been led to devise means by which energy can be accumulated whilst the engine is at rest, this energy being given up whilst working, so as to have, as far as possible, a constant admission to the cylinders, and consequently a high power-factor. If we use continuous current our mind is at once led in the direction of a storage battery. This system, in so far as theory is concerned, is perfect if the battery be of proper proportions, but it does not do away with the starting resistance, although the machine can be started in an economical way by a complicated battery sub-division, the motor being grouped on to various combinations of cells. The disadvantages of such a method of operating are at once apparent, the complicated and delicate electrical contrivances, together with the inherent disadvantages of storage batteries more than compensating for any gain which might be obtained in efficiency of operation. On the Continent numerous electric winding engines, some of considerable importance, have been designed on this plan, but have not proved suitable.

There are, however, methods using mechanical means of compensation which achieve the desired result by means of massive flywheels coupled to the prime movers. The disadvantage of the flywheel method is that a special generator will have to be reserved for each winding engine. For, if we employ three-phase plant and couple the engine on to a distribution network, we shall probably have some difficulty in keeping the alternators in parallel, the frequency never being constant owing to the drop in speed

As far as safety is concerned, the conditions that will have to be realised are: (1) The utmost security of working, as the winding engines are not only used for the extraction of minerals, but also for transporting men. (2) The speed of the machine will have to be regulated independently of the load—that is to say, independently of the current in the armature, and with the utmost possible economy. These conditions, especially the second, have been solved in a satisfactory manner by a new system of compensation devised by Herr Ilgner, of the Donnersmarckhütte. With this contrivance we can, without diminishing the favourable steam consumptions obtained by the other system of compensation, connect any number of winding engines to any kind of electrical distribution system. The arrangement is based on the well-known fact that a continuous shunt-wound motor with field of constant intensity, and fed by an independent source, will run with a speed directly proportionate to the applied voltage and to the number of turns on the armature. The torque is, of course, a function of the current in the armature, as the field is constant. Therefore, if we arrange a continuous-current dynamo with independent excitation, whose voltage can be regulated from zero to a positive or negative maximum by means of a field resistance, then a motor coupled on same circuit, and having a constant field, will run at a speed varying between zero and the positive or negative maximum. The starting of the machine is thus most economical, and at any time the energy consumed is only equal to the product of the voltage by the current. Taking the case of a machine running at quarter speed, the voltage is only one quarter, and, therefore, the energy one quarter of that necessitated at full load, provided the current be the same.

In Mr. Ilgner's device the current taken from the supply drives a converter, composed of a motor, a continuous-current dynamo, and a heavy flywheel. An automatic slipping device is fixed to the motor, by means of which, should the dynamo call for energy, and, therefore, the current in the motor have a tendency to augment, the automatic friction clutch is released, the flywheel giving up kinetic energy to the extent of $1/2k(\sigma_1^2 - \sigma_2^2)$; where k = constant and $\sigma_1 - \sigma_2$ the slip difference. The weight and speed of the flywheel are calculated so that for a given slip the output of the motor remains the same. Thus the winding engine, as far as the supply station is

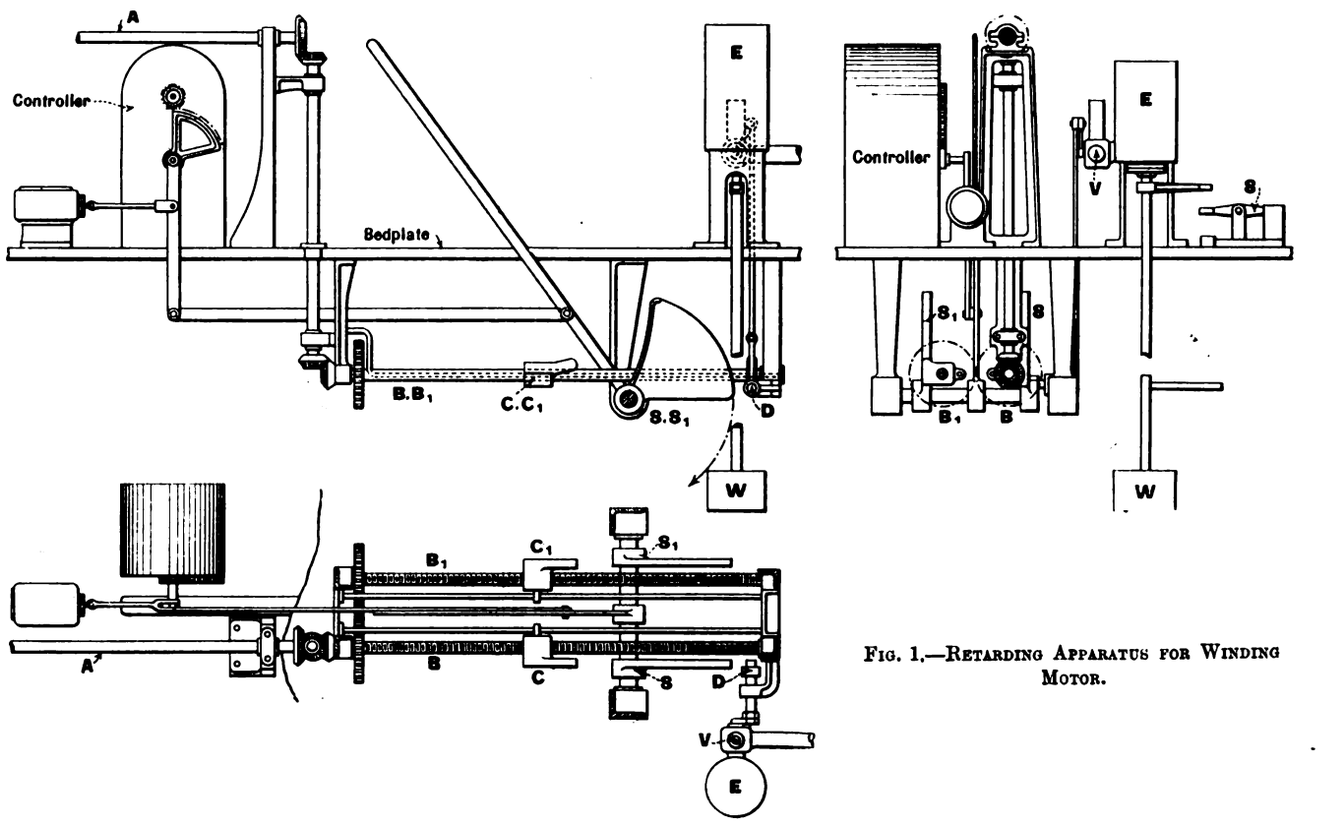

FIG. 1.—RETARDING APPARATUS FOR WINDING MOTOR.

* Abstract of Paper read before the Glasgow Local Section of the Institution of Electrical Engineers.

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concerned, may be considered as an ordinary motor of constant output. Owing to the motor being shunt-wound, the speed is practically independent of the load. This is a most important advantage possessed by no steam or electrically-driven engine; one position of the controller corresponds to but one speed. The brakes are absolutely useless, except for holding up the machine. It is immaterial if the dead weight is badly balanced, for if, at the beginning of the haul, a strong current is necessary to overcome the momentum on the drums, at the end the same will have become negative and will be driving the motor, thus sending energy back into the line.

Current from the dynamo of the converter is carried without interposition of any switch or fuse to the winding motor, and no sudden stoppage of supply to the winding motor is, therefore, likely to occur; safety appliances are practically useless, as the machine cannot be overloaded. The exciting current is produced by a small dynamo on the shaft of the converter. It is absolutely necessary that the voltage at the terminals of the motor should remain the same whatever the latter's speed may be. To effect this a very small dynamo, series wound, is placed next to the exciting dynamo. The current of this auxiliary dynamo passes through windings on the poles of the large dynamo and has a demagnetising effect; thus the fall of speed of the converter will have no effect on the voltage, as it will be compensated by a stronger field due to the current from the auxiliary dynamo diminishing.

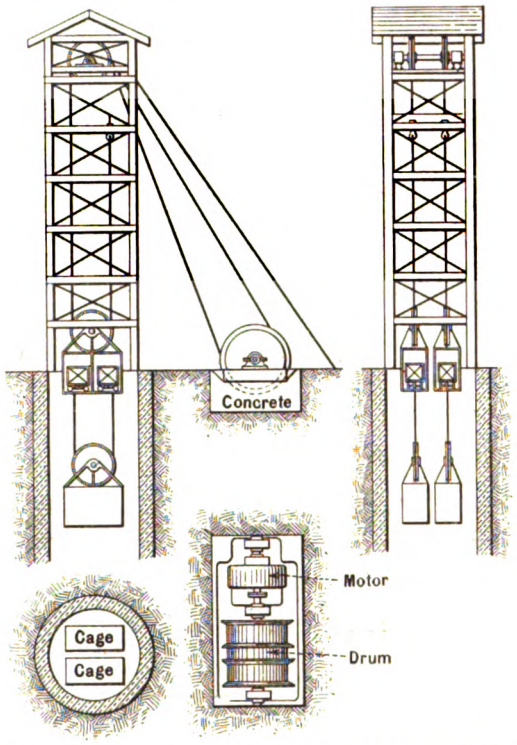

Fig. 2.—Arrangement of Motor Driven Winding Apparatus.

The general arrangements of the governing and safety apparatus are shown in Fig. 1. A horizontal shaft, A, is driven, by means of bevel gearing, from the main shaft of the winding engine. The motion of this shaft is transmitted to two parallel ones, B, B_1, placed directly under the bed-plate of the machine; each is cut as an endless screw, with filleting in opposite directions, and receives a cursor, C, C_1. On the controller levers are fixed sectors, S, S_1. The working is as follows:—When a haul is approaching its end and the machine has to be slowed down, cursor C comes into contact with the sector S. By its pressure the cursor causes the lever to come gradually back to the position corresponding to the minimum speed attainable; this operation brings about a vigorous and economical brakage, energy being thrown back into the line. Once the lever is on the last notch, the apparatus ceases its action, and by this time the cage has come to the surface. With the remaining voltage available the attendant can perform the remaining operations, and, when these are finished, push back his lever to zero, thus commutating the current in the field magnets of the dynamo. If, however, through neglect, he should allow the cage to get up into the pit gearing, the cursor then strikes on another button, opening at the same time the exhaust of the compressed air cylinder E, which holds up the weight W; this weight falls down, and, in doing so, cuts off the current at switch S, thus stopping the machine.

The brakes are two in number, the ordinary working brake being identically the same as that used with ordinary steam winding engines, with the exception that compressed air produced by an electric compressor is used instead of steam. The emergency brake, which is also a stop brake, is operating in the following manner:—The air cylinder E, with a piston, holds up the weight, and the section of the cylinder is calculated in such a way that the weight is only completely lifted when the pressure of the air is sufficient to ensure the proper acting of the working brake. The cylinder is provided with a three-way cock, V, which allows it to be placed either in communication with the atmosphere or the reservoir containing the compressed air. This cock cannot be opened by hand. It is, therefore, absolutely unnecessary for the attendant to pay any attention to slowing down his machine; the apparatus does it for him, and also stops it should he be unable to do so. Moreover, the attendant cannot start too suddenly, as the cursor takes a certain time to get back beyond the radius of action of the levers, and full speed cannot be obtained before this is done. The sudden stoppage of electric energy from the main does not interfere in any way with the good working of the engine, as the kinetic energy stored in the flywheel is more than sufficient to complete several hauls. Any winding engine can be employed with this system, but in any case it is always advisable to choose such an arrangement that renders possible the use of high-speed motors for a given rope-speed, and which at the same time reduces to a minimum the moment of inertia of the system. In Germany, friction discs are much in favour. These possess a small moment of inertia, and can be of small diameter, this factor being only limited by the thickness of the rope, the adherence being a function of the angle embraced and not of the length of arc. Thus, for a flat cable with a strain equal to 10 tons on the rope, and a factor of safety of 10, we can choose a disc of about 10ft in diameter, which, for a maximum speed of 40ft. per sec., would require a motor making 75 revs. per min. These discs have the disadvantage of only allowing a haul from one particular level, as the distance between the cages is always the same; and then, should the rope break, both cages fall to the bottom. The strain on the rope, however, can never be very great, as, should the cage meet with an unlooked-for resistance, the cable will have a tendency to slip on the discs, thus saving it from too great a strain.

An original arrangement adopted in some cases is shown in Fig. 2. It will be noted that the speed of the rope is equal to 2V, V being the velocity of the cage, and as the cage is held by two ropes, the diameter of same is only $\sqrt{2}/2 = 0{\cdot}707$, that of a single one; the diameter of the drums can, therefore, be smaller and the speed of the dynamo can be $2n \times 1/0{\cdot}707 = 2{\cdot}8n$, or about three times as great as if the ordinary arrangement be used. The cost of the installation is thus greatly reduced. It should also be noted that in the case of a steam hauling engine, the effort, and, therefore, the strain on the rope, is variable, and depends on the position of the cranks of the engine, whereas in the case of an electric winding-engine, this effort being constant, the rope is likely to last very much longer.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, March 10.

Mr. H. H. HUMPHREYS, consulting engineer to the National Traction Engine and Owners' Association, advocated increasing the speed of heavy traction engines in London from 2 to 4 miles per hour. He further stated his views with regard to the construction of new roads, regulation of traffic, unloading vehicles, &c.

Hon. SCOTT MONTAGUE, among other things, was greatly in favour of restricting trolley-wire standards for electric tramways to the side of the footpath. He stated that some years ago he moved in the House of Commons a resolution to this effect in respect of the London United Tramways, and to this Mr. Clifton Robinson had agreed. He also advocated new roads, street widenings, &c.

Mr. CHAS. BOOTH recapitulated what had been said by many others as to the establishment of a special tribunal, and stated that it was necessary that a complete scheme should be formulated under Government control.

Friday, March 11.

Mr. J. F. S. GOODAY, general manager of the Great Eastern Railway Co., recalled, was cross-examined on the question of workmen's fares.

Major-Gen. C. E. WEBBER said that a necessary line of communication in London was one running from Paddington to Clapham. Many years ago a tube railway along this route had been promoted, but had been refused by a Committee of the House of Commons. Mr. Greathead's estimate for the line was, that with trains capable of seating 150 passengers, running at two-minute intervals for 18 hours per day, and 6½ days per week, and with half the seats occupied, 27,000,000 passengers per annum would be carried. It was also calculated that with half this traffic the line would pay 4 per cent. dividend. His (witness) opinion was that, based on the traffic now carried by the Central London Railway, the traffic on the Paddington–Clapham route would be 15,000,000 passengers annually. The estimate for the railway, including two tubes 11ft. 6in. diameter, permanent way and stations, but exclusive of electrical equipment and rolling stock, was £907,000. He mentioned this latter fact because the cost of tube lines, which at present passed under the most

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densely occupied parts of London, had been much more in proportion. Subway railways provided smaller load units running at greater frequency than those on the Metropolitan, District or tube railways. The continually travelling platform was the ideal means of meeting the convenience of a dense town population. The next thing in practice to this was a railway with units the capacity of which was governed by the frequency. In one respect the latter was superior to the moving platform, because it was more elastic in its application both as regards size of unit and frequency. With regard to the disturbance of the surface of the streets by undertakers having statutory powers, he attributed much of this to the use of cables on the "solid system," which after a time necessitated frequent disturbance of the surface. The "drawing-in-and-out" system of cables, once laid with prudent foresight as regards space in the pipes, reduced interference with the traffic to a minimum. The provision of subways for pipes and cables many years ago would have been possible; but with the present congested condition of the streets with regard to sewers, &c., their construction was almost prohibited.

Mr. R. ELLIOTT-COOPER gave evidence which was intended to supplement that given a short time back by Mr. Arnold Hills respecting the course and reasons for the through line from Hammersmith to the North-east of London which was promoted in 1902. He said that he was of the opinion that no route had ever been suggested which equalled the one mentioned, as it was capable of extension in all directions. Such a through route must lead to better results than a closed circle. The one great objection to any closed circle was that it was incapable of further extension, except by junctions, which would be practically unworkable, and he considered the experience of the Metropolitan and Metropolitan District Railways since the circle was joined up was conclusive on this point. After explaining in great detail all the particulars relating to the Hammersmith-City-North-East London Railway when it was before Lord Windsor's Committee in 1902, witness said that no doubt shallow subways with railways running therein would be very convenient, but under existing conditions their construction would lead to almost insuperable difficulties except in the case of new and wide thoroughfares. Although Col. Yorke had suggested a diameter of 13ft. 6in., in view of the fact that the whole of the existing tube railways, with the exception of the Great Northern and City Railway, had a diameter of 11ft. 6in. where the line was straight, and 12ft. 6in. where it was on a curve, he did not consider there was any great necessity to increase the diameter to the extent mentioned by Col. Yorke, especially having regard to the very greatly increased cost which would be thereby occasioned. The cost of a 12ft. 6in. tube was 10 per cent. more than an 11ft. 6in. tube, so that the increase would be very material if the whole of the line were made with a minimum of 13ft. 6in.

PARLIAMENTARY INTELLIGENCE.

THE BREAKING UP OF STREETS.

In the House of Commons on Monday, Sir GEORGE BARTLEY asked the First Commissioner of Works whether he was aware that the wood and concrete of the new road in the Mall and the pathway between the freshly-planted trees, which had only just been laid, were already being picked up to place telephone or other wires; whether he was aware that similar destruction of the road had already happened twice since September; whether he could say who was responsible for this, what was the extra cost involved and out of what funds it was defrayed; and whether steps could be taken to lay all wires and pipes that were likely to be required for some time before the road was again reinstated.

Lord BALCARRES, in a printed reply, said: The cables of the Electric Supply Co. for lighting the Mall, now being laid, are in positions quite clear of the main roadway between the Queen Victoria Memorial and the present termination of the wood paving near the Duke of York's Column. As originally arranged, they are passing along the footways, which were specially left unfinished in view of this work. Where the Marlborough Gate roadway joins the new Mall, the taking up of a narrow strip of wood-block paving and the forming of a chase in the concrete is unavoidable, because the high-tension mains of the company can only be laid upon what is known as the "solid" system, and this necessitates an open iron casing for filling in bitumen. No earlier facilities to meet this contingency could have been provided, pending a settlement with the company, nor could the work have been undertaken at the same time as the roadwork without postponing the latter, as the mains on the "solid" system take a long time to prepare and are not kept in stock. The disturbance incidental to crossing the branch roadway is reduced to a minimum, and the expense is included in the cost of the cables as agreed upon with the company. This part of the work is chargeable to the supplementary vote passed for the works on the Mall. The First Commissioner is not aware of any telephone wires being required. As regards the roadway around the Queen Victoria Memorial, it was necessary to cross to the centre of the ring after the roadway was laid, and, for the reasons before explained, this had to be executed upon the "solid" system. All wires and pipes likely to be required will have been laid upon the completion of the present work.

LONDON COUNTY COUNCIL EDUCATION SCHEME.

In the House of Commons last week, Mr. WHITMORE asked the Secretary to the Board of Education whether he could state what memorials had been presented to the Board urging that the scheme of the London County Council for its future Education committee should be modified so as to provide for the co-option to it of persons of experience in education.

Sir WILLIAM ANSON, in a printed reply, gave the following list of memorials which had been received by the Board of Education: Central Governing Body of the City Parochial Foundation; Women's Industrial Council; Church School Union (Barnes); Mayfair Curzon Schools; Rev. J. J. Coxhead; Southwark Roman Catholic Diocesan Association; Westminster, &c., Schools Association (Roman Catholic); Miss Helen Conybeare and eight other educationists: Chelsea Borough Council; University of London; London Progressive Education Council; 45 Prominent Educationists; Incorporated Association of Assistant Masters in Secondary Schools; Incorporated Association of Head Masters; Women's Liberal Metropolitan Union; Kensington Borough Council; City of Westminster; Wandsworth Borough Council; City and Guilds of London Institute; B. J. Smythe, Esq.; and F. Pritchard, Esq. The Women's Industrial Council, Women's Liberal Metropolitan Union and the London Progressive Education Council ask for the co-option of a larger number of women.

TELEPHONE DIRECTORIES.

Lord STANLEY, in a printed reply to Mr. W. M'Killop in the House of Commons last week, stated that a copy of the latest directory of the National Telephone Co., containing a complete list of their subscribers, and a copy of the supplementary directory since issued, had been supplied for use at every Post Office exchange and call office in Ireland, as well as in other parts of the United Kingdom. Copies of the latest editions of the Post Office telephone directories had also been supplied. Instructions had from time to time been given that all obsolete directories should be withdrawn from use; and he would be glad if the hon. member will give him the names of any offices at which these instructions would appear to have been disregarded. The National Telephone Co.'s complete list of subscribers in the United Kingdom was published by the company at the price of 10s. per copy.

TELEGRAPHIC COMMUNICATION WITH THE NORTH.

In a printed reply to Sir Andrew Agnew in the House of Commons last week, Lord STANLEY said that the line of pipes for the underground cable to the North of England and Scotland now runs continuously from London to Carlisle, and a section of 19 miles had also been laid over the Beattock incline in Scotland. By the end of the financial year a double line of pipes would also have been laid from Manchester to Leeds. The permanent cable would be ready for use as far as Warrington. He could not at present state when the underground line will be completed, but he fully appreciated the importance of pushing on the work as rapidly as possible, and a large sum had been included in next year's estimates to provide for the extension of the line.

SURFACE CONTACT TRAMWAYS AND ELECTROLYSIS.

TORQUAY TRAMWAYS.

This bill came before Mr. Russell Rea's Committee of the House of Commons on Friday.

Mr. J. D. FITZGERALD, K.C., who appeared for the promoters with Mr. Vesey Knox, said the bill sought to authorise a system of tramways in Torquay. The question of providing tramway accommodation had been before the Torquay Corporation for several years, and the bill was now being introduced without any opposition on the part of the local authority. The tramways proposed ran from the harbour to a place called St. Mary's Church in one direction; from there a return was made through the centre of the city by another line to the harbour, and another line was proposed from the Tor station of the Great Western Railway Co., which was the terminus for visitors to Torquay, through the town to the front. The promoters of the bill were the Dolter Electric Traction Co. The Dolter surface contact system (see *The Electrician*, Vol. L., p. 192) which was new to this country had been very successful abroad. There was no opposition to the bill on its merits, but there were two petitions against the bill which were of a very different character. One was by a landowner who wished to compel the company to purchase the whole of his property, whereas they only wanted 8ft. of land, and the other was on the part of the Torquay Gas Co., which asked for special protection against electrolytic action upon their gas pipes. The history of electrolytic action, counsel continued, was that when electric tramways were first introduced into this country, some 10 or 15 years ago, the National Telephone Co. and some others were in the habit of opposing tramway bills, and asked for very special precautions for their protection. But the question arose, Were they entitled to any special protection at all? Some committees gave it, some refused it and others gave it in a modified form, with the result that the Board of Trade were placed in considerable difficulty as to what was the opinion of Parliament in the matter. Consequently, in 1893, a Joint Committee, under the chairmanship of Lord Cross, was appointed to deal with this question, and a large amount of expert evidence was heard by this Committee. The result was the Board of Trade issued regulations, which were inserted in all electric tramway bills, for the protection of gas and water companies, and clause 22 of the bill embodied these recommendations. For some time after the report of Lord Cross' Joint Committee, however, several promoters had agreed to give special protection, in addition to that afforded by the Board of Trade regulations, in order to save having an expensive opposition to their bills, with the result that the gas and water companies used these instances as precedent in order to get Parliamentary Committees to go beyond the Board of Trade regulations and grant a special clause. About the first case to be contested in this manner was in connection with the

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Dublin United Tramways Co. Then followed a similar contest in connection with the Wallasey tramways, but in both cases the special clause was refused, and the opponents had to be content with the model clause. Probably the most recent case of this character was the Bexley tramways. In that instance evidence was given by the officials of the Board of Trade that as soon as a case was proved to them that the regulations did not go sufficiently far, alterations would be immediately made, but that hitherto no such evidence had been brought forward. No case had been brought forward in which it was proved that the Board of Trade regulations had been complied with and yet damage had been done. After a discussion in the House of Commons last session, a special clause of this character had also been struck out of the Crystal Palace Gas Bill, and, as a matter of fact, no House of Commons Committee had ever yet sanctioned it. In spite of all this, the gas companies opposed wherever possible, and asked the Committees to hear the same old evidence over and over again. One thing which no doubt the Torquay Gas Co. was well aware of, was the fact that a special clause of the character in question was in the bill for the protection of the Torquay Corporation in respect of their water undertaking, and also the half of the gas supply which was in the hands of the local authority. But in this connection he wished to point out that, although the promoters had given the clause, it had been done only in order to secure the consent of the local authority which was necessary under the standing orders of the House. This clause was to the effect that nothing in the act should relieve the tramway company from liability to make compensation for any injury to the gas and water mains of the Corporation, and, of course, having given the clause under the conditions already mentioned, he had no intention of asking the Committee to amend it.

Mr. J. E. WALLER, of Messrs. Kincaid, Waller, Manville and Dawson, consulting engineers, said that hitherto the standard clause in respect of electrolysis had been inserted in all bills irrespective of the system of electric traction which was to be used. It was unnecessary that the Committee should be satisfied as to the merits of the particular system proposed. The consideration of this question was left in the hands of the Board of Trade, without whose certificate no tramway system could be put into operation. Theoretically, it was quite possible that damage to gas and water pipes from electrolytic action might be done, but the view of all tramway authorities was that no lines should be forced to use an insulated return, and this had been practically confirmed by the report of Lord Cross' Committee. He did not know of a case where such damage had occurred and in which the Board of Trade rules had been adhered to. The only instance he knew of was in connection with the City and South London Railway, which did not work under the Board of Trade regulations, and it was found that the drop of voltage was 20 instead of 7 volts. It must be pointed out, however, that even in this case the particular pipe damaged had been in a soil particularly well adapted for facilitating electrolytic action. Generally speaking, he considered the Board of Trade rules limited the escape of electricity as far as possible. After 10 years' experience no alterations were deemed necessary by the Board of Trade, and although a good many laboratory experiments had been made which proved that damage could arise, no case of any great magnitude in which it had actually happened had been discovered. Since the year 1896 he had been connected with 35 tramway bills. Out of this number only nine applications had been made for a special clause, the others having accepted the model clause in the Board of Trade regulations. Of the nine contested bills, in two cases a clause was inserted by consent. In four other bills the opposition was not proceeded with, and of the remaining three which were fought out, two were refused and the other one granted. It was also the invariable practice of the Light Railway Commissioners to refuse the clause. In the case of the Swansea light railway, the Commissioners struck out a special clause although it had been inserted by agreement between the parties. Later on, however, it was re-inserted by the Board of Trade because it had been put in by an agreement. There was very great difficulty in determining, even by chemical analysis, whether corrosion in pipes was caused by tramway currents, lighting currents or earth currents. In fact, it was possible to have corrosion without any current at all.

Mr. BAGGALLAY, K.C., for the Torquay Gas Co.: Do you know that the late Sir Courtenay Boyle once stated that the Board of Trade did not have the special staff to see that the regulations were being carried out?—Yes, but it does not require a special staff to see this if any non-compliance is actually taking place.

The Corporation are the suppliers of gas over one-half the borough, and of water and electricity over the whole of the borough?—Yes.

Is not the position, then, this, that you give to my competitors in lighting what you refuse to give me?—Yes. Neither party should have the clause, but the Corporation has sold us something and we have paid for it.

Are you familiar with the details of the Dolter system?—Not altogether, but I understand the general principles.

Well, the system was not before the public, or even invented when Lord Cross' Joint Committee sat?—No.

Under further cross-examination Mr. Waller explained that in the Dolter system if any stud remained "alive" after the skate had passed over it, a trailing device behind the skate short-circuited the stud.

Mr. BAGGALLAY: Supposing the trailing device does not act?—Then the leakage would be such that the Board of Trade regulations would not have been complied with and the tramway company would be responsible for any damage that might ensue.

Apart from any defective working of the stud or trailing device, is it not a fact that there is a great liability of continuous leakage with this system in wet or snowy weather?—I should not say there would be continuous leakage.

But in the British patent for the Dolter system this very difficulty is recited and a device is patented to get over it?—There might be a small leakage in wet weather, but it is absolutely a question of degree.

Well, then, in wet and snowy weather will you undertake that some current does not get to earth?—No, but the bulk is accepted by the rails, and a small portion would go to earth, but only a small portion of the latter will find its way to the gas or water pipes.

On Monday, Mr. Waller was re-examined by Mr. Vesey Knox. He said that the fact that a few studs leaked did not constitute a non-compliance with the Board of Trade regulations. At Wolverhampton, in connection with the Lorain system, it was found that only 1 per cent. of the studs remained alive, and the system had worked quite satisfactorily, without any question of electrolysis having yet been raised. The fact that a special electrolysis clause had been inserted in the bill for the protection of the Corporation had no reference to the system of traction being the surface-contact system. A second clause in the bill was to the effect that if the system proposed was not satisfactory within a month another system should be substituted.

Mr. W. C. C. HAWTAYNE, consulting engineer to the Dolter Electric Traction Co., who has prepared the plans and estimates for the tramways in question, explained in detail the working of the Dolter surface-contact system. It had been adopted in Paris on a length of 2 miles for two years, and a report had been issued testifying to the satisfactory working of the line. No question of electrolytic action had been raised except in connection with the Sourraine Bridge, but ample provision had been taken and no complaints had been made. He had made experiments in order to ascertain whether any leakage took place between the stud and the rail, but under ordinary conditions of weather no more danger was to be apprehended under this system than the trolley system.

Cross-examined by Mr. BAGGALLAY, Witness said that in Paris the regulations stipulated that there should not be a drop of more than 10 volts on the system, and in spite of there being gas and water pipes, as well as telephone and telegraph mains, along the route of the tramway no complaints had ever been made. From his tests he had not found the leakage from the studs to be appreciable.

By the CHAIRMAN: Excepting that the drop in voltage allowed in Paris was 10 volts instead of 7 volts as in England, the regulations were pretty much the same as those made by the Board of Trade.

This concluded the case for the promoters.

Mr. BAGGALLAY, for the Torquay Gas Co., in opening, said his object was to protect himself against the possibility of the Board of Trade regulations proving ineffective in respect of a system of traction which was not invented at the time the regulations were made. In addition, he would ask the Committee if it was fair that the clause for which he was asking should be granted to the Torquay Corporation and refused to the gas company. The Torquay Corporation supplied gas to one-half of the borough, water to the whole of the borough, and it also owned the electric light undertaking, in respect of all of which protection was given. Further, when the Corporation acquired the company's gas undertaking, the mains would then come under the provisions of this special clause, now granted to the Corporation, yet before the transfer of the undertaking could be completed, any damage from electrolytic action by reason of the tramways would have to be put right at the expense of the gas company.

The CHAIRMAN at this stage remarked that, in order to save time, the Committee was of the opinion that the gas company should be granted the protection it asked for, having regard to the special circumstances of the case. Any arguments on behalf of the promoters would, however, be carefully considered before a final decision was come to.

Mr. VESEY KNOX, for the promoters, pointed out that passing the bill was not necessarily authorising the use of the Dolter system, because the bill took power to utilise any system of traction, and before a particular system could be employed the Board of Trade would have to be satisfied that it was a good system and one which would work without danger to the public or to gas companies. Several instances existed in which the mode of traction was left to the discretion of the promoters, subject to the consent of the Board of Trade, without any special electrolysis clauses having been inserted. At Wolverhampton the promoters merely took powers to use mechanical traction, and no special protection was afforded the gas company. Something of the same sort occurred in connection with the Hastings tramways. With regard to the clause granted to the Corporation, frankly speaking, the promoters did not admit that it was necessary or desirable, but it had had to be given in order to obtain the consent of the local authority to introduce the bill. Never yet had a Committee of the House of Commons inserted such a clause against the wish of the promoters, and practically it had been decided by the Chairmen of Committees in the House of Lords that the clause should not in future be put into any bills originating in the Upper House. He was willing to comply with the regulations of the Board of Trade, and he thought he was doing all that should be asked of him.

The CHAIRMAN said that the Committee was of the opinion that a precedent would not be established if the clause were granted to the gas company, because the broad principle was not before the Committee. The promoters had submitted to liability in this matter over a large portion of Torquay, and when the Committee took that into consideration, together with the additional fact that by an agreement between the promoters and the Corporation any system of traction might be adopted (which might enable them to use a system which had not been considered by a Committee of the House), it was the unanimous opinion that the gas company should be granted the special protection asked for.

Some opposition on the part of a single landowner having been disposed of in favour of the promoters, the Committee found the preamble of the bill proved.

[The agreement between the Dolter Electric Traction Co. and the Torquay Corporation gives the latter the right to purchase the tramway undertaking at the end of 10 years at fair market value].

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AN ELECTRIC RAILWAY IN SNOWDONIA.

PORTMADOC, BEDDGELERT AND SOUTH SNOWDON RAILWAY.

A Committee of the House of Lords, of which Lord Kintore is chairman, considered this Bill last week.

Mr. H. LLOYD, K.C., on behalf of the promoters, said that the bill proposed the construction of about 3miles of railway in North Wales, between Carnarvon and Dinas, and, further, to authorise the acquisition, either by agreement or lease, of the North Wales narrow gauge railway. This latter line already existed from Dinas down to Snowdon, and extensions were authorised under the Light Railways Act down to Beddgelert and Portmadoc. From Beddgelert an extension in a north-easterly direction via Pen-y-Gwrhyd, Capel-Curig to Bettws-y-Coed had also been sanctioned by the Light Railway Commissioners. It was proposed to utilise the waters of the Lake Llyn Llydaw for the purpose of generating electricity by which the lines would be worked, and a pipe line would be run from the lake to the point on the railway, a short distance away, where the generating station would be erected. The district was rich in mines, as well as being a large tourist district, and a large traffic was certain to develop if the district was properly dealt with. At present a line was constructed from Llyn Gwellyn to Dinas, for both quarry traffic and passenger traffic, but at Dinas every slate and every passenger had to be transhipped to the London and North-Western Railway, which ran on to Carnarvon. This naturally resulted in much damage being done to the slates, and it was mainly for this reason that the promoters now asked for powers to construct the line from Dinas to Carnarvon. The only opposition was that of the London and North-Western Railway, and it was in respect of this piece of railway. As a matter of fact, however, the competition must be absolutely infinitesimal, as the London and North-Western Railway Co made practically no provision for local traffic, and the through service was a very poor one. One novel feature of the bill was in respect to finance. The new capital asked for under this bill was only £24,000, with the usual one-third borrowing powers, but it would be asked that this one-third should be applied to the capital powers (£270,000), authorised to the North Wales Narrow Guage Co. in 1901. On that occasion, for some reason, the borrowing powers were put at £60,000 instead of the usual one-third.

Sir DOUGLAS FOX, who has acted as consulting engineer to the company in conjunction with Messrs. Harper Bros., confirmed the opening statement. The reason why the remainder of the lines authorised to the North Wales Narrow Gauge Co. had not yet been constructed was because the gradients were very severe for steam traction, but now that a means had been found for applying electric traction, this difficulty was removed. He considered the new lines from Dinas to Carnarvon were well laid out, it being impossible to carry them otherwise than alongside the lines of the London and North-Western Railway Co.

The CHAIRMAN: What do you estimate the cost per unit of your electricity will be?—One penny.

Mr. E. MOON, K.C.: Does that include the interest on the cost of the generating station?—Yes. One penny is the cost per unit at the generating station. The current will be generated at high pressure and transformed at sub-stations.

The CHAIRMAN: Have you made a proper allowance for loss in distribution?—I think this will be very small. These difficulties are being gradually overcome. In Africa they are talking of transmitting electricity to a distance of over 200 miles.

Financial evidence was then called, which was to the effect that the necessary capital would very quickly be found, as the promoters had some influential supporters.

Mr. RAWLINGS, chairman of the new company and a director of the North-Western Electricity and Power Gas Co., said that the estimated cost of the generating station was £40,000. He thought there would be a large demand for electric power in the neighbouring quarries. The cost of the remaining portions of railway, other than those now constructed, was £140,000.

Mr. MOON, addressing the Committee for the London and North-Western Railway Co., said the proposals of the company under this bill practically constituted it an electric power company, although he could not say that this would be illegitimate. But his contention was that the line from Dinas to Carnarvon was unnecessary, and that his company provided all the necessary facilities which the district demanded.

Mr. H. LLOYD, having replied on behalf of the promoters,

The Committee found the preamble of the bill proved.

EXTENSION OF LIGHTING AND TRAMWAYS AREA.

CHESTERFIELD CORPORATION (TRAMWAYS AND IMPROVEMENTS) BILL.

This bill came before a House of Lords Committee last week, presided over by Lord Crewe.

Mr. J. D. FITZGERALD, K.C., who appeared for the Chesterfield Corporation together with Mr. Acworth, said the objects of the bill were to convert the existing horse tramways to electric traction, to construct new tramways, to extend the boundaries for the supply of electricity, &c. With regard to the electric supply undertaking, which was established in 1901, a profit was shown from the commencement. It was now proposed to extend the boundaries for electrical supply to include the neighbouring parishes of Newbold and Whittington Moor on the north and Hosland on the south, for which consent of the Councils concerned had been obtained. Similarly, it was proposed to construct tramways in those districts, and a saving in capital expenditure could be effected by laying the electric lighting and traction mains in the same trenches. The Councils in question had also given their consent to the tramways, they being the tramway authority. An endeavour had been made to form a joint undertaking of these tramways, but the local Councils had wisely determined that it was better to have one authority to control and work the lines. With the inclusion of the districts mentioned, Chesterfield would be the centre of a population of 100,000, in a radius of 6 or 7 miles. It was admitted that there would not be a sufficient demand either for tramways or electrical supply from a separate installation in either of the districts referred to. In Chesterfield there was a short length of horse tramway along the Chatsworth-road which was acquired for £2,050 by the Corporation in 1897. This would be converted to electric traction and form part of the whole system. The only petition against the bill was that of the Derbyshire County Council, who, although having given its consent as the road authority, opposed with the object of securing protective clauses.

Mr. JAMES PEARSON, Mayor of Chesterfield, confirmed counsel's opening statement.

Mr. E. S. NICHOLAS, borough surveyor to the Chesterfield Corporation, said that the estimates for the street improvements in connection with the tramways amounted to £23,641.

Mr. R. L. ACLAND, electrical and tramways engineer to the Corporation, said that the total cost of the new tramways would be £95,020, including £5,432 for the conversion of the horse lines. The cost of providing an additional generator, boiler, switchboard and other apparatus for the tramways was £8,980, including mains, &c., for the supply of electrical energy to the new districts. The total length of new tramways was approximately 6 miles.

After an adjournment an agreement was come to with the Derbyshire County Council, and the Committee found the preamble of the bill proved

ST. MARYLEBONE ELECTRIC LIGHTING BILL.

An application having been made by the St. Marylebone Borough Council for the insertion of a new clause into their electric lighting bill, which has already been passed by the examiners, the matter came before Mr. Jeune on Friday last week. The clause in question seeks power to authorise the Borough Council to enter into agreements with any company in connection with the execution, maintenance and management of any works needed for the electrical undertaking. No such agreements should be for more than 10 years without the consent of the Board of Trade.

A petition against the proposed clause was entered by the Gas Light and Coke Co. on the ground that standing orders had not be complied with.

The Examiner refused to grant the clause, and referred the matter to the Standing Orders Committee.

The matter came before the Standing Orders Committee on Tuesday, when it was decided to dispense with standing orders and to allow the clause to be inserted in the bill.

In the House of Commons on Tuesday, Mr. GODDARD moved that it be an instruction to the Committee considering the St. Marylebone Electric Lighting Bill to insert the "Bermondsey" clause, the terms of which were given on p. 748 of our issue of Feb. 26, at the time notice of the motion was given. He thought such a clause ought to be inserted in all municipal trading bills.

Mr. KIMBER, who, as we have already notified, has a similar motion on the paper in respect of the Acton Improvement Bill, seconded the motion.

Mr. BOULNOIS (Marylebone) thought the insertion of the clause might unduly hamper the Borough Council. At the same time he wished to point out that he had always opposed municipal trading of every kind, and had gone so far as to refuse to allow his name to be put on the Purchase Bill, but the ratepayers having decided by a considerable majority to proceed with the bill he was anxious to help them get through a bad bargain in the best possible manner.

Mr. FLETCHER MOULTON opposed the introduction of the clause.

Mr. BONAR LAW said the Board of Trade had always refused to insert this clause in electric lighting provisional orders. There was no doubt about it that the clause would protect the gas interests, but it would impose conditions of competition upon the ratepayers which were quite unfair. The Board of Trade opposed the instruction on principle, but there were also special reasons why the Marylebone Borough Council should not have it imposed upon them.

Mr. J. BURNS having opposed the proposition, the instruction was negatived without a division.

TRAMWAY INTERCOMMUNICATION IN LANCASHIRE.

PRESTON AND BLACKBURN TRAMWAYS.

Lord Kintore's Committee of the House of Lords on Friday last week considered this bill, to which the only opposition is by the Lancashire and Yorkshire Railway Co. on the ground of competition.

Mr. J. D. FITZGERALD, K.C., for the bill, said it was a proposal to link up the municipal electric tramway systems in Preston and Blackburn, a distance of 6 miles 4 furlongs, by means of a line of tramway, and to incorporate a company for this purpose. The capital asked for was £250,000, out of which it was estimated that the works would cost £70,000, and that the generating station and equipment would cost £150,000.

Mr. STEPHEN SELLON, one of the promoters of the bill, said that the line would be laid along the existing main roadway between the two towns, which was a splendid thoroughfare. With regard to the opposition of the Lancashire and Yorkshire Railway Co., he said their stations were in quite the opposite part of both Preston and Blackburn to that

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served by the tramway, and he had never known of a bill of this description being rejected on account of such opposition. He considered the estimates were ample, and the capital asked for sufficient in order to make the undertaking a remunerative one, and putting working expenses as high as 60 per cent. he anticipated a 5 per cent. dividend. The tramway would not abstract any traffic from the railway, but would create new traffic. In North Staffordshire the tramways had abstracted 500,000 passengers from the railway company, but at the same time had created a new traffic of 14,000,000 passengers, and since then the railway company had admitted that the tramway had had a beneficial effect upon their traffic. The population in Preston and Blackburn was about 250,000.

Evidence in opposition to the bill was then given by the Lancashire and Yorkshire Railway Co., but after speeches by counsel, the Committee found the preamble of the bill proved.

PRESTON AND LYTHAM TRAMWAYS AND TRAMROADS.

On Monday Lord Kintore's Committee of the House of Lords considered this bill.

Mr. BALFOUR BROWNE, K.C., for the promoters, said the bill proposed the incorporation of a company for the purpose of constructing an electric tramway between Preston and Lytham running via Warton and Freckleton. At Preston the proposed line would connect up with the municipal electric tramways, and at Lytham connection would be made with the authorised tramway between Blackpool, St. Anne's and Lytham, thus giving access to several seaside resorts. The line would be 14 miles long, the cost of construction being put at £122,000. The tramway would be laid almost wholly upon land belonging to private owners, all of whom had been settled with. The chief opposition was by the Lancashire and Yorkshire Railway Co. on the ground of competition.

Local evidence in favour of the scheme having been given,

Mr. STEPHEN SELLON, engineer to the promoters, said that the capital asked for was £250,000 with £62,000 borrowing powers. The total cost of the construction of the lines, including electrical equipment and power station was £205,300.

On Tuesday, Sir RALPH LITTLER, K.C., addressed the Committee on behalf of the Lancashire and Yorkshire Railway Co.

The CHAIRMAN: The Committee do not think that the requirements of the district warrant the construction of this tramway. The preamble is not proved.

WEIGHTS AND MEASURES (METRIC SYSTEM) BILL.

The Select Committee of the House of Lords, presided over by Lord Belhaven, which is to consider this bill, met for the first time on Thursday last week.

Sir HERBERT JEKYLL, of the Board of Trade, said it was considered that two years, within which the bill should come into compulsory operation, was too short. In no country had the metric system been finally adopted within less than four years.

On Tuesday last Mr. PURY, accountant to the London, Brighton and South Coast Railway Co., stated that the company utilised the metric system in connection with their Continental traffic.

Mr. ALLAN GRAINGER, chairman of the Incorporated Society of Weights and Measures, favoured the introduction of the system with regard to weights and measures, and saw no reason for exempting any particular trades.

Col. D. A. JOHNSTON, director-general of the Ordnance Survey, said that the principal objection from the public point of view was that the adoption of the system would alter the unit of all land measures. It would involve a republication of the whole of the Ordnance Survey maps which would take, roughly, 20 years.

Mr. T. KYLE, Inspector of Weights and Measures for Buckinghamshire saw no difficulty in the adoption of the system, and suggested that the Government should first begin operations in connection with the Post Office business, so as to educate the public.

The Committee adjourned.

PROPOSED TUNNEL UNDER THE THAMES.

NORTH AND SOUTH WOOLWICH ELECTRIC RAILWAY.

Mr. Russell Rea's Committee of the House of Commons continued its consideration of this bill on Friday last week.

Mr. STRAUSS, vice-chairman of the Bridges Committee of the London County Council, continued his evidence.

The CHAIRMAN: Will the London County Council maintain the free ferry if this scheme goes through?—I should say so.

And it will be maintained on the same scale?—Yes.

If you construct the subway would that be in substitution of the ferry?—That depends upon the character of the subway. If it is only for passengers we should have to keep the ferry for vehicles.

Then, as a Council, the London County Council has not considered the matter at all, and are not committed to any scheme?—The Council is decidly not committed to anything.

Are you confident that if this scheme is passed the Bridges committee will unanimously recommend this subway?—I think we shall still feel that something is necessary to improve the communication between the North and South of Woolwich, although I do not deny that this line will be of some benefit.

You cannot suggest that we have two rival schemes to consider?—I do not think I can fairly do that.

A MEMBER OF THE COMMITTEE: Would you be prepared to construct the subway within a reasonable time if the clause as to compensation is inserted in this bill?—I cannot pledge my Council, but I think the subway would be carried out within a reasonable period.

Mr. LEWIS COWARD, K.C., then addressed the committee on behalf of the London County Council. He said the attitude of the Council on this matter was perfectly consistent—viz., that the Committee having before them the whole facts of the case, should take care before passing, if they did, any scheme of this character, to protect the Council, and, consequently, the ratepayers through the Council. It was his contention that the Council had purchased a monopoly when it paid £32,000 for the old ferry, which was now free, but he was prepared not to consider this as the crux of his case. All he wanted was to be made safe, so that when the Council came to Parliament next session, as it certainly would, for powers to build a free subway, no question of compensation should be allowed to be introduced by the present promoters. The possible effect upon the ratepayers was that, if this clause were refused, they would be denied the advantage of the free ferry proposed.

Sir RALPH LITTLER replied to the effect that there was no precedent for what the London County Council were asking.

After a short deliberation,

The CHAIRMAN said: The Committee are unanimously of the opinion that the preamble of the bill is proved, but subject to the insertion of the provisions Nos. 2, 3 and 5 of the proviso to clause 13 of the petition of the London County Council.

These provisions stipulate that if at any future time the London County Council applies to Parliament for powers to construct a subway between North and South Woolwich the promoters of the North and South Woolwich Electric Railway shall not oppose, except upon details, and also that no question of compensation shall be brought forward by the railway company.

Sir RALPH LITTLER, on behalf of the promoters, said that after this decision it did not appear that he could usefully proceed with the bill any further, and before the clauses were considered he would ask for an adjournment in order to enable his clients to consider their position. Candidly speaking, he saw great difficulty in the way.

The CHAIRMAN agreed to adjourn the further consideration of the measure for a day or two.

THE CAPITALISATION OF TUBE RAILWAYS.

BAKER STREET AND WATERLOO RAILWAYS.

Mr. Russell Rea's Committee of the House of Commons considered this bill on Tuesday.

Mr. BALFOUR BROWNE, K.C., said the proposals in the bill related to a considerable expenditure upon improving the railway generally. They asked for £384,000 new capital in order to enable the company to construct new stations at Kennington-road, Regent's Park and Edgware-road. This necessarily involved the enlargement of the tunnels at these points, and the expenditure in this direction was put at £168,000, and upon the lifts and equipments in connection therewith another £78,000. Further, it was intended to make every car a motor car, thus having no trailers, and the cost of this would be £90,000, whilst improvements in the various precautions against fire would absorb the remaining £50,000 of the £384,000 asked for by the promoters. The tunnels were now constructed between Baker-street and Waterloo, and it was expected that this portion of the line would be opened in about 18 months. Opposition was given to the bill by the London County Council on the ground that extra capital was superfluous, and also for protective clauses, and a petition had also been deposited by the Southwark Borough Council with regard to the Kennington-road station.

Mr. W. R. GALBRAITH, one of the engineers to the line, said the capital of the company in 1900 was £3,179,000, and the total expenditure on works to date, exclusive of equipment, was £1,522,000.

Sir BENJAMIN BAKER said it was absolutely necessary to have the extra capital asked for in order that the railway could be made of the greatest possible use to the public.

After some cross-examination on behalf of the Southwark Borough Council as to the provision of passenger subways at the Kennington station,

The CHAIRMAN said the Committee could not entertain this opposition, as the Borough Council had no right to demand such subways to be made by the company.

It was then announced that the London County Council would confine its preamble opposition to questions of finance.

On Wednesday, Mr. POLLOCK, K.C., addressed the Committee on behalf of the London County Council. He said that his clients were merely seeking to protect the interests of the public. The authorised capital of the company prior to this bill was £3,179,000, and of this there was at present £1,650,000 unspent, and he complained that he had been unable to get any information from the promoters as to the possible further expenditure upon the undertaking which would be necessary. His whole argument, therefore was that the company had not exhausted its existing capital powers, and that, until this had been proved, no further capital powers should be granted.

The CHAIRMAN asked the promoters for further financial evidence as to the provisions of the bill and of the authorised capital, either by the chairman or a director of the company. He wanted to know the amounts of the estimates for the uncompleted portion of the undertaking for which there was still £1,650,000 available.

Mr. BALFOUR BROWNE, for the promoters, said it was a fact that all the previous capital authorised was already allocated, and there was absolutely nothing with which to carry out the provisions of the bill. If he were given a little time he could satisfy the Committee on this point.

An adjournment was then taken.

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Yesterday (Thursday) Mr. E. B. REID, secretary to the Baker Street and Waterloo Railway Co., handed in copies of two tables of figures which had been prepared. Under the original acts there was a sum of £1,574,000 still not spent. After taking into account the engineers' and surveyors' estimates for works, land, equipment, working capital, law, Parliamentary and engineering expenses, there was left a balance of £87,490,out of which any further interest out of capital during construction and any other expenses would be met. Any profit after the construction of the line above the estimates would go to the contractors. After having assigned the contracts originally entered into with the London and Globe Finance Corp. to the Underground Electric Railways Co. of London, the only balance of the original capital was the sum already stated, viz., £87,490. Since then, however, the Board of Trade had put very stringent regulations upon the company with regard to precautions against fire, and the extra capital now asked for was for this purpose as well as those stated in the opening speech.

Cross-examined by Mr. ERSKINE POLLOCK, K.C., for the London County Council, Witness stated that the original contracts were assigned to the Underground Railways Company of London in March, 1902.

Mr. W. R. GALBRAITH was recalled to testify to the prudence of the contracts.

Sir BENJAMIN BAKER, also recalled, said that in connection with the Central London Railway, for which he had prepared the Parliamentary estimates, he knew, as the arbitrator in all disputes concerning the contracts for that line, that no one made more than 10 per cent. profit. As engineer to the Baker Street and Waterloo Railway, he had prepared the estimates upon a similar basis, and, therefore, he maintained that no inflation was taking place.

The CHAIRMAN said the Committee were of the opinion that the preamble of the bill was proved.

OTHER ELECTRICAL BILLS.

The Metropolitan Railway Co.'s Bill came before the unopposed Committee of the House of Lords on Monday, all opposition having now been withdrawn. The objects of the bill are mainly financial, relating to the consolidation of various stocks and the raising of £750,000 new capital.

The Preston, Chorley and Horwich Tramways Bill, which came before a House of Lords Committee on Friday last week, sought to alter the position of a bridge over the Lancashire and Yorkshire Railway which was agreed upon between the railway and tramway companies when the tramway lines were authorised last session. The difficulty as to the exact location of the bridge, which was to close a level crossing now existing, was introduced by the refusal of the local authority to consent to the site first agreed upon. The railway company argued that the ageeement of last year should be carried out, and the level crossing closed, and this view was upheld by the Committee. It was eventually decided that the level crossing should be closed, and that the local authority, the tramway company and the railway company must agree as to the construction of the bridge.

On Monday in the House of Commons the Great Northern and City Railway (Extension of Time) Bill was read a third time and passed. On Tuesday the London United Tramways Bill was read a second time.

The Soothill Nether Urban District Tramways Bill was considered by a Committee of the House of Commons presided over by the Hon. A. de. Tatton Egerton this week. The proposal is to construct some 2½ miles of electric tramways in the Urban District of Soothill Nether, which is situated between Wakefield and Dewsbury. On one side of the district the tramway system of the Yorkshire (Woollen District) Electric Tramways Co. terminates, and on the other that of the Wakefield District Light Railway Co. This latter company at present has an application before the Light Railway Commissioners for a line serving the Soothill Nether district in much the same way as the proposal contained in the present bill, and, consequently, it has petitioned against it. Mr. J. E. Waller has advised the District Council. The Soothill Nether Urban District Council is undecided whether to work the lines themselves or whether they shall lease them. The argument of the Wakefield Company was that these lines would be merely of a local character, whereas in the event of the proposal which they had before the Light Railway Comissioners being passed, the exisiting Wakefield line would constitute a through route from Wakefield through Ossett and Soothill Nether to Dewsbury. The bill asks for powers to borrow £39,000 which includes the construction of new streets and also a refuse destructor. In his evidence Mr. Waller said that the cost of the tramways was £30,000, and that in the event of the Council working the lines themselves, electrical energy would be bought from the Yorkshire Electric Power Co.

Yesterday the Committee decided that the preamble of the bill was proved, but the lines must only be employed for passenger traffic. In addition, however, the Council will be precluded from constructing the lines themselves, but shall lease the construction and working of the lines for a period not exceeding 40 years. Any profits arising from the lease shall be set aside until a sum equivalent to the cost of the scheme shall be reached, after which the whole of the profits arising from the lease shall be employed for the purposes of relieving the rates. The fund is to be earmarked for the purchase of the undertaking at the termination of the lease.

The North Staffordshire Railway Bill, which has been before a House of Commons Committee this week, contains clauses giving power to the company to work its railways by electricity, and also to employ electric haulage on its canal. These clauses were unopposed.

The Southport-Lytham Tramroads Bill is now unopposed. The bill extends the time for the construction of the lines, and also deals with junctions between the lines of the company and those of the Southport Corporation.

In the House of Lords on Monday, the Govan Burgh Electricity Bill was read a third time.

On Friday in the House of Commons the Hampden-in-Arden Gas Bill was read a third time.

During the week a bill promoted by the Corporation of London for certain alterations to Southwark Bridge, with the object of reducing the steep gradients by which the bridge is at present approached on either side, has been under consideration by a Committee of the House of Commons. Amongst the petitioners against the bill are the London County Council, on the point that if the alterations as proposed are carried out it would not leave sufficient depth of roadway for the construction of tramways on the conduit system over the bridge, if at any future time powers for the construction of such tramways were obtained. The engineer for the City Corporation, however, whilst deprecating the establishment of a tramway terminus within the City limits, said he considered tramways could be constructed over the bridge, if they were ever sanctioned, with but very little alterations from the designs now suggested.

ELECTRIC TRACTION ON THE INNER CIRCLE.

In the House of Commons on Wednesday,

Mr. GERALD BALFOUR, in reply to Mr. Weir, said that both the Metropolitan and the Metropolitan District Railway Co.'s had informed him that the electrical equipment of their lines would be completed early in 1905. There was no statutory limit of time for the completion of the works.

POST OFFICE TELEPHONE SYSTEM.

In answer to Mr. John Campbell, in the House of Commons on Monday,

Lord STANLEY said that it was intended to continue the use of the central battery system for the Post Office telephone exchanges in London. It had given excellent results, and was both efficient and economical. He was not aware that the system had not found favour in other countries. On the contrary, he was informed that it was generally adopted for large exchanges in America, and it was either in use or about to be introduced in important exchanges in several European States.

LEGAL INTELLIGENCE.

Dixon v. Ito Syndicate (Ltd.)

This action came before Mr. Justice Channell, without a jury, on Monday, and was brought by the widow and executrix of Thomas Ingham Dixon, a contractor, to recover from the Ito Syndicate a balance of £7,401 alleged to be due from defendants under an agreement for the construction of electric tramways at Castleford. Plaintiff also claimed damages for wrongful determination of the contract. Defendants denied liability and counterclaimed for £8,000.

By agreement of March, 1902, between the United Kingdom Tramway, Light Railway and Electrical Syndicate, the defendants, and the West Riding Tramways and Electrical Supply Co., defendants undertook to do certain works, the whole of the consideration to be received by defendants being in shares of the West Riding Company. It was provided that plaintiffs should execute the works undertaken by defendants and that the contract price should be £220,000, of which £110,000 was to be paid in cash or shares in the West Riding Company at the option of defendants. Plaintiff executed part of the work, and had been paid £6,732, and in April, 1903, £7,401 more was due on certificate by the engineer of the West Riding Company, but defendants had refused to pay any part of that sum, and refused to allow plaintiff to complete the work.

The defence was that in November, 1902, defendants made a contract with Ernest Schenck for the sale of tramways orders and the undertaking referred to in the agreement. Mr. Schenck undertook to discharge all payments and obligations under that agreement as from Nov. 25, 1902, and plaintiff had full knowledge of that fact. Defendants counterclaimed £8,000 damages for loss suffered by reason of alleged bad workmanship of plaintiff in laying the rails in a dangerous and defective manner.

Mr. PICKFORD, K.C., for plaintiff, denied that plaintiff had accepted Schenck as the person liable to him, or had discharged defendants from liability. The new company formed by Mr. Schenck was called the Yorkshire Electric Tramways Construction Synd. As regarded the counterclaim, plaintiff's reply was that all the work was carried out under the direction and supervision of defendants' engineers.

Evidence was given as to the estimated loss of profits suffered by plaintiff by the non-completion of the contract.

Mr. RUFUS ISAACS, K.C., for defendants, conceded that the giving of the contract to Mr. Schenck in the manner it had been was a breach of contract with plaintiff. The only point was whether he had received any damage. His evidence would show that, in the condition in which the line was, it never could have been passed by the Board of Trade.

Mr. R. H. SCOTTER, consulting tramway engineer, gave evidence as to having inspected the line, and expressed the opinion that the tramway had been badly laid.

His LORDSHIP, in giving judgment, said that on the certificate plaintiff was entitled to £7,401. 1s. 8d. It was admitted that there were certain things which were required to be done in order to remedy defects on the tramway in question, and plaintiff said that for that work £300 was required. Witnesses on the other side said it would cost from £7,000 to £8,000 to put the line in a condition to satisfy the requirements of the Board of Trade. Whilst he considered that the contractor was responsible for doing his work properly in accordance with the directions given to him as contractor by the engineers he was not responsible for anything which might have to be done in order to alter the design to comply with the order of the Board of Trade. He preferred the

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evidence of the witnesses for plaintiff rather than those for defendants. With regard to the counterclaim, he had come to the conclusion that £500 should be awarded defendants in that connection. Plaintiff, however, should succeed on the claim for £7,401, and was entitled to damages for not having had an opportunity of finishing the work. These damages should be £5,000. That meant that plaintiff would have £12,401.

No order was made as to costs.

National Electric Construction Co. v. Rathmines and Rathgar Urban District Council.

In the King's Bench Division, Dublin, last week, Mr. Justice Boyd made an order on the application of plaintiffs for discovery of documents in this action, which is being brought for damages for alleged breach of a "free" wiring agreement, by which, among other matters, it was arranged that defendants should render to plaintiffs quarterly accounts indicating the amount of electrical energy supplied to various premises in the district where wires and fittings had been erected by plaintiffs. The agreement also provided for the rendering by defendants of accounts of the amounts received by them from consumers of the electric current on such premises, and, further, for certain payments to be made to plaintiffs. The documents to be discovered consisted chiefly of the correspondence between the parties.

Automatic Telephone Co. (1903) Ltd.

The petition of H. Le Blanc Smith and others for winding up this company was before Mr. Justice Byrne again on Tuesday.

In giving judgment, his Lordship said he was satisfied there were many things in connection with the company which required investigation, and that there would be no satisfactory winding up except under the jurisdiction of the Court. It was exactly one of those cases where everything pointed to the necessity for a compulsory order. He accordingly made a compulsory order and directed the books and papers to be handed to the official receiver.

Telephone Assessment.

At Edinburgh, on Tuesday, Lord Low closed the record in a note of suspension and interdict against William James Wood, rate assessor, of Glasgow. The complainants (Glasgow Corporation), as owners of the municipal telephone undertaking, had been assessed by the different parish councils in which the undertaking was situated for, among others, poor and school assessments. The annual value of the undertaking as appearing in the valuation roll was £6,820, and the value of the portion within the Parish of Glasgow was £3,472. The actual expenditure of the telephone department for 1903 had been £4,785, which was equivalent to a deduction of 70 per cent. on the annual value of the undertaking, and complainants maintained that in virtue of sec. 37 of the Poor Law (Scotland) Act, 1845, they were entitled to a deduction of at least 70 per cent. from the annual value in determining the amount on which they were liable to pay assessment. The Parish Council of Glasgow refused to grant any such deduction, and had assessed them on the footing that they were only entitled to a deduction of 20 per cent. The Parish Council also declined to refer the question to the assessor of railways and canals and respondent had intimated that he required immediate payment of the rates so imposed.

Tramcar Overcrowding Prosecutions.

At Bradford on Thursday last week the stipendiary magistrate (Mr. C. Skidmore) delivered judgment in the overcrowding case (reported in our issue of 4th inst.), in which Lieut.-Col. H. D. Sichel raised the question of the legality of overcrowding tramcars. The gallant colonel was summoned for refusing to pay his fare as a protest against the car being overcrowded and the stipendiary inflicted a nominal fine of 1d., without costs.

In the other cases the stipendiary said he was unable to find any authority to guide him, and the questions mainly depended upon the Corporation's bye-laws. The Corporation were summoned for not exhibiting notices giving the number of persons the car was licensed to carry, but in that case he thought no offence had been committed. The Corporation had contended that they were not bound by bye-law to exhibit such notices, and he agreed, and would therefore dismiss the case.

In the third case a conductor was summoned by Col. Sichel for failing to notify passengers that the car was full. He thought that, in not warning passengers, the conductor had contravened the bye-laws of the Corporation, and he therefore fined him 1s. and 7s. costs.

The magistrate agreed to state a case.

At Bristol on the same day two summonses (the 89th and 90th) against conductors of the Bristol Tramways and Carriage Co.'s cars for overcrowding were heard. In each case the number of excess passengers inside the car was five, and in one case there were only seven passengers outside. Judge AUSTIN said no practical inconvenience had been caused, but the Watch committee insisted, and the law must be enforced. A fine of 2s. 6d. and costs was imposed in each case.

Wasting Electric Current.

At Maidstone Police Court last week three boys were summoned for causing electric current to be wasted.

Mr. S. LANCE MONCKTON, who prosecuted on behalf of Maidstone Electric Lighting committee, stated that the offence consisted in switching on the incandescent electric lamps in the daytime. They had had great trouble with boys doing that sort of thing. The lights could be easily turned on with a stick, and youths turned them on in the day time and turned them off at night.

All the boys pleaded guilty. The Chairman dismissed them with a caution, and pointed out that if anyone was caught perpetrating that articular offence in future he would be severely dealt with.

Llanelly Tramways Co. v. Llanelly and District Electric Lighting and Traction Co. (Ltd.) and the British Insulated and Helsby Cables (Ltd.)

Mr. Justice Joyce in the Chancery Division yesterday and Wednesday heard an action brought by plaintiffs against the several defendants for specific performance of an agreement for the sale by plaintiffs to defendants of a certain piece of land in Llanelly, together with a building erected thereupon.

After a partial hearing his lordship allowed the case to stand over till to-day (Friday) to enable plaintiffs to amend their pleadings.

A report of the action will be given in our next issue.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Municipal Commissioners of Singapore (Straits Settlements) require an electrical engineer, with experience in the management of three-wire continuous-current supply station, and qualified to superintend the laying and maintenance of underground cables on the solid system and to take entire charge of their electrical department. The appointment will be made for three years, at £360 for first, £390 for second and £420 for third year, with transport allowance. Applications to Mr. C. C. Lindsay, M.Inst.C.E., 217, West George-street, Glasgow, by April 19.

The Council of the University of Birmingham require an assistant lecturer and demonstrator in electrical engineering. Applications to secretary by March 28. Salary £150 per annum.

The Council of the University of Liverpool invite applications for the professorship of Physical Chemistry. Total guaranteed salary, not less than £600 a year. Particulars from registrar, to whom applications by April 1.

A clerk with a knowledge of typewriting and shorthand is wanted in an electric light company's office. See advertisement.

Mr. H. A. Garratt, A.M.Inst.C.E., head of the engineering department of the Northern Polytechnic, Holloway, N., has been appointed principal of the L.C.C. Poplar Technical Institute.

Mr. J. W. Plackett, controller of telegraphs at the G.P.O., Edinburgh, has been appointed traffic manager in succession to Mr. Mason, taking the North of England and Scotland as his district.

Mr. C. E. Davies of Cardiff has been appointed resident engineer to the Wakefield and District Light Railway Co.

Mr. R. S. Pilcher, of Birkenhead, has been appointed tramway traffic manager at Burton-on-Trent.

Aberdeen.—The Tramways and Electric Lighting committee recommend that the salary of the city electrical engineer (Mr. J. Alex. Bell) be increased from £500 to £700 per annum in two annual increments of £100 each. One-fifth of the salary is to be charged to the tramways department.

Aberfeldy.—The proposed electric lighting and water scheme has been referred to a special committee for report.

Argentina.—The "Review of the River Plate" states that about half of the Buenos Ayres Metropolitan Tramway Co.'s system has now been converted to electric traction. It is anticipated that by July the whole of the lines (nearly 18 miles in length) will be operated electrically.

In a scheme submitted by Ganduefo & Co. for the establishment of electricity works for supplying current for lighting and power in Belgrano, Saavedra, Villa Urquiza, Villa Mazzini and Villa Devoto, which is again under consideration by the Buenos Ayres Municipal Council, provision is made for the acquisition of the undertaking by the Council on payment of the capital invested plus 20 per cent.

Mendoza electricity works and the area of supply are to be extended at an expenditure of $600,000 and the overhead conductors are to be replaced by underground mains.

Five 500 H.P. steam dynamos have arrived for installation at Rosario port works. In addition to electric lighting, electric driving is to be adopted for the grain elevators.

P. Lacaze and E. W. Sawyer have asked the Municipality for a concession for electric tramways.

Ashford (Kent).—In the proposed transfer of the Council's electric lighting order to a private company the Board of Trade have inserted a clause under which the Council can purchase the undertaking practically at any time by arbitration, failing agreement as to terms. As the company object to the clause, the Council have decided to amend it by placing a purchase limit of 21 years.

Ashton-under-Lyne.—The charge for electric current for street lighting has been fixed at 2d. and for theatres at 3d. per unit.

The salary of the tramway manager (Mr. A. Coveney) has been increased by £50 per annum.

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Association of Chambers of Commerce.—Among the subjects dealt with at the recent annual meeting of the Association of Chambers of Commerce were :—

Assignment of Trade Debts.—On the motion of Mr. Bedford (Sheffield), it was resolved that in the opinion of the Association any assignment by a private trader of his book debts should be registered in the same way as a bill of sale, and should otherwise come under the operation of the Bills of Sale Act.

Municipal Representation for Companies.—The Association passed two resolutions, moved on behalf of Manchester and London Chambers, expressing dissatisfaction with the refusal of representation to limited liability companies under the existing municipal electoral regulations and their consequent powerlessness to influence or regulate the taxation and expenditure of municipalities, and supporting the principle of a bill to be introduced in the present Session to give effect to the resolution passed in 1902 relating to the franchise in municipal and other local elections for corporations, limited liability companies, and other public companies, limiting the voting power to one vote per corporation or company.

State-owned Telegraphs.—Sir Edward Sassoon, M.P., moved: "That in the opinion of this Association all self-governing British communities around the globe should be united by a continuous chain of State-owned telegraphs." Lord Brassey seconded, and it was carried.

Communication with the Continent.—On the motion of Mr. H. Walker (Liverpool) it was resolved: "That in view of the growing trade of this country with the Continent of Europe, and of the active competition for such trade which its merchants have to maintain with those of other countries, His Majesty's Government be strongly urged to establish without any further delay, additional and improved cables between the United Kingdom and the Continent, and to arrange, in conjunction with foreign Governments, for more direct wires between the chief commercial centres of Great Britain and Europe, and for the more rapid delivery of telegrams in Continental cities."

It was also resolved that the Postmaster-General be urged to arrange with Continental Governments for the establishment of direct telephonic communication between the principal towns of this country and the Continent.

A motion by the British Chamber of Commerce (Paris) calling the Postmaster-General's attention to the inadequacy of telephonic communication between London and Paris for commercial requirements was adopted.

Lighthouse Communication.—It was resolved that steps should be at once taken to connect all lightships and lighthouses with the shore by means of telegraphy, telephones, or wireless telegraphs.

Telephone Call Boxes at Railway Stations.—A motion was adopted urging the railway companies of the United Kingdom to grant facilities for telephone call boxes to be placed on railway station platforms.

Anglo-French Telegraphs.—It was decided to call attention to the tariff for Anglo-French telegrams, which, it was contended, should be reduced to 1d. per word.

Aston.—At a meeting of the Council yesterday the Electricity committee reported that the present plant at the electricity works was inadequate to meet the increased demand for electrical energy, and unanimously recommended that the station and plant be immediately extended. Plans and estimates for the proposed extensions, putting the cost at £30,000, were submitted, and application is to be made for sanction to the borrowing of this sum. It was also proposed to apply for sanction to borrow £20,000 for expenditure in excess of the loan already sanctioned in connection with the electric lighting department.

Beckenham.—The Council have appointed Mr. R. P. Wilson their consulting engineer in connection with the proposed transfer of so much of the undertaking of the Crystal Palace District Electric Light Co. as lies within the Beckenham area; also for the extension of plant necessary to provide electric energy for tramways.

Belfast.—The Corporation have received the terms of sale from the directors of the Belfast Street Tramways Co., and these were considered on Tuesday.

The company agreed to a Board of Trade arbitration on the basis of 3½ years' purchase, calculated on profits taken over a period of seven years. The Corporation decided to offer three years' purchase on a five years' basis, with 10 per cent. extra for the Sydenham undertaking which the company bought last year. It is estimated the price will come to over £400,000. The Corporation have also agreed to allow the company to retain the sinking fund investments and cash and to pay three years' fees and salaries to directors, manager and secretary.

Bethnal Green (London).—The Finance committee have submitted an estimate for £9,250 for the purchase of freehold and leasehold property, for an additional site for electricity and dust destructor works.

Birmingham.—The Tramways committee expect to report shortly upon a comprehensive scheme of municipal electric tramways throughout the city, but the negotiations for mutual running powers for the Corporation's and the City of Birmingham Tramways Co.'s vehicles over the Steelhouse-lane and Aston Cross route have been broken off for the present.

An inquiry was held last week into the application of the Tame and Rea District Drainage Board to borrow £14,000 for the construction of steam and electric generating plant and the equipment of an overhead high-tension power transmission line from Saltley to Minworth Greaves, on lands belonging to the Drainage Board.

The Town Clerk (Mr. E. O. Smith) said the loan was required for an electrical installation, which would obviate the necessity of using any more portable engines. The scheme had received the sanction of the Drainage Board, and he had no doubt it would be approved by the Corporation.

Blackpool Electric Tramways (South) Ltd.—A petition for confirming resolutions reducing the capital of this company from £350,000 (£250,000 of which has been issued) to £100,000, will be heard at Liverpool on 21st inst.

Canadian Electric Railway.—In connection with a tender recently awarded for the equipment of the St. Thomas and Stanley Railway for the Canadian Electric Traction Co., of London, the contractors call attention to the fact that this is probably the first electric railway with plant of entirely British manufacture to run in Canada. The line will be 30 miles in extent, running from London, Ontario, through the city of St. Thomas to Port Stanley on Lake Erie. As soon as the St. Thomas and Port Stanley line is completed the railway will be completed from London to Hamilton, making the total distance 160 miles. Power will be transmitted at 10,000 volts, 25 periods, and will be transformed down to 1,000 volts for the motor cars, which are designed, as elsewhere stated, for a maximum speed of 30 miles an hour on the level and 15 miles per hour on gradients of 1 in 25.

Cape Colony.—The Municipal Council of Kalk Bay are about to introduce into the Cape Parliament a bill seeking authority to establish electricity supply in their district.

Cheltenham.—The Lighting committee recommend that the charge for electrical energy for public lighting be increased to 3d. per unit. The receipts from street lighting for the past year had been only 1·91d. per unit, which entailed a loss on this portion of the load. For current supplied for private lighting and motive power the committee recommend that the existing scale be altered (except to places of worship and special contracts) to the following scale from April 1 :—6d. per unit up to 500 hours' maximum demand per annum and 2d. per unit for all units in excess of that quantity.

Chester.—The question of an increase in the salary of the city electrical engineer (Mr. F. Thursfield) has been settled by what is reported locally as the unexpected resignation of Mr. Thursfield, who has accepted an appointment with Messrs. Preece and Cardew. Mr. Thursfield was appointed to his position at Chester in 1896.

A resolution that Mr. Thursfield's salary be raised from £495 by degrees to £700, which was carried recently by the casting vote of the mayor was, at a subsequent meeting of the Council, rejected. The Lighting committee thereupon offered Mr. Thursfield, as a compromise, an advance to £550, but this offer was declined.

Coventry.—At the City Council on Tuesday attention was called to a resolution of the General Works committee, expressing regret that British firms were practically debarred from tendering for the supply of rails, &c, for the tramway extensions at Coventry.

Councillor WEST said the tramway company was only asking that the points should be of American manufacture, and he understood the reason given was that English points had not proved satisfactory.

Councillor GARDNER said it was Hadfield's Steel Foundry Co., Sheffield, who had moved in this matter. They should have done so earlier. They knew a considerable time ago that these rails were being advertised for, but took no action until the day the tenders were going in. It appeared that the quotations for the same goods from English firms were considerably in excess of the prices of American makers.

Customs Changes.—A decree modifying the Customs tariff of Mexico in regard to a number of articles connected with the electrical industry has recently been issued. Among the items for which a change of tariff is imposed are bare and covered cables, copper, brass, bronze and other wires, covered and uncovered; posts, cross-bars, pegs, &c., for aerial electric lines; manufactures of coppered or bronzed iron, &c.

Dockyard Lighting.—As already announced, the Admiralty are erecting electricity generating stations at Chatham, Portsmouth and Devonport for the supply of electrical energy for lighting and power for the dockyards. Contracts have now been placed with Belliss and Morcom for 15 engines (865—1,080 H.P.) for direct-coupling to continuous-current dynamos, and for the Chatham Dockyard contracts have also been placed for the dynamos. The complete electrical equipment of Chatham station will comprise six 1,000 E.H.P. direct-coupled generating sets, four 100 H.P. balancers and boosters, and 4,000 H.P. in motors (varying from 5 H.P. to 75 H.P.), a main switchboard, &c.

Dublin.—The report of the auditor (Mr. J. W. Drury) on the accounts of the Corporation for the year ended March 31, 1903, has been submitted to the Local Government Board.

Mr. Drury states that he spent a considerable amount of time in investigating the electric lighting accounts and had several interviews with the chairman, the secretary and the consulting and resident engineers of the committee. The large contracts which were entered into for buildings, generating and distributing plant were all carefully considered and the system to which he took exception on a former occasion of placing orders involving large sums of money without public competition had been discontinued. Advertisements were issued, tender sobtained, and in the large majority of cases the contract was given to the firm sending in the

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lowest tender for the particular section of the work. Where the lowest tender was not accepted substantial reasons were, in all cases but two, shown. He had requested further information with regard to those two tenders. As it would be necessary at future audits to examine the financial transactions of the undertaking as a trading concern, it became important to have the account opened on a sound basis and as from a defined time. The period of the change over from the Fleet-street to the Pigeon House installation occurred conveniently at the end of the half-year. He had, therefore, requested that the accounts be separated as at Sept. 30 last, charging all establishment and running expenses, salaries, &c., from that date to the new scheme.

On the general subject of the borrowings of the Corporation, Mr. Drury directs attention to the large number of separate loans contracted with the Commissioners of Public Works on which unexpended or over-expended balances exist. Many are of long standing, and were obtained for works completed a considerable time ago, and in respect of which no expenditure properly chargeable to capital has been recently incurred. As the unexpended balances cannot be applied to purposes other than those for which the loans were incurrred, they should be refunded to the lenders; the over-expended balances should be provided for out of revenue, so that the loan account may be finally closed.

The report also states that the electric light and water works accounts show as "assets" of the year sums of £6,228. 16s. 2d. and £7,119. 1s. 1d. respectively, which were the charges and rents for electricity and water supplied during the quarter ended the last day of the year. The accounts could not be furnished for weeks after it had closed, and yet credit was taken for that "asset" in spite of the fact that the accounts already included the revenue from those supplies for a full year. Mr. Drury contends that these items are improperly included. The Corporation of Dublin (says Mr. Drury) is not a large trading concern; it has no right to assume that position. If it were, and if it were necessary to prepare a profit and loss account to show the results of its trading, it would be correct to bring in assets, though even then not to the extent adopted by the Council.

Dunfermline.—The Council have decided to feu a site of 12 acres at Town Hill to the Fife Electric Power Co. for an electricity generating station.

Eastbourne.—Sanction to a loan of £3,221 for condensing plant has been applied for.

Egypt.—A report has been issued by the British Chamber of Commerce in Egypt, in which it is stated that among the various fields of enterprise in that country which offer at the present time opportunities for expansion is the trade in electrical appliances for traction, lighting, telegraphic and telephonic purposes. Electric lighting as an illuminant is becoming more general in all parts of Egypt, and particularly in many of the interior towns. The telephone is also a developing industry, and the report states that there is a large field for British trade endeavour in Egypt, where trading conditions are not unfavourable to British merchants and manufacturers.

A report recently published by the British Chamber of Commerce, Cairo, lays stress upon the remarkable progress made by Italian enterprise in Egypt during the past few years, particular attention being directed to the imports of generating plant for the Ramleh electric railway system, the Cairo electric tramways, &c.

Electric v. Gas Motors.—A statement made recently at the meeting of the Cork Gas Consumers Co. that many electric motors in Cork had been replaced by gas engines has brought from the engineer and manager of the Cork Electric Tramways and Lighting Co. (Mr. H. Nalder) an emphatic denial. There are about 150 electric motors, aggregating over 1,000 H.P., taking current from the company's mains, and over 30 motors have been installed in factories in Cork during the past 12 months, superseding gas engines in many cases, whereas not one electric motor has been replaced by a gas engine during that period.

Electric Motors in France.—There is said to be a large demand in France for small electric motors ranging from $\frac{1}{12}$ H.P. to $\frac{1}{8}$ H.P., built as compactly as possible.

Electric Tramways and Progress.—At a recent inquiry into an application by the Crosby District Council for a provisional order, the surveyor (Mr. W. Hall) attributed the great increase in the rateable value of the district during the past five years to the influence of the electric tramways.

Electric Tramways over Thames Bridges.—In connection with the proposal of the London United Tramways to construct tramways over Kingston and Hampton Court bridges, in order to connect with their authorised routes in Surrey, Surrey County Council have appointed a committee to confer with a committee of Middlesex County Council and the company on the subject of widening or reconstructing the bridges.

Electricity and Gas.—The chairman (Mr. C. R. Kemp) of the Lewes Gas Co., at the meeting last week, corroborated the statement that electricity supply tended rather to improve than depreciate the gas undertaking. At Lewes there had been a great increase in the consumption of gas, and the competition had enhanced the standard of light in the town.

Electricity in Bakehouses.—At the South-Western (London) Police Court last week a baker was fined 20s. for keeping an underground bakehouse which was not lighted by electricity, in accordance with the conditions on which the Fulham Borough Council grant certificates for such bakehouses.

For defendant, counsel argued that the regulations referred to sunlight and not to artificial light, and also that the condition requiring electric lighting was unreasonable.

The magistrate held that the 21 days' grace allowed for appeal against a refusal of a certificate having expired, the Court had no jurisdiction as regarded the reasonableness or otherwise of the rule.

Electricity in Mining.—The British Westinghouse Co. have booked a large order from the Gwendreath Valleys Anthracite Co., including the supply and erection of generating plant with all accessories and numerous motors. The plant will be on the three-phase system and have a capacity of 200kw., the motors being of the Westinghouse polyphase induction type. They will be utilised to drive pumps, a 100 H.P. main and tail haulage, a Waddle fan with a capacity of 50,000 cubic ft. per minute, &c. A Belliss compound two-crank engine will be used to drive the generator.

The "Australian Mining Standard" states that the Australian General Electric Company, Melbourne, recently installed at the Duke United Gold Mines, Maryborough (Victoria) a 22½kw. dynamo driven by a 50 I H P. Atlas engine for the generation of electric energy for haulage and lighting. For haulage there has been supplied a two-motor locomotive with two sets of driving wheels, a motor being mounted on each set. The surface works are lighted by two arc lamps, and from 60 to70 16 c.p. incandescents. The main drive also is lighted electrically.

Exhibitions.—The ninth annual International Motor Car Exhibition will open at the Agricultural Hall, London, to-morrow (Saturday), and remains open until 26th inst. We are informed that there are more than 300 exhibitors, and that the display will be of a very representative character. A number of club meetings in connection with automobilism will be held during the exhibition, and there will be a display of air-ship balloons.

The Electrical Exhibition which was to have been held in Warsaw in May this year has been postponed indefinitely.

Fatal Accident—An inquest was held at Southwark (London) on Tuesday on the body of an assistant linesman named Furlonger, lately in the service of the London Electric Supply Corp., at the distributing station, 234, Blackfrairs-road, S.E.

John Baker, linesman, said that on March 4 he was disconnecting a transformer when he saw the current flash out from the terminal in the corner of the room in which he was working He rushed to the lad and caught him as he was about to fall. He was unconscious. Witness at once sent for a doctor, and meanwhile started artificial respiration, with the result that Furlonger recovered consciousness He immediately lapsed into a semi-conscious state again. On the doctor's arrival Furlonger was taken to Guy's Hospital. At the time of the accident Furlonger was cleaning down the switchgear, and should not have touched a certain terminal without orders. When terminal cleaning was necessary current was always switched off. At the place where the boy was cleaning the current was already cut off, but he apparently tripped, and put his hand on a live 10,000-volt terminal.

Dr. Kenneth Black, of Guy's Hospital, said Furlonger was severely burned about the limbs. He very soon got over the shock of the accident. Witness called in two surgeons, and it was decided to remove three limbs. On the Monday following the accident Fuslonger's right arm was removed, and on the following Thursday both feet were amputated. The lad died eight days after admittance to the hospital from exhaustion. The artificial respiration resorted to by Baker had undoubtedly prolonged his life.

The jury returned a verdict of accidental death, adding a rider that the terminals should be protected by a guard if possible.

Floors Castle Lighting.—Extensive alterations are being carried out at Floors Castle, N.B., the seat of the Duke of Roxburghe, which include an electric lighting installation for the castle and stables. The plant will comprise two 50 H.P. oil engines, dynamos and a battery of accumulators. This work is being executed by Mr. Leo Sunderland.

Glasgow.—In December a deputation, consisting of the Lord Provost and Councillors Bruce Murray, Cleland and Steven (accompanied by Mr. John Lewis, inspector of lighting; Mr. Alexander Wilson, gas engineer; Mr. W. A. Chamen, electrical engineer; and Mr. John J. M'Intyre, of the Police Clerk's department) was appointed to visit Leeds, Bradford, Sheffield, Liverpool, London and Brighton to obtain information as to street lighting, &c.

The deputation were interested in (among other things) (1) The system of adapting the illuminating power of lamp to the requirements of different classes of streets, and of increasing such illuminating power at crossings; (2) that in no city visited was the electric arc lighting superior that of Glasgow; (3) the unsuitability of electric incandescent light for street illumination; (4) the generally low standard of street lighting in Glasgow compared with that in other cities, with the exception of the streets lighted by electricity.

There are at present 799 electric arc lamps and 14,753 gas lamps for street lighting in Glasgow. Of the former, 749 are 12-ampere and 50 7½-ampere lamps.

In view of the anticipated successful financial year commencing June 1, the Electricity committee recommend that the gas depart-

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ment be repaid £18,895, the deficit on the operations for the year to May 21 last, which was transferred to the gas account in terms of the Glasgow Corporation electric lighting order, 1890.

Heckmondwike.—The Council on Monday decided to reduce the charge for electric current for private lighting to 4d. per unit.

Holborn (London).—The Council were recently asked by London County Council to consent to the adoption of the conduit system of electric traction on the tramways within the borough, but have resolved to send the following communication to the Board of Trade:

Having regard to the experience which has already been gained in connection with the electrification of the London County Council's tramways in South London, to the enormous expense involved in the adoption of the conduit system, and to the very serious disorganisation of traffic which inevitably occurs, the Borough Council are of opinion that it is desirable that the tramways within the borough should be worked on the overhead or trolley system.

Hornsey (London).—The Council on Monday accepted tenders for additional generating plant, &c. There are 411 private consumers, representing an equivalent of 24,419 8 c.p. lamps, connected to the mains, and the demand for current continues to increase at a very satisfactory rate. During the recent electrical exhibition an order was placed for wiring 60 houses at Muswell-hill, and requisitions have since been received from other parts of the district. The cost of the exhibition, including electric current for lamps and motors, was met by the payment for stall space by exhibitors.

Horsham.—Charges for electric current are to be reduced to the following scale:—(1) For all units in excess of first hour's daily average use of the maximum demand, 3d. per unit instead of 5d.; (2) for places of worship a uniform rate of 5d. per unit. Meter rentals have been abolished.

Hove.—The arbitrator, Mr. H. Graham Harris, appointed to determine the value of the tramways in Hove, has issued his award at £3,588. The cost of the arbitration proceedings have to be borne by the Council.

Hyde.—A communication from the Stalybridge, Hyde, Mossley and Dukinfield Joint Tramways and Electricity board was considered on Tuesday by the Council, in which it was stated that probably £2,000 would be required from the Borough of Hyde to meet the deficiency on the past year's accounts.

Councillor HIBBERT said the amount represented a 4d. rate, and asked how long this money would have to be paid.

The CHAIRMAN of the Finance committee explained that £2,000 was part of £8,000 required to meet interest and sinking fund charges on capital expenditure to date. They were bound to construct before they could work the system. They hoped to commence supply on a portion of the system by the end of April.

Ilford.—Sanction to a loan of £20,500 to cover excess expenditure on electric tramways has been applied for.

Islington (London).—The Lighting committee reported on Wednesday that the treasurer had called attention to a number of accounts rendered for the supply of electricity during the December quarter averaging 5s. 6d. each, and suggested that having regard to the capital outlay incurred in laying house services and providing meters, for which no rent is charged, it would be advisable to fix a minimum charge.

The committee are of opinion that in all such cases a small meter rental should be imposed, and recommend (1) that a minimum charge of 11s. 8d. per quarter be made for the supply of electricity, (2) that in all cases where the value of electricity consumed does not amount to 25s. per quarter a rental of 2s. 6d. per quarter be charged for each meter.

Java.—British manufacturers and dealers in electrical goods, who are prepared to meet German competition, are notified that there is a good opportunity for enterprise in this direction in Java, where numerous installations for lighting and power are a feature of present-day developments.

Johannesburg.—On the recommendation of the consulting engineers (Messrs. Mordey and Dawbarn), the Municipal Council have decided to put down gas-driven plant at the new municipal electricity works, which will supply electrical energy for lighting, power and traction. The contracts for the supply of the plant have not yet been settled, but it is reported that a Glasgow firm has received an order for gas engines aggregating 12,000 H.P.

Katanning (Western Australia).—A small plant has been installed in this town which, though primarily intended for lighting a local flour mill, is of sufficient capacity to permit of current being supplied through overhead mains, carried on jarrah poles, to surrounding residents. The plant comprises a Babcock and Wilcox boiler, with a 40kw. Witton multipolar dynamo driven by a Clayton and Shuttleworth compound engine. The contractors for the plant were J. Barre Johnston & Co., Murray-street, Perth, W.A.

Kensington (London).—The Council will re-wire the central library.

Lecture.—A lecture will be delivered at Carpenters' Hall, London Wall, London, E.C., on the 25th inst. at 8 p.m. by Mr. Basil Mott, A.M.Inst.C.E., entitled "Developments of Methods of Locomotion," with lantern illustrations. Admission free, by ticket to be obtained at Carpenters' Hall.

Lampeter.—The Council recently asked Prof. Ferrier to report as to electricity supply. The Council has decided to support the Lampeter-Llandilo light railway project and to subscribe a sum not exceeding £100 towards the preliminary expenses.

Leicester.—The capital expenditure of the electricity department is £212,450, of which £9,223 was spent during the past half-year. The authorised capital at the end of the year was £164,974, but sanction has been recently obtained to borrow £100,000 further.

Generation expenses for the six months were £3,773, an increase of £500; cost of distribution was £717, rates and taxes £1,648 (an increase of £568), and management £647 (increase, £214). The total expenditure (£6,801) showed an increase of £1,503. Sale of current had produced £14,968, increase £2,052; meter rents brought in £555, and there was £153 profit on sale of fittings. The total income was £15,676, leaving a gross profit of £8,874. Interest was £3,380 and sinking fund £2,545, and the net profit £2,948, an increase of £262 for the half-year. The accumulated profit was now £9,750, but some of this had been spent during the half-year on things for which they could not raise capital.

The Chairman of the Gas and Electricity committee (Councillor EDWARDS) on Tuesday said they had the misfortune to have the switchboard at the town office burnt, which cost £1,030, and they had written it off. They had spent £854 on renewal of meters, and £1,358 in relaying a worn-out trunk cable. They had spent £3,242, or £300 more than the profit, leaving them with a capital to carry forward of £6,507. He thought the policy of carrying forward their profits was a wise one. They had no idea as to the length of life of machinery and plant, and they would have had to come upon the rates if they had not had the reserve to pay the expenses of the past year. The consumption of electric current was going up by leaps and bounds—something like 25 per cent. over last year. Altogether the department was thoroughly sound and successful.

The report and accounts were adopted.

Light Railways.—At last week's meeting of Quarry Bank District Council it was announced that the Council had obtained an order authorising the construction of the Quarry Bank light railway.

A light railway inquiry was held last week into the application of the Cheltenham and District Light Railway Co. for authority to construct a line 130yds. long in the upper part of High-street in connection with the extension to Charlton Kings and Leckhampton, which has already been sanctioned.

Littlehampton.—A special committee has been appointed to consider the electric lighting scheme recently submitted by Mr. L. Alwyn.

Llangollen.—The Council have decided to adopt electric lighting in three of the principal thoroughfares. Current will be supplied by the Llangollen Electric Light and Power Co.

London County Council.—At Tuesday's meeting a report by the Finance committee referred to the Marylebone Borough Council's bill before Parliament. Following is an abstract of the report:—

The borrowing powers in this bill amount to £1,881,444. The bill provides for the borrowing of money by mortgage of the general rate and the revenue of the electric lighting undertaking, or either of those securities, without the sanction of this Council. In addition, the bill would give the Borough Council power to create and issue stock under the Local Loans Act, 1875. This Council has decided to petition against the bill, and, in our opinion, the clauses in the bill giving the Borough Council power to borrow should be amended so as to conform with the existing conditions under which the metropolitan borough councils are empowered to raise money. The Borough Council has now asked that this Council will, subject to the passing of the bill, undertake to advance to it £1,365,000 for the purchase money and compensation payable to the Metropolitan Electric Supply Co., and has intimated that it will also apply for sanction to the borrowing, and for the advance by instalments, of a further sum of £460,000, for the purchase of a site for the erection of buildings in connection with the undertaking, and the laying of mains, &c. We are strongly of opinion that the present system of finance, under which the Council provides practically all the funds required on loan by the local bodies of London, is the best in the interests of London as a whole, and we should view with grave apprehension any departure from that system in the direction of the creation of separate local stocks. We have, therefore, given careful consideration to the request of St. Marylebone Borough Council, and have decided that we cannot recommend the Council to make the provision asked for at the present time. The amount is exceptionally large, and the conditions of the money market render it imperative that the Council's issue of stock should be kept within the smallest possible limit. The Council itself has undertaken important works of improvement and construction for which funds must, as far as possible, be provided this year, and the demands of the other local bodies in London for loans must also be taken into account. Although we do not see our way to make provision in this year's bill for the loan of £1,365,000 to St. Marylebone, we are prepared to advise the Council to entertain the proposal for the loan to St. Marylebone as soon as the financial situation becomes sufficiently favourable. We are, therefore, of opinion that the Borough Council should make some temporary arrangement for meeting this liability rather than attempt to create a permanent debt at a most disadvantageous time. We think the Borough Council should endeavour to arrange with the Metropolitan Electric Supply Co. for the payment of interest on the purchase money until the stock can be issued, or should obtain powers from Parliament to borrow temporarily by means of bills or otherwise, either the whole sum required or so much of it as is necessary for payments which cannot be postponed, and that no power should be given for the creation of a local stock so long

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as this Council is willing to raise the money for St. Marylebone when the financial conditions warrant it. We recommend accordingly.

Consideration of the report stood over on the suggestion of Lord Welby.

Londonderry-Moville Electric Railway.—A memorial to the Lord-Lieutenant in Council to authorise the construction of this railway and to confirm the approval already given by Donegal and Londonderry County Councils and Londonderry Borough Council has been lodged.

Manchester.—At Wednesday's meeting the City Council approved increases in the salaries of employés of the electricity department aggregating £396 per annum, but one of the largest items (£50 per annum for the secretary of the department, Mr. F. E. Hughes) was refused by 39 votes to 20.

Marylebone (London).—At the meeting of the Council last evening the motion which was disposed of at the previous meeting of the Council (in the absence of the proposer, Mr. Edward White), that "the engagement of Mr. Arthur Wright be determined" was again brought forward.

Mr. White submitted that the moving of the motion by somebody else in his absence and the voting on it by the Council was illegal. He said the engagement of Mr. Wright was an unnecessary expenditure, inasmuch as he was to be paid about £8,000 a year. He then moved the resolution standing in his name.

Mr. Councillor Dunn seconded, but there was no discussion, and the motion was lost with only two votes in its favour.

In answer to a question, the Mayor said the negotiations with the Metropolitan Company were still proceeding, a meeting with the officials of the company was likely to be held shortly, and there was no reason that he could see for despairing of a favourable offer from the company.

With regard to the Council's bill now before Parliament, the Electric Supply committee reported that they had successfully resisted the petition of the Metropolitan Company for a locus standi to oppose the bill. They had also been successful in overriding the opposition of the Gas Light and Coke Co. to the Council's additional clause empowering them to enter into a working agreement with some electrical company.

The Electric Supply committee further reported that at the meeting of the Council in committee last week to consider the clauses of the Marylebone Electric Lighting Bill, 1904, only one amendment was carried—viz., a proviso to clause 16 ensuring that the Council should not execute the work of wiring private property beyond the meters, except through contractors. This will come up for confirmation by the Council at next meeting.

Mica.—A geological expert recently appointed by the Australian Commonwealth Government has expressed the opinion that the mica industry of Central Australia has a bright future before it. The mica mines are situate about 45 miles east of the gold mining district of Arltunga.

Morley.—It has been decided to reduce the charge for electric current for private lighting from 4½d. to 4d. per unit from April 1, and new consumers are to be supplied with current free of charge during April, May, June and July.

Motor Car Regulations.—In the new regulations for motor vehicles just issued by the Local Government Board the limits of speed for heavy motor lorries have been removed, and these vehicles are now only subject to the general terms of the Motor Car Act. The maximum width allowed for automobiles is increased from 6ft. 6in. to 7ft. 2in. The only condition attached to the use of powerful lights on cars is that these must be fixed and not capable of having their direction suddenly changed. It is now incumbent upon motor car drivers to pull up on a sign from the driver of any horse, and not only of "restive" horses, as heretofore.

Municipal Honours.—Mr. T. O. Callender, J.P., managing director of Callender's Cable and Construction Co. (Ltd.) has been elected a member of Kent County Council.

Municipal Telephony.—The 1904 edition of the Glasgow Corporation telephone directory is issued. The list forms a volume of 250 4to pages.

Financial particulars for 1903 are just issued relating to the Guernsey States Telephone Department. The number of instruments working on the service on Dec. 31 last was 1,217; total capital expenditure on telephone construction £21,262. 4s. 2d. (in addition to £2,321. 18s. 11d. on purchase of land and erection of buildings); total revenue for the year £4,064. 7s. 2d.; amount set aside for sinking fund and depreciation, £3,830. 9s. 5d. (in addition to a special contingency fund of £397. 2s. 5d.). The net profit for 1903 was £201. 12s. 6d. This is the sixth complete year of working of the Guernsey States telephone service.

On Wednesday, Swansea Telephone committee recommended the Council to withdraw the notices to terminate certain agreements with the National Telephone Co. as to telephone poles and to inform the National Co. that the Corporation would raise no objection to the company examining the municipal telephone books and agreements provided the company would allow the Corporation the same privilege, and that the Postmaster-General be supplied with a copy of the communication from the National Co. with a view to obtaining, if possible, his opinion upon the question of what connections for inter-communication should be provided by the Corporation.

Mr. Morgan Hopkin hoped it did not mean they were going to law. He advocated a conciliatory attitude towards the National Co.

Mr. D. Davies, in reply, said that at present there were more subscribers than had been anticipated and there were over 200 still awaiting connection. The expenditure was £3,000 below the estimate.

The minutes were adopted.

Musselburgh.—The promoters of the local electric tramways have abandoned the idea of adopting the surface contact system, and have decided to equip the lines on the overhead trolley system.

Northampton.—On the mediation of the Board of Trade the Rural Council and the Northampton Electric Light and Power Co. have come to terms as to the granting of a provisional order for extending the company's area of supply into the rural district.

Obituaries.—There passed away on Saturday last Mr. Peter John Mosley, who as far back as 1846 joined the staff of the Electric and International Co., at the old Sandhill offices, Gateshead. Mr. Mosley was one of the band of messengers employed in bridging the distance between Gateshead and Newcastle with telegraphic messages before the high level bridge over the Tyne was constructed. He soon received promotion, and, in 1853, was transferred by the company to their Edinburgh branch, and subsequently occupied positions as telegraph superintendent at Manchester, Newcastle, Bristol, York, Amsterdam and London. He was at Newcastle when the State became the purchasers of the telegraphs, and remained in the telegraph branch of the service until 1892, when he was appointed postmaster at Stoke-on-Trent, and was afterwards transferred to Sunderland. He retired a short time back, and died at Gateshead, as above stated, after only a short illness. He will be affectionately remembered by many members of the service who now hold high positions as a most kindly chief and adviser.

The death occurred suddenly on Monday, at Knutsford, of Mr. Charles John Galloway. Mr. Galloway, who was an active member of what is now the firm of Galloways Limited, of Manchester, had nearly completed his 71st year. His name will be remembered in connection with the construction of the famous Ulverstone Viaduct on the Furness Railway, and he was prominently associated with the management of the Manchester Ship Canal Co., of which he was a director at the time of his death.

Partick.—A committee is considering what extensions of the Glasgow Corporation tramways are desirable in Partick.

Pembroke (Dublin).—The Council have adopted Mr. Robert Hammond's scheme for the extension of the electricity works, and application has been made for sanction to a loan of £25,000.

Perth.—The Town Council last week considered the report of the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson) as to the reconstruction and electrical equipment of the existing tramways and the extension of the system at an estimated cost of £47,000. It was decided to have specifications, &c., prepared, and tenders are to be invited.

Plymouth.—The Council are advised to apply for a further loan of £20,000 for extensions of the plant at the electricity works.

The chairman of the Electricity committee (Mr. Radford) states that the undertaking has shown an uninterrupted record of progress from the beginning. In the first half-year there was a loss of £1,257, and in the first complete year (1900-1) £1,907. In the following year they had a net profit of £347, and last year the profit was £2,601. In the nine months of the present financial year (to Dec. 31) the profit was £1,634. They estimated that next year they would make considerably more profit, and with the accession of plant which would be provided by the proposed loan they would make a profit sufficient to justify the outlay. They had now a margin of plant of only 5,000 8 c.p. lamps, and this would be exhausted before Christmas next.

Pollokshaws.—The Council having withheld consent to the application of the Clyde Valley Electrical Power Co. for a provisional order for the burgh, the company have now asked the Board of Trade to dispense with this consent. As a counter move, the Council have asked Glasgow Corporation whether they would take over any provisional order obtained by the Council and whether they would supply electric energy within the burgh:—

Glasgow Electricity committee state that they are in sympathy with the endeavours of the Council to have the supply of electric energy within Pollokshaws placed in the hands of Glasgow Corporation, but that they cannot commit themselves to any definite proposal without the Corporation's approval.

Portadown.—The Council are considering a scheme submitted by the Belfast and North of Ireland Electricity and Power Gas Co. for supply of electricity and power gas in the district. The members are favourable, but no arrangement has yet been entered into.

Post Office Telegraphs.—A statement has been issued showing the gross amounts received and expended in respect of the State telegraph service from the date of transfer (1870) to March 31, 1903. The statement shows that for the year to March, 1903, the total receipts were £3,723,866. 6s. 4d. (including £92,121, value of telegraph services performed for other public departments without remuneration). The total expenditure amounted to £4,325,577. 14s. 7d., and the deficit was, consequently, £601,711. 8s. 2d., comparing with a deficit of £651,880. 3s. 6d. for 1902, £337,641. 5s. 9d. for 1901 and £288,591. 18s. for 1900.

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Presentations.—On 7th inst. the staff of the Cork Electric Tramways and Lighting Co. entertained Mr. Charles Mittelhausen (who was leaving to take up the position of electrical engineer and manager to Bexley Urban Council) at a farewell concert, and at the close the chief engineer of the company (Mr. Nalder) presented the late traction manager, on behalf of the staff, with a tantalus and some books. On the following Tuesday the employés of the company similarly entertained Mr. Mittelhausen and presented him with a gold watch subscribed for by the motormen, conductors and workmen. Mr. P. Kelleher made the presentation.

The chief signal superintendent of the Great Eastern Railway Co., Mr. W. Hyde, who is retiring from the service after 55 years' service, was last week presented with a purse of gold and an album containing an illuminated address with the names of the subscribers, numbering 378. The presentation was made by Mr. H. G. Drury, superintendent of the line.

Mr. W. Wyld has been presented with a timepiece on the occasion of his departure from Doncaster to assume the duties of tramway manager to Birkenhead Corporation.

Railway, Tramway, &c., Bills.—The report of the Board of Trade on the railway, tramway, electricity, &c., bills and provisional orders of the 1904 session (but not including provisional orders lodged under the Private Legislation Procedure (Scotland) Act, 1899), states that the total number of bills is 159, compared with 188 in 1903. The total capital proposed to be raised is £37,825,761, compared with £75,287,015. There are 39 tramway bills (36 for England and Wales, one for Scotland and two for Ireland) for powers to construct 228 miles of line (including 10 miles of tramroad), and the total capital is £5,323,971, of which £1,219,000 is by shares and £4,104,971 by loan. There are 15 electricity bills (11 for England and Wales and two each for Scotland and Ireland). The total capital is put at £12,216,444, of which £9,880,444 is by shares and £2,336,000 by loan. There are 15 applications for provisional tramway orders for England and Wales and Scotland. The length of route for which tramways are proposed is 6 miles 72 chains of double line and 28 miles 30 chains of single line. The estimated expense of construction is put at £307,380. There are 74 applications for provisional electric lighting orders, and the scheduled capital is £1,167,598.

Shoreditch (London).—The Board of Trade have approved the additional system of supply at a pressure of 240 and 480 volts. The Borough Council have also accepted the conditions of the London County Council upon which they would sanction the change of pressure.

South Shields.—The Corporation recently invited t nders for leasing, or for constructing and electrically-equipping and leasing a system of tramways in the borough, but only two tenders have been submitted—viz., from the British Electric Traction Co. and from a firm of solicitors representing a Manchester syndicate. Reports on these two schemes, together with details of the tenders, are being prepared for early consideration. The British Electric Traction Co. ask for a lease for 28 years, but do not make any proposal for construction. The Manchester syndicate are prepared to construct and equip, but ask for a lease for 42 years.

Southend-on-Sea.—The substitution of electric for gas lighting on the pier is under consideration.

Southwark (London).—The Council have declined the offer of the County of London Co. for the supply of electricity in bulk.

Stewart Electrical Syndicate, Ltd. (in Liquidation).—We have received the following letter for publication:—

146 and 147, Houndsditch, London, E.C., March 16, 1904.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Our attention has been called to certain advertisements and paragraphs which state or imply that the sale of the "goodwill" of the Stewart Electrical Syndicate, Ltd. (in liquidation) carried with it rights in the Stewart arc lamps. As these statements are calculated not only to do us serious injury but to mislead the public in regard to the channels through which these lamps can be obtained, we shall be grateful if you will allow us to state that some weeks prior to the sale we acquired the sole rights in the Stewart arc lamps, and that no firm is entitled to make or sell Stewart arc lamps not supplied by the original makers or by our agents and customers or ourselves.

For J. DEFRIES & SONS (LTD.),
Wolf Defries, Managing Director.

Stepney (London).—The following details of the estimated income and expenditure of the electric lighting department for the year ending March 31, 1905, have been approved by the Borough Council. The figures in parentheses are for 1903-4, actual expenditure to Christmas, 1903, with three months' estimated expenditure to 31st inst. added:—

Income; Private lighting and power, £20,979 (£18,333); public lighting, £8,176 (£6,603); other receipts, £250 (£240). *Expenditure:* Generation and distribution, £11,808 (£9,567); management and general expenses, £3,070 (£2,733); public lighting, attending and repairs, £1,950 (£1,650); interest on and repayment of loans, £9,131 (£6,475); temporary work, £100 (£300); reserve for future repayments and other purposes, £1,000 (£2,200). *Available surplus,* £2,346 (£2,251).

Subways for Electric Mains, &c.—Falkirk Corporation recently constructed a thoroughfare 40ft. wide between High-street and Newmarket-street in which a brick conduit, 6ft. high and 4ft. wide, has been constructed for main water aud gas pipes and electric light and telephone cables.

Swansea.—The Corporation are recommended to exercise their option to purchase from Mr. J. S. Brown the electrical installation in the market, and that the maintenance be undertaken by the electrical department.

Tariff Changes.—Changes recently effected in the customs tariff of Cuba include an increase of 25 per cent. in the duties upon copper wire and copper wire gauze, overhead electric wires and cables, copper pipes and alloys of copper in ingots, bars and sheets, all articles of copper and its alloys not specially classified, dynamo-electric machinery, tramway cars and carriages and many other items in which the electrical industries are interested. A 30 per cent. increase has been added to the duties on electric insulators and incandescent electric lamps (mounted or unmounted), stoneware conduits, underground electric cables and electric lighting carbons.

Under the recent tariff changes in Russia large increases have been made in the duties on imported dynamos, electric motors and transformers, and also upon all machines made of copper or its alloys in the composition of which these metals are present in a proportion exceeding 25 per cent. of the total weight of the machine.

Tramway and Railway Competition.—At the meeting of the Caledonian Railway Co. on Tuesday, Sir Andrew Mure moved the following resolution: "That this meeting resolves that the imposition of rates and taxes and the passenger duty, called Government duty, are unjust and unfair impositions on the railway." Sir Andrew said the tramways, which paid no duty, competed with the railways and had seriously reduced the income of railway companies. If they could get the burden of £110,000 a year removed, their position would be much improved. The motion was unanimously adopted.

Walsall.—The total capital outlay on the tramway undertaking is £126,193. In addition, £20,000 has been allocated to meet expenditure incurred by the electricity department in connection with the supply of current to the tramways. The actual cost of the construction of the permanent way of the extensions and the reconstruction of part of the old lines was £73,033. 9s. 2d., and the cost of the electrical equipment and re-equipment £34,557. 1s. 9d.

In view of the Board of Trade requiring that the electrical equipment of the old lines should be brought up to the present general standard, the Tramways Committee recommend that the lines on the Wednesbury and Bloxwich roads be re-equipped electrically at an estimated cost of £2,600. During the present year the committee propose to consider the whole question of reconstructing, where necessary, the permanent way of the old part of the tramways, and of substituting double for single track where necessary.

The committee further recommend that honorariums of 250 guineas to the borough surveyor and of 150 guineas to the electrical engineer, be granted in consideration of the work done by them for the tramways, which the committtee estimate has saved an expenditure of several thousand pounds in engineers' charges.

Wandsworth.—The Borough Council on Wednesday granted permission to the County of London Co. to lay conduits in 14 thoroughfares and to construct two transformer boxes. A Board of Trade inquiry was held on Thursday last into the appeal of the company as to the conditions proposed by the Council for laying certain conduits.

Watford.—The Council's proposed provisional order, authorising the extension of the electricity supply area, will be opposed by Bushey Parish Council, as the latter allege that the undertaking has hitherto been managed inefficiently.

Whitehaven.—Electric current will be supplied to the Harbour Commission at 3¼d. per unit for three years, and the Council will lay mains to the harbour at a cost of £200, and to the workhouse at a cost of £1,090.

Whitstable.—The Council have decided to obtain terms for public electric lighting from a company.

Wireless Telegraph Ordinances.—The Bermuda authorities have passed an act, which is to remain in force until Dec. 31, 1903, under which it is unlawful for any persons in the Bermuda islands to transmit or receive messages across the seas by means of any wireless telegraph, or to instal, erect, construct, establish or maintain in these islands any apparatus for use in telegraphing, unless furnished with a written license from the governor, under a penalty for a first offence not exceeding £25, and for second or subsequent offences £100, and forfeiture of instruments, apparatus, &c.

A similar order has been issued by the Governor of British Honduras. Offenders in this case are guilty of a misdemeanour within the meaning of the Criminal Code of British Honduras.

Wireless Telegraphy.—Arrangements have been made by the Belgian Government for the use of wireless telegraphy between Belgian wireless stations and the Belgian line of mail steamers plying between Ostend and Dover (presumably up to the 3-mile limit range of the English coast). The charge has been fixed at 2d. per word, with a minimum of 1s. 8d. per message.

Worcester.—As the local tramway company has been unable to take the 200,000 units of electrical energy agreed upon, owing to

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the non-completion of the tramways, the Council have decided to issue a writ for the value of the current, £1,666. 13s. 4d.

Smoking Concert.—A smoking concert of the Glasgow Local Section of the Institution of Electrical Engineers will be held at the Grand Hotel, Charing Cross, Glasgow, to-morrow (Saturday) at 7:30 p.m. Mr. W. A. Chamen will preside. A lengthy musical programme has been provided.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1904 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date, and the Directorial Division of the new volume has been corrected up to February 11th, 1904. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates over 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. A number of large sheet Tables, Maps, &c., are included in the issue. Digest of Contents will be sent post free.

TENDERS INVITED.

St. Annes-on-the-Sea District Council invite tenders for the supply, delivery and erection of surface condensing plant and natural draught cooling tower. Specifications, &c., from the chief engineer, Mr. James H. Clothier. Tenders to the clerk, Council offices, St. Annes-on-the-Sea, by noon March 26. See also advertisement.

Dundee Town Council invite tenders for the supply of electricity meters. Specifications, &c., from the city electrical and tramways engineer, Mr. H. Richardson. Tenders to the town clerk (Mr. W. H. Blyth Martin), City-chambers, Dundee, by March 26. See also advertisement.

Dartford Urban District Council invite tenders for construction and subsequent working for a term of years of light (electric) railways in the district. Copies of deposited plans, the Dartford Light Railway Order (1901) and Extensions Order (1903) can be seen at the offices of the consulting engineers (Messrs. Hawtayne and Zeden), 9, Queen-street-place, London, E.C., from whom further particulars may be obtained. Specifications, &c., from the clerk to the Council (Mr. W. Kay), Council offices, Dartford, and tenders by noon March 26. See also advertisement.

Westminster Electric Supply Corp. invite tenders for the supply and erection at their Duke-street sub-station of a high-tension and a low-tension switchboard. Specifications (for high-tension switchboard after 18th inst. and for low-tension switchboard after 25th inst.) with forms of tender, &c., from the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to the secretary (Mr. Frank Iago), Eccleston-place, Belgravia, London, S.W., by 10 a.m., April 18. Further particulars are given in an advertisement.

The Council of the Metropolitan Borough of *Poplar* invite tenders for the supply and erection of the following sub-station plant:—Five three-phase alternating-current motor-generators, three switchboards, three-phase alternating and direct-current hand travelling cranes. Specifications, &c., from the borough electrical engineer (Mr Percy N. Hooper), Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders to the town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, by 9 a.m. March 26. See also advertisement.

The Government of *Natal* invite tenders for the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, &c., from Sir Walter Peace, K.C.M.G., Agent-General for Natal, 26, Victoria-street, Westminster, S.W., or from Mr. Chas. J. Crofts, M.Inst.C.E, harbour engineer, Natal. Tenders to the Agent-General, or to the chairman, Tender Board, Pietermaritzburg, Natal, by May 9. See also advertisement.

Melbourne City Council invite tenders up to 2:15 p.m. May 13, for supply and delivery of one 750kw. direct-current steam generator. Specification, &c., from the Agent-General for Victoria, 142, Queen Victoria-street, London, E.C. The town clerk is Mr. John Clayton. See also advertisement.

Ilford District Council invite tenders for the supply and erection of one 1,000kw. steam dynamo (vertical engine coupled direct to multipolar dynamo); extensions to main switchboard and cable connections; works distributing switchboard; condensing plant, comprising surface condenser, water driven pumps, water cooling tower and pipe work; feeder and pilot cables, feeder pillar and joint boxes. Tenders to Chairman by noon March 22.

The Executive committee of *Winsley* Sanatorium will consider proposals for the electric lighting of their sanatorium now being erected at Winsley, Wilts. Particulars from Messrs. Silcock and Reay, architects, 47, Milsom-street, Bath, to whom proposals with estimates by March 21.

Stockport Gas and Electricity committee invite tenders for one 500kw. steam generator. Tenderers must submit drawings and full particulars to the electrical engineer (Mr. A. J. H. Carter) by March 25. Tenders to chairman, gas and electricity department, electricity works, Stockport, by March 30.

Newport (Mon.) Corporation invite tenders for boosters, balancers, &c., switchboards, tramway poles and brackets, overhead material, section pillars, cables and trolley wire. Tenders to chairman Electricity committee by first post March 21.

Handsworth (Staffs.) District Council invite tenders for permanent way, pavement and roadwork, and overhead equipment. Tenders before noon March 30.

Tenders are invited by 9:30 a.m. 23rd inst. for 12 months' supply of incandescent lamps and various stores to *Rotherham* tramways department.

Tenders are required by 10 a.m. 25th inst. for supply to *Keighley* tramways department of rails, overhead equipment, section boxes, bonds, cars, cables and switchboard and for erection of car shed.

Aberdeen Electric Lighting committee invite tenders for two water-tube boilers and accessories. Tenders to the city electrical engineer (Mr. J. Alex. Bell), by noon 31st inst.

Sunderland Corporation invite tenders for 12 months' supply of indiarubber-covered cables. Tenders by noon March 31.

Twickenham Urban District Council require three steam boilers, refuse destructor plant, &c. Tenders by noon 23rd inst.

Swindon Corporation invite tenders by 31st inst. for water-softening plant.

Walthamstow District Council invite tenders, by 5 p.m. April 8, for extending their electricity generating station.

Tenders are invited for plant for the electric lighting of *Damas* (Turkey). Particulars from M. Noman Bey, 12, Rue du Pot d'Or, Liège, Belgium.

Tenders are invited by April 11 for the establishment and working for a period of 20 years of a telephonic system in the *Martorell* district of Spain, including a number of adjacent districts. Tenders are to be sent to the Director-General of Posts and Telegraphs, 10, Carretas, Madrid. The "Madrid Gazette" of March 13 contains further particulars.

Fifty tons of galvanised iron 4mm. telegraph wire is required (in 10-ton deliveries, for Madrid, Barcelona, Seville, Valladolid, and Zaragozo, *Spain*), for the use of the State Telegraph Department. Tenders are to be sent to the Director-General of Posts and Telegraphs, 10, Carretas, Madrid, by April 9. The "Madrid Gazette" of March 13 contains further particulars.

A concession is offered for tender for the electricity supply for all purposes for 20 years at Vila do Conde, Azuara, Caxinas, and Poça de Barea, *Portugal*. Further particulars are given in the "Diario do Governo" (Lisbon) of March 15.

The "Moniteur Belge" of March 11 announces that tenders are invited for the construction, maintenance and working of electric tramways on the overhead system in *Liège*, *Angleur* and *Herstal*. As in the case of all Belgian tenders, considerable sums have to be deposited before the adjudication of the tenders, which have to be sent to M. le Gouverneur, Municipal Government, Liège, Belgium, up to March 30. Specifications, &c., can be seen at the Provincial Government Office, Liège.

The *Italian* Naval Department invite tenders for indiarubber goods and fittings to the value of 40,000 lire (about £1,600) and electrical material to the value of 20,159 lire (about £806), to be delivered as required at the Royal Arsenals of Spezia, Naples, Venice, Taranto and Castellamare. Tenders will be opened at 11 a.m. April 13 for the indiarubber goods and on March 26 for the electrical materials.

TENDERS RECEIVED AND ACCEPTED.

Amongst recent contracts placed with Messrs. Belliss and Morcom, Ledsam-street Works, Birmingham, are:—

One 1,200 H.P. engine (through Dick, Kerr & Co.) for direct-coupling to English Electric continuous-current dynamo, for Edinburgh.

One 585—781 H.P. engine for direct-coupling to a Mather and Platt 400kw. alternator, for Belfast.

Fifteen engines, 865—1,080 H.P., for direct-coupling to continuous-current dynamos for His Majesty's dockyards (six for Chatham, five for Portsmouth and four for Devonport).

Ealing Corporation have accepted the tender of Bertrams Limited for the supply and erection of condenser plant at £2,360. 10s. The contract for a 750kw. steam alternator (Davy-Paxman engine and Siemens alternator) has been let to Messrs. Siemens Brothers & Co. at £5,811. 10s. There were two other tenders for the latter contract at £6,366 and £3,350, six further tenders for the condenser

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plant only at from £8,480 to £2,860. For the complete plant required, six tenders were received, ranging from £10,797 to £8,874.

Maidstone Council have received the following tenders for wiring small houses in the district under their assisted wiring scheme:—

	9 lights.	8 lights.	3 lights.
Stevens and Barker (*accepted*)	£3 10 0	£3 0 0	£1 15 0
W. T. Burrows	5 10 0	4 7 6	2 10 0
T. King	4 17 6	3 13 0	1 19 6
W. Cogger	4 15 6	3 17 6	2 5 0
Haynes Bros.	4 15 0	3 10 0	2 0 0
A. H. Woolley	4 10 0	3 17 6	2 16 0
Morris, Jones & Co.	4 0 0	3 3 0	1 15 0

Kilmarnock Corporation have accepted the following tenders:—

Oliver & Co., arc and incandescent lamps, posts and gear, at £1,275. 2s. 9d.

Callender's Company, lighting and traction feeders, mains and switch pillars, and road work, at £14,115. 8s. 4d.

Chamberlain and Hookham, electricity meters, at £209. 2s.

The contract for pipe work, feed pump, economiser, jet condensing plant, &c., has not yet been let.

Tenders have been accepted for the sum of £42,250 for electric cars and power house equipment for the Canadian Electric Traction Co., London, who are about to construct and work the St. Thomas and Port Stanley railway electrically. The contract comprises the equipment of a 1,000 H.P. power station, including three-phase transformers, &c., and 10 250 H.P. three-phase motor cars (each to seat 50 passengers) with a speed capacity of 30 miles per hour. The Ganz system of working is to be employed, the whole of the plant being built in Edinburgh.

The following contracts have recently been placed with Cowans Limited, Springfield-lane, Salford, Manchester:—

Extensions to switchboard and standard high-tension oil-break main-switches controlling 4,500kw. for Shanghai Municipality at £668. 10s.

Two heavy current disconnecting plug switchboards for Brighton Corporation at £429.

An extension order for Andrews' duplicate mains system for Hastings Corporation at £126.

Fulham (London) Borough Council have accepted the following tenders for electrical stores:—General Electric Co., Brush Co., W. H. Wilcox & Co., British Thomson-Houston Co., British Insulated and Helsby Cables (Ltd.), W. Woods & Co., Vacuum Oil Co. and W. F. Thomson & Co.

Fulham Borough Council have also accepted the tender of Messrs. Lancaster for constructing "rising" electric mains, distributing boards, &c., at mansions in Queen's Club Gardens.

As announced in our issue of Feb. 12, the contract for the motor equipments of the cars of the group of underground railways in London controlled by Mr. Yerkes has been awarded to the British Thomson-Houston Co. It is stated that the contract comprises motors for 480 cars, and that the amount is about £1,400,000.

Hornsey (London) Council have accepted the tender of Babcock and Wilcox for water-tube boilers at £3,025, that of the General Electric Co. for engine house plant at £6,298. 10s., and that of the Wilskemp Limited for smoke-consuming apparatus at £266. 16s. 6d. 39 firms submitted tenders.

The Electric Lighting committee recommend the acceptance of the offer of the North British Railway Co. to take electric current for lighting their goods station at 2½d. per unit up to 20,000 units per annum.

Walton District Council have accepted the tender of Mr. N. C. Badois for electric fire alarms between Walton, Hersham and Oatlands at £99. 14s. The G.P.O. tendered at an annual rental of £34. 15s.

Glasgow Electricity committee recommend the acceptance of the tender of Gray & Sons for the concrete and granolithic work at the northern extension of the Port Dundas generating station at £1,275. 0s. 8d.

The Admiralty have accepted the tender of the Westminster Engineering Co. for the electric light and power installation of the Harwich Naval Hospital, Shotley Point, Harwich. The plant includes three 50 H.P. Gardner oil engines.

Brighton Town Council have accepted the tender of Rowland Bros. for erecting a new converter house, cable culverts, &c., adjoining the North-road electricity works at £5,699.

Ashton-under-Lyne Council have accepted the tender of the British Thomson-Houston Co. for supply of electric motors for ensuing year.

The Bridgwater and District Electric Supply and Traction Co. (Ltd.), have let to Mr. C. Bryer, jun., the contract for the erection of electricity station buildings at between £1,500 and £1,600.

Harrington Guardians have placed an order with the British Westinghouse Co. for two electric motors for their laundry at £49. 10s.

Durham County Council have accepted the tender of C. A. Parsons & Co. for two 150kw. steam turbine sets for the electric lighting of the county asylum at £5,192. 10s.

Whitehaven Town Council have accepted the tender of the Reason Mfg. Co. for one year's supply of fuse boxes; those of the Edison and Swan Co. and J. Defries & Son for electric glow lamps, that of Ferranti Limited for electricity meters, and that of Callender's Co. for joint-box compound.

Whitehaven Town Council have also accepted the tender of the Electrical Power Storage Co. for the repair of the storage battery at the electricity works.

Islington Borough Council have accepted the tender of the British Insulated and Helsby Cables (Ltd.) for the supply and laying of solid mains and paper-insulated cables during the ensuing 12 months.

Aston Electricity committee have accepted the tender of the General Electric Co. for a 750kw. generating set at £6,435.

Kettering Guardians have accepted the tender of Barnett and Soames for the supply of electric light fittings, &c., at £124. 5s.

Colne Council have placed a contract for a 400kw. steam dynamo, the engine being by Belliss and Morcom.

BUSINESS NOTICE.

Messrs. Julius Sax & Co. are removing from Rupert-street to more commodious premises at 10, Great Newport-street, Charing Cross-road, London, W.C.

LIQUIDATIONS, BANKRUPTCIES, &c.

Ferranti Limited.—The adjourned meeting of creditors was held in London on Wednesday, Mr. Ferranti again presiding. A report was presented which had been prepared by Mr. Tate and Mr. Henderson.

Mr. TATE explained that his statement must be accepted only as a personal one, because as a receiver and manager it was not for him to influence the creditors in any particular direction. With Mr. Henderson he had gone carefully into the position of affairs, and taking the business as from Sept. 2 to Dec. 31, 1903, the expenditure and liabilites had been compared. There was a loss of £1,593 for the period in question, which was not a serious matter when it was considered that there were very large contract orders being worked off. There were contracts outstanding amounting to £87,113, and it was estimated that £83,000 of this would come in. The meter department was a safe and profitable one, especially as they had an improved meter which they hoped would be ready for the market in a few months. The meter department should in 12 months turn over something like £30,000 to £40,000. The amount necessary to carry on the works from March to December next would be £49,500. This would be used for salaries, wages, material and ordinary working expenses. The returns expected would be approximately £3,000 per month. He suggested the meeting should consider the position from the point of view of (1) continuing the works for another three months, (2) of continuing for 15 months beyond that (*i.e.*, 18 months in all), and (3) of continuing the business by dropping the engine and dynamo departments, but keeping on the switch and meter departments. If continued for three months only, he estimated that there would be a deficit of £18,000, and the creditors would get nothing. Under the second head he estimated a balance of £23,000, or £10,000 after deducting certain expenses. This would give about 3s. 6d. in the £ to the creditors. Mr. Field and Dr. Garrard had reported and both agreed that, under careful management, the business should in time give 20s. in the £ to all creditors. Perhaps the difficulty could be met, as to future working and continuing the business, if the creditors would agree to give, say, 4d. in the £ on their claim and the debenture holders relinquish £26,000 of their claim.

Mr. HENDERSON said they were grateful for Mr. Tate's report and for the suggestions put forward, but their great difficulty was that the liquid assets coming in would go to the debenture holders for 18 months, and leave them with the task of finding some £60,000 to carry on the business. Where was this working capital to come from? He objected to finding more capital to keep the thing going for the benefit of the debenture holders, although he would put more in for the benefit of the creditors. Why not sell the business now, either in lots or as a whole? No mention had been made of the action pending in the House of Lords for infringement of patent, which would cost probably £30,000 before it was settled. Then, after 18 months had expired, who would find about £40,000 to keep the business going? He proposed that the meeting be postponed for three months and that steps be taken to find a purchaser.

Mr. TATE said the debenture holders were not trying to gain any undue advantage. All they wanted was that some arrangement should be come to for the benefit of all concerned. He thought they must either liquidate or adopt the proposal he had suggested.

Mr. FERRANTI suggested that the creditors should decide upon some definite policy. He agreed with Mr. Tate's suggestion because three months hence the assets would be so much less, and the present uncertainty must act detrimentally to the company. He thought they had no option but to realise now, or agree to try and build it up on the basis of Mr. Tate's scheme.

Mr. HENDERSON said they had to look at the matter as business men. He reminded them that it was the debenture holders who brought the action to recover their money. The Court would not allow the receiver and managers to continue to trade. All they could legally do was to collect and apportion the moneys received. Would the receivers and managers withdraw their action on the part of the debenture holders?

Mr. TATE said if the creditors made that as a definite proposal he would submit it to the debenture holders.

Mr. HENDERSON said if the receivers and managers would withdraw their action he would move a resolution that the business continue on present lines for three months, arrangements to be made with debenture holders,

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creditors and shareholders during that period to continue arrangement for a further 15 months, neither debenture holders nor creditors to press their claims in the meantime.

A CREDITOR: If the receivers and managers withdraw, what will be the position of those who are now fulfilling orders under their hands?

Mr. BERGTHEIL said there would be no greater risk then than now. Those in doubt need not take the orders, but there were those who would.

The resolution was then put and carried. About one-third of those present voted.

Mr. Ferranti and Mr. Scott-Lings, with two gentlemen from among the creditors, were appointed to arrange matters, and the meeting terminated.

The Tramway and General Appliances Co. (Ltd.) is to be wound up voluntarily. Mr. H. C. Lewis, 7, Waterloo-street, Birmingham, is liquidator.

Mr. J. D. Pattullo, 65, London Wall, E.C., has been appointed liquidator of W. C. Horne & Sons, Ltd., electrical engineers, &c., Torrens-street, City-road, London, E.C.

Percy James Murley, electrical engineer's manager, lately fire alarm contractor, of Park-row, Leeds, and Brook-street, Bradford, has been adjudicated bankrupt. First meeting of creditors 23rd inst. at 22, Park-row, Leeds, public examination April 12 at County Court, Leeds.

Sale by Auction.—We would call our readers' attention to the important sale of modern electrical mining plant which is to be disposed of without reserve on Monday, Tuesday, Wednesday, Thursday and Friday, April 11, 12, 13, 14 and 15, at the Frongoch Mines, near Aberystwyth, by Mr. George N. Dixon, the well-known auctioneer of Liverpool. The whole of this valuable plant, which has cost upwards of £68,000, will be sold, and the sale affords what is probably the first opportunity ever offered of acquiring a well-equipped installation of electric mining plant, machinery, apparatus, instruments, materials and accessories. Some further particulars are given in an advertisement on another page. Catalogues (when ready) and all other information are obtainable from Mr. G. N. Dixon, 89, Hanover-street, Liverpool.

Plant for Sale.—Govan Corporation invite tenders for three-wire Ediswan main switchboard, arranged for eight three-wire feeders, six dynamos, battery and balancer; also for three-wire booster by the British Thomson-Houston Co. The plant may be seen and full particulars obtained on application to the burgh electrical engineer, Mr. T. C. Parsons, Helen-street, Govan. Tenders to the town clerk (Mr. A. Macdonald), Town Hall, Govan, by March 29. See advertisement.

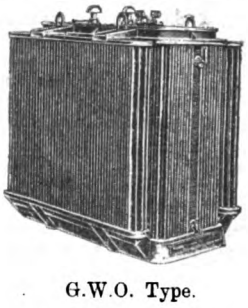
Premises, &c., to Let.—Messrs. Waring and Nicholson, 38, Parliament-street, Westminster, London, S.W., have premises to let in prominent corner position suitable for a factory or warehouse.

An advertisement contains particulars of a suite of offices to let at 64, Victoria-street, Westminster, S.W.

Concession in Spain.—An advertiser is willing to dispose of a concession for the construction in Spain of 85km. of railway, which would traverse two mountain ranges, where abundant water-power for electric generation of current is available.

Catalogues.—The General Electric Co. have ready a pamphlet treating of "Witton" small electric motors. A complete range of standard motors from 1 H.P. to 10 H.P. at moderate speed are now being made for all voltages ranging from 100 to 500 volts, of either open or semi-enclosed type. A large stock of each size of these motors is available for immediate delivery.

A new transformer price list (No. 4B) is issued by the Electrical Co., in which several types of these machines are shown and full particulars given. We illustrate examples of the G.W.O. and G.D.O. types of these transformers. The former is a single-phase machine, and is made from 50 to 400 kilo volt amperes for primary pressures up to 10,000 volts, and differs from the A.W.O. type of transformer supplied by the Electrical Co. (shell type) in being of the internal core type, but in other respects both types conform closely to the same specification. The G.D.O. is a three-phase machine made from 70 to 600 kilo-volt amperes, and also for primary pressures up to 10,000 volts. The standard frequency is in all cases from 50 to 75 periods, but the company supply transformers for other periodicities and for larger types and higher pressures. These transformers are all made to withstand very heavy excess pressures and voltages. Copies of new list can be obtained free on application.



G.W.O. Type.

G.D.O. Type.

The second edition of a catalogue issued by the Linolite Co., 47, Victoria-street, London, S.W., is ready. The company state that since the issue of the first edition a large quantity of linolite has been supplied.

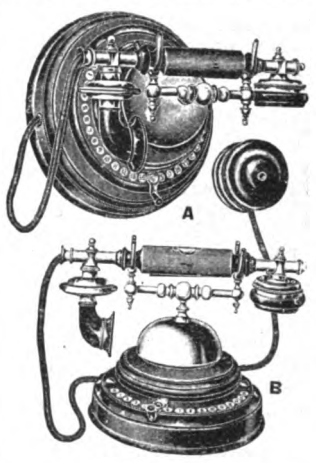
Messrs. Monté-Callow & Co., of 6, Ludgate-broadway, London, E.C., notify that they have in preparation a new price list of "Perfecta" resistance apparatus, and are now prepared to quote for "light load" starters for starting up motors on a line of shafting only.

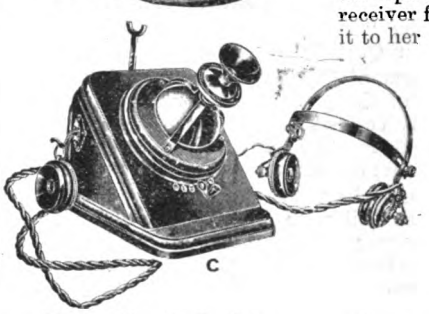
"Controllers and other Apparatus for Electrically-driven Cranes, Hoists, Lifts and other Variable Speed Machines" is the subject of list No. 13B, just issued by the Lahmeyer Electrical Co., 109-111, New Oxford-street, London, W.C. A large assortment of this apparatus is listed, illustrated and described.

Messrs. Bray, Markham and Reiss, Walthamstow, London, E., have ready a new price list of patent resistances.

Mr. Fernand Espir, 3, East India-avenue, London, E.C., is the sole agent for the United Kingdom and British Colonies of the Compagnie des Tréfileries du Hâvre, and this company has prepared and is now issuing a new catalogue of bi-metallic wire, of which over 30,000 miles is in use. The catalogue sets out the merits of this wire for various electrical purposes.

A new list (B. 52) of British-made intercommunication telephones is issued by the Electric and Ordnance Accessories Co., Stellite Works, Birmingham. Our illustrations Figs. A and B show the convertible wall or table type of self-restoring "Stellite" telephone. Communication is obtained by depressing the button indicating the station required, and, when the handset is replaced in the cradle the button is released and the call instrument is ready to receive a call. If desired, the home station can speak to four or five people at the same time, according to the number of buttons simultaneously depressed. Fig. C shows the stenographer's table telephone, designed for the use of shorthand-typists. When the bell rings, the operator removes the watch receiver from its hook and places it to her ear. When required to take notes the watch receiver is placed upon the table and the head-gear adjusted. If more than one typist is in the room the headgear can be provided with two receivers. This instrument is also supplied as an ordinary table set without head-gear. Copies of the new list can be obtained free on application to the company.





Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from March 9 to 15, with the ports of destination:—

Africa—Alexandria, £163; Cape Town, £629; Durban, £432 (including £17 telegraph material); East London, £1,718. *Argentina*—Buenos Ayres, £228. *Australasia*—Auckland, £132; Fremantle, £247 (including £73 telegraph material); Melbourne, £25; Otago, £754; Perth, £185; Sydney, £107; Wellington, £2,061. *Brazil*—Rio Janeiro, £30. *China*—Shanghai, £1,050. *France*—Paris, £400. *Germany*—Hamburg, £60. *Gibraltar*—£3,060. *Greece*—Piræus, £372 (telegraph stationery). *Holland*—Amsterdam, £40; *Hong Kong*, £99. *India*—Bombay, £89; Calcutta, £567 (including £200 telegraph material); Madras, £1,029. *Japan*—Tokio, £82; Yokohama, £1,529. *Seychelles*, £179 (telegraph apparatus). *Siam*—Bangkok, £114. *Sweden*—Gothenburg, £90. Total £15,471, against £22,363 in the corresponding week last year (March 11 to 17).

COMPANIES' MEETINGS AND REPORTS.

W. T. Henley's Telegraph Works Co. (Ltd.)

The twenty-fifth ordinary general meeting was held on Friday last, Mr. SYDNEY GEDGE presiding.

The SECRETARY (Mr. A. E. Salmon) read the notice calling the meeting, and the auditors' report was read.

The CHAIRMAN said: Gentlemen, there are many things upon which I think we may mutually congratulate each other. The first is that we are meeting in our own offices. Then I may congratulate you upon our works being in good order. I have been recently over them with Mr.

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Hatton. We also may congratulate ourselves that during the year there has been no accident to the workmen sufficiently important to remain in one's memory. There may have been one or two small accidents, but in that case they were of very little account. And next, as usual, I am able to report that there has been no reduction in the Bahamas cable repairing fund by reason of the cost of repairs during the year. From 1892 till now more than 12 years have passed with very little being taken from that repairing fund, and it has been increasing year by year, and at the end of eight years more the company's liability will be at an end, and any surplus that may remain—and it looks as if the whole, or a very large portion of it, will remain—will be divided equally between the company and the Government of the Bahamas. We have added £55,000 to the item of permanent assets, which you will see at the top of the balance-sheet on the credit side. That £55,000 is made up of £20,000 for land—12 acres of excellent land, on the river side at Gravesend, which we have recently purchased and paid for. Then £16,000 was the price of these commodious offices—the lease is for 22 years and the balance of about £19,000 was for the large new shop at the works, and two excellent cranes, and other improvements to the works, and new machinery. Then we may congratulate ourselves upon the fact that the whole of the new capital, both the ordinary and the preference shares, were taken up almost entirely by the shareholders, either by the shareholders or one or two of our large customers to whom we were able to allot a few that were left over. In that way they were all taken up at very little expense indeed. Having regard to the depressed state of things, and to the unfortunate fall which occurred in the value of our shares about the time of the issue, that speaks very well indeed for the estimation in which we ourselves, who know most about it, hold our own property and prospects. This remark does not refer to last year's accounts, as what I have spoken of has happened since Jan. 1. Another remark I may make is, that although there was a diminution in the business last year, I am happy to say that up to the present time, comparing the first two months of this year with the first two months of last year, there has been a considerable increase in the amount of our business, and I believe its character is as good as that done up to this time last year. And then, lastly, I think we may be congratulated upon the fact that in these bad times we are paying the very substantial dividend of 15 per cent. I dare say you would rather be congratulated upon our paying 20 per cent. 20 per cent. is a very high dividend, and we felt it right—and you sanctioned our doing so—to pay such a dividend in the three previous years because it was well earned and the profits enabled us to put aside a sum of money, too. But although 20 per cent. is better than 15 per cent., yet 15 per cent. is a very good dividend for our large capital, and I think we may fairly congratulate ourselves on having been able to pay it. No doubt we could have very well taken £8,750 extra for raising the dividend to 20 per cent. without anybody being able to say that we were not paying it fairly and honestly. But I think you will sanction the course which the directors have taken in recommending a dividend of only 15 per cent. It shows we do not divide profits up to the hilt. The money is not wasted, but it is all there, and if anyone wants to sell his shares he should get all the more for them because we have so strong a balance-sheet and have kept the money in hand, and not divided every sixpence; but like a conservative company, we have gone on on old-fashioned lines and kept money in reserve with which to meet all possible contingencies. We admit that it is a little disappointing for the dividend to go down, but what are the causes? First, I have to mention keen competition, and I suspect the fact of our having paid 20 per cent. has not tended to diminish that keen competition, but if people will study the history of the company they will find that you cannot just put down your money in works of the description of ours and immediately get 20 per cent. on it. More than half of our capital has been raised at 4½ per cent., so that there has been barely 5½ per cent. paid on the Company's capital from time to time since its formation. I do not think that 5½ per cent. is such a very large dividend as to attract further capital into the field for starting rival companies, and it is just as well, as we appear to have been paying magnificent dividends, that the exact facts should be known. Besides keen competition there has been a general depression in the trade of the country. You know the enormous fall there has been in the dividends of nearly all industrial companies and in the value of their shares. We have very good customers, as other industrial companies have, among the municipalities. They used to be able to borrow money at 3 per cent., and now they cannot get it under 4 per cent., and in these altered circumstances those who have the control of municipal funds are not launching out into luxuries in the way of electric lighting and telephones and traction enterprises to the extent that they used to do when they could get money on easier terms. But money will be easier again, and these municipal enterprises must increase. I therefore look forward with confidence to the business of this Company, which stands in the van of the leading companies, not going down but continuing to grow. We are obliged to be up to date and ready to undertake work that comes to us. In these matters time is the essence of the contract, and we must be ready to complete our contracts as quickly as other companies. These are the considerations, or some of them, which have led us, with trade not so good as before, to go on with the purchase of the additional land at Gravesend so that the works may be taken in hand and completed and ready to earn money for you by the end of this year. There is one other point to mention, and that is that you may know that this Company is now—I believe I may call it—a mother. It has a child which is called the South African Company. You are the only shareholders, apart from the neces-ary seven signatories with one share each. It was found with regard to the business in South Africa, which is now commencing—and we hope, through our active agents there, will increase—it was found that the business there could be managed much better and more economically, and subject to fewer restrictions in the colony, if there was a company specially registered for the colonial work, and accordingly that company had been formed. Amongst the assets you will see the item "Debentures and Shares held in other Companies £8,065." That is about £2,300 more than last year, and is mainly made up by £2,000 of shares in that Company which are held by this Company. I do not think it is necessary for me to go, as in former years, through the balance-sheet. It shows no doubt that the business was not so large nor quite so remunerative as before. We have written down the full sum for depreciation and on the machinery we have provided for £300 more, carrying forward a couple of thousand pounds more than last year. I may just say, before I sit down, that the Directors have had every reason to be satisfied, in every way, with the care and attention, and the skill and industry, shown by the staff, from the Managing Director, if I may call him one of them as well as being one of ourselves, and the secretary, who went specially at some personal inconvenience to Australia to look into our agency there, and corrected some things which were not as we wished them to be and put matters on a right footing, which he did with great ability. In the able report which he submitted to the Board he gave us an account of how he found matters and of what steps he had taken to put matters right, and the Company is greatly indebted to him for the skill and energy with which he fulfilled the commission entrusted to him. I was saying how much we are indebted to all our staff, to the Managing Director, to the Secretary, to Mr. Hatton our able engineer, down to, I may say, the last importation into the office here or at the works. The Directors have reason to be satisfied with them all and congratulate you upon having so efficient a staff. I now move the adoption of the report and accounts.

Mr. GEORGE SUTTON seconded, and expressed his satisfaction with the progress of the business and the outlook for the future. The electrical industry was certainly going through a bad time. The last six months had been the worst period he had ever known. In all departments of their business, prices had been reduced, and that had meant a reduction of profits, and in one department they showed a loss. But even in this present year they already showed a profit on that particular department. Everything in their accounts it was necessary to write down had been dealt with, so that they started free and fair the current year without any dead horses to pull. With regard to the amount owing to the company (£141,000) it was less by some £17,000 than last year, notwithstanding that they had certain retention money kept back by the municipalities. They hoped some day, and in the near future, to be able to get municipalities to see the error of their ways in keeping back 10 per cent. on the amount of their contracts for six and sometimes 12 months. I think where a municipality is dealing with a reputable firm like ours that they should be satisfied as the Government are—the large spending departments of the Government—to pay when the work is completed and not want to retain large sums in hand for so long To one or two other companies doing a larger business than they were with municipalities this retention of money was becoming a very serious burden. It means that enormous sums of money are outstanding until the termination of the retention time.

Resolutions were then passed approving the dividends, re-electing the retiring directors and auditors, and increasing the number of directors, and the sum allocated for their remuneration.

The CHAIRMAN moved and it was carried that a cordial vote of thanks be given to the managing director, the secretary and the staff in London and at the branches at home and abroad, and also to the chief engineer and his staff at the works for their services during the past year.

Mr. SUTTON having replied, and a hearty vote of thanks having been passed to the chairman and other directors, the proceedings terminated.

Metropolitan Electric Supply Co. (Ltd.)

The seventeenth ordinary general meeting was held on Tuesday under the presidency of Mr. W. HARRISON CRIPPS.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, I will briefly allude to a few of the most important features in the report. The capital expenditure of the company is now £2,090,000, an increase in the year of £244,000 roughly. Of this there has been £33,000 spent in Marylebone. We need not worry very much about that for the moment, because it will be repaid. Of the other chief items, the largest are those of £89,000 for machinery, £68,000 for mains, and £53,000 for buildings. The great bulk of this money was spent at Willesden. Of course, you must remember that in spending capital upon an electric supply undertaking the amount must vary enormously from year to year. It is not possible to put in in one year sufficient for the next year. When once you make an advance and put in more capital it is always better and cheaper to provide for some years ahead. That is what we have done at Willesden, which is now, perhaps, one of the most magnificent stations for producing power in this country. We have finished the first wing of it, and it contains 22,500 H.P. of machinery, all in perfect working order. We do not grudge spending money on this station to make it perfect, as Willesden has this special advantage—it is outside the Electric Lighting Act of 1888—that is to say, that this is our own freehold. We have not to hand it over to any of these jealous borough councils at a stated time, but there it is for us for all time, and its position is such that it will enable us to produce current cheaper than almost any one else. We have the facilities there of cheap water, cheap coal, and, above all, we are free from that constant annoyance there which we have always experienced at our London stations from our neighbours, who suffer, owing to their nerves, from many ills which exist only in their imagination. So much is this so that one of our neighbours at the present time, the St. Pancras Borough Council, have an injunction against their main station for disturbing someone's sleep. We are exempt from all

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this petty annoyance at Willesden, and that is one of the reasons we get on so well there. During the year our capital has been increased by half a million of preference shares. Two-thirds of these shares were taken up at par by our shareholders, while the remaining third is being disposed of from time to time as we require the money; and I may say that they are being disposed of at a fair and substantial premium. Seeing that the investor in preference shares is a person who likes to get his money steadily and regularly, we propose in future to pay the dividend on these shares on July 1 and Jan. 1. Holders of the present preference shares will, therefore, not only get their dividend now, but a second dividend in about three months' time—that is, on July 1. As regards our bank loans, at the beginning of last year we owed our bankers £390,000; at the end of the year we had reduced this amount to £290,000, and we have now still further reduced it, so that our bank loans stand at only £210,000. Of course, we shall be able very easily to wipe off that amount so soon as we are paid some of the large sums which are now due to us. Now, let us consider the revenue for a moment—a rather more interesting subject, as a rule, than capital. In 1902 our gross revenue was £261,000, and this year it was £281,000, an increase of £20,000. My own belief, however, is that in the future we shall not be able to reckon upon these large increases. Cost of generation was about £113,000 in 1902, while in the year that has just passed the cost was only about £98,000, a saving of £15,000, although we have sold £20,000 worth more electricity. I regard that as a very satisfactory condition of things. This great diminution in cost of generation is almost entirely due to the cheap working at Willesden—partly owing to the actual improvement of our machinery there, but due in no small measure to the great care and supervision exercised there by our chief engineer, Mr. Hightield, and in mentioning his name, I should also like to say that Mr. Markby, our resident engineer at Willesden, has also shown the greatest energy in reducing our expenses. I think I may say that all our engineering staff, including those at the London stations, have had in mind the question of economy in production. In case I should forget to refer to the matter later on in my speech, I should like, while I am talking about the officials of the Company, to say that the Directors would wish me to state how very greatly indebted we have been to our secretary, Mr. Cunliffe Owen, and to our extremely able general manager, Mr. J. Conacher; and I can only say to all companies who have keen competition to meet, if they wish to economise, especially in expenditure, that the way to do so is to get a general manager down from Scotland. Well, as I have said, our gross income is £281,000. Working expenses come to £138,000, leaving £143,000. Out of this we have to pay interest and preference dividend (£10,000) leaving £103,000. Add £5,000 interest upon our invested reserve funds, and the amount we brought forward and we have to deal with £108,000. We have already paid you a dividend at the rate of 8 per cent. for the last half-year, which absorbed £40,000, and £68,000 therefore remains to be dealt with now. From this we propose to take £18,000 for reserve, a very much larger sum than we have ever before carried to that account. This leaves us £50,000 to deal with, and the directors propose to pay a dividend for the last half-year at the rate of 9½ per cent. per annum, making 8¾ per cent. for the year, against 7¼ per cent. last year. So far as I know, we are the only electrical company that has made any real progress in the amount of dividend to be paid this year as compared with last. That will leave us something over £2,000 to carry forward—about double the amount we carried forward last year. As to our general position, ever since our birth we have been fighting. Indeed, there seems to be a large section of the community who think that an electric lighting company should be regarded as a criminal to be prosecuted in every possible way, and this year, as usual, we have spent a considerable amount of our time in arbitration proceedings and in the Law Courts, and we have not been altogether unsuccessful. We had to sell our Sardinia-street station to the London County Council, and the arbitrator has awarded us £183,150. This we consider a very fair and reasonable award for that station. Although we have been awarded that amount, I need hardly tell you that we have not yet received the money. Public bodies—the London County Council is not the only one—are very pleased to incur debts, but they are not so ready in paying them. In addition to this £183,000 odd, we have had a new site given us on the new area equivalent in extent to the site we had in the old slum. As regards Marylebone, I am on rather delicate ground. For a great number of years, after persecuting us in every possible way they could, the Borough Council at last got their compulsory order to buy us. Since then they have been looking for someone to borrow the money from. Up to the present they have not found anyone sufficiently confiding to lend them the money; but we have contended all along that, as a matter of fact, all this difficulty about arranging the money and applying to Parliament was not necessary. If there had been a bona fide intention on the part of all parties to advance the money it would have been obtained, I believe, without difficulty. As matters stand we are in a very curious situation. We are bound by our statutory powers to carry on the supply in Marylebone, but the concern does not belong to us. We are carrying it on for the Council, and the Council thought we should not only carry it on for them, but do so with our own money. It is, however, very expensive to carry on one of these electric lighting businesses and provide new capital, so we sought the assistance of the Courts, and obtained an order by which they had to pay us £60,000 down as part of the expenses we had already incurred. That order we got at Christmas, and I have now seen what you perhaps have not had the luck to see—one of the rarest autographs—the autograph of a borough council for a large debt. That has actually been paid by cheque into our account. Another little amount of £15,000 is due to us at the end of this month. After the award the Council approached us—I suppose they would say we approached them, but we got into contact—as to whether we would make any arrangement with them to cancel the award. But we would enter into no arrangement except on the condition that that award money was paid. I think that they have got that thoroughly at heart. We ran our risk. If the award had been against us, and had turned out to be only £200,000 instead of a million and a quarter, and we had gone to them and asked them to cancel the debt, I am sure that they would not have done it. We negotiated as to whether we might make some terms, after they had paid this money, for supplying them wholesale from our station at Willesden. We know that we can do it very much cheaper than they can do it. Having their own supply means putting up an entirely new station at a cost of little short of half a million: and they would have to spend many more thousands in disconnecting the present system in Marylebone, which is connected at Willesden, all ready for the supply. And they would have to spend this money uselessly, I say, except for the pleasure of doing a little municipal trading. Out of all the ratepayers in Marylebone only about one-fifth—a little more than 20 per cent—really take the electric light, and the majority never will. According to their own account the Borough Council must lose a considerable sum on the trading. How do they propose to make it up? I say they ought to do so by charging an extra amount to those who consume the electric light. What they will do is to charge it upon the other 78 or 80 per cent. of the ratepayers who do not take the light at all. It is very hard on a man who lives in a back street, and who is satisfied with his gas or oil, that he should have to pay in order that the magnificent shops in front streets should attract their customers by a more brilliant light. As to providing the supply and undertaking a lease, we made certain suggestions by which we should be willing to work the concern for the Borough Council. I do not know whether they considered these suggestions or not. But they have been negotiating with certain other companies and, indeed, it seems to me that they have been casting about in Europe and America to see what sort of supply they can get from someone else. Yet, here are we, actual neighbours in their midst, having lived with them—I will not say quite amicably, but on decent terms—and paid their rates. Yet I should not be surprised if they prefer to get their supply from some foreign firm with an unpronounceable name instead of from us. I now move the adoption of the report and accounts, and the payment of the dividends recommended therein.

Sir JAMES PENDER, Bart., seconded the motion.

The resolution was carried unanimously.

The retiring Directors, Sir James Pender, Bart., the Hon. John Birkbeck Lubbock and Mr. James Carr Saunders were then re-elected, as were the retiring auditors, Messrs. Deloitte, Dever, Griffiths & Co., and a cordial vote of thanks to the Chairman and Directors for the conduct of the Company's affairs and to the General Manager, the Secretary and staff was carried unanimously. The proceedings then terminated.

Chelsea Electricity Supply Co. (Ltd.)

The annual meeting took place on Friday last, Mr. J. IRVING COURTENAY in the chair.

The SECRETARY (Mr. S. J. Cluer) read the notice convening the meeting and the auditors' certificate.

The CHAIRMAN said: Gentlemen, I congratulate you on the improvement in the company's business, the profit for the year being £33,054. 19s. 2d., against £27,988. 19s. 3d. last year, enabling us to recommend a dividend of 5½ per cent., or 1 per cent. more than last year. A further reduction in the working costs per unit was effected during 1903, chiefly due to economies in working facilitated by the greatly increased demand for electricity supply. The total cost per unit only amounted to 1·90d., against 2·38d. for 1902. This increase is due mainly to the adoption of electricity for other than lighting purposes, such as motive power, heating, and for charging batteries of electric carriages. Chelsea being chiefly a residential neighbourhood, does not contain many factories or workshops, and consequently the demand for electric current for power cannot be so great here as in certain other parts of London. There are, however, many uses for small motors, both in private houses and in business premises. The number of lamps added during the year was 19,233, compared with 14,971 during 1902, the total at the end of the year being 195,235, and the units sold per lamp show an increase of 1·25 for 1903, the total number of units sold during the year being 481,793 more than the previous year. The capital expenditure on plant during the year does not call for special remark. Further progress has been made in the extension of mains which supply current direct from the generating works, thus obviating the cost of additional transforming plant and the losses necessarily occurring in sub-stations. The work of changing over to the 200-volt supply our earlier customers, who were originally supplied at a pressure of 100 volts, has made great progress, and we hope before long to complete this work over the whole of our area, and to supply all our customers at one uniform pressure, the object being to reduce capital expenditure on mains in the future. We recently decided to bore an artesian well at the generating works, and the result has been entirely satisfactory. I desire to call attention to the large amount this company pays in rates. The amount paid last year (£3,073) is nearly 22 per cent. of the amount recommended to be distributed as dividends, and is nearly 1½ per cent. on the ordinary share capital. I do not see any prospect of their being reduced. At the last annual meeting mention was made of a scheme for cancelling the founders' shares, and giving the holders an immediate participation in the profits of the company by means of income certificates. That scheme does not appear to have commended itself to the holders, and a conference was, therefore, held a few weeks back. Some further discussion and an agreement as to terms are necessary before proposals can be formulated. I now move the adoption of the report and accounts and the payment of the dividends set out therein.

Major-Gen. C. E. WEBBER, C.B., seconded.

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In reply to several shareholders as to the cancellation of founders' shares, the redemption of debentures, and the increase in the rates,

The CHAIRMAN said the board had appealed against the company's rating, but they had lost. His own view was that there should be a combined movement by companies of all descriptions to bring before Parliament the ever-increasing pressure of the rates. The directors had not yet provided for the redemption of debentures, but when the company got stronger the directors might consider the question of making some such provision. As to the cancellation of the founders' shares, if their bill was unopposed the cost of its promotion would be about £750. It would, however, be best if terms could be arrived at between the various classes of shareholders. As to depreciation, this was now a fixed percentage on the capital expenditure.

The resolution was then carried with a few dissentients.

The retiring directors and auditors were re-elected, and a vote of thanks to the chairman and directors terminated the proceedings.

County of London and Brush Provincial Electric Lighting Co. (Ltd.)

The tenth ordinary general meeting was held on Monday, under the presidency of Mr. J. B. BRAITHWAITE, jun.

The SECRETARY (Mr. H. B. Renwick) read the notice convening the meeting and the auditor's report.

The CHAIRMAN then said: Our record for the past year is one of quiet, steady and satisfactory progress, with nothing sensational in it. Taking the balance-sheet, the chief change that has occurred is in capital expenditure, which has amounted to £133,772 in the year. We have been largely extending the capacity of our generating plant at both our London stations, and these extensions will probably carry us over next winter without further additions. Other extensions to buildings and mains have also been effected. Looking to the future, and in view of the large area we have to serve and the demand for power which is growing up, it is desirable that we should make quite sure that we have the means of extending our City-road generating station whenever the time comes for this purpose, and the arrangements for this extension that we have made will, I think, be satisfactory to you. You will see that we have spent on mains £45,272. The expenditure made on this item in the last two or three years has invariably justified itself and brought us a fair return. Our company owns the largest area for electricity supply of any company in London, and consequently our expenditure on mains must also be the largest in due course. On transformers, motors. meters, switchboards and electrical instruments we have made a large expenditure. Turning to the revenue account, we have every reason for quiet and modest satisfaction. Our progress has been all along in the right direction, and is steady and well maintained, tending to increase. Receipts from the sale of current for the year stand at £105,316, an increase of £13,071 over last year, equal to 13·6 per cent. Generating expenses have increased by about £1,000, so that we have increased the profit from our London stations for the year by £11,724, which means that the ratio of working expenses has again gone down. This was 36·4 per cent. in 1902, and for 1903 33·1 per cent. I think we may look forward to some still further reduction. The increase in units sold last year was 886,346, compared with an increase in 1902 of 517,180, and this, in spite of the absence of fog, which of course makes a big difference in the consumption of current. The increase of lamps is a record in the history of the company. It represented last year 112,564 8 c.p. lamps, compared with 90,314 in the previous year. A large proportion of this increase was due to the demand for electrical energy for motor power. We have more power on our mains at the present time than any other London company, with possibly the exception of the City of London Company. There are 595 consumers taking an aggregate of 5,837 H.P., of which 1,413 H.P. were added during the past year. We may, I think, look to a steady increase in this demand, which will have an important effect on our load factor. Interest and dividends received show an increase over last year of £2,189, due to the thorough reorganisation of the Scottish House-to-House Electricity Co., from our holding in which we are now able to derive a profit. With regard to the item in the accounts of profit on investment realised and commissions, that shows the large decrease this year of £4,899, due to the fact that we have realised our shares in the Dover Electricity Supply Co. The net result is that we are able to maintain the same dividends as were paid last year, and are able to carry £2,000 more to depreciation. It does not require an engineering expert to show that the provision we make for depreciation is totally inadequate at present, but we can only make such provision as we have the funds, and now that we have got on to a steadily increasing basis of profit from the London stations, I hope we shall be able every year to increase the depreciation allowance until we reach an adequate figure. I am pleased to make the gratifying announcement that our troubles with regard to the municipal authorities are for the moment at an end. The attack made upon our area by the London Electric Supply Corp. last year, at the instance of Camberwell Borough Council, has been defeated, as the Board of Trade, after holding a full inquiry, did not grant the order asked for. The Bermondsey Council also made an application and were defeated, so that I hope we are to have a few years' peace from these harassing applications. As to the future, I may say that up to the present we have received since Jan. 1, applications for the equivalent of 26,872 8 c.p. lamps, compared with 15,040 for the same period last year, an increase of 78 per cent. over last year's increase. After making certain adjustments of last year's figures and allowing for the disconnections made this year, the actual net increase is 17,428, compared with 7,842, or an actual increase of 122 per cent. It is not probable that we shall continue this rate of increase, but it shows that the applications are coming in at an accelerated pace. The number of units of current sold up to March 8 gives us an increase of 216,036 on the year. There has also been an increase of 123 consumers up to the present date for 1904. I have not mentioned anything about our investments in the Bournemouth and Richmond Companies, as we are only interested as shareholders. These companies are paying an 8 per cent. dividend again, and are putting increased sums to depreciation. Our shares in the Bournemouth Company are valued in the balance-sheet at cost, but as certain of the shares stand at a good premium, we shall, when we come to sell them, have a nice little nest egg to add to our depreciation fund. I now move the adoption of the report and accounts.

Mr. F. W. REYNOLDS seconded.

A discussion followed, mainly on the point of depreciation, and Mr. KITCHEN asked as to the company's holding in the Marylebone Company.

The CHAIRMAN, in reply, said he had overlooked their small holding in the Marylebone Company. The directors thought they would await the final settlement between the Marylebone Council and the Metropolitan Electric Supply Co. before the amount of the company's holding in the Marylebone Company was extinguished. With regard to the question of depreciation, he had already told them that in his view the provision made was ridiculously inadequate. At the same time, he might say as they improved their profits an endeavour would be made to put the depreciation fund in a more satisfactory condition.

The resolution was then carried unanimously.

The CHAIRMAN then dealt with the matter of the proposal to change the name of the company to the County of London Electric Supply Co. (Ltd.) He said the remaining words in the company's present title of "Brush Provincial" were misleading and lead to confusion; and as they had now disposed of their provincial interests they proposed to omit this portion of their title.

The motion was carried. Resolutions were also carried approving the dividend and re-electing the retiring directors, Mr. Joseph Shaw and Mr. F. E. Savory. The auditor having been re-appointed, a vote of thanks to the chairman, the secretary and the other officers of the company was carried, and the proceedings terminated.

ALLGEMEINE ELEKTRICITATS AKTIENGESELLSCHAFT.—At the recent meeting a lengthy report was presented as to the negotiatiations between the company and the General Electric Co. of New York, and also as to the proposals for acquiring the undertaking of the Union Elektricitäts Gesellschaft and for purchasing certain shares in Brown, Boveri & Co., &c. These proposals, which involve an increase in the share capital from £3,000,000 to £4,500,000, were approved.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors' report states that the total applications received to Dec. 31 was equivalent to 100,538 8 c.p. lamps, an increase of 19,542 8 c.p. lamps for the year, compared with an increase of 13,343 for 1902; units sold, 1,520,002, an increase of 259,736. Capital expenditure for the year was £55,433. 2s. 7d., bringing the total to date to £286,889. 11s. 3d. The balance to credit of net revenue, after payment of interest and providing for depreciation and redemption funds, is £12,960. 7s. 3d. The preference dividends have been paid, and the directors recommend a dividend on the ordinary shares of 8 per cent. (less tax), leaving £3,305. 11s. 7d. to be carried forward. Additional generating plant has been erected at the Bourne Valley station, and the directors anticipate this will be sufficient for the company's requirements for the next few years. The generating station at Christchurch has been completed, and supply for both lighting and traction purposes commenced in June last. The company has secured a contract from Christchurch Council for electric lighting in the public streets. The company's mains have been extended to Pokesdown, where a supply of current has been available for some time past.

BRITISH INSULATED AND HELSBY CABLES (LTD.)—The report of the directors for 1903 states the profit amounted to £129,446. 3s. 4d., which, added to £3,468. 5s. 1d. from last year, makes £132,914. 8s. 5d. After deducting directors' and trustees' fees, &c. (£2,250), interest (£22,500), depreciation (£18,500), transferring £8,500 to special reserve and £5,000 to debenture redemption account, and paying preference dividend (£30,000) and the interim ordinary dividend to June (£20,000), the available balance is £26,164. 8s. 5d., and the directors recommend a further dividend of 4 per cent. on the ordinary shares, making 8 per cent. for the year, and leaving £6,164. 8s. 5d. to be carried forward. During the past year the volume of trade has been less and competition more severe. The completion of the instrument factory at Edge-lane, Liverpool, and the telephone cable factory at Prescot and other extensions, which are now in working order, will enable the company to do an increased business in the future.

BURY, ROCHDALE AND OLDHAM TRAMWAY CO. (LTD.)—The directors report that the dispute between the company and the purchasing authorities has been arranged; and an agreement has been entered into with all the authorities, except Whitefield District Council the (lease of whose lines expires in seven years), providing for working the tramways until completion of sale. Mr. H. Graham Harris has been appointed arbitrator.

CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)—The directors' report for the year ended Dec. 31 states that, after providing for interest (£12,000) and preference dividend to Dec. 31 (£12,083. 6s. 8d.), the surplus is £59,977. 18s. 6d., from which is deducted £2,104. 14s., the amount of interim dividend at 5 per cent. per annum on the ordinary shares for the June half-year, leaving a disposable balance of £57,873. 4s. 6d. The directors recommend a further dividend on the ordinary shares at the rate of 5 per cent. for the six months to Dec. 31, and a bonus of 5 per cent. (making 10 per cent. for year), requiring £6,314. 2s.; and that the balance (£51,559. 2s. 6d) be carried to reserve. During the year 49,969,345 passengers were carried, the gross earnings were £264,556 and the net earn-

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ings £81,978, compared with 47,960,869 passengers and £254,691 and £51,781 respectively in 1902.

COMMERCIAL CABLE CO.—The report of the directors for 1903 states that the net revenue, including $147,529 from previous year, amounts to $2,656,055, out of which have been paid interest $800,000 and 8 per cent. dividends on capital stock ($1,200,000). $350,000 has been placed to reserve and $150,000 to the fund for insurance of stations, apparatus and repair steamer, leaving $156,055 to be carried forward. The reserve now amounts to $5,372,520 and insurance to $1,020,862.

DAVIS AND TIMMINS (LTD.)—The chairman (Sir Henry C. Mance) stated at the meeting on Monday, that, considering the conditions of trade during the last year or two, the results of the company's working were very encouraging. The net profit for the year, including £2,890 brought forward, after allowing for deprecation and commission to managers, was £12,821. The available balance (£11,021) would be dealt with as follows: In payment of six months' dividend on preference shares to Dec. 31 (£1,800), a dividend at the rate of 8 per cent. per annum on the ordinary shares for the year (£3,760), and £2,000 to general reserve, leaving £3,461 to be carried forward. 3,000 ordinary shares were still unissued, but for the present it prevented them obtaining a quotation on the Stock Exchange, as the issue did not amount to £50,000. They would be useful in the future if they had to extend their factory at Wood Green, which he hoped would be necessary before many years. They did not find that trade in general throughout the country had improved, and competition had been very keen. Their plant and machinery had been kept in thorough order, and no less than £1,746 had been written off for depreciation.

DEVONPORT AND DISTRICT TRAMWAYS CO.—For the half-year ended Dec. 31 the revenue was £13,573. After deducting expenses, the profit was £3,687. £1,000 is placed to depreciation and reserve, a dividend at the rate of 4 per cent. per annum is declared. Experiments made during the year with regenerative control having proved satisfactory, the board have decided to proceed with the equipment of the cars. Total expenditure to Dec. 31 last amounted to £154,524. Part of the tramways constructed by Devonport Corporation and leased to the company were taken over for working on Sept. 10, and the remainder on Oct. 31. The company has made application for power to construct light railways in Devonport and Plymouth.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The directors' report for the year to Dec. 31 states that, after making provision for the interest and sinking fund, there is a credit balance to revenue of £10,835. 15s. 6d. After adding the usual £5,000 to reserve, there remains £5,835. 15s. 6d. The directors recommend payment of balance dividends for 1903 of 10 per cent. on the preference and 4 per cent. (tax free) on the ordinary shares, absorbing £5,436. 0s. 11d. The remainder (£399. 14s. 7d.) is transferred to credit of contingencies account, now amounting to £1,180. 3s. 9d. Traffic receipts show a decrease of £1,797. 11s. 9d., compared with 1902, due to interruptions to the cables. Working expenses increased by £95. 11s. 7d. The Bilbao cable has been twice interrupted during the year, the first interruption being for 50 days, bad weather in the Bay of Biscay having delayed the repair. The second interruption in May (for 12 days) was promptly restored by the "Mirror." The Marseilles-Barcelona cable was interrupted in January, 1903, and was not repaired for 25 days. The cost of these three repairs (£10,591) has been charged against reserve. Both cables have since worked well.

Owing to difficulties experienced in working the Bilbao cable, in consequence of electrical disturbances at Bilbao, caused by electric tramways, &c., it was found necessary to convert the cable house at Arrigunaga into a cable station, and to erect overhead wires into the town of Bilbao. Since these alterations the service has been carried on more efficiently. This expenditure (£1,467. 1s. 3d.) has also been charged against reserve. From July 1 next reductions of rates will come into effect between Great Britain and Spain, Portugal and Gibraltar from 3½d. to 3d. per word.

GREENOCK AND PORT GLASGOW TRAMWAYS CO.—The report for 1903 states that the outlay on electrical reconstruction amounted to £5,818, bringing the total expenditure to Dec. 31 to £176,882. Revenue was £29,025, expenses £18,219, net profit £10,806. Depreciation and renewals accounts receive £1,500, reserve (sinking) fund £1,780, and a dividend of 6 per cent. is declared on the ordinary shares. The short extension in Port Glasgow has been constructed, and was opened for traffic on Nov. 2.

HADFIELD'S STEEL FOUNDRY CO. (LTD.)—The chairman (Mr. R. A. Hadfield), at the meeting on Monday, gave an instance where, in tramway construction, the company held their own with American competitors. About 15 months ago they had the chance given them of undertaking certain kinds of work for tramway construction on the conduit system. Up to that time the Americans, who had necessarily greater experience than they in that special work, held the field entirely and absolutely. However, they were given the chance of competing, and they accepted it, though they had at the time no plant suitable for the work, and it was a difficult class of work. The contract was divided between them and the American firm, and they had to deliver it within a certain time. They were able to execute the contract a fortnight before the time specified, and they got the whole of the next contract against the American firm. The greatest satisfaction had been expressed with the way in which the work had been carried out. The directors contemplated certain developments which would be of the greatest benefit to the shareholders, and of great importance in helping forward the future prosperity of the company. By arrangements with Messrs. Fraser and Chalmers, they would develop their trade in South Africa in about half the time it would otherwise have taken. The capital of the company is to be increased to £500,000 by the creation of 50,000 new ordinary shares of £1 each.

HOVE ELECTRIC LIGHTING CO. (LTD.)—At the meeting on Wednesday the chairman (Col. A. J. Filgate) said the greater portion of the capital expenditure during the year (about £16,500) was on the new generating station and its equipment. During the year they had added 1 mile 746 yds. to the mains and 1 mile 484 yds. of feeders at a cost of £3,968. It was estimated that a further £5,000 was needed to complete the new station and plant. 1,148 houses were connected to their system, an increase of 108; the equivalent number of 8 c.p. lamps and motors connected was 77,366 against 69,024 at the end of 1902, and the units sold to consumers amounted to 779,985 compared with 735,316. The revenue was £19,035, compared with £17,562. Expenditure was £7,820, against £7,519. Allowing for full outlay on maintenance and repairs during the two years, the actual expenditure had been £7,834 in 1903 and £7,803 in 1902. The net revenue was £11,214 compared with £10,043. The directors recommended placing £3,000 to reserve and £500 to maintenance reserve; and a final dividend at the rate of 10 per cent. per annum for the half-year, making 8¼ per cent. for the year. They were much indebted to their engineer (Mr. C. B. Smith) and his staff and their secretary (Mr. F. R. Reeves) for their good work for the company. In regard to the question of voltage, he hoped the difficulty with the Corporation was in a fair way towards settlement.

OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY (LTD.)—The directors announce that the total revenue for 1903 was £30,451. 2s. 10d., expenditure (including £1,600 for interest) £23,566. 15s. 8d., profit £6,884. 7s. 2d., added to £123. 12s. 9d. from previous account. £7,007. 19s. 11d. is available for distributing as follows:—£1,000 to depreciation and reserve, cumulative preference dividend £2,419. 1s. 10d., and at the rate of 9 per cent. on the ordinary shares for the six months to Dec. 31 (making 7 per cent. for year) £3,418. 16s. 9d.; carried forward £170. 1s. 4d. The reduction of dividend on ordinary shares by 1 per cent. is due to distress in the cotton industry, unfavourable weather and loss on joint working by company and Stockport Corporation of new line from Hyde to Bredbury.

SWANSEA IMPROVEMENTS AND TRAMWAYS CO.—The directors report for the half-year to Dec. 31 states that the gross receipts were £15,485. 17s. 7d. (increase £1,725. 9s. 10d.), expenses (including interest) £10,121. 14s. 8d. (increase £504. 18s.). The profit was £5,364. 2s 11d. With £1,322. 1s. 9d. brought forward, £6,686. 4s. 8d. is available, and the directors recommend that £1,000 be placed to reserve to be applied in reduction of balance of advances due to British Electric Traction Co. After payment of preference dividend for the half-year and a dividend on the ordinary shares at the rate of 2½ per cent. £1,137. 0s. 8d. is carried forward.

The action brought by the Corporation to determine their rights of purchase of the company's undertaking under various Acts of Parliament, more particularly that of 1882, has been decided by Mr. Justice Buckley in a manner favourable to the company. The construction of the Corporation tramways and light railways has been commenced by the Corporation. When completed, the lines, as previously stated, will be leased to the company. It is anticipated that one section will be opened for public traffic in the early summer. The working of the Mumbles railways and pier shows a profit of £738. 16s. 8d., which, deducted from the deficiency of £2,543. 10s. 6d. for the June half-year, leaves a net deficiency on the year of £1,804. 13s. 10d., which is to be provided by the British Electric Traction Co.

TYNEMOUTH AND DISTRICT ELECTRIC TRACTION CO. (LTD.)—The directors' report for past year states that the total capital outlay on electrical construction and equipment is £85,314. 6s. 5d., revenue was £16,138. 3s. 1d., and expenditure (including interest) £10,036. 4s. 3d., profit £6,101. 18s. 10d., added to £138. 10s. 3d. from last account. £1,500 is put to depreciation and reserve, the balance cumulative preference dividend absorbs £437. 10s., and 7½ per cent. on the ordinary shares for the year £3,000, leaving £240. 9s. 1d. to be carried forward. It is hoped the construction and equipment of the light railway to Whitley Sands will be arranged for during the summer of 1904. 4,000 additional ordinary shares of £5 each are to be issued.

VICKERS, SONS AND MAXIM (LTD.)—At the meeting on Wednesday, the chairman (Col. T. E. Vickers) denied the rumours as to the discharge of workmen at Sheffield and as to their intention to issue new capital. Their present reserve fund was invested in bricks and mortar, goodwill, or otherwise locked up in the company. The directors thought it would be better to discontinue that class of reserve fund, and to wipe it off and start a cash reserve fund. They had very much larger orders on hand now than at the same period last year.

NEW COMPANIES, LIENS REGISTERED, &c.

NEW COMPANIES.

CARBONE ARC LAMP SYND. (LTD.)—Reg. March 9, capital £9,880 in £1 shares (9,500 ordinary, 190 A deferred and 190 B deferred), to acquire from A. Stevenson the benefit of certain existing inventions relating to electric lamps, and to carry on the business of lamp manufacturers, electrical and mechanical engineers, &c. The subscribers are: A. Stevenson, manufacturer, J. W. Nasmith, engineer, E. W. Cowan, C.E., L. Andrews, electrical engineer, E. E. Johnson, C.A., A. H. Stevenson, manufacturer, and T. R. Lawley. First directors, M. Bartholomew, E. W. Cowan, J. H. Leather, J. W. Nasmith, A. Stevenson and H. Wollheim.

OTTO ELECTRICAL MFG. CO. (LTD.)—Reg. March 7, capital £10,000 in £1 shares, to acquire English and foreign patents and applications therefor in connection with the manufacture of arc lamps, granted or to be granted to O. Gross, and to carry on the business of electricians,

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mechanical engineers, suppliers of electricity, &c. The subscribers include O. Gross, electrical engineer, W. H. and L. B. Wilson, electrical engineers, H. J. C. Somerville, electrical engineer. First directors, H. J. C. Somerville, J. Deakin, O. Gross and W. H. Wilson.

MORTGAGES AND CHARGES.

BROCKIE-PELL ARC LAMP (LTD.)—Memorandum of satisfaction in full of debenture dated Nov. 30, 1903, securing £1,000, has been filed.

ELECTRO VOELKER SYND. (LTD.)—Debenture, dated March 4, 1904, to secure £215. 15s. 9d., charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. No trustees.

LANGDON-DAVIES MOTOR CO. (LTD.)—Issue on March 8 of £400 4½ per cent. debentures, part of series created Oct. 15, 1902, to secure £6,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £5,400.

UXBRIDGE AND DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Issue on March 7 of £3,900 debentures, part of series created by resolutions of July 18, 1901, and May 26, 1903, to secure £25,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £20,000.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 26⅛d. per oz. (March 17). Consols 86⅛—86⅛ for money, 86⅜—86⅝ for account; 2½ per cent. annuities 86⅛—86¾ (March 17). Consols Pay Day April 7; Stocks and Shares Continuation Days, March 26 and April 12; Ticket Days, March 28 and April 13; Pay Days, March 29 and April 14; Mining Share Carry-over Days, March 25 and April 11.

BERLIN ELECTRIC RAILWAY.—The second year's working of the combined elevated and underground electric railway will permit of a 3½ per cent. dividend.

BRITISH COLUMBIA ELECTRIC RAILWAY.—For the half-year ended Dec. 31 a dividend of 3 per cent. on the deferred ordinary stock is recommended. The gross receipts were £85,286, working expenses £46,932, net receipts £38,354, compared with £29,905 last year.

BRUCE PEEBLES & CO (LTD.)—The net profit for 1903 was £11,000. The directors propose a dividend on the ordinary shares of 6 per cent., £1,750 is put to special and £1,250 to general reserve and £2,000 written off preliminary expenses. The carry forward is £544.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LTD.)—The directors recommend payment of a dividend of 3 per cent. (3s. per share), tax free, on the ordinary shares for 1903, after allocating out of net revenue £5,000 to renewals, £2,500 sinking fund, £4,500 off capital expenditure, £500 to accidents insurance fund, £1,301 to meet loss on sale of surplus stores. The carry forward is £2,480.

CHARING CROSS, EUSTON AND HAMPSTEAD ELECTRIC RAILWAY CO.—Mr. C. A. Grenfell has joined the board of this company.

CHATHAM AND DISTRICT LIGHT RAILWAYS CO.—After payment of the preference dividend £556 is carried forward and £1,500 transferred to reserve for depreciation.

CLONTARF AND HILL OF HOWTH TRAMROAD CO.—For the year ended December the net revenue was £1,175. Interest absorbed £1,125, and the balance has been applied in reduction of the outstanding debit.

FAIRBAIRN, LAWSON, COOMBE AND BARBOUR (LTD.)—The report for 1903 states that the profit, after charging depreciation (£14,169), &c., amounted to £40,775. After providing for preference dividend, the directors recommend an ordinary dividend of 1 per cent.

GENERAL ELECTRIC CO. (LTD.)—The transfer books for the debenture stock of this company will be closed from 18th to 31st inst. inclusive, for the payment of the half-yearly interest.

LANARKSHIRE TRAMWAYS CO.—The directors recommend a dividend at the rate of 4 per cent. per annum from date of opening (July 22) to Dec. 31 last, after placing £1,000 to reserve and writing £385 off cost of original order and promotion expenses. £351 is carried forward.

NEWMARKET ELECTRIC LIGHT CO. (LTD.)—The chairman (Mr. G. H. Verrall, J.P.) at the meeting on Monday said that during the past year the equivalent of 2,632 8 c.p. lamps had been connected, making the total 16,453 lamps. Applications for a further 887 lamps had been received this year. Additions to the buildings and plant had been completed. The profit on the year's working, added to £126. 13s. 4d. brought forward, amounted to £2,267. 8s. 8d. An ordinary dividend of 4½ per cent. was declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered the further issue of £45,000 4½ per cent. Vancouver Power debentures of £100 each of the *British Columbia Electric Railway Co. (Ltd.)* and the further issue of £68,533 4½ per cent. redeemable first mortgage debenture stock of *Edmundson's Electricity Corp. (Ltd.)* to be quoted in the official list. Application has been made to allow the further issue of £2,500 ordinary £5 shares of the *Oxford Electric Co. (Ltd.)* and 14,000 £5 ordinary shares of the *Bromley (Kent) Electric Light and Power Co. (Ltd.)* to be quoted in the Official List.

WOKING ELECTRIC SUPPLY CO. (LTD.)—The revenue for 1903 was £7,960. 9s. 2d., expenditure, £4,043. 3s. 1d., balance £3,917. 6s. 1d. Interest absorbed £1,389. 12s. 7d., and half-year's preference dividend £792. 6s. 8d., and a 4 per cent. dividend on the ordinary shares £626. 5s. 7d., £750 is put to depreciation. There are 660 consumers, representing an equivalent of 25,010 8 c.p. lamps connected. During the year 136 new consumers were obtained, exclusive of the lighting of the London and South-Western Railway Co.'s Woking station, which was connected in December, and is already a large consumer of electrical energy. Expenditure on capital account on Dec. 31 amounted to £65,480. 4s. During 1903 a new engine room was built, a 400kw. generator installed (more than doubling the generating capacity of the works), a new switchboard of the most modern type erected, and 8 miles of cable laid. Further expenditure upon boiler power and other works will be required during the current year.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Mar. 12	1,065	+ 226	41	49,496	+ 9,795
Airdrie	,, 4	197	...	4	718	...
Ayr Corporation	,, 12	158	- 15	43	11,991	+ 153
Barnsley	,, 4	143	- 15	9	1,350	- 58
Barrow	,, 4	139	+ 85	4	592	+ 367
Bexley District Council	,, 11	132	...	23	3,388	...
Birkenhead	,, 13	959	+ 9	...	...	...
Birmingham Corporation	,, 12	273	...	10	2,908	...
*Birmingham Tramways Co.	,, 12	4,994	+ 169	10	£0,580	+ 2,650
*Blackburn Corporation	,, 11	704	- 2	§50	41,664	+ 2,130
Blackpool Corporation	,, 10	277	- 46	§49	40,769	- 343
Blackpool and Fleetwood	,, 12	213	- 22	11	1,943	- 105
Blackp'l, St. Anne's & Lytham	,, 10	155	+ 155	‡19	2,792	+ 2,218
Bolton Corporation	,, 18	1,705	+ 36	59	89,984	+ 8,928
Bournemouth Corporation	,, 9	905	...	49	49,651	...
*Bradford Corporation	,, 13	3,494	+ 45	48	185,200	+ 22,787
Brighton Corporation	,, 18	762	- 51	49	44,145	+ 2,464
Brisbane Tramways	Jan. 27	2,128	- 144	4	8,808	- 190
*Bristol Trams & Carriage	Mar. 11	4,843	+ 89	16	71,508	+ 2,566
*Buenos Ayres & Belgrano	Feb. 14	3,010	+ 17	17	56,902	+ 2,993
Burnley Corporation	Mar. 12	573	+ 162	50	48,659	+ 9,388
Burton Corporation	,, 18	281	...	32	10,834	...
Calcutta Tramways Co.	,, 12	R36,166	r R1,587	11	R384,376	+ R67,979
Camborne-Redruth	,, 14	102	...	19	2,094	...
Cardiff Corporation	,, 12	1,806	+ 140	53	96,842	+ 23,181
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 12	7,119	+ 7	11	77,484	+ 757
Chatham & Dist. Lt. Rys.	,, 10	490	+ 55	10	4,940	+ 55
City & South London Rly.	,, 13	3,101	+ 11	11	35,277	- 528
Cork Electric Trams Co.	,, 10	348	- 37	10	3 819	- 78
Darwen Corporation	,, 11	185	- 33	50	11,154	- 287
Devonport & Dist. Trams.	,, 4	425	+ 20	9	4,082	+ 659
Dover Corporation	,, 12	164	- 24	‡50	10,811	- 80
Dublin & Lucan Railway	,, 13	104	+ 9	11	961	+ 65
Dublin Southern District	,, 11	645	- 36	¶10	43,357	+ 756
Dublin United	,, 11	3,455	- 173			
Dudley—Stourbridge	,, 4	635	- 13	9	6,533	+ ‡59
Dundee Corporation	,, 9	749	- 2	42	35,764	+ 2,174
East Ham Council	,, 12	609	+ 80	‡50	32,631	+ 8,736
Gateshead & Dist. Trams	,, 4	807	- 12	9	7,771	+ 440
Glasgow Corporation	,, 12	12,939	+ 3	41	536,342	+ 51,131
Gravesend—Northfleet	,, 4	199	+ 22	9	1,860	+ 296
Gt. Northern & City Rly.	,, 12	952	+ 3	4	3,641	...
Greenock & Port Glasgow	,, 4	478	+ 40	9	4,232	+ 693
Halifax Corporation	,, 2	1,053	+ 15	§49	64,392	+ 6,206
	,, 9	1,043	- 84			
Hartlepool Tramways	,, 4	224	- 4	9	2,201	+ 267
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 14	1,969	+ 224	‡50	95,507	+ 7,773
Ilkeston Corporation	,, 9	117	...	17	2,030	...
Ipswich Corporation	,, 12	308	...	10	4,754	...
Isle of Thanet Co.	,, 12	254	- 82	...	...	...
Kidderminster & District	,, 4	92	- 5	9	833	- 51
Kirkcaldy Corporation	,, 9	184	...	2	375	...
Lanarkshire Trams Co.	,, 10	521	...	10	5,710	...
Leeds Corporation	,, 12	4,798	- 99	50	269,245	+ 15,287
Liverpool Corporation	,, 5	§9,004	- 74	10	91,277	+ 8,045
*Liverpool Overhead Rly.	,, 13	1,585	+ 21	11	16,678	+ 332
*London County Council	,, 5	9,139	+ 1,224	‡49	477,589	+ 83,195
Lowestoft	,, 5	115	...	¶33	6,935	...
	,, 12	122				
Manchester Corporation	,, 12	10,634	+ 1,992	88	445,788	+ 193,136
Mersey Railway	,, 12	1,474	+ 400	10	14,277	+ 8,557
Merthyr	,, 4	180	- 10	9	1,692	+ 151
Middleton	,, 4	228	- 2	9	2,163	+ 184
Newcastle-on-Tyne Corp.	,, 12	3,526	+ 484	10	34,591	+ 4,868
Newport (Mon.)	...	...	...	...	...	...
Oldham, Ashton & Hyde	,, 4	458	- 60	9	4,385	- 232
Perth (W. A.) Elec. Trams.	,, 11	1,344	+ 182	10	13,999	+ 1,851
Peterborough	,, 4	99	- 10	9	979	- 165
Poole and District	,, 4	211	- 21	9	1,979	- 54
Portsmouth Corporation	,, 12	1,431	+ 59	‡50	84,722	+ 5,532
*Potteries	,, 4	1,589	+ 126	9	14,572	+ 1,118
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 1	39	- 2	9	389	+ 38
Salford Corporation	,, 14	3,639	+ 649	50	189,447	+ 51,444
Sheerness	,, 2	42	...	9	100	...
Sheffield Corporation	,, 14	4,447	+ 349	‡51	226,983	+ 18,0 1
*Southampton Corporat'n	,, 10	803	- 45	10	8,374	+ 168
Southend Corporation	,, 9	204	+ 8	49	15,002	+ 2,250
Southport Tramways	,, 4	226	+ 11	9	2,123	+ 226
S. Staffordshire Trams.	,, 4	867	- 88	9	6,521	+ 355
Sunderland Corporation	,, 13	1,122	+ 126	50	59,675	+ 2,9 0
*Swansea Trams	,, 4	417	- 23	9	4,126	+ 183
Taunton Trams	,, 4	42	- 7	9	415	- 22
Tynemouth and District	,, 4	182	- 25	9	1,821	- 19
Tyneside Trams Co.	,, 9	276	+ 6	10	2,705	+ 484
Wallasey District Council	,, 14	572	+ 36	‡50	33,540	+ 3,955
West Ham Corporation	,, 10	246	...	2	493	...
Weston-super-Mare	,, 2	20	- 6	9	200	- 16
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 4	303	- 38	9	2,933	- 105
Worcester	,, 4	215	+ 78	4	1,011	+ 456
Wrexham	,, 4	102	...	9	880	...
Yorkshire Woollen District	,, 4	46	+ 323	9	4,462	+ 1,136

(a) These comparisons are with the corresponding period last year.
*Partly electrical. ‡ Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Mar. 16.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS, WEEK TO MAR. 16 Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4⅜—4¾	5 2 6	April, Oct	4 13/16	4 15/16
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
St.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	..	..
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	98	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 10 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10¼—10⅝	3 15 11	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	83 —86	3 10 8	..	..	..
St.	5%	Do. Pref. Ord. Stock	98 —101	5 0 9	..	99	97
10	5/0	Do. 5% Cum. Perp. Pref.	10¼—10¾	4 13 0	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅝	4 7 0	..	105	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	9 —10	8 0 0	..	9⅜	9 5/16
10	6/0	Do. 6 per Cent. Cum. Pref.	10 —11	5 9 1	Feb, Aug	10⅜	10 5/16
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 —123	4 1 4	..	122	121½
5	..	Buenos Ayres and Belgrano Ord.	2⅞—3⅛	..	..	3 1/16	3 1/32
5	3/0	Do 6 per Cent. "A" Cum. Pref.	5⅛—5⅜	5 4 0	..	..	..
5	3/0	Do. "B"	4¾—5⅛	5 14 3	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	..	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 —100	5 0 3	..	..	..
5	2/6	Calcutta Tramways	6¾—7¼	4 9 8	..	6 1/16	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 —107	4 4 2	..	..	..
1	1/0	Cape Electric Tramways Shares	1⅞—2	8 10 0	..	2	1⅞
St.	4%	Central London Ordinary Stock	92 —95	4 4 4	June, Dec	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	101	100½
St.	4%	Do. Deferred Stock	86 —89	4 9 11	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 —113	3 11 8	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾—5¼	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2%	City and South London Rly. Con. Ord.	49 —52	4 11 4	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 —126	3 19 4	Feb, Aug	..	..
St.	5%	Do. (1896)	119 —122	4 2 0	..	..	..
St.	5%	Do. (1901)	118 —121	4 2 8	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101 —104	4 18 1	..	101	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract. ofAust.6%Cm.Prf.	2½—3½	8 11 5	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..
10	3/0	Gt. Northern & City Rly. Prf. Ord. (4%)	6½—7½	4 0 0	..	7¼	6½
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	9%	‡ Imperial Tramways Ord	19 —20	4 7 10	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	†Liverpool Overhead Railway Ord.	4 13/16—4 15/16	2 16 5	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	9⅞—10½	4 17 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98½—100½	3 19 10	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11 —11½	4 7 0	..	11½	11 1/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 —103	3 18 5	..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅜—⅝	..	..	1/16	..
1	0/6	Do. 5% Cum. Pref.	⅞—1⅛	4 8 11	..	..	..
100	5%	Montreal St. Rly.St'g 5%Mrt. Dbs.(1908)	101 —103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs.(1922)	104 —106	4 4 11	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	..	May	..	..
St.	5%	Perth (W.A.)Elec.Trams.1st Mt.Db.Stk.	99 —102	4 18 0	..	99½	99
10	10/0	Potteries Electric Traction Ord.	8½—9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	83 —91	3 8 8	June, Dec	88½	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	98½	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	16/0	Anglo-American	48 —51	5 18 8	F,My,Ag,N	48½	48
St.	30/0	Do. Preferred	91 —93	6 9 0	F,My,Ag,N	92½	91⅞
St.	2/0	Do. Deferred	6¼—7¼	1 7 6	F,My Ag,N	..	..
100	$2	Commercial Cable Capital Stock	180 —190	4 4 5	Jn,Ap,Jy,O	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 —91	4 8 3	Jn Ap,Jy,O	91	..
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	7⅝	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 8	Feb Aug	..	..
5	2/0	Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7½—8½	5 17 8	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	98⅞—101⅞	4 9 1	Jan, July	..	..
20	3/0	Direct United States Cable	9½—10½	6 6 10	Ja,Ap,Jy,O	10⅛	10
100	4½%	Direct West India Cable 4½%Rg.Db.(rd.)	98 —101	4 9 1	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	117 —122	5 14 9	Ja,Ap,Jy,O	119⅜	117½
St.	17/6	Do. 3½ per Cent. Pref. Stock	87 —80	3 17 10	Ja Ap,Jy,O	..	..
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 15 8	May, Nov	105⅜	104½
10	2/6	Eastern Extension	10¾—11½	6 4 5	Ja,Ap,Jy,O	11 1/16	10⅝
8	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 16 0	Feb, Aug	103⅜	..
100	4%	* Eastern & S. African 4% Mrt. Deb,1909	98 —101	4 0 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅞—102⅞	3 18 11	May, Nov	..	..
10	5/0	Great Northern of Copenhagen	24 —25	5 0 0	Jan, July	..	..
100	4½%	Halifax & Bermuda4½%1stMt.Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	12/6	Indo-European	38 —41	6 1 11	May, Nov	40½	..
100	4%	Pacific&Europe'n Tel.4%Guar.Dbs.(rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..
2½	..	West Coast of America	⅜—½	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅞—1	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	6 —6½	9 4 8	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	100	..
10	3/0	Western Telegraph	11¾—12½	5 14 3	Mr,Jn,O,D	12⅛	11⅞
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100—103	4 18 2	June, Dec	101	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 3	..	99	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8¼—8⅝	4 11 5	Ja Ap Jy O	8⅝	8¼
10	3/0	Do. 6 per Cent. Pref.	12 —12	4 16 0	Ja Ap,Jy,O	12 5/16	12 1/16
5	4/0	Reuter's	6¾—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	115 —120	5 2 2	April, Oct	..	..

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Mar. 16.	RATE PER CENT. YIELDED. £ s. d.	DIVIDEND DUE.	BUSINESS WEEK TO MAR. 16 Highest.	Lowest.
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	4½—5½	5 14 3	August ..	..	..
St.	6%	National Co. Pref. Stock	99 —101	5 19 2	..	100⅜	99
St.	5%	Do. Def. Stock	73 —76	6 11 8	..	74	73
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 —14	4 5 9	Feb, Aug	13½	13½
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13½—14½	4 2 9	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5½	4 15 3	Feb, Aug	5⅛	5
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	94 —96	3 13 1	June, Dec	95½	94
St.	4%	Do 4 per Cent. Deb. Stock (red.)	99 —101	4 0 0	..	99½	..
1	0/7½	Oriental	⅞—1	6 13 4	April, Oct	31/32	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	..	..	..	..
5	3/0	United River Plate	5½—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 —105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝—¾	..	..	..	..
1	0/8⅜	† Do. 7% Cum. Pref.	1⅜—1⅝	..	..	1½	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	115 —118	3 17 4	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	13	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	103	102¾
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½—10¾	4 13 0	..	10½	..
5	3/6	Do. 7 per Cent. Pref.	9½—10½	3 8 4	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	6½—7	4 12 10	..	6 13/16	6 11/16
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7½—7¾	5 3 2	Feb, Aug	7⅞	7⅞
5	2/3	Do. 4½ per Cent. Pref.	5½—5⅝	4 5 9	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	..	..
5	1/7	Do. Do. (19.3)	4¾—5	..	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 18 5	..	..	..
5	2/0	Chelsea Electric Supply Ord.	5¾—6¼	4 8 0	March ..	6	5 31/32
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 3 1	Jn, Dec ..	..	..
10	5/0	†City of London Electric Lighting Ord.	10½—10¾	4 13 0	Feb, Aug	10 15/16	10½
10	6/0	† Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	104	103
10	4/0	County of London & Brush Prov. Ord.	7½—8½	4 14 2	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	103 —109	4 2 11	..	..	..
St.	27/6†	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5¾—6½	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 3	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	..	I of W. Elec Lt. & Power 4½% Db St (red.)	100 —105	..	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6%CmPrf.	⅜—½	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	11 —12	5 0 0	..	11⅜	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	103 —106	3 16 2	..	..	..
3	..	London Electric Supply Ord.	1½—1⅝	..	..	..	..
5	3/0	† Do. 6 per Cent Pref.	4½—5	6 0 0	..	4⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 —98	4 2 1	Mr,Jn,S,D	96½	..
10	8 0	Metropolitan Electric Sup. Ord.	18 —19	4 1 7	April, Oct	18⅞	18½
5	..	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	..	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 9	..	..	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6.0	Notting Hill Electric Ord.	13 —14	4 5 9	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
5	4 0	†Oxford Electric Ord.	5½—6	5 8 4	March ..	5⅜	..
St.	4%	Do. 4% Deb. Stock	96 —99	4 0 9	..	..	..
1	..	Rand Electric	⅞—1	..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅜	14½
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8½	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	3½	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3 0	†South London Electric Supply Ord.	3 - 2½	4 5 8	..	..	..
5	2/6	Urban Electric Supply Ord.	4⅜ 5	5 0 0	..	..	..
5	2.6	Do. 5% Cum. Pref.	4¼—5½	4 17 7	..	..	..
5	7/0	Westminster Electric Supply Ord.	12½ - 13¾	5 0 0	Mar, Sept	13½	12¾
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½—¾	6 13 4	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	13/16—15/16	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6 —6½	7 13 10	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3¾—4½	7 1 2	..	4	3 13/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 3 4	..	94½	93⅛
½	..	Brush Electrical Engineering	½—1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1½	9 12 0	Mar, Sept	1⅛	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	72 —77	5 18 4	Jan, July	75	..
5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	11	10½
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.	104 —108	4 3 3	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
1	0.7½	Chadburn's Ship Telegraph Ord	1—1½	8 0 0	March ..	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	7 10 0	Jan, July	1⅝	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.	96 —99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	8 —8½	..	..	..	..
5	..	Do. 6% Cum. Pref.	5½—5¾	..	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
5	..	Edison & Swan United("A"Sh.)(£3 pd.)	½	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 —81	6 3 5	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5⅜—6½	5 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5½—6¼	4 16 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 4 11	..	105	..
2	1/2½	Electric Construction Co.	1½—1¾	6 71 2	Jan, July	..	..
2	2.9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	½—⅝	..	..	..	..
1	7½	Do. 7 per Cent. Cum. Pref.	½—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	8½—9½	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	90 —100	4 1 8	..	..	..
5	6/0	Henley's Telegraph Works Ord.	12 —13	7 13 10	Feb, Aug	12	..
5	2/3	† Do. 4½ per Cent. Pref.	4 —5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	110	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18½—19½	5 2 7	Feb, Aug	18⅜	18½
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	100 —103	3 17 4	Mar, Sept	101½	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	†Telegraph Construction & Mainten'ce.	33 —36	6 13 4	Mar, July	35	33½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	3 —4	8 12 6	Apr, Oct	3 1/16	3⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	4½—5¼	5 14 4	Apr, Oct	5	4 15/16
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	97 —101	4 0 3	May, Nov	..	..

†ating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have refused to quote these...

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NOTES.

WE were given to understand by Lord STANLEY in the House of Commons on Wednesday that "pourparlers" have been commenced between the Post Office and the National Telephone Co. with regard to a purchase of the Company's system by the State. The Postmaster-General's statement was necessarily somewhat vague, owing to the undesirability of affecting the negotiations which, we are informed, should follow the pourparlers if the Company is amenable to reason, for Lord STANLEY particularly said that it would not be his fault if some agreement of this nature were not arrived at. Indeed, he has gone so far as to promise the appointment of a Select Committee to consider the terms of such an agreement. A transfer of this nature would be desirable from every point of view. We have consistently advocated that the telephone system of the country should be placed under one control—that of a Government Department—and, moreover, from the purely financial point of view, it is evident that the Post Office does not profit by its competition with the Company in London. During 1902-3 there was only a profit balance of £6,155 to meet a charge of £60,870 for interest on capital and depreciation, and, although it is anticipated that the corresponding balance will be increased to £48,000 this year, yet the capital charges will also have increased. Moreover, competition with the Company must necessarily cause the amount of the royalty received by the Government (10 per cent. of the Company's gross receipts) to be less than it otherwise would have been. In the meantime, however, further development of the Post Office system is not being delayed. £1,500,000 is to be voted for extending the London system, £1,300,000 on new trunk lines, and £200,000 on provincial exchanges, the latter provision being, we are led to believe, mainly for the purpose of extending the telephone service to smaller towns and districts that are at present without it.

THE longest press message yet transmitted by wireless telegraphy appeared in last Monday's *Times*. It was about 1,400 words in length and had been transmitted by wireless telegraphy from *The Times* dispatch boat with the Japanese fleet to Wei-hai-wei, and thence by ordinary cable. *The Times* not only commissioned a dispatch boat so as to secure early news from the seat of the war, but also enterprisingly wired to the De Forest Wireless Telegraph Co. in America to fit up an installation upon it, and a corresponding station on the mainland at Wei-hai-wei. So far as we are able to ascertain at the moment this installation has been carried out on the lines described in our illustrated article of December 4th last when experiments which were being made between Holyhead and Ireland. The De Forest Company claim for this apparatus a speed of from 20 to 30 words per minute, and probably the range of a ship's installation would be at least 100 miles—possibly greater if local circumstances are propitious. The stations are attended to by members of the De Forest Company's staff, and although not completed quite so quickly as was anticipated at *The Times* in London, to judge by the result in Monday's paper it should now be working most satisfactorily. While it may be regretted that one of the English systems of wireless telegraphy has not been employed on this occasion, we must still congratulate our leading daily paper on its ready and purposeful appreciation of one of the latest applications of electrical science. We trust that it will continue more successful than the rather too ambitious attempts to utilise wireless telegraphy for a news service across the Atlantic.

ALTHOUGH the principle of the mercury vapour lamp is by no means a new one, yet the apparatus has never attained commercial success, and for very obvious reasons. Its prime

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and hitherto insuperable difficulty is one of colour. In spite of all assurances of its manufacturers to the effect that green and photographic rays are most suitable and least fatiguing to the human eye, the mercury vapour lamp has not been received with enthusiasm, or even approval, by the public. Another objection to most forms of the lamp is their shape. A glass tube of three or four feet in length is most unsuitable for public street lighting, and in this direction also there was room for improvement. A third and not such a serious objection was the difficulty of lighting, but this has now been overcome by several more or less suitable devices. There is the method of breaking down the high initial resistance of the lamp by employing the inductive effects of an electromagnet; a second method is that known as the "tilting" method, in which a path is first formed for the current through the mercury itself, and the column of mercury then broken by tilting the lamp at an angle, thus drawing out an arc.

In the lamp described in another column of this issue, an ingenious modification of the tilting method has been employed, and, instead of this operation having to be performed by hand, it is effected automatically. The Bastian lamp certainly bids fair to attain a certain amount of success in the direction of side-street lighting, and it may even be useful for interiors; but at an inspection of the lamp which we were enabled to make last Saturday afternoon, it did not appear that the colour defect has been entirely overcome. Although the addition of an under-run carbon lamp does constitute a distinct improvement, yet the rays do not "mix" as well as might be expected, and the resulting illumination is still of the nature of moonlight. But with or without the carbon lamp there is undoubtedly a hopeful prospect of a new competitor to the gas mantle for outdoor lighting, and when the extraordinary high efficiency of the lamp is taken into account the prospect becomes brighter still. Moreover, the resistance of the carbon filament in series decreases the voltage across the terminals of the mercury tube and, consequently, the length of this tube. The efficiency of the lamp is necessarily less than that of the Cooper-Hewitt form, but the neater shape makes a commercial adoption of the lamp possible, and herein lies its chief advantage.

The National Physical Laboratory report for the year 1903 contains a large amount of encouraging information and also some that is discouraging. Under the former heading may be classed the work which has been carried out in all departments of the Laboratory, especially those of electricity and magnetism, optics and engineering. The tests of apparatus during 1903 have increased in numbers out of all proportion to those effected during the first nine months of the life of the institution in 1902, and the receipts for work done have, as a consequence, also become augmented. But, unfortunately, in spite of this seemingly prosperous condition, the lack of necessary funds is being felt very keenly, and the operations of the Laboratory will be seriously affected if money is not forthcoming at an early date. There was a deficit of £106. 10s. 3d. at the end of 1903, and it has, moreover, now become necessary to instal new apparatus of an expensive nature. Indeed, the report states that, although the work can go on for another year, the financial position must be reconsidered at the end of that period. It seems, also, that the staff is more or less under-salaried, and that provision must be made for placing the members of the staff on a more secure footing.

The Laboratory already owes much to the generosity of firms and individuals. The organisation of the photometry department may be taken as an example. This was commenced in the early summer of 1903, and the Laboratory is now well equipped for tests of all classes. A 300-volt accumulator battery was presented by the Electrical Power Storage Co., and the Laboratory is indebted to Prof. Fleming and to the Robertson Electric Lamp Co. for a number of large bulb secondary standard incandescent lamps. Experiments with a view to perfecting a primary standard are being made. The photometers themselves have been presented by Sir Wm. Preece (who has given a photometer bench of the Reichsanstalt pattern and a Harcourt 10 c.p. Pentane lamp) and Mr. A. P. Trotter (a bar photometer of his own design); and Messrs. Crompton & Co. have supplied the indispensable potentiometer. The equipment of the photometric laboratory also includes a Kelvin electrostatic voltmeter, with mirror attachment, and two Ayrton and Mather reflecting galvanometers, with resistances, one used as an ammeter and the other as a voltmeter. An apparatus has been made for automatically regulating the voltage of lamps on life test, and as it is giving results of so satisfactory a nature, a larger piece of apparatus is now under construction for the same purpose. The photometric laboratory is thus in an exceptionally good position to carry out useful and necessary everyday commercial tests, as well as also to pursue those researches into the fixing and repetition of absolute and secondary standards which are of scientific as well as industrial importance. Work of a similar nature is being carried out in the other departments, and we trust that the hopes for an increase in the Government grant may not be disappointed, so that no obstacle may be placed to the useful activity of the National Physical Laboratory.

All those interested in the cause of higher education will be gratified to learn of the magnificent donation of £100,000 which Sir Donald Currie has made to University College. For some time past it has been the aim of both the College and the London University authorities to incorporate University College into the University of London. Serious obstacles, however, in the shape of financial difficulties, appeared, but with this exception there was apparently nothing to prevent the consummation of a scheme which has been considered desirable on every hand. When the suggestion of incorporation was first advanced, the College was deeply in debt; and, although many of its obligations have since been discharged yet the authorities had not sufficient funds to erect the required buildings for the school of advanced medical studies on a site which had already been purchased. No less than £80,000 will be required for this purpose and the balance of £20,000 Sir Donald proposes to employ in providing a nurses' home and suitable living accommodation for medical

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students who have to work in the neighbourhood of the hospital. Although the whole £100,000 will be devoted to medical purposes, yet it will be the means of securing benefits to the other faculties, including engineering and physics, by reason of the College becoming part and parcel of the London University.

ONE important result of the new Education Act on technical education is the announcement that the Goldsmiths' Company have decided to give up their New Cross Institute. This Institute is supported solely by the private funds of the Goldsmiths' Company, and has never received financial support from any other body. Now, however, the aspect of affairs is changed; the entire secondary and technical education of London has passed into the control of the London County Council, and the Goldsmiths' Company, therefore, feel that they are not called upon to compete with educational facilities provided by the rates, nor would the New Cross Institute any longer represent something unprovided for by public funds. The capital represented by the ground, buildings and equipment is no less than £120,000, and the cost of maintenance has naturally increased year by year until it has become so serious as to form one reason for discontinuing the work. Added to this is the fact that, owing to the foundation of other technical institutes under public control, the number of students is on the decline, those entering educational classes for the year ended September 30th last being 6,888 and those for the previous year 7,150. For these reasons the Goldsmiths' Company have decided not to attempt to compete with public institutions, and they have, therefore, decided to close the New Cross Institute on September 29th.

THIS decision might well engender a feeling of regret, and there is no doubt that it will have this effect; but, on the other hand, it is gratifying to learn that the whole Institute has been offered, as it stands, as a free gift to the University of London. On Wednesday afternoon the Senate resolved to accept the offer, subject to certain administrative details being settled satisfactorily. It is to be hoped, therefore, that the Institute—which was opened by the KING and QUEEN, then the PRINCE and PRINCESS of WALES, in 1891—will thus continue to perform a most useful work, although the nature of the work must necessarily undergo certain changes. The present buildings occupy 3 acres, and adjacent thereto are 4 acres of open ground which form part of the gift. It is, of course, useless to speculate as to the lines on which the Institute will be worked by the University, and these details will doubtless be settled in due course. In the meantime it is advisable to bear in mind that the expansion of the University in this fashion means increased expenditure, and as that estimable body is even now none too wealthy, the financial problem will certainly require further investigation in the near future.

Royal Institution.—Among the announcements of Friday evening discourses for after Easter are the following:—May 20, "The Radiation and Emanation of Radium," by Prof. Ernest Rutherford; May 27, "The Progress of Oceanography," by His Serene Highness Albert Prince of Monaco; June 3, "The Development of the Theory of Electrolytic Dissociation," Prof. Svante Arrhenius.

Radium Ore.—It is announced that the Austrian Minister of Agriculture, acting at the request of the Academy of Science, has decreed that, until further notice, no trading be allowed in the residues from the manufacture of uranium colours at Joachimsthal. It has also been ordered that 10 tons of these residues be reserved for purchase by the Academy, and that the same quantity be placed at the disposal of M. Curie, of Paris.

Personal.—Mr. A. P. Trotter, the electrical adviser to the Board of Trade, asks us to state that he leaves for the Continent on the 28th inst. and expects to be back at his office on April 11th.

Mr. Frederick Soddy, M.A., has been appointed Lecturer in Physical Chemistry at the Glasgow University. The appointment is for a period of five years, and dates from October 1st, 1904.

Lancashire and Yorkshire Railway.—The formal inauguration of the electrical driving upon the Liverpool–Southport line of the Lancashire and Yorkshire Railway Co. took place on Tuesday, when the electric service for the regular passenger traffic was successfully started. We commenced a detailed description of the line and its equipment in our last issue, and we give a further portion of the article this week.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 12, 1902
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Tarifa—Tangier	Jan. 18, 1904
Cape St. Jacques—Haiphong	Mar. 7, 1904

Leeds University.—The charter for the new Leeds University, which has just been issued as a Parliamentary paper, besides conferring powers for granting degrees, contains provisions for taking over the Yorkshire College and for apportioning endowments now held by the Victoria University. Clause III. stipulates that it shall be "the duty of the University to co-operate, by means of a joint board or otherwise, with the Victoria University of Manchester and the University of Liverpool for the regulation and conduct of matriculation examinations, including the conditions of exemption therefrom."

Telephonic Communication with France.—Arrangements have now been made for telephonic facilities between Birmingham, Bradford, Brighton, Bristol, Cambridge, Cardiff, Derby, Hull, Ipswich, Leeds, Leicester, Liverpool, Lowestoft, Manchester, Newport (Mon.), Norwich, Nottingham, Sheffield, Southampton and Yarmouth, and the following places in France:—Chartres, Orleans, Rouen, Paris, Paris suburbs, and about 250 places in the neighbourhood of Paris. The service will be commenced on April 11th, and the charge has been fixed at 8s. for a conversation of three minutes during the day, or by contract arrangement, for six minutes at night. The service will only be available from Post Office call offices, or by subscribers to the Post Office service. The names or numbers of subscribers in France can be ascertained at Post Office exchanges.

International Engineering Congress at St. Louis.—Among the Papers to be read at the St. Louis International Congress are the following:—"Lighthouses and other Aids to Navigation," by officers of the Lighthouse Board, U.S.A.; "Turbines and Water Wheels," by Prof. Gardner S. Williams; "Underground Railways," by William Barclay Parsons; "The Substitution of Electricity for Steam as a Motive Power," by James G. White; "Disposal of Municipal Refuse," by Rudolph Hering; "Ventilation of Tunnels," by Charles S. Churchill; "Passenger Elevators," by Thomas E. Brown; "Electrical Power—Generating Stations and Transmission," by L. B. Stillwell; "Engineering Education," by Prof. Robert Fletcher and Prof. Calvin M. Woodward. Many Papers from England, France, Holland and other foreign countries have been promised.

An Electric Railway from Rome to Naples.—A new rail way from Rome to Naples, which will be run by electricity, has been surveyed by a British company. This will run from Rome across the Pontine Marshes to Terracina and thence to Formio, a small town which is practically a suburb of the

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important garrison town of Gaeta, and thence to Naples, following more or less the line of the coast. Energy will be derived entirely from water-power, and mainly from the Tiber and the Volturno, the latter river almost bisecting the line and being capable of supplying the greater part. The line will probably enter Naples at the west end of the city, and as it will be mainly dependent on its passenger traffic, will prove of great convenience to travellers, who will be set down in the residential part of the city, instead of, as is now the case, at the exteme east end of the town. Another Italian electric railway has been opened in the course of the past year by Messrs. Thos. Cook & Sons. The line will, in the near future, run from the city of Naples to the base of the funicular railway which has carried passengers up the cone for many years. The present railhead is at Pugliano, a village close to the entrance of the excavations of Herculaneum, and consequently within a few feet of the sea level. Pugliano is reached by carriage from Naples in a little more than an hour, and from thence an ordinary overhead electric car takes the traveller through a forest of oaks, and afterwards through vineyards and gardens to the generating station. This section of the line is 3,500 metres in length, and is an adhesion line with a gradient of from 5 to 8 per cent. The second part of the line from the generating station to the Hermitage is 1,650 metres in length, and is a cog-wheel line with a gradient of 20 to 25 per cent., and here an engine is attached which pushes the car up till it reaches the Hermitage, where the third part of the line, of the length of 2,700 metres, begins. This is, again, an adhesion line as in the first part of the railway. For the production of the gas two Dowson gas generators, of 200 H.P. each, are employed. These supply gas for two engines, provision having been made for the addition of a third should it be required. Each engine drives a continuous-current dynamo, and the two generators are in parallel with a battery, regulation being effected by the Stur system. The third section of the line runs from the Hermitage to the foot of the cone, passing close beneath the observatory, and after crossing the lava beds terminates at the base of the wire-rope railway. This funicular railway has been completely rebuilt, and nothing but the iron rails of the old railway have been used. The old railway was on wooden sleepers, but these have all been removed, and the substructure is now made in solid masonry, the sleepers are of iron and the rope of the very best steel wire obtainable. The cars are provided with powerful automatic and ordinary brakes of the most modern description.

The Faraday Society.—At an ordinary meeting of the Faraday Society, held on Monday, a Paper by Dr. F. M. Perkin, and Mr. W. C. Prebble on "The Electrolytic Analysis of Gold" was read in abstract by Dr. Perkin. The object of the researches described was to arrive at an electrolytic method of estimating gold which should be perfectly accurate and yet far more rapid than the ordinary double cyanide method. Solutions of sodium thiosulphate, cyanide, sodium sulphide, potassium thiocynate and ammonium thiocynate were all tried and the results compared. The first-named was useless; of the others—which are all accurate—the thiocynates gave the best results, and the ammonium salt was better than the potassium. With 0·2 ampere per square decimetre the deposition of 0·05 to 0·08 gramme of gold was complete in five or six hours. With a current of 0·4 to 0·5 ampere 1½ to two two hours sufficed. The presence of a little persulphate considerably reduced the voltage required. Experiments were also made to determine the best method of removing the deposited gold. Chlorine or bromine water were satisfactory but slow; aqua regia was risky; the authors recommended a 2 per cent. solution of potassium cyanide containing a little hydrogen peroxide or a persulphate. One or two minutes then sufficed to remove the gold. An improved form of basin electrode for working with hot solutions was described. A lamp-wick syphon, from a small reservoir, supplied water to compensate for evaporation.

Mr. Chas. R. Darling then read a Paper on "Thin-film Electrolysis and a Proposed Application to Printing," which was illustrated by experiments. While investigating a process for letterpress printing by electrolysis without the use of ink, the author found that the final results of electrolysis—when the electrolyte formed only a thin film—often differed materially from those observed in an ordinary cell. In these experiments a carbon or metal plate formed the anode; on this was placed an impression pad, consisting of some sheets of moist blotting-paper, the trial sheet carrying the electrolyte film was placed on the impression pad, and the cathode type or coin rested on the trial sheet. Voltages from 6 to 200 were employed. To obtain a clear image of the type a certain minimum strength of solution was requisite. The first experiments were made with saline solutions; silver nitrate gave a clear, permanent black image of the type, but the paper, of course, darkened on exposure; copper sulphate and nitrate yielded images that faded after a time; the same unexpected result occurred with lead, mercury salts and bismuth. The best images were obtained with manganese salts. These, consisting of the oxides or hydrates, were quite permanent; all purely metallic deposits, except silver, disappeared after a time. In the case of non-saline solutions the paper, which might consist of asbestos or pure Swedish filter-paper soaked in distilled water, acquired the properties of an exposed photographic plate, and on treating with a silver salt and developer a perfect image of the cathode was obtained, even after a long interval. The latent images were not due to hydrogen peroxide, nor to metallic compounds, as they occurred with carbon electrodes; but they resided in the surface of the paper in contact with or towards the cathode. The author ascribed them to a class of phenomena investigated by Bose and termed "the response of inert matter to electrical stimuli," and thought they were probably the result of some state of strain set up in the film by the current. The fading of the metallic images might be simply due to recombination, although that explanation was not entirely satisfactory. In the discussion Mr. N. J. Bluman said that in some electrolytic printing that he had carried out they had used some organic solutions with good results. Mr. Fontana suggested that the latent images might be due to occluded hydrogen, and Dr. Perkin thought this supposition could be tested by exposing the paper to an oxidising agent. Dr. Steinhart did not agree with the "strain" theory put forward by the author. All materials contained some trace of saline matter, and one was almost sure to get chlorine or some such substance given off on electrolysis. Mr. Darling, in reply, said that organic substances eventually discoloured the paper. He did not think hydrogen the cause of the latent images; certainly hydrogen peroxide did not destroy the image.

Recent Advances in Electro-chemistry.—The last of a course of three Cantor lectures on this subject was delivered by Mr. Bertram Blount at the Society of Arts on Monday evening; the preceding lectures were reported in our notes columns of March 11th and 18th. In commencing the lecture, Mr. Blount said that he intended to confine his remarks to electric furnaces, and, in order to give demonstrations, he had had furnaces built in the lecture theatre. The electric furnace possessed no superiority over the old form when it was desired to attain a moderate temperature, and in this case the combined gases might very well be used as the source of heat, but for very high temperatures the electric furnace was immeasurably superior, and in some cases the only means of obtaining the desired temperature. Moreover, contact with foreign matter other than the electrodes was avoided. Calcium carbide and carborundum were made solely by the electric furnace, by the agency of which carbon bisulphide and zinc were also manufactured. Electric furnaces might be divided into two general classes—viz., arc and resistance furnaces. The development of the former was largely due to Moissan, and he showed a Moissan furnace at rest and at work. It was found, continued the lecturer, that the product of the electric furnace was frequently a simple element, or more often a compound of two elements, but never a complex body, and this was easily accounted for by the exceedingly high temperature. Calcium carbide was produced by fusing lime and coke together electrically, and, of course, either alternating or continuous current would serve the purpose. Two types of furnace were generally used, one called the tapped carbide furnace and the other the block carbide furnace. In the former the electrodes

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were kept a fixed distance apart, the mixture of lime and coke fed into the top of the furnace and the calcium carbide tapped off at the bottom; this furnace produced very good carbide, and the containing vessel was usually lined with magnesia as this substance was not attacked by liquid carbide. The block carbide furnace consisted of a vessel containing an electrode fixed on the bottom and a movable electrode suspended immediately above it. At the commencement of operations the two electrodes were placed in contact with each other and the furnace filled with lime and coke. Current was then turned on and the upper electrode gradually withdrawn from the lower one; the result was that the arc fused the materials in its neighbourhood, but the resulting carbide always contained a certain amount of unfused lime and coke. One advantage connected with this type of furnace was that an iron containing vessel could be used, as its walls were always protected by semi-solid material, but the carbide produced was not so good. There was never less than 100 H.P. employed for each industrial carbide furnace, and although power to this extent was not available in the lecture room, carbide was produced quite successfully in the demonstration given. Mr. Blount said that the cost of power in the manufacture of calcium carbide constituted a very large part of the total cost. Formerly, 1 ton of carbide per horse-power-year was produced, but it was quite common practice now to obtain 1¼ tons. After referring to the manufacture of carborundum and graphite, the lecturer said he thought there would be a probable industry in the fusion of quartz for making large vessels. Electrical processes held the field in the manufacture of carbon bisulphide and phosphorus. With regard to iron, the blast furnace was very economical and electrical power could not compete with it, but he thought that there was a very great future for electric furnaces for the refining of pig iron and the production of special alloys. The brothers Cowles had done very valuable work in connection with zinc in 1882—1884, and he thought the process whereby zinc oxide was heated with a reducing agent had a cheerful outlook; the present process was costly and cumbrous. After thanking the Owens College authorities for lending him some furnaces, Mr. Blount gave some highly interesting and successful demonstrations in the production of carborundum, metallic chromium from Cr_2O_3 and ferro-vanadium.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, March 25th.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "Note on the Measurement of Small Inductances and Capacities and on a Standard of Small Inductance," by Prof. J. A. Fleming, F.R.S. (2) "A Hot-Wire Ammeter for measuring very small Alternating Currents," by Prof. J. A. Fleming, F.R.S. (3) "The Energy of Secondary Röntgen Radiation," by C. G. Barkla.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7:30 p.m. Ordinary Meeting at the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Included in the business of the evening will be the discussion on Mr. B. C. Laws' Paper on "Technical Education."

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at the Holborn Restaurant (King's Hall). Mr. W. M. Mordey in the chair.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.

8 p.m. Ordinary Meeting. Paper to be read: "The Relative Advantages of Continuous and Alternating Current for Traction Purposes," by J. M. Kennedy.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Liquid Hydrogen Calorimetry." by Prof. Dewar, F.R.S.

SATURDAY, March 26th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture VI.: "The Life and Work of Stokes," by the Right Hon. Lord Rayleigh, F.R.S.

TUESDAY, March 29th.

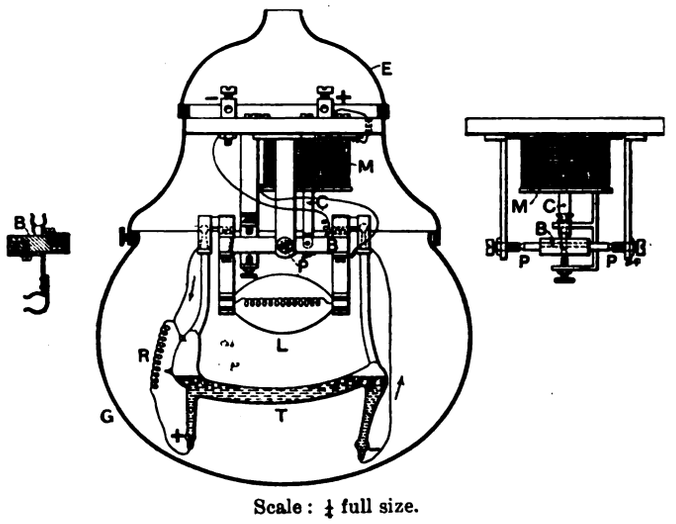
INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.

7:30 p.m. Meeting at Owens College. Paper to be read: "Safety Devices for Electric Traction," by T. W. Sheffield.

A NEW MERCURY-VAPOUR LAMP.

The newest form of mercury-vapour lamp to be brought before the public is one designed by Mr. C. Orme Bastian and Mr. A. E. Salisbury. Mr. Bastian, whose name is familiar through his connection with the Bastian meter, has been working for some considerable time at the problem presented by mercury-vapour lamps, and has at length evolved a type which possesses several features of novelty.

The drawings which we reproduce show the lamp in its normal position. E is a spun copper bell-shaped cover which protects the internal mechanism from wet, and provides a means for suspending the lamp and fixing the tubes and other devices. G is an ordinary glass globe. As shown in the illustration, the lamp is not at work and it will be observed that the mercury in the tube T connects together the two wires sealed into the glass. Fixed to one end of the glass tube is an iron plunger C which acts as a core to the electromagnet M. Now, it is obvious that if the switch were closed with merely the column of mercury in the circuit the only result would be to blow the fuse, and therefore the resistance R, the electromagnet M, the carbon filament lamp L and the mercury in the tube T are all connected in series. On closing the switch, the core C is drawn up by the electromagnet, T being



Scale: ¼ full size.

pivotted at P, and the continuity of the mercury being broken, an arc is formed. It will thus be seen that the tilting of the tube is effected automatically instead of by hand, as in other forms. But the mere tilting is not sufficient to effect all that is necessary, for the resistance R has to be short-circuited, and this, again, is brought about automatically. To fill the left-hand bulb of the tube with mercury merely by tilting would be inexpedient, as the tube would have to be brought into a position approximating the vertical. Happily, the pressure of the mercury vapour set up by the arc forces the mercury up into this bulb, and thus cuts out the auxiliary resistance. All these operations occupy but a fraction of a second, and there is no "time-lag" in the starting of the lamp.

A more or less successful attempt to overcome the absence of red rays has been made by fixing the carbon filament lamp L just above the mercury tube. This lamp is under-run and its radiation is consequently rich in the required red rays.

The patentees claim an efficiency of 2½ c.p. per watt when the carbon auxiliary is not used, and 1 to 1·5 c.p. per watt when the latter is used. Each lamp requires from 40 to 60 volts and 0·65 of an ampere, and the candle-power is said to be 80. Lamps have been run both continuously and intermittently for over 1,500 hours, and the inventors believe that the average life will be about 3,000 hours. Although they hope that there will be a demand for the lamps for indoor lighting, the principal object is to provide an electric lamp for side street lighting which will compete successfully with incandescent gas lighting

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POWER SUPPLY IN SUNDERLAND.

The Corporation of Sunderland commenced a supply of electricity in March, 1895, from their first station at Dunning-street. The growth of output has been uniformly steady, and the tramway plant which was laid down at the first station in 1900 utilised the whole of the available space, and rendered it necessary to build the second and principal station at Hylton-road. (*The Electrician*, Vol. XLIX, p. 779.)

At Dunning-street there are 11 engines of 200 H.P. and 500 H.P. respectively, aggregating 2,165kw. This plant, owing to the position of the site, is non-condensing, excepting the tramway units, for which the circulating water is re-cooled by a fan draught tower. Coal has to be delivered by carts.

In 1901, the Corporation acquired a site of 3 acres at Hylton-road, where there already existed a deep well, lined with masonry, by means of which a copious supply of water is now obtained from the underlying Permian beds. The levels of the site are such that coal is delivered by means of a viaduct, direct from the Hetton Collieries into the station overhead bunkers. The site is some 90ft. above the river

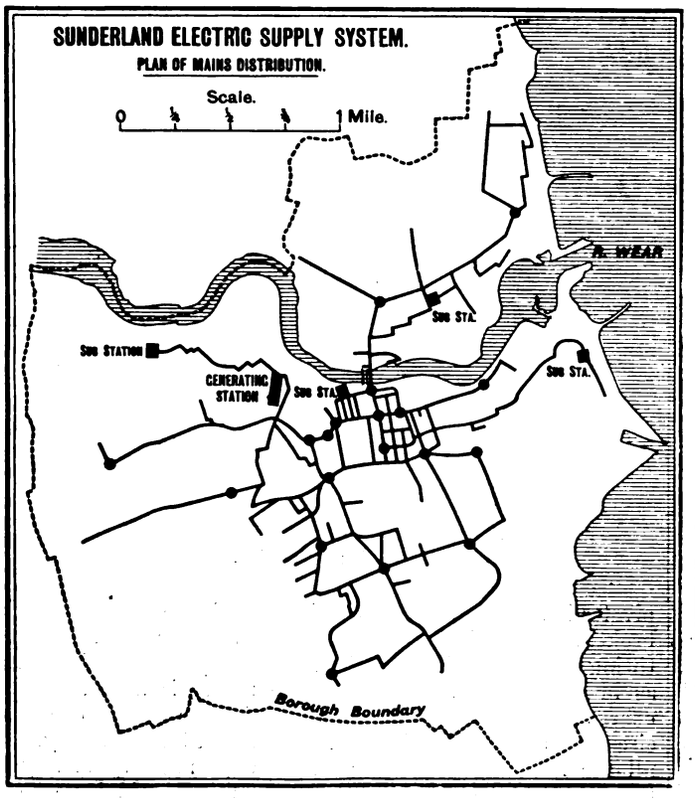

FIG. 1.—MAP OF DISTRIBUTING SYSTEM.

level, it being practically impossible to obtain a riverside site owing to the prevalent shipbuilding industry, and so far, therefore, the circulating water supplied from the station well is re-cooled by a fan draught Klein tower. As the station grows, water will probably be raised from the river by combined motor-turbine pumps, and delivered into an auxiliary reservoir in the station grounds. There are now installed eight Belliss and Morcom engines; five coupled to continuous-current Silvertown dynamos, aggregating 1,280kw., and three new sets coupled to three-phase alternators by the Electrical Co., with a total output of 2,260kw., making 3,530kw. in all at Hylton-road station, or a total of 5,695kw. for the two stations.

The system has been, until recently, partly the original three-wire 110-volt system installed to Prof. Alexander Kennedy's specification, and partly a two-wire, 220-volt system. The original three-wire system has been done away with, and a uniform system of distribution is now obtained from the two wires. The principal reason for adopting this system in preference to the more usual three-wire one is partly on account of the large demands which may be expected from the 21 shipbuilding and engine works in the borough, a large number of which were already electrically equipped with 220-volt motors driven from the works own generating plant; and partly because of the engineer's steady development towards sub-station distribution in Sunderland, as will be seen from the accompanying map (Fig. 1) of the distributing system. The principle of the distribution at which he is aiming is to generate three-phase currents at one station, at a pressure of 5,000 to 5,500 volts, and transmit to sub-stations where the current will be transformed by motor-generators and distributed to areas, the radius of the largest area not exceeding five-eighths of a mile. In each of these sub-stations will be a large storage battery.

THE NORTH-EASTERN MARINE ENGINEERING CO.

There are already two of the largest and most important works connected, each of which is equipped with its own sub-station; the first is The North-Eastern Marine Engineering Co. (Ltd.) at the South Docks, which company have installed a complete system of induction motors to the specifications of their consulting engineer, Mr. Wilson Carr. To supply these works, the Corporation has put down a sub-station (Fig. 2) in a separate small building at the works; this sub-station contains three standard transformers, each of the three-phase type, and each having a output of 300kw. Each transformer is immersed in oil, and contained in a special cast-iron case with radiating grilles, so as to provide a maximum cooling surface. As a matter of fact, after a week's run at about three-quarters load, the temperature rise is barely perceptible. Each transformer weighs about 2 tons complete and is mounted on rollers.

There are two 0·1 sq. in. three-core feeders laid from Hylton-road to this sub-station, each of which is connected to its own feeder panel, and each feeder panel contains A.E.G. switch fuse, ammeter transformers, and panel isolater. There is a separate panel to control each transformer, each panel being equipped with the panel isolater, instrument transformers and switch fuse. The whole is securely caged off, and locked in the usual manner, as shown in Fig. 2. The low-tension mains consist of copper strip connecting the transformers to the low-tension meter panels in an adjoining room, which also contains the company's distributing board. There is a low-tension panel to each transformer, containing an ammeter, voltmeter, three-pole switch, and two single-phase A.E.G. wattmeters, which have been fixed on account of a possible want of balance between phases, due to the lighting circuits in the works. The primary voltage is 5,000 and the secondary 240, at a frequency of 50~per second. The sub-station has been constructed with every precaution against danger to person or from fire. The total number of motors to be installed is 22, with an aggregate capacity of 520 H.P., including some very fine 60-ton travelling cranes, supplied by the British Westinghouse Co. This consumer alone is expected to take some 600,000 to 800,000 units per annum. The company's enterprising directors and general manager (Mr. G. Weir) are well pleased with the installation.

MESSRS. WILLIAM DOXFORD & SONS.

The second important installation is at Messrs. William Doxford & Son's shipyard, where there are at present 23 motors connected, representing 445 H.P., but the ultimate connections, upon which the contract with the Corporation is based, is for motors with a total output of 1,892 H.P. In this case one-half of these important works is supplied from Messrs. Doxford's own generating station, in which are four triple expansion Sunderland Forge steam dynamos, representing a total output of 800kw., and of which Mr. W. Vidal is the resident electrical engineer. The second half of the works, now under construction, is being driven from the Corporation's Pallion sub-station, in which are installed two A.E.G. synchronous motors, coupled to compound-wound multipolar

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generators, each of 250kw. at a pressure of 220 volts, the stator receiving high-tension three-phase current at 5,000 volts. The field magnets are mounted on the rim of a massive rotor, and receive their current at 220 volts through the usual slip rings. The continuous-current machine consists of an eight-pole compound-wound dynamo, generating current at 220 volts, the field-magnets being of the A.E.G. standard pattern, each pole-winding being put on in three separate former-wound coils with air space between each, thus ensuring ample

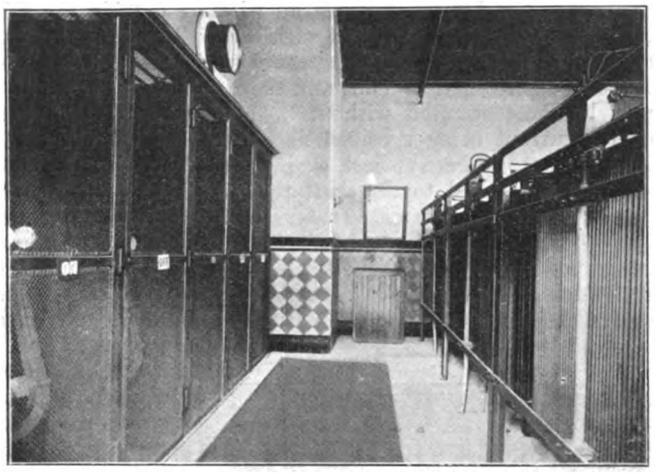

Fig. 2.—North Eastern Marine Engineering Co.'s Sub-station.

ventilation. The armature is drum-wound. The commutator is large to ensure ample ventilation and sparkless commutation, the speed being 370 revs. per min. To run up this machine there is installed a motor-generator, by the A.E.G., of 30kw. output, consisting of a three-phase induction motor, receiving current at 240 volts from a three-phase oil transformer, and directly coupled to a four-pole shunt-wound 220 volt dynamo.

The switchboard is in two sections, and consists of two feeder panels similarly equipped to those at the South Docks, and two machine panels, each containing an isolater, instrument transformers, A.E.G. oil-break switch, and high-tension fuses; the high-tension switches, &c., are mounted on the wall at the back of the board. The instruments are, of course, mounted on the front marble panels, and the oil-break switches are also operated by extended handles from the same position. All the instruments, &c., are at low tension, and the framings are thoroughly earthed. The whole of the high-tension work is caged in and under lock and key, and so arranged that it is impossible for the attendant to come in contact with any portion of the high-tension circuits.

The low-tension instruments are mounted on marble panels, which carry the usual magnetic cut-outs and main switches of the standard A.E.G. type. The whole arrangement, including the field rheostats, is particularly neat in appearance. A synchronising panel is, of course, provided. The sub-station is connected both by private and National telephones to the generating station, and is equipped with a 5-ton travelling crane.

Dunning-street.

Two synchronous motor generators have been installed at the old Dunning-street station, as shown in Fig. 3, each of 250kw. capacity. These machines are identical with the Pallion machines described above, except that they are shunt-wound and arranged so as to be reversible—*i.e.*, they are capable of being driven from the continuous-current side and generating three-phase currents, or *vice versâ*. The addition of these two motor-generators has enabled the whole of the day-load to be dealt with from Hylton-road. The switchboard is also of a very similar character to that at Pallion. It is intended to instal two 500kw. inductor motor-generators for either tramway or lighting purposes, each inductor being coupled to two 250kw. compound-wound machines, arranged to run in series or parallel, and it is ultimately intended to convert the whole station to a sub-station driven from Hylton-road.

Monkwearmouth.

A large sub-station has been erected at Monkwearmouth, which will be capable of accommodating plant to the extent of 2,500kw. The first instalment consists of two 125kw. inductor motor-generators; the inductors being started up through slip rings with a water resistance, and arranged with the usual short-circuiting lever. The multipolar dynamos are shunt-wound, and arranged to give from 220 to 250 volts. There is also a motor-driven battery booster, which has a maximum output of 500 amperes, at any voltage from 0 to 80. The switchboard is similar in design and principle to those described above, but also contains a booster panel with reversing switch, low-tension panels with two 'bus bars, plugs and the usual standard equipment of instruments. A synchronising panel has also been erected for future extensions. On the first floor there is a battery of 120 cells, by the Electrical Power Storage Co., having a capacity of 800 amperes for one hour, with a minimum of 1·85 volts per cell, or 260 amperes for seven consecutive hours. A milking booster and switchboard manufactured by the Sunderland Forge and Engineering Co. has also been supplied. The inside of the station is lined with glazed bricks, and the machine room is paved with red Ruabon tiling. The battery floor, which is designed to carry 2 cwt. per square foot, is composed of Mark Fawcett's patent flooring with the spandrils filled in with concrete, brought up to a smooth surface, and with ¾in. of acid-proof bitumen asphalte. The whole installation is of a substantial construction, and is designed with a view to large extensions.

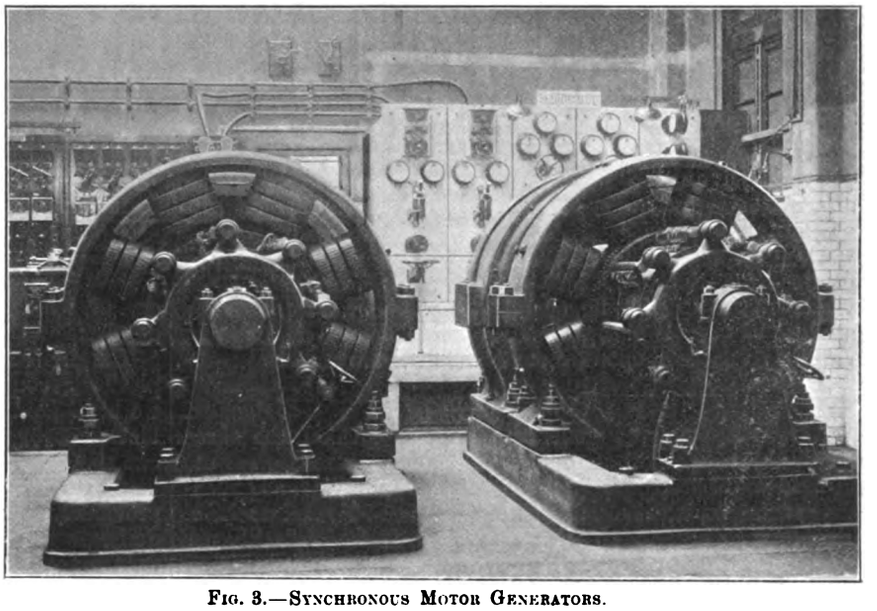

Fig. 3.—Synchronous Motor Generators.

Hendon.

A southern sub-station at Hendon will shortly be in operation. This will be on the same lines as the Monkwearmouth station, except that the battery room will be on the same level as the machine room.

Distributing System.

The three-core mains are laid everywhere in duplicate and through about 1 mile of the town are drawn through Doulton stoneware 12-way conduits, embedded in concrete, and with

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manholes 80yds. apart built in 18in. brickwork; the insides of the manholes are of white glazed bricks. The lowest boxes are connected to the sewers, and each box is drained to the other by means of a 2in. wrought-iron pipe embedded in concrete. The highest boxes are ventilated. The whole system has remained perfectly dry and clean. The conduits and the cables drawn through them were supplied and laid by Callender's Cable and Construction Co. Beyond the termination of this conduit system, the cables are laid solid in cast-iron trenches filled with compound, the whole being supplied and laid by the British Insulated and Helsby Cables. The joints (besides being accurately surveyed and recorded on a 44in. plan) are marked on the street by letters and figures recessed into the pavement. The cables are three-core throughout, each of 0·1 sq. in. section, paper-insulated, lead-covered and steel armoured, the armouring being carefully bonded at each joint, and the whole earthed at several points along each line. Under each manhole in the conduit system there are copper earth plates embedded in coke, to which all cable sheathing is connected.

Tests at 18,000 volts for half an hour were carried out on the cables at the respective works, and at 12,000 volts after laying, and there has not been the slightest trouble in any way. At one place in the South Docks route the cables have been taken across the dock to the North-Eastern Marine Engineering Co.'s works (which are situated on an island), and had to be drawn through a submerged tunnel under the dock sills. Here 4in. special cast-iron pipes with easy quarter bends, and with specially long sockets, were fixed, the tunnel being kept dry by special pumps temporarily erected for the purpose; the cables were easily drawn through afterwards. The whole of the outside work was carried out under the supervision of the distributing engineer, Mr. J. F. Moore, and the absence of trouble throughout the contracts and afterwards, reflects great credit upon him and upon the contractors.

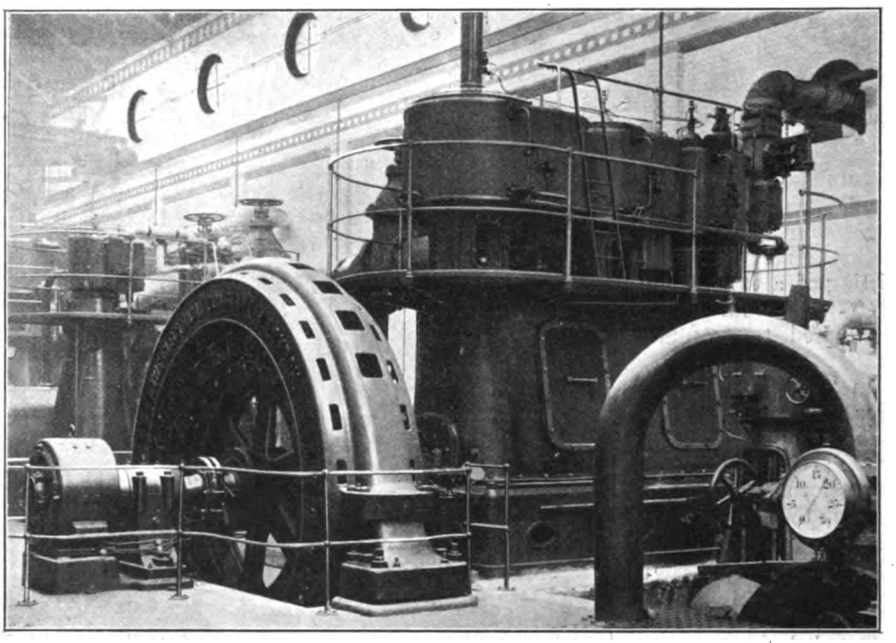

Fig. 4.—750kw. Three-phase Alternator.

Hylton-road.

At the Hylton-road generating station each of the three steam alternators has an output of 750kw. The engines are of Belliss and Morcom's type, each of 1,100 B.H.P. triple expansion surface condensing, and the speed is 250 revs. per min. The steam consumption with a range pressure of 160lb. per square inch, with 100°F. of superheat, and when exhausting into a 25in. vacuum was 13·91lb. per B.H.P. hour at full load, equivalent to 20·26lb. per kilowatt-hour. The alternators were supplied by the Electrical Company; each is provided with a separate exciter coupled to the end of the alternator shaft, and is wound to give 78 amperes per phase on a non-inductive load and 91 amperes on an inductive load, with a power-factor of 0·85 and a pressure of 5,500 volts between phases. As may be seen from Fig. 4, the alternators are of massive and rigid construction. The armature casting is in two parts; the upper and lower of which are bolted together and carried by two feet at opposite ends of a diameter. These feet are bolted to two sole plates, and are also provided with the A.E.G.'s standard method of centering the armature with regard to the fields, which can be done quickly at any time. There is also an adjustable screw pillar placed under the centre of the lower half of the armature, so that it is quite impossible for any strain set up in it to cause the slightest want of alignment. The laminations are packed into the armature casting, and kept in position by bolts passing through from side to side.

The three-phase windings are carried in mica tubes inserted in oblong tunnels, stamped through the laminations. Each section is wound with two cotton-covered wires in parallel, which simplifies the operation of winding and allows of its being done rapidly. Part of the winding outside the mica tubes when finished is covered with several layers of prepared tape, and varnished. The armature windings were tested with 15,000 volts for half-an-hour, and the machine, when running, may be short-circuited without fear of damage, the short-circuit current being specified not to exceed twice the full-load current. The flywheel, or inductor, carrying the field-magnets is secured to the shaft by two keys which are first driven up tight, and then two rings are shrunk on to the inductor boss. The iron circuit for the fields is, of course, laminated, the laminations being carried on the periphery of the inductor between two circular plates, to which they are secured by bolts and nuts. To give the utmost rigidity taper keys are also inserted, one from each side, and driven up tight. The pole-pieces are carried on the outside of the laminations, into which they are dovetailed, and secured by two taper keys, which construction allows of a pole-piece being removed in a short time without disturbing the armature. The pole shoes are also detachable so as to allow of the former-wound winding being slipped off without delay, should occasion arise. The field magnets are excited in series at 220 volts from the above-mentioned independent exciter, which is carried outside the tail bearing, or independently from a separate source.

The high-tension switchboard is supported by a raised platform, constructed of Mark Fawcett's patent terra cotta work, floated over with concrete, and finished with wood block flooring. It consists at present of eight feeder panels, one synchronising panel, and three generator panels with two blank panels for further extensions. This board (like the others previously described) is of the Electrical Company's standard design, which makes it absolutely impossible for the attendant to touch any of the high-tension work. The front panels of the board are of white marble, each circuit panel carrying one shunt low-tension ammeter and one insulated oil switch hand-wheel. The synchronising panel contains three electrostatic voltmeters giving the potential between each 'bus bar and earth, synchronising voltmeter and lamps, 'bus bars, voltmeter and pilot voltmeter. Each dynamo panel contains a shunt low-tension ammeter in the main circuit, and also wattmeter, exciting current ammeter, main generator oil switch hand-wheel, two-way exciting switch, with potential breaker, and exciter field rheostat; in front of each panel there is a vertical hand-wheel for regulating the resistance in the field-circuit. The back of the board is protected by a wirework screen with a door, and each circuit and dynamo panel is

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isolated by a slate slab 1½in. thick, so that any breakdown is entirely confined to its own compartment. The fittings of each compartment are similar to those previously described. There is only one set of 'bus bars, so as to simplify the board. The framework consists of channel and angle iron, and no wood or other inflammable substance is used anywhere. Below the platform, also protected by expanded metal screens, are the three-way cable boxes at which the main cables terminate, and three-pole magnetic blow-out lightning arresters, with a non-inductive water resistance discharge for each feeder. Under the platform are also the three field rheostats and two exciting 'bus bars, together with one integrating wattmeter, with current and voltage transformer for each generator. All cables are carried on insulators, mounted on the iron framework, so that a fire about the board would be rendered practically impossible. The switchboard is surrounded by an ornamental iron railing with polished teak handrail, and the whole presents a very handsome appearance.

Two additional Galloway boilers, 30ft. by 8ft. 6in., have been installed together with Galloway superheaters at the back of each boiler, and each boiler is fitted with the "Triumph" mechanical stokers. The following additions to the existing plant have also been made:—An economiser, by Messrs. E. Green & Son, containing 360 tubes; a motor-driven "Sirocco" fan by Messrs. Davidson, driven by a 60 H.P. direct-current motor manufactured by the British Electric Plant Co., and a surface condenser of 4,500 sq. ft. surface by Messrs. Alley and MacLellan. The whole of the pipe work, of steel with cast-steel T-pieces and Hopkinson valve bodies, was supplied and erected by the Wearmouth Foundry Co. At the present time a load-factor is being obtained from this station of 41·6 per cent., and it is hoped that a very material reduction in the cost of generation will shortly be made.

Mr. Edward White, station superintending engineer, supervised the entire erection of the work inside the generating stations, and has carried it out with great success. The electrical contract has been supervised on behalf of the Electrical Co. by Mr. A. E. Hadley, with Mr. F. J. Rynd as resident engineer. The whole of the work was carried out to the specification and under the superintendence of the borough electrical and tramways engineer, Mr. John F. C. Snell, to whom we are indebted for the above particulars.

THE LIVERPOOL-SOUTHPORT ELECTRIC RAILWAY.

(Continued from page 854.)

The four engines driving the 1,500kw. sets are of the horizontal cross-compound type, with cylinders 32in. and 64in. diameter by 4ft. 6in. stroke, and run at 75 revs. per min. They were supplied by Messrs. Yates and Thom. The cylinders are of the built-up type, with separate ends and barrel, the valves,

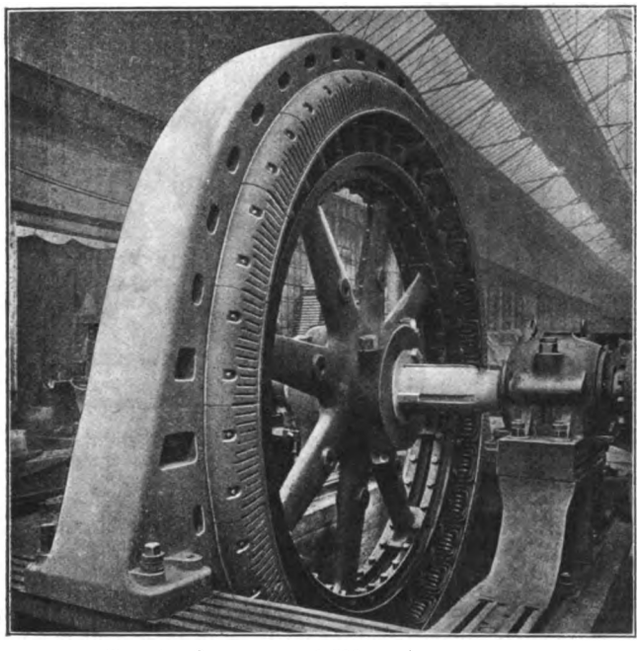

FIG. 4.—ONE OF THE 1,500KW. ALTERNATORS.

which are of the double-ported type, being placed in each case in the cylinder end, which thus form the steam box. The steam valves are worked by a modification of Messrs. Yates and Thom's usual trip gear, the closing of the valves being accomplished by powerful vacuum dash-pots. Each governor is fitted with safety stop arrangement, independent of the cut-off gear, which will completely stop the engine in the event of its reaching a speed 10 per cent. above the ordinary working speed, and will also shut down the plant in the event of any failure of the governing gear. The cylinders are bolted at the front end to a massive cast-iron bed frame of the Corliss trunk type (designed to bear upon the foundations throughout its entire length) having bored out guides formed in it for the piston rod crossheads. The outer or bayonet ends of these frames are bolted up to suitable facings cast on the crankshaft pedestals, which are large independent castings resting directly on the foundations.

The engines are solidly constructed and of massive proportion, the weight of each bed frame being 14½ tons. Each crankshaft main bearing weighs about 11 tons, and the crankshaft 17 tons, the cranks weighing 5 tons each. The pistons are of cast iron fitted with Ramsbottom rings, the low-pressure pistons having also bands of white metal to improve their wearing properties. The piston rods are made of Siemens-Martin steel secured to the pistons by means of large nuts, and are carried through the back ends of the cylinders. The flywheels are 22ft. diameter, and are directly attached by strong bolts to the magnet wheels of the alternators, which are otherwise independent of the flywheel. Each engine is fitted with a barring gear driven by an electric motor. The condensing plant for each engine consists of two Edwards air pumps worked from the low-pressure tail rod by means of links and

FIG. 5.—TOP HALF OF ARMATURE OF 1,500KW. ALTERNATOR.

levers. The condenser, which is of the jet type, is suitably placed relatively to the cylinder and to the air pumps, and has in connection with it a sluice valve and an automatic exhaust valve, so that the engines run non-condensing if necessary. The exhaust pipes from the main engines are 24in. diameter, and connected directly to jet condensers. For the exciter engines, fan engines and the boiler feed pumps there is an auxiliary surface condenser.

The alternators are three-phase, 25-cycle, the larger ones running at 75 revs., and the smaller one (a 750kw. machine coupled to a vertical cross-compound Yates and Thom engine) at 94 revs. per min., with a pressure of 7,500 volts per phase. These machines, as also the remainder of the electrical plant, were made made at the Preston works of Messrs. Dick, Kerr & Co. The magnet wheel is carried between the cranks, the

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armature ring being erected on its own slide beds, concreted in and bolted down on the engine foundations.

The magnet wheel of the 1,500kw. generator carries 40 radial cast-steel poles of oval section secured by tap bolts to the outside rim of two finished cast-steel rings of massive T section. These, in their turn, are fixed to a cast-iron spider by 16 axial bolts. The pole tips are of laminated steel with a central air space—corresponding to grooves on the pole sides and the clearance between the rotor rings—dovetailed tight into the poles to keep the field coils in position. The latter are of bare copper strip wound edgewise. The outer surface of the coils is left bare to aid the dissipation of heat, while the central ducts on the poles give ample ventilation to the iron. The cast-iron spider is built in halves and clamped on the shaft by four heavy bolts. The magnet rings are also in halves, but staggered relatively to each other and the spider, and shrunk together by double-headed keys. The slip rings are of cast-iron of stiff section, and are carried on either side of a cast-iron spider by axial bolts insulated with ebonite. Three carbon brushes bear on each slip ring. The weight of the magnet wheel complete is about 48,500lbs, of which the poles account for 12,800lbs. and the spools 6,350lbs.

There are three independent exciter sets each consisting of a standard Dick-Kerr four-pole 100kw. generator coupled to a Willans high-speed engine, running at 380 revs. per min., the working voltage being 125. They also operate the station lights, the ash conveyor, and the barring motors.

As already mentioned, the main switchboard is erected on a gallery, beneath which are the working parts of the main switches in a fireproof high-tension chamber. The switchboard is built up of 33 2ft. panels of enamelled slate. Starting from the right there are swing brackets carrying two 'bus-bar voltmeters reading to 8,000 volts, a synchronising voltmeter, and an Everett-Edgcumbe rotary synchroniser (see *The Electrician*, Vol. L., p. 422). The first 16 panels are as follows, from right to left: Five main alternator panels, one blank panel, one total station power panel, six high-tension feeder panels for distant sub-stations (Seaforth, Sandhills and Birkdale) and three exciter panels. Then come the "local sub-station panels" for the rotary converters and the continuous-current feeders. First of these is the "sub-station total power received panel," then four panels for the high-tension side of the transformers, one blank panel, four rotary converter continuous-current panels, one blank panel, one "sub-station total power delivered

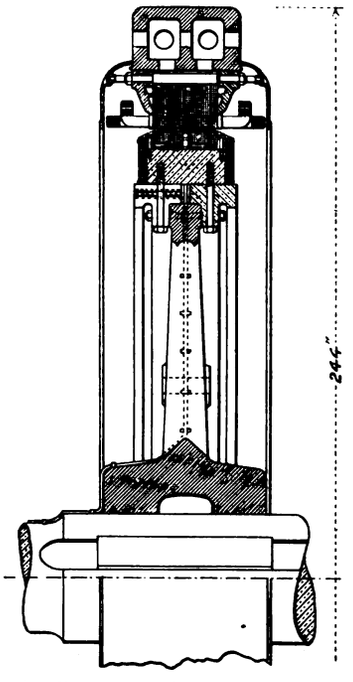

Fig. 6.—Section of 1,500kw. Alternator.

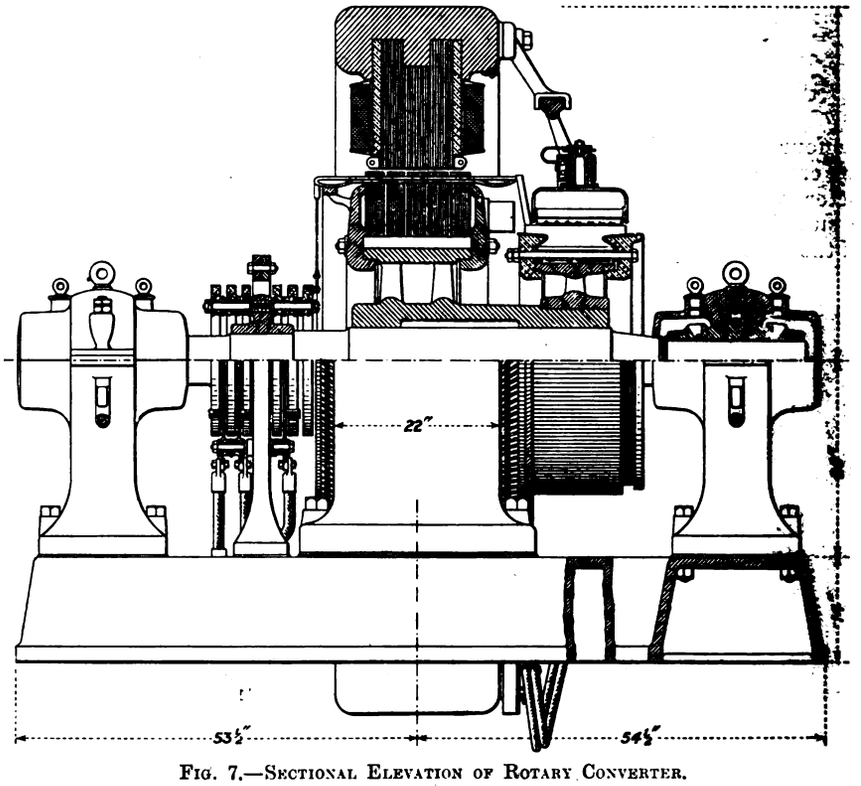

Fig. 7.—Sectional Elevation of Rotary Converter.

The stator consists of a cast-iron frame carrying the core discs on its inner periphery. The core segments are of annealed iron, punched in sections with their paper insulations. The sections break joint to equalise the reluctance, and are strung true on through bolts that clamp them up between a deep internal flange and a stiff cast-iron end ring built in sections. The complete stator weighs 75,800lbs. Each coil is fully insulated, dried and tested to 15,000 volts before being inserted in the slots. Special ventilation ducts are provided, the rotating field forcing cool air through these ducts and out at apertures cored in the frame. The winding of each phase is distributed over two slots per pole. The connection is star with centre earthed. In each alternator provision is made for shifting the stator axially by ratchet jacks to clear the rotor and give comfortable access to the windings.

Fig. 4 is from a photograph taken in the test-bed at the Preston works, the position of the machines in the engine rooms rendering it difficult to take a good view *in situ*. Fig. 5 represents the top half of the stator, and Fig. 6 shows the alternator in section.

The constructional features of the 750kw. alternator are almost identical with those of the 1,500kw. sets.

panel" (also comprising one sub-panel switch for starting the rotary converter from the continuous-current 600-volt 'bus bars), four continuous-current feeder panels for the line feeders, and, lastly, one station lighting and blower motors' starting panel, and swing bracket with rotary converter 'bus-bar voltmeter and paralleling voltmeter. The blowers are for the stationary transformers, which are of the air blast type.

All the high-tension switch gear, oil switches, instrument transformers and 'bus bars are erected in the fireproof high-tension chamber already alluded to, the dimensions of which are 79ft. by 12ft. It is constructed of steel girders and concrete. Connection between the alternator armature and its oil switch is made by a three-core high-tension lead-covered cable passing along an independent duct through the foundation up to the cellar ceiling. The rest of the high-tension wiring is by single braided rubber-insulated cables. The instruments were supplied by Messrs. Elliott Bros. and the Stanley Wattmeter Co, and are all worked through instrument transformers, none being connected directly on the high-tension circuits.

Connection to each triplet of transformers is made through a hook switch, oil switch and three cast-iron tail-end glands,

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bushed with corrugated porcelain bobbins, piercing the front wall of the chamber. Each transformer is single-phase split-phase, and has two independent secondaries, the six of the triplet being grouped in double mesh to afford six phases for operating the rotary converters. Connection between the grouped secondaries and the six rotary slip rings is made through a pair of three blade switches carried on a stand, on which is also placed the equaliser switch for the series field.

The most interesting feature of the alternating board is the high-tension oil switch, already referred to briefly. The

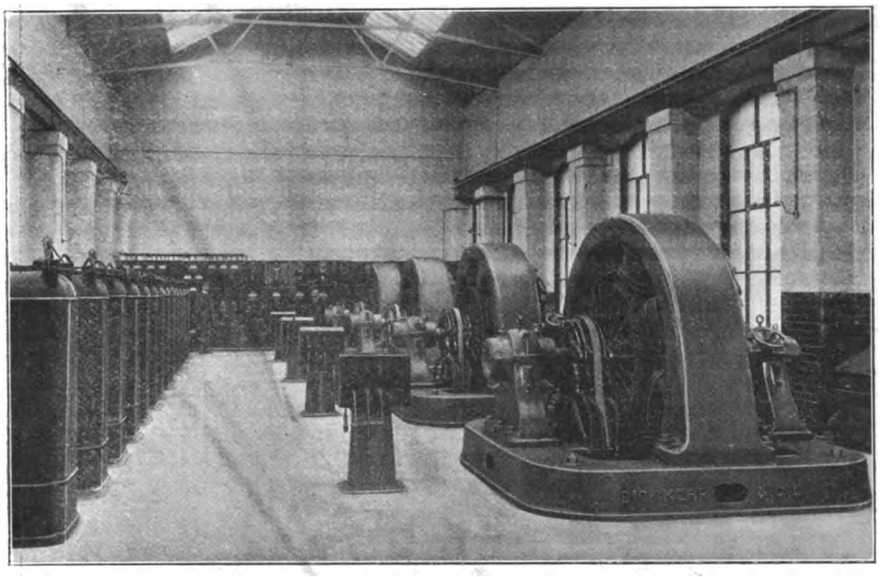

FIG. 8.—ONE OF THE SUB-STATIONS.

handle of the switch is so arranged that it has to be lifted and pushed down again, whether for switching on or switching off. Two indicating lamps next to it show whether the switch is on or off. On the working parts of the switch in the chamber below is an overload release operated through a transformer circuit, and this can also be actuated by a small press switch on the switchboard next to the transformer handle. This is customarily employed for switching off, as it is more convenient to tap the handle of this little switch than to lift up and press down the main switch handle; moreover, it affords a test that the overload release is in order. The handles of the main switches are seen in Fig. 9, which although representing the high-tension part of one of the sub-station switchboards illustrates equally well the corresponding panels of the switchboard at the power house.

The three largest sub-stations, Seaforth, Sandhills and Formby, have each four rotary converters, whilst Birkdale has three, provision being made in each case for extensions. Otherwise all the sub-station equipments are alike. Each rotary converter is arranged with its corresponding groups of stationary transformers alongside, as seen in Fig. 8; the switchboard is on floor level, and is similar to the "local sub-station" part of the switchboard at the power house, and the high-tension oil switches are in a cellar beneath.

The rotary converters resemble in their general lines standard continuous-current machines. They are 8-pole, developing 600kw. on the continuous current side at 600–650 volts, the speed being 375 revs. per min. The core discs are segmental and dovetail into machined grooves on a cast-iron spider, the rim of which, following standard practice, is sectional, to avoid shrinkage strains. A section through the converter is shown in Fig. 8. The machines are six-phase. The transformers have each a capacity of 200kw. They are circular, and are built up of copper strip wound on edge. The secondaries are inside, next the core; the primaries above and outside. Ample ducts are left between the coils, core and casing to afford free passage for the air blast, which enters from an air-duct below the floor and may be regulated by a baffle above. The windings are accessible on unscrewing the sheet-iron sides. Each transformer weighs approximately 5,450lb., and the rotaries weigh 40,940lb. (armature 10,380lb. and magnets 21,380lb.). The blowers, of which there are two in each sub-station, consist of a 5 H.P. motor, coupled on a combined base to a Davidson "Sirocco" fan, which is keyed directly on the motor shaft. The capacity of each fan is 8,000 c. ft. of air per min., at a pressure of 2in. to 3in. of water.

As no battery or induction motor is provided in the sub-station, the first rotary converter has to be started from the A.C. side if the third rail is not yet alive. This is done simply by closing the three-phase switch, when the eddy currents induced in the pole-pieces and spool flanges are sufficient to bring the machine up to the speed of synchronism just as if it were an induction motor for the time being. On the sub-station switchboard there is a double-scale voltmeter, which is connected across the continuous-current brushes of the machine when starting in this way. When nearing synchronism, the oscillation of the needle of the voltmeter from one side to the other of zero is very plain, and the man standing near the machine closes the field-breaking switch on the rotary, thus exciting it, when the needle shows that the continuous-current volts across the brushes are of the right polarity. Should, however, the first rotary come up of the wrong polarity, it would be connected up to the continuous-current 'bus bar just the same, and the second rotary then would be started from the continuous current side; for this purpose there is a double-throw reversing switch connecting the continuous-current 'bus bar to the starting 'bus bar. Up to the present the machine is started up with about half normal voltage on the A.C. side, and the rotary requires about half a minute to come up to synchronism, taking nearly twice full load current. When more than one sub-station is to be started at the same time, the first rotary in one of them is started up with reduced volts; and then the other sub-stations can be started up either in a similar way, or in the usual manner from the D.C. side with current from the third rail. The shunt field of the rotary is split up in four places in starting, so that there are only two coils in series to decrease the strain on the insulation. When starting from

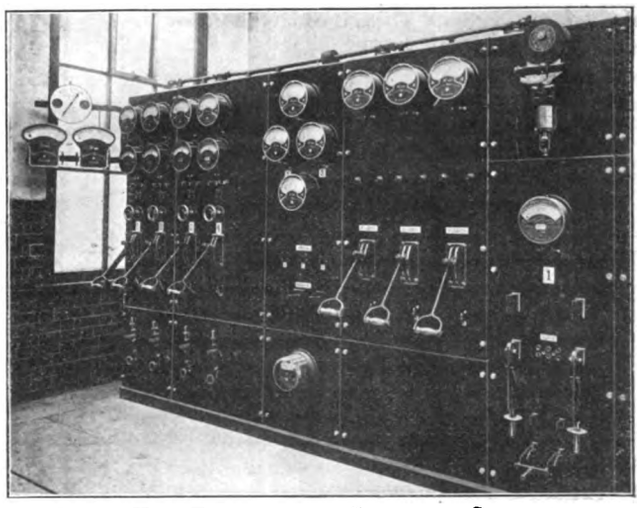

FIG. 9.—HIGH TENSION END OF SUB-STATION SWITCHBOARD.

the A.C. side the shunt to the series field terminals is, disconnected, otherwise there would be a short-circuited winding of very low resistance on the fields. This opening of the shunt across the series field is obtained by opening the equalising switch, which carries three contacts and is mounted on the same pillar close to the rotaries, with the two sets of three-phase low-tension switches going to the collector rings.

(To be continued.)

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A LARGE ELECTRIC TRAMCAR.

The Hartlepool Electric Tramways Co. can claim not only the credit of possessing the largest electric car in the B.E.T. organisation, but also the merit of having constructed it. The car in question has a seating capacity of 84 passengers, 42 inside and 42 outside; and its entire construction was carried out at the Hartlepool depot to the designs and under the able superintendence of the manager. The total cost (exclusive of trucks) was £140. The following description, prepared by the manager, may be of interest.

The body of the car has been adapted from two obsolete car-bodies (see Fig. 3) and is supported by a composite frame of channel iron girders and oak. Two longitudinal girders run the whole length of the coach, thus imparting great strength to the car; and the entire frame is bolted together by bolts of a driving fit into rimered holes. The roof, which has been constructed with considerable "camber," is fitted with a strong sail-canvas covering tightly stretched over the whole area, and painted with several coats of oxide paint to ensure its being waterproof. The platforms are carried on oak bearers, two of which have angle-irons securely bolted to them as a precaution against sagging. As an additional safeguard against this contingency, the platforms have been given a slight rise towards their extremities.

The staircases are of special design, the winding reversed stairs being superseded by two flights of straight steps connected by a landing, the top flight being at right angles to the lower one, as may be seen in Fig. 1. In these stairs the treads are all of equal width; more "headway" is thus obtained, and, consequently, the stairs can be used by elderly or nervous people. Another distinct advantage of this type of staircase over the reversed staircase is that the car can be loaded and discharged with ease during busy times. The upholstering of the interior of the car is quite simple. The seats are covered with carpet of a warm red design, and the curtains are to match. Electric bells are installed between driver and conductor; but the usual inside pushes have been omitted, as experience in Hartlepool has proved that they are liable to be used without reason.

The lighting of the car is effected by three series of five lamps. These include electric dash lights and two canopy lights on the

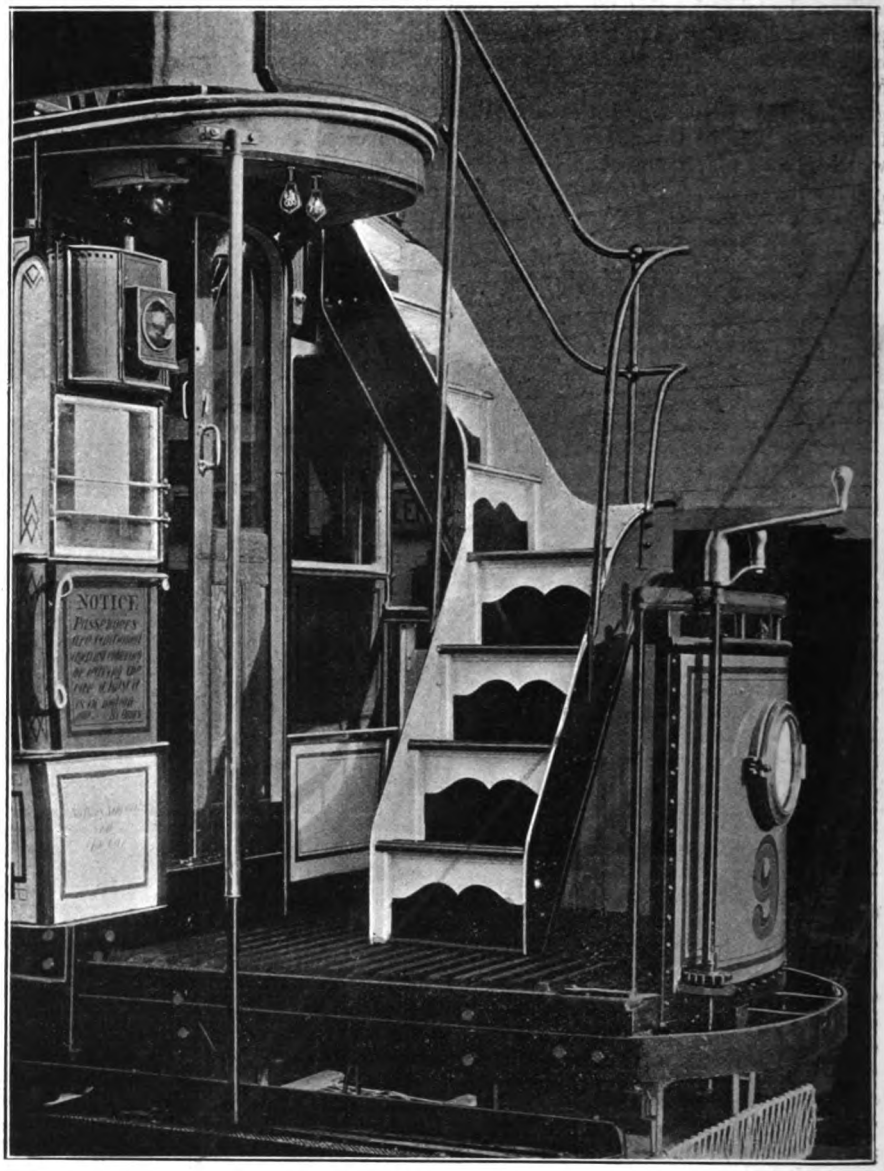

FIG. 1.—PLATFORM OF NEW CAR.

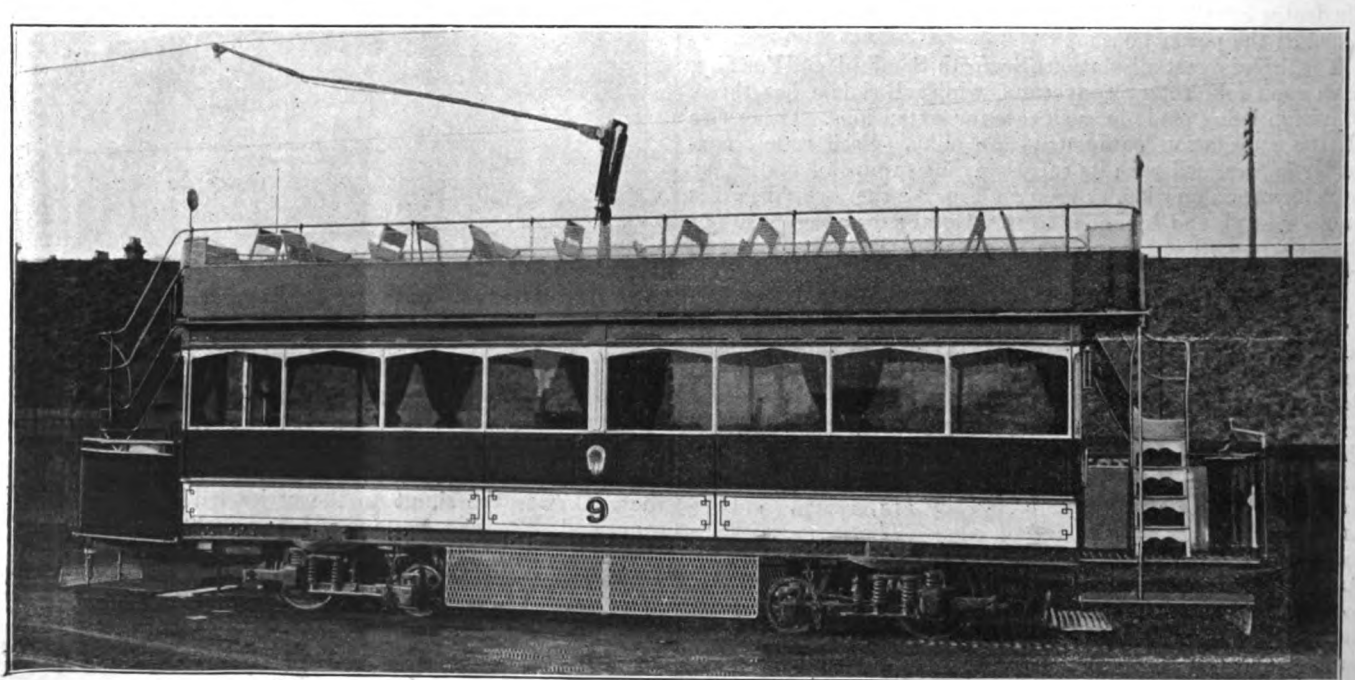

FIG. 2.—THE CAR.

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rear platform, which are so arranged that by means of a three-way switch they may be used at alternate ends of the car. One set is so connected that in the event of the main fuse being blown the lamps are extinguished, so that the trouble can be immediately located. The main electrical equipment consists of two 33N Walker motors operated by Walker controllers of the series-parallel type, and resistances on the "Short" system. The arrangement is such that the car starts almost imperceptibly and without jar.

The sand gear is of new design, the boxes being of extra large capacity. The mechanism is reduced to the fewest working parts, and consists of a vertical spindle having a mitre and seat as in a steam valve, a spiral spring being used to keep the spindle down

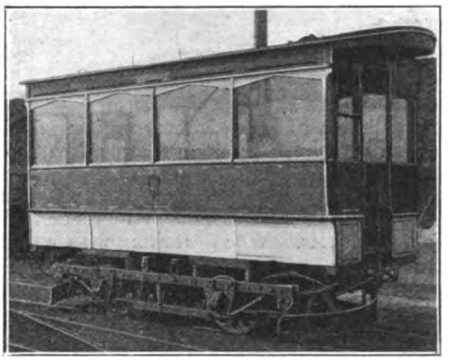

FIG. 3.—OBSOLETE CAR BODY WITHOUT PLATFORMS.

and the valve shut. The box is worked by a foot lever which lifts the spindle and releases the sand, the spring before-mentioned shutting it off again automatically when the foot punch is released.

The trucks of this car are of the Brill maximum traction standard type; other cars so treated, however, will be mounted on Brush trucks. The weight of the car when empty, but ready for use, is 13 tons 16 cwt.

In conclusion, it may be stated that the car has undergone a series of trials, and has now started in service. So far it has run without a hitch.

NEW ELECTROMAGNETIC TRACK BRAKE.

The British Thomson-Houston Co. sends us the following particulars with regard to an electromagnetic track brake for tramways which it is about to place on the market. From Fig. 1, which clearly indicates the general principles on which the brake has been designed, it will be noticed that the brake proper is suspended from a stiff bracket, which is fastened to the side of the truck, by means of compression springs and wrought-iron eye-bolts. By using compression springs the advantage is secured that, even if a spring should break, the brake shoes are kept clear of the track. The brake shoe itself consists of a substantial steel casting with a cored recess, containing the magnetising coil. This recess is closed at the top by a water-tight brass cap. A steel core extends through the coil, providing two magnetic circuits, each of which is completed by the section of rail immediately under the brake shoe. Wearing plates of cast steel are bolted to the under-side of the shoes in such a manner

mentioned that the track brake is entirely independent of the ordinary hand brake. Fig. 2 represents the application of this track brake to a maximum traction truck. For single trucks two shoes are used, the coils of which are connected in parallel, and for bogie cars four track brakes are employed, two in series and two groups in parallel.

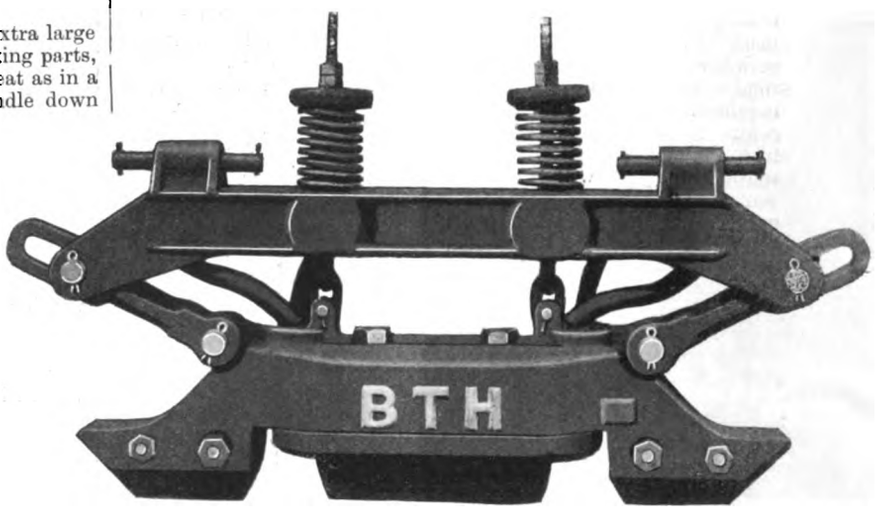

FIG. 1.—GENERAL ARRANGEMENT OF ELECTROMAGNETIC TRACK BRAKE.

We are informed that the efficiency of the brake as an emergency and service brake has recently been demonstrated by a series of tests carried out under actual working conditions. A four-wheel double-deck car with two motors was used. The weight of the car was about 9 tons, and it carried five or six persons, engaged in the trials. Some tests made with the magnetic track brake are recorded below:—

Emergency Stops.

Speed on applying brake.	Time to stop.	Distance to stop.	Grade down.
25 miles per hour.	4 seconds.	25yds.	1 in 13 / 1 in 14
14 ,,	1·6 ,,	5·3 ,,	Level.

Speed Regulation on Descending Grades.

Speed maintained.	Grade.	Current per motor.
5 miles per hour.	1 in 13 / 1 in 14	4 amperes.
5 ,,	1 in 17	3·5 ,,
5 ,,	1 in 45	2 ,,

The first test represents extreme conditions, such as a car running away down a steep incline, the stop being made in about 2½ car lengths.

The second test corresponds to the case of a car travelling at a moderate speed and obliged to pull up suddenly; such a stop can be

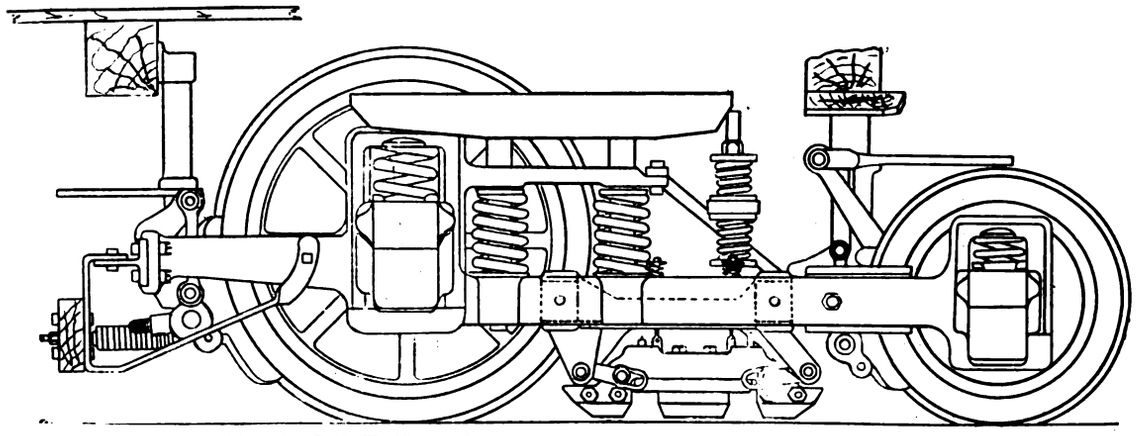

FIG. 2.—B.T.-H. TRACK BRAKE APPLIED TO A MAXIMUM TRACTION TRUCK.

that they can be renewed without removing the shoe from the truck. The magnetising coil is supplied with current from the motors, when these are acting as generators, the current being led to the coil by means of flexible wires in duplicate, introduced through bushed holes into the recess of the cast steel frame of the shoe. It may be

made in less than a car length. The second table is interesting inasmuch as it shows that a low and even speed can be maintained when the car is coasting down the steepest grades. If necessary the car can be stopped by further movement of the controller handle, and held at rest by the wheel brake.

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THE RIEDLER-STUMPF TURBINE.

Amongst the newer steam turbines is one developed by the German Profs. Riedler and Stumpf, which is described in a recent article in *Engineering*.

The Riedler-Stumpf turbine occupies an intermediate position between the De Laval and Parsons type of turbine. In order to reduce the speed of the shaft, wheels of large diameter are employed, made of a 10 per cent. nickel steel with the buckets cut into the periphery (Figs. 1 and 2). Contrary to the De Laval construction, a rigid shaft is employed, which is supported by either one or two bearings. This is made possible by very accurate balancing. The centre of gravity in the 2,000 H.P. Riedler-Stumpf steam turbine installed at the electricity works of Moabit (Berlin) was, indeed, specified to be within 0·1mm. (0·004in.) of the geometrical centre. This condition was fairly well fulfilled, and the centre of gravity could afterwards be made correct within 0·01mm. (0·0004in.).

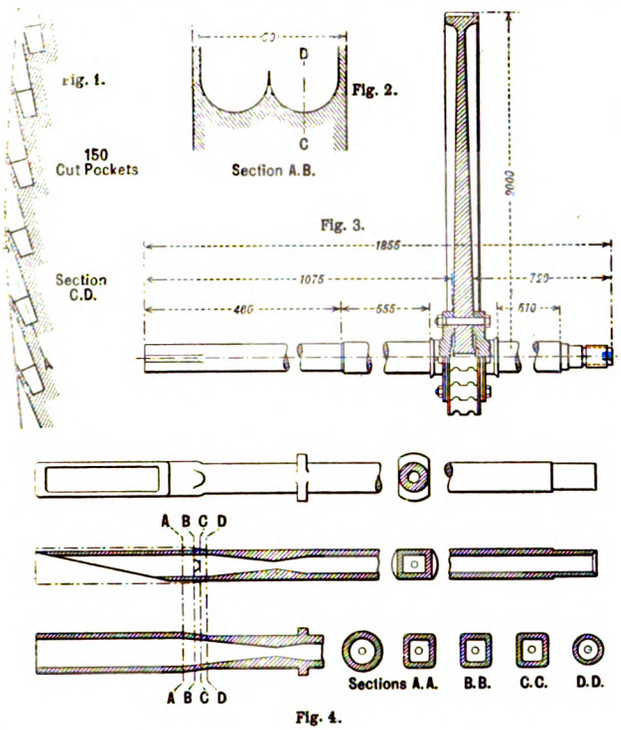

Fig. 4.

In these circumstances, the motion of the turbine in question, when running at a speed of 3,000 or 4,000 revs. per min., is stated to be imperceptible to the eye. Figs. 1 to 5 refer to this 2,000 H.P. turbine, Fig. 5 representing the nozzle ring. As seen from Fig. 4, the nozzles are square in cross-sections, and not elliptical as in the De Laval type. They are made of round bored nickel steel tubes; the portion below the stricture, the size of which depends upon the desired expansion, is then drawn out square and finally cut off obliquely. The complete nozzle-ring furnishes a full steam-jet ring. If partial admission is intended, the nozzles are united to an arc, and the rotor buckets not played upon by the steam are covered, to decrease the ventilating resistance. Between the rotor and the nozzle the clearance is, in the Moabit turbine, 3mm. (0·12in.) measured radially and 10mm. (0·4in.) when measured in the axis of the nozzle. The radial clearance has, it is said, been increased to 5mm. (0·2in.) without affecting the efficiency. The buckets of the rotor may be made of a simple **U**-shape, so that the steam jet is turned through an angle of 180deg. in its path through the

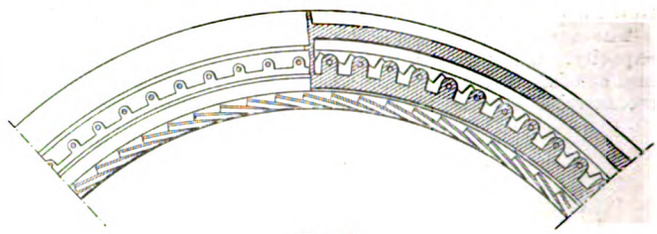
Fig. 5.

bucket; or they may be as illustrated, representing a double **U**, in which case the steam strikes the partition between the two buckets and leaves on both sides. The first experimental steam turbine in the engineering laboratory of the Charlottenburg College was constructed with two rotors, 1·5 metres (4·9ft.) in diameter and provided with simple **U**-buckets. When working with condensation, both rotors were used; when non-condensing, only one wheel was employed. In the latter case a steam consumption of 13kg. (28·9lb.) per brake horse-power hour was observed. In the 2,000 H.P. turbine, already referred to, several concessions were made to simplicity at the expense of efficiency. Thus, Prof. Riedler states, there was a loss of steam velocity in the nozzles amounting to 5 per cent., a further loss of 15 per cent. in the buckets and also a loss of 15 per cent. because the steam was allowed to enter the condenser at a high velocity. The rotor weighs 850kg. (1,890lb.). When the steam velocity is to be utilised twice, the inventors employ the reversing guide blades shown in

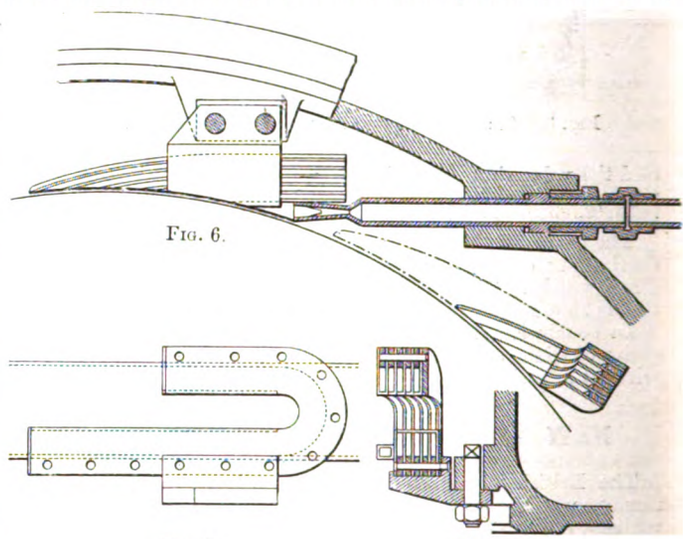
Fig. 6.

Fig. 7.

Fig. 8.

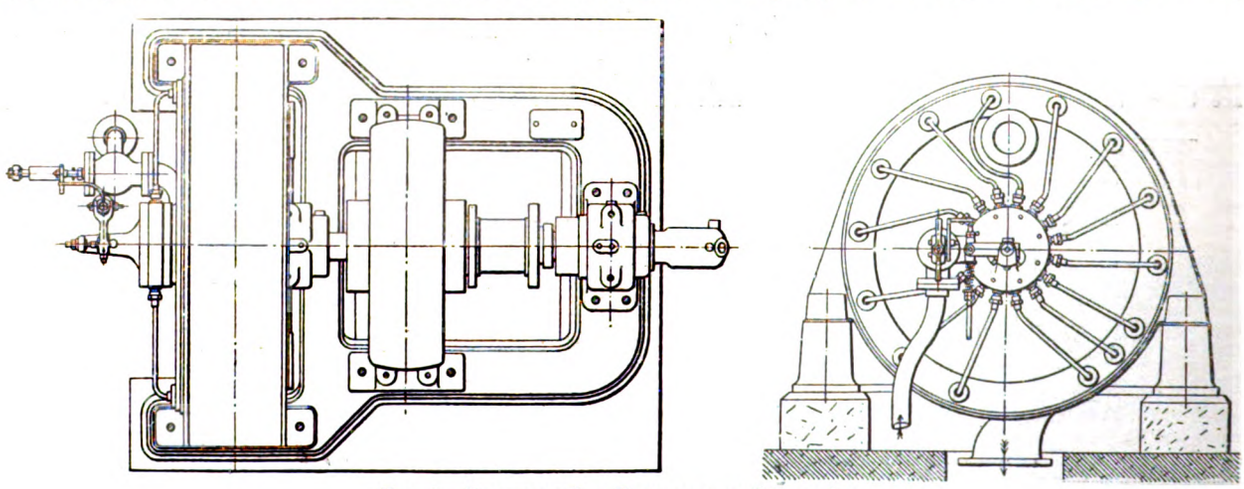
Fig. 9.—Plan and End Elevation of 100kw. Set.

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Figs. 6, 7 and 8. Should the turbine rotate below its normal speed the steam will leave the buckets in a backward direction, and the object of these reversing guide-blades is to gather up this steam and to re-direct it either on to a second revolving turbine wheel or on to other buckets of the same wheel.

A 20 H.P. turbine with one guide-blade ring and a diameter of 800mm. (2ft. 7½in.) was the first one of this kind built. When driving a dynamo at 3,500 revs. per min. it consumed 17kg. (37·8lb.) of steam per brake horse-power hour non-condensing. Without the reversing guide-blades, however, the consumption was found to be 26kg. (57·7lb.) Fig. 9 represents a 100kw. turbo-generator, built by the Allgemeine Elektricitäts Gesellschaft. Only two bearings, it will be noticed, are provided.

More than two steps in compounding for the velocity are not advisable. By applying the compound principle to both the steam pressure and velocity, Profs. Riedler and Stumpf have succeeded in reducing the speed to 750 and even 500 revs. per min. In such cases the dynamo is placed between a high and low-pressure turbine; each of these may further be subdivided—that is, we may have two (or more) wheels, separated by a partition which completely divides the casing, and each of the four wheels may have two rings of guide-blades. The turbine has also been built vertical, resembling the Curtis turbine arrangement.

The following table relates to some tests of the 2,000 H.P. set alluded to above. It is stated that at subsequent brake tests, when the output was 1,917 H.P., a consumption of 7·9kg. (17·6lb.) of steam per kilowatt-hour was observed, the speed being 3,800 revs. per min.:—

Date.	Load.		Steam pressure.	Steam temp.	Vacuum.		Steam consumption. Lbs.	
	Kw.	Per cent.	Lbs. per sq. in.	Deg. F.	In.	Per cent.	Per kw.-h.	Per elec. h.p.-h.
Nov. 12, 1902	850	57	115	568	27·6	92	20·9	15·3
Nov. 13, 14, '02	830	57	116	554	27·6	92	20·4	15·1
May 17, 18, '03	554	37	99	523	26·5	89	22·0	16·2
June 15, 1903	1,365	nearly 100	129	562	25·5	85	19·8	14·4

THE NATIONAL PHYSICAL LABORATORY.

(Concluded from page 866.)

Abstract of the report of the director (Dr. R. T. Glazebrook):—

PHYSICS DEPARTMENT.—I. ELECTRICITY.

A.—*General Measurements.* (Mr. Campbell and Mr. Melsom.)

In addition to the tests mentioned in the report of the Committee, two series of investigations on the change of resistance of metallic films due to annealing have been completed.

Tests on Laboratory Instruments, &c.—The standard B.A. air condensers were measured from time to time, their constancy being satisfactory within the limits of accuracy attained. An investigation was also made into the absorption in mica condensers by Muirhead and Carpentier. In connection with an endeavour to obtain steady temperatures, four thermostats have been tested, and the distribution of temperature in a well-lagged oven investigated. The electric clock, presented by Prof. McLeod, was partially rebuilt and set up. It has now been going for about a month, and is at present under observation. In connection with the question of Matthiessen's standard of copper conductivity a number of samples of copper were tested. For purposes of comparison, tests have been made upon seven samples of magnet steel of high-class make. In connection with the 1-ampere balance in course of construction, a short research was carried out on the rise of temperature of thin strips carrying various currents. In the same connection a number of samples of brass were tested for permeability. The standard Kelvin voltmeter has had its scale drawn, and is being calibrated at intervals. Some tests have been made on a sample Bastian meter. With a view to the testing of ampere-hour meters on long runs, an investigation has been made upon sensitive relays, and an apparatus has been set up which automatically regulates current to one part in 1,000. A series of tests was made on the Crompton potentiometer belonging to the laboratory, and a number of instruments and resistances were tested for the photometric department.

Apparatus.—The following apparatus has been constructed or installed:—Standard 0·001 ohm for 250 amperes, standard 0·1 ohm for 15 amperes, potential-dividing box for 500 volts, regulating box (four dials and slide wire), four shunts for Weston voltmeter (1 to 25 amperes), set of standard coils to build up 10 ohms, ratio box (0·1 to 10,000 ohms) for condenser tests, air condenser for insulation tests, electromagnet to give H=1,000 for watch testing, set of coils (10 to 200 ohms), marble mutual inductance standard (0·0001 to 1 henry), shunt box and special key for insulation tests, three electric ovens for same, two clamps for high-voltage tests, shunt box and regulating resistances for workshop test room and set of regulating resistances (to carry 100 amperes) for low-resistance tests.

B.—*Fundamental Units.* (Mr. Smith.)

Experimental Work.—(a) Mercury Standards.—The work in connection with the mercury standards of resistance has been carried to a successful conclusion during the past year, and a full report is now ready for publication. Of these mercury standards, eight are of Jena 16''' glass, and three of verre dur, the lengths of the 11 tubes varying from 60cm. to 120cm. Fittings for each tube have been constructed, enabling the measured resistance to either include or omit the "end correction," the value of the latter having been determined for the special kind of connecting cups used. The resistance measurements were made by means of the Kelvin bridge, the potentiometer, and the Carey Foster bridge, the two former methods being adapted to either include or omit the end correction, and the last necessarily including it. The object of these different forms of measurement was to determine experimentally the best means of adapting the mercury standard as an easily reproducible standard for the laboratory. The result of the observations on the whole 11 tubes shows that the difference between the international ohm, as defined by a uniform column of mercury 106·300cm. long and 14·4521 grammes mass at 0°C., is known to about 0·001 per cent. In order to render the experiments complete, the temperature coefficient of mercury in Jena 16''' glass, and also in verre dur glass has been determined. The two values of the temperature coefficient of a constant volume of mercury as deduced from these measurements are in very close agreement, and the probable error of the whole determination is exceedingly small. It is proposed that these 11 mercury standards be compared with the manganin and platinum-silver standard of the laboratory at least once in each year. In addition, some mercury standards of a more convenient form will be set up permanently in the coming year. The probability of changes occurring in these standards owing to the strained condition of the glass is discussed in the report, and but very small variations are anticipated. Moreover, such changes are capable of detection by repeating the processes employed in the construction. The laboratory is, therefore, in a very firm position with respect to the reproduction of its unit.

(b) Comparison of Units of Resistance.—The unit of resistance employed at the laboratory has been compared with that of the Board of Trade and also with the Reichsanstalt unit. The results of these comparisons were published in a Paper read before the British Association at Southport. A comparison with the international ohm has, of course, been obtained by means of the mercury standards already referred to.

(c) Wire Standards of Resistance.—A complete report dealing with the past and present values of the platinum-silver and manganin standards of the British Association was presented at Southport. Marked changes were noted in certain of the coils. In addition, there are several new manganin standards—some purchased, and others made at the laboratory. These coils range from 0·001 to 10,000 ohms, the coils from 1 ohm upwards having been kept under very close observation. The lower coils are now being similarly observed, so that much information is accumulating respecting the reliability of wire standards for accurate work.

(d) Standard Cells.—The tests made on these have proved entirely satisfactory, but progress with new cells will not be made until next year. For these, Dr. Carpenter has prepared several samples of mercurous sulphate. The whole of the cells made in 1902 are in good condition, and the change in voltage of the faulty ones has been very much as anticipated. During the year several standard cells have been submitted for test, the results proving that the Clark cell cannot at present be regarded as liable.

(e) Ampere Balance.—Experimental coils wound on marble have been constructed in the engineering department, and the necessary insulation tests, &c., made. Brass rods and castings intended for use in the construction of the balance have been tested for magnetic permeability with final satisfaction.

C.—*Electrotechnics.* (Mr. Paterson.)

This division is being organised for the purpose of undertaking tests on electrical instruments, such as ammeters, voltmeters, wattmeters, watt-hour meters, &c.

Equipment.—Arrangements are being made for dealing with heavy currents, both alternating and direct, as well as high voltages. A 5kw. motor-alternator, presented by Messrs. Siemens Brothers, has been put down and tested. Single-phase, two-phase and three-phase currents can be obtained from this machine at frequencies varying from 20 to 120 alternations per second. Messrs. Siemens are also giving three high-tension transformers. The following apparatus has been purchased and delivered:—One 50 to 150-volt Kelvin electrostatic voltmeter, with mirror attachment; one 600-ampere Kelvin ampere balance; one 100-ampere Kelvin ampere balance; one 10-ampere 1,000-volt Kelvin watt balance, with dividing resistance; one 100-ampere 1,500-volt Siemens wattmeter; one 10-ampere 1,500-volt Siemens wattmeter; one 16 to 320-volt Weston alternating-current voltmeter. Three Addenbrooke electrostatic instruments (wattmeter, voltmeter and ammeter) are on order for use in alternating-current testing. These will be used in conjunction with a slightly modified form of Mr. Addenbrooke's special switch box. Non-inductive series resistances and dividing resistances for high voltages will enable the apparatus to be used over a wide range. A special low-resistance potentiometer has been designed by Mr. Melsom, for use in direct-current measurements, and will be put in hand early in the coming year.

II.—THERMOMETRY. (Dr. Harker and Mr. Hugo.)

New Apparatus Constructed.—(a) Three new high temperature electric furnaces, with nickel heating coils. *(b)* Three annealing ovens for mercury thermometers, for 100, 250 and 450deg., heated in series from the 100-volt lighting circuit, with heating coils of "Eureka" wire. *(c)* New steam bath for mercury thermometers. *(d)* Five thermo-junctions for high temperature work. *(e)* Baths for high temperature fixed points of long stem thermometers. Boiling points of naphthaline and diphenylamine. *(f)* New ice baths for Tonnelot thermometers and for thermo-junctions.

Research Work.—High Temperature Comparisons of Standards.—The research work of the department for the year has consisted mainly of a continuation of the investigation mentioned in last year's report on the

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various high temperature standards. In addition to the comparisons of gas and platinum thermometers. investigations have been made on the behaviour of thermo-junctions for high temperature measurement, and in particular the junctions of platinum and platinum-rhodium obtained from the Reichsanstalt, where they had been standardised at a number of fixed points by Dr. Holborn. During the present year the inter-comparison of the gas thermometer with porcelain bulb, one of the platinum-platinum-rhodium junctions alluded to, and two different platinum thermometers has been continued, and after all corrections are applied the discrepancies between the different instruments are found to be very small. Between the two types of instruments least affected by temperature lag—namely, the platinum thermometers and the junctions—the difference in one set of experiments, extending from 500°C. to 1,000°C., never attains 1°C., and the several series of independent measurements with different fillings of the gas thermometer concord as closely as could be expected. The results of these experiments have been communicated to the Royal Society.

Constants of Steam.—Conjointly with the engineering department work has been commenced on a redetermination of the constants of steam: the first of these undertaken being the specific heat of superheated steam. An apparatus has been constructed and erected in the main engineering laboratory which promises to give satisfactory results. A heating coil of "Resista," a nickel steel of very high resistivity, has been built of thin strip, insulated with mica, by which a current of steam from the experimental boiler can be superheated up to about 300°C., the temperature of the steam being taken by thermometers in steel tubes at the points where it enters and leaves the superheater. For this small preliminary apparatus the maximum flow given by the boiler is 40lbs. of steam per hour with an atmospheric gas burner, but provision has been made to considerably increase this by addition of an air blast, when required. In the larger apparatus shortly to be constructed provision is being made to take all the temperatures electrically, thus obviating the many difficulties peculiar to high temperature mercury thermometry.

III.—Metrology. (Mr. Keeling.)

Tests.—These have comprised coefficients of expansion, tests of "line" and "end" measures of length, specific gravities (chiefly of rail steels for the Engineering Standards Committee), &c.

Work Done.—Progress has been made with the standardisation and inter-comparison of the Laboratory standards. A steel H-form bar, divided on a platinum-iridium strip over 40in. into $\frac{1}{10}$ths, has been delivered. A 36in. length of this bar has been compared with a cast-iron yard placed at the disposal of the Laboratory by the Board of Trade Standards Department, and also with the Laboratory metre. Using the latest determination of the relation between the yard and metre (1 metre = 39·37011in.) and taking 16·67°C. on the hydrogen scale as the standard temperature for the yard, the two values thus obtained agreed to about one part in one million. Progress has been made with the calibration of the sub-divisions which, it is hoped, will be completed early in the coming year. In addition to the above, a nickel H-form metre has been acquired, and its error at 0°C. and its coefficient of expansion have been determined. Attention has been paid to the Laboratory's end-standards. The sub-divisions of the foot have been compared amongst themselves with a resulting change in the relative errors attributed to each.

IV.—Chemistry. (Dr. Carpenter and Dr. Caspari.)

Investigations of a somewhat extensive character have been made on a material used for electrical insulation purposes. The analytical work includes complete analyses of nickel-steel forgings, phosphor-bronze rings, mild steel rivets, steel rails, standard copper, water, coke and caoutchouc. In addition, analyses of some 30 iron-carbon alloys, made in the metallurgical department have been carried out. Further experiments on the preparation of pure mercurous sulphate for standard cells have been made.

V.—Metallurgy. (Dr. Carpenter and Mr. Keeling.)

Apparatus.—Electrically-heated tube furnaces, suitable for cooling curve work are now installed. A potentiometer has been specially constructed for use with the thermo-junctions employed in the measurement of temperatures up to 1,500–1,600°C.

Research.—Some 33 iron-carbon alloys of great purity have been made by melting in a crucible furnace suitable mixtures of a low-carbon and high-carbon alloys. These latter were kindly supplied by Mr. Hadfield. Each alloy weighs between 3lb. and 4lb. The carbon content varies from 0·12 to 3·87 per cent., broadly speaking. by increments of 0·1 per cent. as aimed at. The range of temperature through which the solidification of each alloy extends has been determined. In addition, the various critical changes which take place before the alloy has cooled to the ordinary temperature have been investigated by differential coolings against platinum; the results have shown the necessity of further micrographic investigation, as the alloys cool from 600–500°C. This is in progress.

The series of medium-carbon nickel-iron alloys, referred to in sec. (2) [Report for the year 1902], have been prepared at the Hecla Works, Sheffield. Eight alloys, whose compositions vary as follows, have been cast:—

		Carbon.		Nickel.		Manganese.
1798	A	0·47	....	Nil	....	0·95
	B	0·50	....	1·27	....	0·89
	C	0·46	....	2·19	....	0·83
	D	0·40	....	4·18	....	0·75
	E	0·43	....	7·97	....	0·79
	F	0·41	....	12·19	....	0·82
	G	0·45	....	15·94	....	0·83
	H	0·41	....	19·81	....	0·96

Part of each ingot has been forged to a bar 1¼in. diameter. The remainder has been cut into test pieces. Unannealed as well as annealed test pieces of A, B, C and D have been prepared. Alloys E, F, G and H were so hard that they could only be machined after annealing at a particular temperature, which was different for each alloy. The forging, machining and annealing have been done at Sheffield. The electrical conductivities of the forged bars have been determined at Bushy House.

VI. Optics. A.—*Photometry.* (Mr. Paterson.)

Equipment.—The organisation of this department was begun in the early summer of the present year. The 300-volt battery kindly presented by the Electrical Power Storage Co. has been installed, together with a regulating switchboard, and three separate circuits to the photometer room; these, in addition to alternating-current leads and two circuits from the experimental battery, will fully meet all requirements for photometric work of incandescence lamps. The equipment of the photometer room has been carried out with a view both to rapid and accurate repetition work and convenience in experimental research. Messrs. Robertson & Co., Hammersmith, have kindly undertaken to make, and present to the Laboratory, a set of large bulb secondary standards, with voltages ranging from 100 to 250, and candle-powers from 8 to 100. Messrs. Robertson are paying special attention to the manufacture of these lamps, which will form a very complete set of standards. Four have already been delivered. The equipment for life tests is not yet complete.

Apparatus.—The following are the principal pieces of apparatus:—one photometer bench (Reichsanstalt pattern) by Messrs. Schmit and Heensch, presented by Sir William Preece; one Crompton potentiometer, presented by Messrs. Crompton & Co.; one Harcourt 10 c.p. Pentane lamp, presented by Sir William Preece; one Trotter bar photometer, presented by Mr. A. P. Trotter; three Fleming type large bulb secondary standards, presented by Dr. Fleming; one Kelvin electrostatic voltmeter with mirror attachment and scale at 2 metres radius reading to $\frac{1}{100}$ volt; one Ayrton and Mather reflecting galvanometer shunting a set of series resistances, used as ammeter; one Ayrton and Mather reflecting galvanometer with dividing resistances, used as voltmeter. An apparatus has been made for automatically regulating the voltage of lamps on life test. This is giving satisfactory results, and a larger piece of apparatus is now under construction for the same purpose.

Tests.—The chief work undertaken up to the present has been the thorough investigation of a 10 c.p. Harcourt Pentane lamp, with a view to determine the variation of its light strength with barometric pressure, as well as humidity and carbon dioxide in the air. In connection with these experiments, the chemical department has fitted up an apparatus for measuring the carbon dioxide in the air by titration method. These investigations will be carried on during 1904, but they are now sufficiently far advanced to enable lamp testing on a large scale to be undertaken.

Abstract of report on the Observatory Department for the year ending December 31, 1903, made by the superintendent (Dr. Chree) to the director:—

The work at the Kew Observatory in the Old Deer Park at Richmond, now forming the Observatory Department of the National Physical Laboratory, has been continued during the year 1903 as in the past.

1. Magnetic Observations.

The magnetographs have been in constant operation throughout the year, and the usual scale value determinations were made in January. The ordinates of the various photographic curves representing declination, horizontal force and vertical force were then found to be as follows:—Declinometer: 1cm. = 0° 8′·7; bifilar, January, 1903, for 1cm. δH = 0·00051 C.G.S. unit; balance, January, 1903, for 1cm. δV = 0·00049 C.G.S. unit. On May 5 it was found necessary to readjust the position of the dots of light of the horizontal force curves, as their position had become too wide apart for safe registration. On July 22 the vertical force instrument was also readjusted. During the earlier part of the year the curves were generally quiet, but since June they have become more disturbed. The principal movements that were recorded took place on the following days:—April 6th; June 1st, 2nd, 30th; July 25th to 28th; August 11th, 22nd, 26th; September 19th, 20th, 23rd; October 12th, 13th, 31st; December 13th, 31st.

The magnetic storm of October 31st is much the largest recorded at Kew since February 14th, 1892. The curves for the 30th showed some disturbance of an ordinary type after 8 p.m.; but the first distinct precursor of the storm was a sudden movement at about 6:3 a.m. on the 31st, most conspicuous in the declination and horizontal force traces. Larger movements followed at about 6:45 a.m., and the disturbance remained prominent until 7 p.m. or 8p.m., and continued very appreciable, especially in declination, until 4 a.m. next morning. During the storm there was an altogether exceptional number of large sudden movements, mostly of an oscillatory character. These were largest between 1:30 p.m. and 7 p.m., but more numerous between 10 a.m. and 1 p.m. The following were amongst the largest movements in declination: 70′ in 3 minutes at 2:5 p.m., 66′ in 3 minutes at 2:12 p.m., 80′ in 6 minutes at 3:45 p.m. Between 6:50 p.m. and 7:12 p.m. there was a movement of 77′ to the west and return movement of 82′ to the east. The extreme range of the declination needle during the storm was about 2¼deg. The value of the horizontal force at 1:26 p.m. exceeded that at 1:2 p.m. by 685γ ($1\gamma \equiv 1 \times 10^{-5}$ C.G.S.), a rise of 525γ having occurred in 6 minutes. Between 3:16 p.m. and 3:36 p.m. there was a rise of 500γ, and between 3:45 p.m. and 3:53 p.m. a fall of 450γ. There were also large rapid changes in vertical force. In the case of both the horizontal and vertical components the trace went repeatedly off the photographic sheet, so that the full extent of the disturbance was not determined; the difference between the extreme values certainly exceeded 870γ in horizontal force and 500γ in vertical force. A brief account of the storm was communicated to *Nature* and *The Electrician*.

The hourly means and diurnal inequalities of the declination and horizontal force for 1903 for the quiet days selected by the Astronomer

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Royal have been tabulated as usual, together with the monthly means of the inclination as derived from the absolute observations. Owing, however, to the disturbance of the vertical force produced by electric trams, it has been found impossible to tabulate the curves for this element satisfactorily. This has led to the omission of the tables of diurnal inequalities of vertical force and inclination published previous to 1902. A correction has been applied to the horizontal force curves for the diurnal variation of temperature, use being made of the records from a Richard thermograph as well as of the eye observations of a thermometer. The mean values at the noons preceding and succeeding the selected quiet days are also given, but these, of course, are not employed in calculating the daily means or inequalities. The following are the mean results for the entire year:—

From curves	Mean westerly declination	16° 40·5 W.
	Mean horizontal force ..	0·18488 C.G.S. unit.
From absolute observations, corrected	Mean inclination.....	67° 6·5 N.
	Mean vertical force.....	0·43784 C G.S. unit.

The absolute observations have been reduced to the mean value for the day by applying corrections based on the diurnal variation observed in previous years. Observations of absolute declination, horizontal intensity and inclination have been made weekly as a rule.

Between May 11th and 16th the superintendent and the chief assistant proceeded to Eskdale Muir, the intended site of the new magnetic observatory, and took a number of magnetic observations. The weather was, unfortunately, wet and stormy, and somewhat unfavourable to field work. The observations did not disclose any source of appreciable local disturbance, and the mean values obtained—viz.: Declination 19° 6·2W., inclination 69° 41·5N., horizontal force 0·16818 C.G.S.—seem consistent with the results obtained in that neighbourhood in Rücker and Thorpe's "Magnetic Survey of the British Isles," when allowance is made for the secular change.

Electrograph.—This instrument worked generally in a satisfactory manner during the year. The E.M.F. of the battery fell off considerably during the early part of February; accordingly, on February 10th-12th, the spare set of 20 chloride of silver cells were charged up and used in place of the more faulty set of 20, while the remaining 20 cells were cleaned and re-charged. Opportunity was taken of this interruption to entirely dismount, overhaul and clean all parts of the instrument. This was the only serious stoppage during the year. Determinations of scale value were made on February 13th, February 19th, July 13th and November 20th. A series of curves—usually 10 a month—have been selected as representative of the variations of potential on electrically "quiet" days, defined as days when irregular fluctuations of potential are fewer than usual. Owing presumably in large measure to the fewness of the selected days, the values deduced from the actual curve measurements show in some months a considerable non-cyclic element. This element has been eliminated from the diurnal inequality in the way customary in dealing with meteorological data. Owing to the pressure of other work, but few observations on the loss of positive and negative electrical charges have been made with the "dissipation apparatus" of Elster and Geitel's pattern.

Inspections.—In compliance with the request of the Meteorological Council, the following observatories and anemograph stations have been visited and inspected:—Stonyhurst, Armagh, Dublin, Kingstown, Valencia, Scilly Isles, and Falmouth, by Mr. Baker; Radcliffe Observatory (Oxford), Aberdeen, Deerness (Orkney), North Shields, Alnwick Castle, Glasgow, and Fort William, by Mr. Constable.

Atmospheric Electricity.—The comparisons of the potential, at the point where the jet from the water-dropper breaks up, and at a fixed station on the observatory lawn, referred to in previous reports, have been continued, and the observations have been taken every day when possible, excluding Sundays and wet days. The ratios of the "curve" and the "fixed station" readings have been computed for each observation, and these have thrown considerable light upon the action of the self-recording electrometer, especially with reference to the insulation problem.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, March 17.

Mr. R. W. PERKS, chairman of the Metropolitan-District Railway Co., detailed the history of that undertaking up to the period when Mr. Yerkes took in hand the electrical equipment of the Inner Circle in conjunction with a number of tube railways. His own opinion was, however, that the Inner Circle line had, for the purpose for which it was authorised, failed to accomplish its object, and that, owing to the expansion of London and the natural flow of traffic from east to west, it did not afford the public facilities which were anticipated. This view was strengthened by the effect of the construction of the Central London Railway upon the traffic of the District undertaking. In consequence, the District Company was now trying to reduce the number of trains on the Inner Circle, and to give increased facilities to the suburban lines with which their undertaking was connected. With regard to the electrical working of the Inner Circle, the District Company was now negotiating with the London and North-Western Railway Co. for the electrification of the line from Earl's Court to Willesden. At present, however, the London and North-Western Railway could not agree, and it would appear that the result would be that at Earl's Court steam engines would have to haul the London and North-Western trains to the Mansion House. That would be so inconvenient that he was sure it was an arrangement which would not last long. Witness then made reference to the deep level railway from Earl's Court to the Mansion House, which was authorised some years ago, and went on to deal with the financial transactions of the District Company in connection with the electrification of the lines. He said that in 1900 they secured a site at Lot's-road, Chelsea, for the purpose of their undertaking generally. Since then, however, the arbitration between the District and the Metropolitan Companies had taken place, and the result was well known. It had consequently been decided to erect a huge generating station at Lot's-road for supplying power to the District Company and a number of tube railways, and the station was well on the way towards completion. The cost of the whole work would be £1,500,000, and the capacity of the station 60,000kw.

Mr. GIBB: What will be the greatest distance to which you think you can transmit current?—16 or 17 miles.

Mr. PERKS continuing said that the company had the greatest possible security by their arrangements for a continuous supply of electrical energy. The greatest possible interchange of traffic would take place between the tube railways and the District Company's system. For instance, the Great Northern, Brompton and Piccadilly Railway Company's trains would come to the surface some 300 yds. to the west of West Kensington Station. When the new system was installed, it would be possible to get from Hammersmith to King's Cross in 30 minutes, Charing Cross to Euston in 10 minutes, Charing Cross to St. Pancras in 15 minutes, and from Charing Cross to Highgate and Hampstead Heath in 19 minutes. By means of the Baker Street and Waterloo Railway the Elephant and Castle would be 8 minutes from Charing Cross, and Baker-street 10 minutes from Charing Cross, and the whole distance from Hammersmith to Bow would occupy 39 minutes.

Mr. E. B. TURNER, vice-president of the National Cyclists' Union, deprecated the introduction of further tramways in London. Neither did he think that underground streets, if constructed, should be used for fast traffic, as the noise would be so considerable as to render it confusing to anyone to tell at what distance the on-coming vehicle was behind.

Friday, March 18.

Mr. PERKS, continuing his evidence, dealt with the question of the effect of the London County Council becoming a railway and transit authority for London and its suburbs. He considered such a course would be inexpedient, because the County Council would be a competitor with the railway companies. It would not properly discharge such duties, it had not the necessary experience; and as it would necessarily have to deal with outside areas, there was no means of harmonising the interests of the local authorities with those of the Council. In addition to this, it would raise the whole question of State-owned railways. He next dealt with the serious burdens imposed upon the suburban railway companies by the existing practice of Parliament in connection with the acquisition and holding of land, and then drew attention to the heavy and progressive burden of local taxation upon railway companies in the metropolis. With reference to the establishment of a tribunal to deal with all questions affecting London and suburban railway, street and other traffic, his company was in favour of such a tribunal, which, however, he thought should not be without supervision by Parliament, or the Board of Trade. In conclusion, he made the following suggestions with a view to the improvement of the suburban services of London:—(1) That a serious attempt should be made by the directors of the Metropolitan and District companies to amalgamate those two undertakings. (2) That either upon the amalgamated undertakings, or upon the separate undertakings, there should be a uniform rate imposed for all classes regardless of their occupation or the time at which they may travel, some special provision being made for such passengers who desire for an extra charge to travel in a separate car. (3) That railway companies should have power to run upon main thoroughfares cars propelled by electricity or other power, as feeders for their main lines along routes beneath or over which it is inexpedient to construct railways, and that power should be given to the railway companies to subscribe to tramcar undertakings. (4) That the present prohibition upon the railway companies acquiring and holding land should be removed, so that the railway companies may be encouraged to construct suburban lines by looking, to some extent, for their remuneration to the increment which will take place from the value of the lands by the construction of the railways. (5) That the railway companies should be exempt from local taxation along routes where new competition has been set up by the local authorities running at the public cost competitive tramcar or railway undertakings.

Mr. C. T. YERKES dealt first with the creation of a tribunal having charge wholly or partly of the building of railways, tramways, &c., and said there was no doubt in his mind that a tribunal of some sort should be formed. This present procedure by Parliamentary Committees was unsatisfactory, inasmuch as the members of the Committee were being asked too much of, there being serious questions to be considered of which in many cases they had insufficient knowledge. The tribunal in question, he thought, should consist of not more than five members. He suggested that a tribunal should be appointed and not elective, and a fair salary be paid to each member as would ensure the devotion of the whole of his time to the work before him. The appointment should be for a long term of years, but no member should serve after the age of 65 years. The duties of the tribunal should be to report upon the practicability of all schemes for railways which it was decided to promote in Parliament. With reference to the procedure, he thought the present manner of obtaining information for Parliamentary committees was entirely wrong. The intention was that witnesses should give information so that the Committee might have a full understanding on the subject; but the method resolved itself into an examination by most astute counsel, and frequently the witnesses were made to say what they did not mean; and, in fact, the whole subject was given very much the appearance of a trial in court. Therefore, if there was a tribunal whose business it was to get full information and give it to the Parliamentary Committees, all this would be saved and the proceedings would be much less expensive.

The Commission adjourned.

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THE ACCIDENT ON THE PARIS METROPOLITAN RAILWAY.

The Committee appointed by the Paris Municipal Council to inquire into the disaster on the Metropolitain Railway in August last, has prepared a voluminous report which, we believe, will be shortly accessible to the public. The report embodies the main conclusions and recommendations of a technical report made by a technical committee consisting of MM. Mascart, Hospitalier, Blondel and Picou, which is attached as an appendix. The document gives a history of the case and deals in lengthy detail with the construction, equipment, working arrangements, administration, &c., of the line. What concerns us most are, firstly, the official account of the accident, its causes and results, and secondly, the recommendations of the Commission and the Technical Committee directed towards the avoidance of such disasters in future. As these give more precise information as to the cause of the accident than has been available hitherto, and include much also that is applicable to electric railways generally and underground lines in particular, we need not apologise for summarising from the Commission's report what must be taken as the authoritative and reliable narrative. The accident occurred on the evening of August 10, 1903, on the northern section of line between the stations of Barbes and Menilmontant. The stations in the order passed on an eastward journey are Barbes, La Chapelle, Aubervilliers, Allemagne, Combat, Belleville, Couronnes, Menilmontant, Père Lachaise. The distances between stations are not great. The total length from Barbes to Père Lachaise is under 2¼ miles. Couronnes and Menilmontant are separated by about 513yds. From Barbes to near Combat the line is open; the remainder is in tunnel, including the stations. The line is a shallow subway, not a "tube," and both up and down tracks are in the one tunnel. Four-coach and eight-coach trains were in use,

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the four-coach trains having one motor car and three trailers; the eight-coach trains are simply two four-coach trains coupled tail to tail, so that there is a motor car at each end. The motor car has a cabin at the front end for the driver and the various apparatus, and carries two 100 H.P. motors on its axles. The two motor cars are connected by a set of cables running under the trailer coaches, and either controller deals with the current for all four motors, reversing being effected by electro-magnetic switches. We described the arrangement in *The Electrician* of April 24, 1903, and it is very similar to one used on the Liverpool-Southport Railway, and details of which will appear in our articles upon that line. The current is picked up from a third rail by four shoes on each motor car. The third rail was, at the time of the accident, continuous from end to end of the line, and fed by three sub-stations situated respectively at l'Etoile, Barbes and Père Lachaise. The feeders had circuit breakers on the sub-station switchboards only.

Eight-coach train No. 43, with motor car M. 202 leading on an east-bound trip, arrived at Barbes "without incident" about 6:53 p.m. The station inspector noticed smoke rising from the "off" side, and called the driver's attention to it. He and the "chef"—the responsible officer in charge of the train—got down to examine the car, and found some of the cables between the controller and one of the motors, and some of the casing of the shoe cables on fire. They ordered the passengers out of the train, used an "extincteur," and afterwards a fire-hose to put out the fire, the shoes being raised and blocked up with wood out of contact with the rail. The fire stopped, the train started, evidently to run to the eastern terminus and get in the shed for repair. It may or may not be only a coincidence that the train had been out of service for several trips during the day, on account of repeated blowing of the fuses on the brake compressor motors. The fire broke out again, and, stopping at Allemagne to get an "extincteur," the train then ran to Combat, where another "extincteur" and fire-hose were used. Here the wooden packing blocks put under the shoes fired, and the telephone in the station was used to get current cut off. After five minutes, the fire being out, current was ordered on, and again the flames burst out. Then an attempt to run with the rear motor car only having also failed, a message was sent to the following train to come on and help. This is in accordance with the rules then in force, and consequently the four-coach train No. 52 emptied out its passengers at Allemagne station, went on to Combat and started to push No. 43 home. The collecting shoes of M. 202 were not lifted, and very soon the burnt cables short-circuited to the frame, and again the woodwork blazed. The coupled trains ran on until, at the entrance to Menilmontant station, loud reports indicated severe shorts; the driver of train 43 whistled to stop, and the trains came to rest with M. 202 enveloped in flames. The four men in the driver's cabin of that car jumped out, two to each side, and messages were again sent for the current to be shut off. This occurred about 7:37, say, 45 minutes after the trouble began. What followed is well known. Neither the officials nor the passengers waiting in the station recognised the danger. No attempt was made to uncouple and save the sound coaches. The blazing car was at the commencement of the platform, hardly clear of the tunnel, and directly under a corridor crossing the station roof, containing the booking office and approaches to the platform staircases. This corridor as well as the upper part of the station was soon filled with dense smoke, and the station was left in darkness; the fire burnt through one of the two lighting circuits supplying the whole line, and the smoke hid the remaining lamps. The smoke spread through the tunnel to the Couronnes station in which was a train very full of passengers, having picked up many of those turned out of the preceding trains. The stationmaster was informed by telephone of the state of affairs, but these passengers in their turn refused to be convinced of the danger and did not attempt to leave the station until they saw the smoke pouring in from the tunnel. The exit was at the end of the platform from which the smoke came, and a large number of passengers crowded in the darkness to the blind end and were suffocated. Next morning 50 corpses were taken from that end, 25 from other parts of the station, seven from Menilmontant Station, and two from the tunnel.

Such is the broad outline of the story that is told with almost cold-blooded precision of detail in Chapter IX. of the report. Following the Commission's example, we will leave aside all questions of personal responsibility and conduct and glance over their recommendations for the prevention of similar accidents. The point upon which the greatest stress is laid by the Technical Committee is that it should be possible for the train staff to cut the current off the conductor rail at any point. That this may be done, they suggest that the rail should be cut up into a number of separately fed sections, such that not more than five or six trains can be on any one section, and that every train shall carry a "short-circuiting bar" which can be dropped across the conductor and running rail in case of need and so actuate the circuit-breakers controlling the section. This is otherwise described as "a metallic arrangement ('dispositif') with an insulated handle," and is apparently to be operated from the driver's cabin. The next most positive pronouncement is that the lighting of the stations and tunnels should be provided from a number of sources, some of them entirely independent, not only of the traction supply—as the lighting always has been—but even of the company's generating and sub-stations. The Technical Committee has naturally discussed the rolling stock at considerable length, and with the majority of its recommendations we find no fault. But there seems to be a notion running through this portion of the report that the non-inflammable car is at present hardly attainable—that short-circuits must be expected, and that when they do occur some risk of fire is unavoidable. So they cling tenaciously to their homœopathic cure (only with a maximum instead of a minimum dose) of the "short-circuit bar." We are not sure that it is quite safe or quite easy to provide in practical shape, and fully understand the exceeding reluctance of the Metropolitan Company to put such a tool into the hands of every train crew. A considerable measure of technical education, and education of judgment, too, will have to be applied to the train staff to guide its members to a discreet use of such an appliance.

The Committee has inverted the proper order of the measures required. We should draw the lesson, first, that the essential condition of safety is to design and equip the motor cars in such a way that ignition of combustible material is hardly possible. The story of the accident seems to show that motor car No 202 did put up with a long-continued bad treatment before it blazed up irremediably, and that, in fact, the feeding system used—though open to criticism—did not appreciably interfere with the removal of the fault until the motor car was a mass of flames and was destroying the lighting and, probably, the telephone circuits. We cannot understand why the fuses or circuit-breaker on the car did not operate, or, if the fault was in the shoe cable, why the shoes were not lashed up clear of the rail or the cable disconnected. By an exercise of common sense and ordinary skill the faulty train could certainly have been run into the shed without any approach to disaster. But with rubber-covered cables boxed in with wood, a shoe that cannot be readily lifted from the rail, and circuit-breakers or fuses set for too heavy a

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current, it is conceivable that a short-circuit may put a car into a blaze in a few seconds, and constructions carrying such risks must be avoided. Mr. TROTTER'S report on the Liverpool Overhead Railway accident went somewhat fully into these matters, and the lines of safe design are well indicated. The recommendations of the Technical Committee follow these lines; we are sure that cars constructed in accordance therewith would be very much safer than the Committee seems to think, and that the "sectioning" of the third rail and the provision of short-circuit bars take a secondary place. The various and manifold recommendations as to structural improvements, separate lighting, clear indication of exit directions, and removal of obstructions from the platforms, staircases and gangways of the stations, are all to the good but hardly essential. Nothing will ever make it safe to burn a train in a tube or tunnel, and on the much disputed question of ventilation there appears to be only a choice of evils.

Apart from the material there is an important lesson as to the *personnel*. The mere relation of what happened to train No. 43 suggests that neither the train men nor the station staff had been instructed how to deal with an electrical fire. The driver and chef struggled with a bad short-circuit for nearly an hour and showed no signs of panic or lack of courage. They soaked cables and shoe insulators with water, and tried again and again to go on with their own motors—until the car was ablaze they stuck to it. A very little knowledge would have prescribed a different course of action, and a very little judgment would then probably have shown them that they could not safely put pressure on to cables that had evidently broken down and fired badly before the first discovery. The report is well worth reading, and may give useful lessons on many other points than the salient ones here noted.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Subjective Effect in N-ray Observations.—O. Lummer points out a source of error in the observation of N-ray effects which may easily mislead the observer. It is the conflict between the rods and cones of the retina in viewing a faintly luminous object. According to Von Kries, the cones are the colour-seeing light apparatus, and the rods are the colour-blind "dark apparatus." The rods have the faculty of considerably increasing their sensitiveness in the dark. But they are absent on the fovea centralis, and are, therefore, inactive when the eye is fixed upon an object. On interposing a lead screen between the faintly luminous object and the N-rays, the observer would naturally fix his attention more sharply upon the object in order to observe the effect. The rods are thus placed out of action, and the object would naturally appear to lose in brightness. The author admits that this view leaves many of the effects described unexplained, and that any objective proof of the effects of N-rays would dispose of his argument.

[O. LUMMER, *Phys. Zeitschr.*, March 1, 1904.]

Transparency of Bodies for N-rays.—E. Bichat has examined a number of metals for their transparency to N-rays, and found that they show a well-marked selective absorption. Aluminium and silver are the only metals which transmit all the N-rays. On the other hand, palladium, nickel and iridium intercept them all. Copper, glass and zinc are opaque for all waves whose index of refraction in aluminium lies below 1·48. Pure lead is, strangely enough, transparent for some of the greater wave-lengths. But this transparency is masked, as a rule, by the opaque film of carbonate which clings to the commercial metal. Zinc oxide, on the other hand, is transparent, and the author can tell a piece of wood painted with white lead from another piece painted with zinc white by means of the N-rays. The selective absorption of N-rays offers a ready means of isolating definite homogeneous beams.

[E. BICHAT, *Comptes Rendus*, February 29, 1904.]

The Diastoloscope.—C. Charrié has invented a new optical instrument of remarkable power, which he calls the "diastoloscope." It is a kind of eye-piece, which is attached to a microscope in place of the ordinary eye-piece. Instead of lenses, it contains two cones on the same axis. The field of view shows a central blank space surrounded by a ring, in which the object under examination appears considerably magnified, though distorted. The distoftion does not interfere with the mapping out of hitherto undiscoverable detail. The author reproduces photographs of diatoms showing considerable dilatation and detail, and expects to realise magnifications of 6,000 diameters.

[C. CHARRIÉ, *Comptes Rendus*, February 29, 1904.]

Motion of Radium in the Electric Field.—J. Joly has discovered that a light disc, delicately suspended, and coated upon the one side with a few milligrammes of radium bromide of high activity, exhibits, when an electrified body is brought near it, motions very different from what would be observed in the case of an inactive substance. The electrified body, whether positive or negative in sign, repels the suspended body if brought up to it on the side coated with radium, but attracts it if presented on the naked side. Two explanations are possible. The effect may be ascribed to the presence of electrified particles or ions of both signs in the region between the radium and the fixed electrified body. Then if a plus charge is presented opposite the radium the positive particles are repelled against the vane, while the negative particles are withdrawn. The repulsion, since it hits the vane itself, will be the only effective force. The same thing, but with signs reversed, will take place if a minus charge is presented to the disc. Another explanation is that the presence of the charged body induces a charge of opposite sign upon the radium, and repels the charge of the like sign to the remote side of the disc. The first (attractive) charge rapidly dissipates owing to the ionising influence of the α-rays, and the second (repellent) charge alone remains to exert a mechanical effect upon the vane. The author decided between the two theories by having two vanes connected with a wire and suspended in a Coulomb balance. He then obtained an attraction instead of a repulsion. The repulsion was restored on breaking the metallic connection between the vanes. This shows that the second explanation is correct. For when the repelled charge can escape into the other vane, its repelling action disappears.

[J. JOLY, *Phil. Mag.*, March, 1904.]

Luminosity and Conductivity of Flames.—It has been known for some time that the introduction of chloroform into a flame coloured with the salts of lithium, potassium or other metallic salts considerably reduces the luminosity of those flames. Since no corresponding change in the conductivity has hitherto been observed, it is currently assumed that there is no connection between luminosity and conductivity, although Arrhenius suspected a connection between the luminosity of a gas in a vacuum tube under the influence of cathode rays and its conductivity. F. L. Tufts has now devised a more sensitive method of studying the conductivity of flames by means of electrodes consisting of platinum wires treated with calcium oxide. He obtained a close correspondence between luminosity and conductivity. Thus the introduction of chloroform into a lithium chloride flame reduced its luminosity of the red line to 64 per cent. of its original value, and reduced the current through the flame at the same time to 62 per cent. of its original value. The corresponding figures in the case of sodium chloride were 78 and 73. In the case of calcium chloride the current was reduced in a greater ratio than the luminosity, but this may be explained by the fact that there is a spectrum of calcium chloride independent of the spectrum of the calcium and its oxide.

[F. L. TUFTS, *Phys. Zeitschr.*, March 15, 1904.]

Action of Magnetic Fields on Phosphorescent Substances.—C. Gutton recently (*The Electrician*, this volume, pp. 696 and 740) reported an intensification of the luminosity of a phos-

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phorescent substance when placed in a non-uniform magnetic field. He has now discovered another and equally interesting effect—viz., an intensification of the luminosity when the substance is placed in a uniform field which varies in time. Whenever, in fact, an E.M.F. is produced in the phosphorescent substance owing to its being cut by moving lines of force, it shines out. The author describes three different experiments which show this effect. In one of them the phosphorescent calcium sulphide is placed in the centre of a coil 63cm. long and 13cm. in diameter, traversed by a current of 0·4 ampere. When the current is gradually reduced to a very small value by means of a rheostat, and while it is being so reduced, the screen shines more brightly. It does the same while the current is being gradually restored to its former value, but not while the current is kept at a constant value. When the screen is kept fixed and the coil is moved in any direction perpendicular to its axis, the luminosity also increases, but not when the coil is moved in a direction parallel to the axis, since there are then no lines of force cutting the sulphide. A uniform field due to a distant magnet may also be used. Thus the author rotated a magnet about its axis and observed a flickering of the screen some distance off. He also had a bar magnet moved about in an adjoining room, with the same result.

[C. GUTTON, *Comptes Rendus*, February 29, 1904.]

THE RAILWAY ELECTRIFICATION PROBLEM AND ITS PROBABLE COST.

The following is an abstract of the discussion that took place in connection with the Paper on this subject read by Mr. F. F. Bennett at the Institution of Electrical Engineers on March 10th. The Paper was published in an abridged form in our last issue:—

Mr. H. M. SAYERS, in a communication read by Mr. W. M. Mordey, said that Mr. Bennett's whole argument and train of calculations were based upon such an unsound foundation that it could be expected to carry no conviction whatever, and might even have the unfortunate effect of persuading some that electrical engineers did not understand the elements of the problem. Mr. Bennett's fundamental error was that of "averaging." He had taken the total railway traffic, receipts, train mileage and other relevant figures, and assumed that if he divided these out equally among a number of equal areas, then he might say that the cost of electrifying such an area, the working costs, the receipts and the profits might be properly taken as representing pro rata similar figures for every other area, and, therefore, for the whole country. This method had the effect of ignoring entirely some of the facts which formed the most difficult problems in the way of general railway electrification. The assumption was so far from the facts that to treat it as even an approximation suggested want of acquaintance with the problem. Take away the following nine of Mr. Bennett's 65 "areas":—Metropolitan, Bristol, South Wales Coalfields, Birmingham, Hull, Sheffield, Manchester, Liverpool, Leeds and Bradford, Newcastle-on-Tyne—and consider how much the output, load-factor and traffic receipts of the remaining 56 would be reduced. Further demonstration was hardly needed to prove that the "average" area of Mr. Bennett's was a purely imaginary entity. It followed by no means that the fat districts compensated for the lean. Working one station at a poor load-factor was not in the least compensated for by working another at a good one. One was simply better off without the lean district. The cost of distribution was even more hopelessly against the thin district for reasons that need not be gone into there. Mr. Bennett had not only averaged things geographically, but also in respect to time. The whole year's passenger figures were smoothed out over 18 hours of 365 days, and the average load, &c., so arrived at was taken as that to be provided for. For goods 24 hours per day was taken. It did not need to be a good railway expert to know that there were not only great differences in railway traffic as between one season and another, week-days and Sundays, but also as between hour and hour of each week-day. These traffic "peaks" were what determined the provision for generation and distribution of power, and, of course, the whole of the financial results, and this time-averaging, just as much as the area-averaging, had the effect of greatly reducing Mr. Bennett's figures for capital expenditure, improving his load-factor, and generally putting a rosy colour upon his estimate. A comparatively minor point, yet making for the same result, was his estimate of power needed for the mean train. A mean speed of 24 miles per hour was taken, and the figures of tractive effort put forward as the basis of the power calculation was merely that needed to keep a train of 200 tons weight in motion at 24 miles per hour on a straight level track. No allowance for acceleration, nothing for gradients, nothing for curves. The 5·3lb. per ton placidly assumed would be doubled on a rising gradient of 1 in 420, even on a straight line. A side-on gale would add as much more. Falling gradients were far from compensating for rising ones. It was difficult to suppose that Mr. Bennett has not seen the diagrams and Papers that have taken so large a space in the technical press of late months, demonstrating the large amount of energy called for by quick stopping and starting, but he made no sign of knowledge. On the other side the estimates were made out on the basis that 50 per cent. of the power generated would be lost in distribution, and that rotary converter sub-stations and continuous-current distribution would be used. The distribution efficiency—*i.e.*, from switchboard to car wheels—might not be much underestimated with the converter system suggested, but by means already in sight better results might safely be expected. No one could suppose that our general railway electrification was going to be based on rotary converter sub-stations. Something much simpler and more economical in both capital and working expenditure would be necessary, and there were hopeful signs that it will soon be available. He (Mr. Sayers) desired to make it clear that he believed general railway electrification would come, and be an economic and social success, but he thought it all the more unfortunate that a Paper on this subject should be based upon unsound premises that would give the impression that electrical engineers have not begun to appreciate the realities of the case.

Mr. J. W. JACOMB HOOD (London and South-Western Railway Co.) said he supposed that no one thought the great railway problem would be solved in this particular way, even assuming that the financial difficulties did not stand in the way, which, of course, they did. It was fair to enquire whether the power that Mr. Bennett proposed was anything like sufficient. This was really the most interesting point for such a grand question as this. Mr. Bennett appeared to have taken a wrong basis for his figures in assuming that the mechanical horse-power of the train on his 900-miles area would be a guide for such a scheme as the general electrification of the railway system of England, If electrification was justified at all, it would involve more trains and faster trains, and, consequently, a much larger horse-power than existed to-day. Then, again, the tractive effort formula which the author used, made no allowance for the numerous difficulties that were constantly ensuing, and to suggest to the world that a tractive effort of 5·3lb. per ton was sufficient was a mistake. This same formula had been used by Mr. Langdon, and some severe comments had been made concerning it. Mr. Langdon had suggested the use of 10,000kw. upon 50 miles of railway, and this was a better guide than the suggestion of 10,000kw. of plant for the running of 235 miles of railway made by Mr. Bennett. During last summer this question had been investigated by his company, Taking as example a service of trains which indicated the load of the London and South-Western Railway between London and Southampton on the day before Coronation day in August, 1902, by assuming an average fixed weight for passenger trains and a fixed weight for goods trains, and taking the speeds from the time table diagram, and also assuming the whole service to be run against a gradient of 1 in 750, the maximum mechanical work done was 875,000,000 foot-pounds a minute. This meant that a generating plant of 20,000kw. for that 80-mile section would be needed, and this bore out Mr. Langdon's estimate somewhat of 10,000kw. for 50 miles. In these circumstances, Mr. Langdon's estimate of £10,000 per mile would also be more accurate than Mr. Bennett's, which was under £7,000, and this increase would again raise Mr. Bennett's estimate for the cost per train-mile by 1½d. Another figure which would not hold water in the Paper was the cost of coal—viz., 7s. 11½d. per ton. He did not know what the experience of other companies was, but he was perfectly certain his company could not buy coal for that price. Personally, he did not think the average price could be put at less than 10s. per ton, and if this were so the cost per train-mile would have to be raised by another half-penny, and this would make the total cost per train-mile something like 11¾d. Again, the author compared the cost for electrical working per train-mile with the cost per train-mile deduced from the Board of Trade return for 1901. The average price per train-mile in this return was 12·105d., but the return for 1902 showed a considerable reduction in the cost of haulage per train-mile. Of the 11 great companies in the country which worked between them nearly two-thirds of the train-mileage of the country, the total cost for haulage, according to these more recent returns, only amounted to 11·54d. per train-mile on the average. Of these 11 companies only three were above the average, the rest being all slightly below the average, so that on Mr. Bennett's showing the advantage of electrification disappeared at once. Therefore, he ventured to think that Mr. Bennett had not made the best of his case. First of all, the electrical train-mileage must evidently be very much larger than the steam-mileage of to-day. Incidentally, he wished to point out the absurdity of using the train-mileage as a measure of the work done on railways. The latter part of Mr. Bennett's Paper dealt with the question of whether general electrification would secure an increase of profits to the companies, and the manner in which it was treated was an obvious one to anybody—viz., that with an increase of passengers at the same fares there would be an increase of profits. But there was another way of dealing with this question—viz., from the point of view of the rides per head of population. The rides per head of population in New York city during 1902 amounted to over 400, whereas in Greater London they were only 120 and in Great Britain only 40. He was sorry to see Mr. Bennett give up the electrical question for a moment at the end of the Paper in order to have a dig at the railway companies in a manner quite unworthy of him. Arguments such as those in the latter part of the Paper with regard to comparison of freight rates could hardly do for an Institution such as theirs. The comparative figures at the end of the Paper were explained away by themselves, because it was comparing like with unlike—viz., water carriage with railway carriage. It had been stated over and over again that, if the conditions were equal, the rates would be equal, but the conditions were not equal in the instances mentioned by Mr. Bennett. For instance, the carriage of foreign pianos was a part of a hipload, whereas the railway rates were for a single piano. If the English piano maker would only ship his pianos to London in train loads the thing was done.

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Mr. G. J. MORRISON said he only wished to deal with one point, which might be called a detail, but he ventured to think it was the whole crux of the case—viz., the possible speeds on electric railways. In working out his scheme, Mr. Bennett had made it quite clear that, in order to carry the traffic proposed, the speed must be increased by about 70 per cent. But he thought he would be borne out by a good many when he said that we had very nearly, if not quite, reached the maximum speed which it would be possible to attain on English railways. He knew very well what had been done in Germany, on a permanent way no better—and probably worse—than what existed here; but that particular line upon which 200km. per hour had been reached had no over-bridges, no curves of a less radius than 2,000 metres and also no junctions. We had none of these conditions on English railways. On ordinary local lines in this country, which often formed part of the main line, the curves were very often severe, and the shock from rounding these at high speed was very great. But even if the shock could be got over, there was the super-elevation of the rails, which would have to be increased for the quick trains, which would not be applicable to the slower trains. Again, with the over-bridges that now existed, to super-elevate the rails sufficiently for the quick trains would bring the sides of the trains against the bridges. This was a serious matter, although in tunnels it would not be quite so bad, as the speed was slower; but if all the bridges had to be rebuilt the expense would be very considerable. Then there were the junctions, and if there was a junction one line at least must be curved, and in many cases two. But on a junction it was not possible to put any super-elevation at all, because the rails would not cross each other unless they were all on one plane. Therefore, at the junctions all trains must slow down, and if this had to be done at every junction it would be impossible to get up any higher speeds than those which at present obtained. Consequently, no system of working even the minor traffic of this country electrically which involved a material increase of speed in the quicker trains was really worth serious consideration, unless the problem of so altering the lines as to make them carry the quick trains was also fully dealt with. Possibly it would be found cheaper to make entirely independent lines for the fast traffic than to try to alter the existing lines, and this was a question which would have to be gone into before the possible number of passengers which would be carried through running the trains at a higher speed was considered.

No other members desiring to speak, and Mr. Bennett not being present to reply to the discussion, the debate was then closed.

DIRECT-READING MEASURING INSTRUMENTS FOR SWITCHBOARD USE.*

BY KENELM EDGCUMBE AND FRANKLIN PUNGA.

GENERAL CONSIDERATIONS.

Accuracy.—The great difficulty which is met with in the design of electrical measuring instruments is the smallness of the forces dealt with. It is clear that the greater the force for a given weight, the smaller will be the frictional error; but unfortunately, any attempt to increase the force beyond a certain point is almost invariably accompanied by increased electrical errors, quite apart from the question of excessive power consumption. Amongst mechanical errors, besides friction, must be included set and variation in strength of the springs, want of balance in spring-controlled instruments, and also, of course, any deformations which may have taken place owing, for example, to rough handling. The electrical errors include those due to hysteresis, eddy currents, frequency, wave form, changes of temperature, weakening of magnets, disturbing magnetic fields and so forth. Unless great care is taken in marking the scales large calibration errors may creep in, quite apart from the question of the accuracy of the standards used, and in this respect the card or paper scale is, as a rule, much to be preferred to the engraved or painted dial.

Errors of reading can hardly be looked upon as belonging to the instrument, as they depend greatly on the skill of the observer; but at the same time, some forms of pointer and scale are much more easy to read than others. This is a matter of considerable importance, which does not always receive the attention it deserves. A pointer which is well adapted for reading at a distance is usually ill-suited to accurate work, and vice versa. Accuracy of reading is obtained in the case of central-station instruments by making the scales long and the pointers bold, so that they can be readily seen at a distance; while for testing work a mirror is usually provided under the pointer, which latter should be flattened out so as to present a thin edge to the observer. For this kind of work a scale more than 6in. in length will be seldom found advantageous, as the increased weight of the moving parts introduces errors which more than counterbalance the increased accuracy of observation.

While the electrical errors, with the exception of those due to external magnetic fields, can be very fairly expressed as a percentage of the reading, the mechanical errors are more accurately given as a constant deflection of the pointer; thus the accuracy of an instrument should strictly be expressed in some such form as $+x\% \pm y°$. As a compromise, makers often specify the accuracy as so much per cent. of the maximum reading, as distinguished from a percentage of the actual reading. A better system, and one which is now adopted by at least one firm of consulting engineers in their specifications, is to demand a certain accuracy throughout, expressed as a percentage of the maximum reading, and a greater accuracy from, say, two-thirds of full load upwards.

As regards the actual value of the various errors, it is, of course, extremely difficult to lay down even approximately what is to be expected. W. Marek (*Elecktrotechnische Zeitschrift*, 1902, p. 447), from a number of very careful experiments, gives the following values for direct-reading laboratory instruments of the very highest class provided with mirrors under the pointer:—

Errors of reading, ± 0·07mm. (± 0·0028″).
Frictional errors less than 0·1mm. (0·004″).
Calibration errors, 0·05mm. to 0·1mm. (0·002″ to 0·004″).
Total mechanical error, say, 0·1mm. to 0·2mm (0·004″ to 0·008″).

The actual length of scale is not stated, but may be assumed to have been about 5in. On this assumption the total mechanical error would correspond to an angle of 0·07 to 0·15deg. It is probable that for switchboard instruments these figures might be increased five times, and still be well within the mark.

It is even more difficult to assign values to the various electrical errors, but the following table may serve as a guide These errors are to a large extent independent of the size of instrument, though as a rule one of medium size, suitable for, say, a 3in. to 4in. pointer, is more accurate than one having a larger dial.

Table I.—*Electrical Errors of Various Types of Instrument.*

Type.	*Hysteresis.* Difference between up and down curves.	*Temperature.* Error due to 10°C. change.*	*Frequency* Difference of reading from 40 ~ to 60 ~.	*Stray fields.*† Error due to bar with 1,000 amps. at 1m. from instrument.
Direct Current.	Per cent. of max. reading.	Per cent. of max. reading.	Per cent. of max. reading.	Per cent of max. reading.
Moving-coil voltmeter	Nil	0·01	..	0·2 In cast-iron case
,, ,, ammeter	,,	0·75	..	0·2
Moving-iron voltmeter	1	0·5	..	1 unshielded
,, ,, ammeter	1	Nil	..	0·25 shielded
Hot-wire voltmeter ..	Nil	0·75 For short periods	..	Nil
,, ammeter ..	,,	1·5	..	,,
Alternating Current.				
Moving-iron voltmeter	..	0·5	1·0	1 unshielded
,, ,, ammeter	..	Nil	0·5	0·25 shielded
Hot-wire voltmeter ..	..	0·75 For short periods	Nil	Nil
,, ammeter ..	..	1·5	,,	,,
Induction voltmeter..	..	0·5	4	0·5
,, ammeter..	..	1·0	15	0·5

Power Consumption.—The following table gives approximately the power taken by various types of modern ammeters and voltmeters at the maximum readings:—

Table II.—*Power Consumption.*

Type of instrument.	Current taken by voltmeters.	Voltage-drop on ammeters.	Watts.
Moving-iron voltmeter, 10 volts..	0·2 amp.	..	2
,, ,, 100 ,, ..	0·06 ,,	..	6
,, ,, 200 ,, ..	0·05 ,,	..	10
,, ,, 500 ,, ..	0·04 ,,	..	20
,, ammeter, 10 amperes	..	0·3 volt	3
,, ,, 100 ,,	..	0·03 ,,	3
,, ,, 500 ,,	..	0·007 to 0·01v.	3·5 to 5
Moving-coil voltmeter, 0 to 200v. .	0·01‡ amp.	..	2
,, ,, 100 to 200v.	0·02‡ ,,	..	4
,, ammeter, 500 amp...	..	0·08‡ volt	40
Hot-wire voltmeter, 200 volts	0·17‡ amp.	..	34
,, ammeter, 500 amperes .	..	0·2‡ volt	100
Induction type voltmeter.....	§	§	5 to 8
,, ammeter.....	§	§	5 to 8
Dynamometer type—			
Voltmeter, 200 volts	0·05 amp.	..	10
Ammeter, 100 amperes..	..	0·5 volt	50

* Abstract of a Paper read before the Institution of Electrical Engineers last night.

* In many cases the passage of the current itself will cause a much greater rise of temperature than 10°C., and hence a correspondingly increased temperature error. This is particularly the case with moving-iron voltmeters.

† In the case of alternating currents the stray field is assumed to have the same periodicity as the current or voltage which is being measured.

‡ The same coil winding is, as a rule, employed for all ranges, so that these values are independent of the actual range.

§ Transformers usually employed.

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CHIEF TYPES OF SWITCHBOARD MEASURING INSTRUMENT.

Permanent-Magnet Moving-Coil Ammeters and Voltmeters.

This type consists, as usually constructed, of a small coil so pivoted in a strong uniform magnetic field, and as the torque due to the controlling springs is practically proportional to the angle turned through, it follows that this angle is itself proportional to the current. As a result, an evenly divided scale is obtained throughout the whole range. If the spring is "set up," so that when the pointer is at the beginning of the scale a torque is already exerted by the spring, the pointer will not begin to move until a certain predetermined current is flowing through the coil. An open scale is thus produced at the upper part of the range. This arrangement is only applicable to instruments in which the electrical errors are small, as it in reality merely enables more accurate *readings* to be taken, and cannot increase the electrical accuracy of the instrument itself.

The permanent-magnet moving-coil voltmeter is probably as perfect an instrument from an electrical point of view as could well be desired. In the first place, the permanent-magnet field is strong (the induction in the air-gap is usually about 700 lines per square centimetre), and consequently a very small number of ampere-turns is required on the moving coil. This means that the power consumption is small (as is shown by Table II.), and that, further, the moving parts can be made very light. The resistance of the moving coil is only 10 or 20 ohms, so that the copper can be entirely swamped by a series resistance having a negligibly small temperature coefficient. The actual temperature coefficient of a 100-volt moving-coil voltmeter is less than $\frac{1}{100}$th per cent. per degree Centigrade.

The chief source of error to be guarded against in a moving-coil voltmeter is the variation with time of the springs and magnet. Non-magnetic springs can now be obtained, which, if properly fixed, introduce practically no error. The steel used for magnets, as also the methods of hardening and "ageing," have been so far perfected that, with proper treatment, little or no trouble is experienced from this cause. As regards general design, it is important, in order to secure permanence, that the length of the magnet compared with its area be as great as possible, and also that the air-gap be kept as small as possible in length and as large as possible in area.

Owing to the fact that only a very small current can be taken through the moving-coil system, it follows that for ammeters intended for currents exceeding, say, $\frac{1}{2}$ ampere, shunts must be employed. In order to keep down their dimensions, if for no other reason, it is necessary to so proportion these shunts that the P.D. at their terminals is small (usually less than $\frac{1}{10}$ volt at full load, see Table II.). Consequently, the resistance of the instrument must be low (say from 1 to 5 ohms), and it follows that the proportion borne by the copper winding to the total resistance is always large (usually from one-half to one-fifth), so that the temperature coefficient of the whole is by no means negligible, errors of from 0·05 to 0·2 per cent. per degree Centigrade being commonly found. Were the shunts constructed of a metal having the same temperature coefficient as the instrument itself the error would disappear, supposing it possible to ensure that neither the shunt nor the coil were heated by the current flowing through them, or, at any rate, that they both became equally warm. Unfortunately, neither of these conditions can be fulfilled in practice, so that all that can be done is to construct the shunt of a material whose resistance is practically unaffected by temperature, and to put as great a length as possible of a wire of a similar material in series with the copper of the moving coil.

Supposing the magnet employed to be as strong as is consistent with permanence, and the controlling force to have been decided upon from a consideration of the frictional resistance to be overcome, it is clear that a definite number of ampere-turns will be required in the moving coil. This varies in practice from $\frac{1}{2}$ to 1 ampere-turn. Such being the case, it can be shown that for any given size of coil the necessary P.D. at its terminals will be inversely proportional to the sectional area of the wire used.

A limit is, however, soon reached, firstly, owing to the fact that a decreased resistance means an increased current and with it the chance of contact resistance troubles, and, secondly, owing to the resistance of the leading-in springs or strips. These latter will have a temperature coefficient ranging from 0·1 to 0·4 per cent. per degree Centigrade and a resistance of 0·1 to 0·5 ohm. It can be shown that the best results will be obtained when the resistances of the coil and springs are to one another in the inverse ratio of their temperature coefficients

Several methods have been suggested for getting over the temperature error. One of the most ingenious is that due to Mr. Albert Campbell and shown diagrammatically in Fig. 1, where *e* represents the moving coil, while the points *f* and *g* are connected to the shunt. The arms *a* and *d* are composed of copper, *b* and *c* of a material having a negligible temperature coefficient. If the resistance of *a*, *d* and *e* be 3 ohms each, while *b* and *c* have a resistance of 1 ohm each, practically perfect compensation will be attained. A resistance having as large a negative coefficient as may be required can be constructed as shown in Fig. 2. It consists of a thermometer tube, inside which is stretched a thin platinum wire. Any increase of temperature causes the mercury to expand, and hence to short-circuit more or less of the wire according to the dimensions of the apparatus.

Unless carefully shielded, moving-coil instruments are, contrary to the usual assumption, very considerably affected by stray magnetic fields. Campbell has found* that even the earth's field may produce a change of flux of as much as 0·1 per cent. in an unshielded permanent magnet with a moderate air-gap. It must be borne in mind that, although the permanent magnetic field is in itself fairly strong, the presence of the iron very materially concentrates any disturbing field, so that its effect is greatly increased. The ordinary cast-iron case appears to be quite an efficient shield for switchboard instruments. When using portable moving-coil instruments (which are usually fitted in wooden cases) great care should be taken to keep them well away from dynamos and motors, and, which is equally important, from one another also. Two such instruments standing side by side may frequently read 5 or 10 per cent. wrong from this cause. The effect of stray fields can be allowed for in the case of portable instruments by taking a second reading after having turned the instrument round through 180deg. The mean of the two readings will give the correct result. Another source of error in the case of moving-coil ammeters is thermo-currents due to unequal heating of the two terminals of the shunt. The thermo-E.M.F. between copper and several of the alloys used for the construction of shunts is quite appreciable; for example, copper and constantan (which is used very extensively on the Continent) have

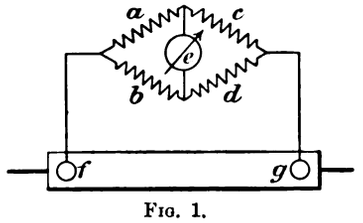

Fig. 1.

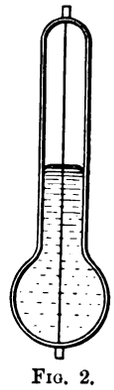

Fig. 2.

a thermo-E.M.F. of 37 micro-volts per degree Centigrade. It frequently happens that one terminal of a shunt is connected to a large mass of metal, which serves to conduct away the heat more rapidly than is the case with the other terminal, and unless attention is paid to this point, errors of as much as 2 per cent. of the full scale reading may often be traced to this cause.

Moving-Iron Instruments.

These may be roughly divided into three classes according as the fixed coil acts on: (1) a single moving iron mass, (2) a fixed mass of iron attracting or repelling a moving mass, or (3) a combination of attracting and repelling irons. Of these the second class is by far the most used.

Almost all the errors to which moving-iron instruments are liable, apart from those of a purely mechanical origin which they have in common with all other instruments, and which have been already alluded to, are traceable to hysteresis in the iron. This has, firstly, the effect of causing the readings taken with a rising current to be lower than those obtained with a falling current, and further, owing to hysteresis, an instrument calibrated with direct current will read low on an alternating circuit. In order to reduce hysteresis to a minimum, it is essential that the magnetic lines should lie in the iron for only a small portion of their total length, and, further, that the iron should be as short as possible, so that the demagnetising effects of the ends may have the maximum effect. It is clear that if the iron is saturated the effect of hysteresis will be small; and, on the other hand, if the flux density is kept very low, the same end will be attained. In order to obtain the minimum hysteresis error, then, the mass of iron should either be very small or very large. The former alternative means reduced power and the latter increased weight.

There is a further disadvantage in the high-density arrangement when the instruments are to be used for alternating currents, in that, if the iron is saturated, the force at each instant will be approximately proportional to the instantaneous value of the current, so that the instrument will indicate the *average* value instead of the R.M.S. (effective) value. Now, the ratio of the average to the effective value depends very much on the wave-form, so that such an instrument if calibrated with a sine-wave current, for example, will give altogether incorrect readings with a peaky or

* "The Magnetic Fluxes in Meters, &c.," *Phil. Mag.*, 55, Vol. XLVII., No. 8 (1899.)

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flat-topped wave. In those instruments, on the other hand, which employ a low induction, the force is roughly proportional to the square of the current, and therefore the instrument shows very approximately the effective value irrespective of wave-form.

It is often assumed that an instrument whose indications are practically independent of frequency will also be independent of wave-form, and vice versa. While this is true for all errors which depend purely on self-induction, it is far from being true when the error arises from the iron itself. Every instrument whose indications are not dependent on the square of the current must of necessity give inaccurate readings with any other wave-form than that with which they are calibrated, although with a given wave-form its indications may be entirely independent of frequency. In a well-designed instrument the error from this cause should not amount to more than, say, 1 per cent., and in an instrument working at a low density to considerably less. Figs. 3 and 4 show the readings are recorded in Fig. 5 is practically unaffected by changes of frequency or wave-form, while that in Fig. 6 is considerably affected by both.

A great drawback to the use of moving-iron instruments for many purposes is to be found in the fact that the lower portion of the scale is always very cramped. This is due to the fact that the scale in reality roughly follows a square law, and is only artificially made approximately even. The scale of moving-iron ammeters are seldom marked below one-tenth of full load, and the scale is only approximately even from one-fifth of full load upwards. In the case of voltmeters, a decided advantage can be secured in that the scale may be enormously opened out at the upper or working portion of the range, while at the same time the zero is still visible, which is often useful.

Magnetic Shielding.—For switchboard work the question of how far the instruments employed are likely to be affected by stray

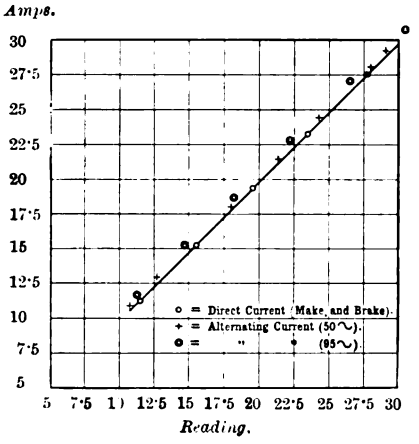

Fig. 3.

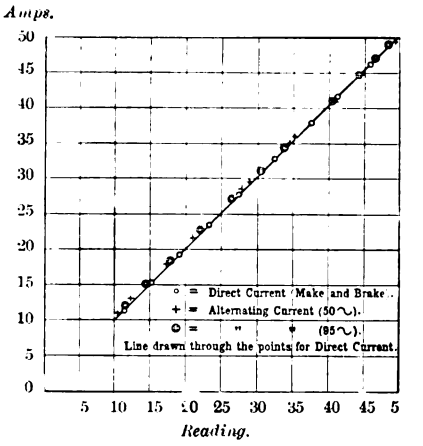

Fig. 4.

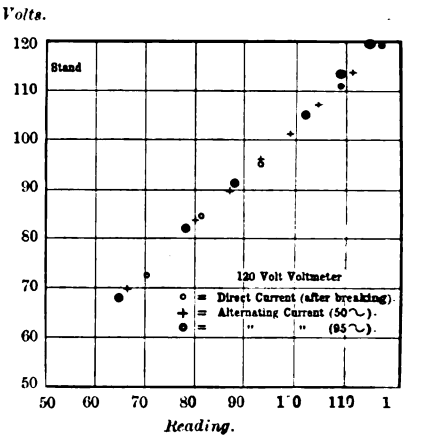

Fig. 5.

of frequency on two distinct types of ammeters. Readings were in each case taken with direct current, and with alternating current at 50 ∿ and at 95 ∿. Fig. 4 refers to a 30-ampere ammeter of a well-known make having fixed and moving irons. Fig. 5 gives the results obtained with a 50-ampere Everett-Edgcumbe Universal ammeter. This latter instrument is based upon a principle due originally to Uppenborn, and first put upon the market by Messrs. Siemens and Halske of Berlin. It is practically a modification of the well-known Miller type; the shape of the iron used, however, is different. It consists of a number (usually three) of soft iron discs of a special shape, which are mounted eccentrically on the spindle of the instrument and are drawn by the current into the flat coil. The section of the iron

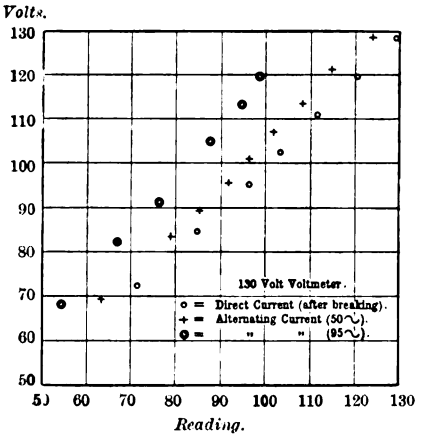

Fig. 6.

and the ampere-turns of the winding are so chosen that only a very low flux density is employed, with the result that the hysteresis error is reduced to a minimum, as are also the errors due to wave-form. A further advantage of this construction in the case of voltmeters is that the cross sectional area of the coil is so small that the self-induction is quite negligible for all ranges over, say, 80 volts. This is well seen in Fig. 5, which shows the difference of reading between direct current and alternating current at 50 ∿ and alternating current at 90 ∿ in the case of a 120-volt voltmeter. Fig. 6, on the other hand, shows the corresponding results obtained with a 130-volt voltmeter of another very well-known make. It need hardly be said that the instrument whose magnetic fields becomes a most important one, particularly where moving-iron instruments are employed. The effect is somewhat difficult to predetermine owing to the complicated nature of the resulting fields, but, other things being equal, an instrument which in itself utilises the strongest field will be the least affected.

In Fig. 7 curves are given showing approximately the effect on three types of moving-iron instrument of a 'bus bar carrying 1,000 amperes and placed at a distance of 1 metre from the instrument coil and in such a position that its effect on the reading is a maximum. The numbers along the bottom (abscissæ) show the reading as a percentage of the full load (assumed to be 100 in each case), while the ordinates represent the error, as a percentage of the full-load reading of the instrument.

Curve A shows the effect on a 30-ampere moving-iron ammeter of a well-known make in a brass case (ampere turns 450). The

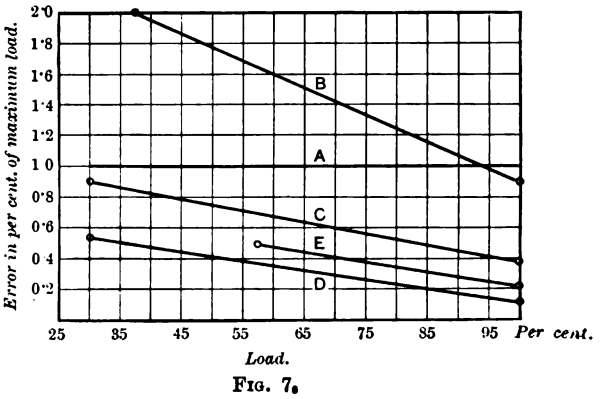

Fig. 7.

movement consists of a fixed mass of iron repelling a moving mass. It will be noticed that the percentage error is practically constant; the effect, in fact, at zero was as great as at the end of the scale. Curve B was taken with an Everett-Edgcumbe 10-ampere Universal ammeter with cast-iron case removed (ampere turns 400). It will be seen that the error falls off very rapidly as the load increases. Curve C refers to the same instrument after replacing it in its cast-iron cover, while curve D shows the effect of the addition of an iron back to the instrument case. Curve E shows the error produced in a Siemens and Halske 130-volt voltmeter of a type which has already been described, and which is constructed on much the same principle as the instrument just mentioned. It

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is fitted in a brass case, and is shielded by the coil being placed on a sheet of soft iron and enclosed on the three remaining outer edges by a strip of soft iron bent round it so as to form, as it were, an open-ended case.

In this connection a word or two may not be out of place as to the effect of shields on the accuracy of the instruments to which they are applied. Attempts were at one time made to fit the ordinary moving-iron instruments into cast-iron cases, with the result that, as was to be expected, the hysteresis error was very much increased. It is clear that if the ordinary bobbin be placed in a cast-iron case practically the entire path of the lines of force, after leaving the coil, will lie in cast iron, with the result just mentioned In an instrument, however, of the Siemens and Halske or the Everett-Edgcumbe type, a cast-iron case can be employed with impunity, owing to the fact that only a very small part of the return path of the lines lies on the iron of the case.

The curves in Fig. 7 were actually taken with a coil of large diameter, through which currents of various strengths could be passed. Its dimensions were so calculated as to be equivalent to a 'bus bar of infinite length placed at a given distance from the instrument, and the value of the constant was afterwards checked and found to agree with the calculated value, within the limits of accuracy attainable in the readings. In practice, the fact that the 'bus bars are not of infinite length causes the errors to be slightly less than those given, but the difference is extremely small, and is on the right side. If the actual length of a 'bus bar is four times its distance from the instrument, the disturbing effect will be 3 per cent. less than if infinitely long.

The curves were taken, as has been already stated, with the coil in its most effective position. The effect in any other position was found to be, as would be expected, proportional to the cosine of the angle between the two positions. The effect is further directly proportional to the current flowing, and inversely proportional to the distance between the instrument and the 'bus bar. The values have been reduced to 1,000 amperes at a distance of 1 metre.

In the case of instruments in which the axis of the coil is horizontal, and perpendicular to the 'bus bar, the worst possible position for the 'bus bar is above or below the coil, while when the axis of the coil is vertical the worst position is directly behind the instrument.* In order to reduce the effect of stray fields to a minimum, the + and − 'bus bars should be kept as near together as possible, and the conductors carrying current to the instrument should, particularly in the case of heavy currents, be brought near together.

Damping.—It is an extremely difficult matter to devise an efficient damping arrangement for a moving-iron instrument, owing chiefly to the relatively large mass of the moving parts. Devices depending on the viscosity of liquids are the easiest to apply and have, therefore, been most largely employed in the past. It is essential that the surface exposed to the liquid (usually oil) should remain continually immersed, otherwise a certain quantity will adhere to that part which is drawn out of the liquid, and "creeping" in the reading will inevitably result. Probably the oldest and most successful application of oil damping is that which Lord Kelvin uses in his multicellular electrostatic voltmeters. The axis of rotation being vertical, the entire surface remains continually immersed, and if the wire attaching the damping disc to the instrument is in line with the axis of rotation, creeping is practically avoided. An ingenious attempt to overcome the objection to the open oil vessel was made in 1890 by Mr. Frank Holden, of the Thomson-Houston Company, who placed a small quantity of glycerine is an hermetically closed drum carried by the spindle of the instrument. Owing to the fact, however, that as the drum revolved an entirely new surface was being continually presented to the oil, considerable creeping resulted, and the device has, we believe, been now practically abandoned.

At first sight, a method depending on eddy currents, would appear to be the most promising, but, as a matter of fact, several difficulties present themselves. The presence of a permanent magnet close to the coil of a moving-iron instrument intended for direct current has a considerable effect on the readings, and although the instrument is, of course, graduated with the magnet in position, at the same time the small magnets with comparatively large air-gaps which have to be employed have a great tendency to lose their strength, so that the effect on the readings is a variable one. With alternating currents also the field due to the instrument coil tends to demagnetise the permanent magnet, unless the latter is shielded. The method is also clearly inapplicable to moving-iron instruments which are intended to be used for both direct and alternating current. For hot-wire and electrostatic instruments the device has, however, been employed with success.

Air damping, although doubtless used before any other system for galvanometer and other laboratory instruments, has only within the last few years been employed for commercial ammeters and voltmeters. Messrs. Evershed and Vignoles were probably the first to apply it to such a purpose. Their arrangement consists of a sector-shaped box fitted above the coil of the instrument, and in which moves a light vane attached to the spindle. The clearance is reduced to a minimum, and hence considerable damping is obtained. This device has since been adopted in a more or less modified form by several Continental manufacturers.

Fig. 8 shows a form of damping arrangement introduced by Messrs. Siemens and Halske some three years ago. It consists, as will be seen, of a curved cylinder in which works an aluminium piston, without, however, touching the walls of the cylinder. This device has recently been adopted by Messrs. Everett, Edgcumbe & Co. for use in their commercial ammeters and voltmeters. When it is said that the clearance all round does not exceed 0·015in., it will be seen that the mechanical difficulties of manufacture are great; but as regards durability and reliability, it is found from experience as a matter of fact that blows severe enough to bend the pointer have no effect whatever on the damping arrangement. The cylinder, in fact, by checking the motion of the piston performs much the same function as does the pointer catch, which is often fitted to portable instruments. The piston, moreover, in travelling to and fro, keeps the cylinder clear of dust, while the reverse is the case with magnetic damping, as small particles of iron have a great tendency to accumulate in the air gap. It will be noticed that this method, as also the magnetic, is equally applicable to portable instruments, as it works equally in any position.

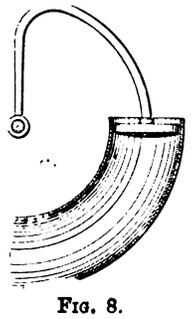

Fig. 8.

(*To be concluded*).

* In the latest form of Universal instruments it may be mentioned that the axis of the coil is parallel to a horizontal 'bus bar, so that the disturbing effect is nil.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Refuse Disposal and Power Production." By W. F. Goodrich. (London: Archibald Constable & Co.) 16s.

"Modern Electric Practice." By Magnus Maclean. (London: The Gresham Publishing Co.) 9s.

"Alternating Currents: Their Generation, Distribution and Utilisation." By G. T. Hanchett. (London: Chapman and Hall.) 4s. 6d. net.

"X-Rays Simply Explained." By R. P. Howgrave-Graham. (London: Percival Marshall & Co.) 6d.

"Transactions of the American Institute of Electrical Engineers," December, 1903. Vol. XX., No. 10. (New York: The Institute.) 50c.

"Proceedings of the Royal Society of Edinburgh." Vol. XXV., No. 1. (London: Williams and Norgate). 7s.

"Logarithms for Beginners." By Charles N. Pickworth. (London: Whittaker & Co.) 1s.

"Specification for Architects, Surveyors and Engineers." No. 7. 1904. (London: "Builders' Journal and Architectural Record.") 2s. 6d.

"Oil Engines: Their Selection, Erection and Correction." By W. A. Tookey. 1s

"L'Électricité en Agriculture: Lecture before the Société Centrale d'Agriculture de Belgique." By Emile Guarini. (Paris: "L'Eclairage Électrique.") 1fr. 25c.

"Wechselstromtechnik." By M. T. Zsakula. Vol. I. Der einphasige Wechselstrom. Vol. II. Mehrphasige Wechselströme und Wechselstrom-Systeme. Vol. III. Wechselstrom-Generatoren. Vol. IV. Wechselstrom-Transformatoren und Wechselstrom-Motoren. (Wien and Leipzig: A. Hartleben.) Each volume 5m.

"Die elektrische Bühnen- und Effekt-Beleuchtung." By Dr. Th. Weil. (Wien and Leipzig: A. Hartleben.) 5m.

"Dynamomaschinen für Gleich- und Wechselstrom." By Gisbert Kapp. (Berlin: Julius Springer.) 12m.

"Die Metalle, Geschichte, Vorkommen und Gewinnung nebst Ausführlicher Produktions- und Preis-Statistik." By Dr. Bernhard Neumann. (Halle-a-S.: Wilhelm Knapp). 16m.

"Krieg und Seekabel." By Dr. Franz Scholz. (Berlin: Franz Vahlen.) 4m.

"Lehrbuch der Physik." By O. D. Chwolson. Vol. II. (Brunswick: Friedrich Vieweg & Son). 20m.

"La Télégraphie sans fils." By André Broca. 2nd edition. (Paris: Ganthier-Villars.) 1904. 4f.

"Proceedings of the Royal Society." Vol. LXXIII. No. 491. (London: Harrison & Son.) 1s.

"Fortchritte der Elektrotechnik" 1903. No. 2. Edited by Dr. Karl Strecker. (Berlin: Julius Springer). 8m.

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CORRESPONDENCE.

THE OUTPUT AND DESIGN COEFFICIENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the formulæ proposed for the output in terms of the dimensions of the machine, no notice had been taken of what may be called the "radiating length" of the armature except by Mr. Hobart. It is purposed in the following to develop a formula that shall take into account, not only this radiating length, and with reference to the effectiveness of the materials used, but it is hoped will furnish a satisfactory basis for comparing one design with another.

The output equation in its more general form can be written: Rated output $= sD^xL^y$ revs., where s may be designated as the design coefficient (its signification will be given later) and x and y are unknowns as to form and specific value.

Let η = per cent. efficiency of the given apparatus, W = rated output, and τ = final temperature rise. It will then be premised that the machine always attains its final temperature rise τ. The watts wasted by the machine as a whole can then be represented by: Total loss $= W(100 - \eta)/100$; introducing a factor $100f$, where f is taken in hundredths, the loss of the armature with reference to the entire output can be taken as $f(100 - \eta)$, and the watts that must be radiated by the revolving barrel-surface of the armature are: Armature watts $= Wf(100 - \eta)$.

From experimental data—which, by the way, include tests on such high-speed machines as direct-current turbo-generators—it has been determined that the watts radiated per square unit of surface per unit of peripheral speed for a given temperature rise τ_0 can be satisfactorily taken as a constant. In all cases had the radiating length been assumed—*i.e.*, $L + l$. The quantity l is the length of the end connections and L is the core-length. The watts radiated by the armature are then: Total armature watts $= \pi^2D^2$ revs. $(L + l)r\tau/\tau_0$, where r is the radiating constant for the temperature rise τ_0. The value l can be taken as proportional to the pole-pitch, or $l = \kappa D/p$, and κ is some constant. Again, let $L = mD$, where m is an arbitrary assumed value, the watt equation then becomes: Armature watts $= \frac{\pi^2 r D^3}{\tau_0}\tau$ revs. $\left(m + \frac{\kappa}{p}\right)$, which must be equal to $Wf(100-\eta)$.

Then, if $a = \pi^2 r/\tau_0$, $D = \left(\frac{Wf(100-\eta)}{a\tau \text{ revs. } (m + \kappa/p)}\right)^{\frac{1}{3}}$.

This is the value for D which should be inserted in the equation $w = s$ revs. D^xL^y. Making the substitution of L in terms of D the latter becomes: $w = s$ revs. $D^{x+y}m^y$, and $D = (w/s \text{ revs. } m^y)^{\frac{1}{x+y}}$; whence by the former value of D $x + y = 3$ and $m^y = m + \kappa/p$. Substituting these values in the equation for output the latter becomes:

$$W = s \text{ revs. } D^3\left(m + \frac{\kappa}{p}\right),$$

or

$$W = s \text{ revs. } D^2(L + l),$$

which is the form of the output equation proposed.

It will be seen that what has been called the "design" coefficient has been taken to have the following value, $s = \frac{a\tau}{f(100-\eta)}$

or

$$s = \tau.\ \frac{\text{Radiation capacity of unit surface at unit peripheral speed}}{\text{Armature loss factor} \times \text{total loss of efficiency factor}}$$

It is then evident that for a large design coefficient the temperature τ_0 should be as high as permissible. A temperature rise below specification would be evidence of poor design. In comparing machines with different temperature rise limitations it would be better to divide s by τ in the output equation, in order to bring the relationship between the machines to a common basis.—Yours, &c., A. PRESS.

London, March 23.

PARLIAMENTARY INTELLIGENCE.

ST. MARYLEBONE ELECTRIC LIGHTING BILL.

Sir A. K. Browne's Committee of the House of Commons considered this bill on Monday. The chief opponents are the Gas Light and Coke Co. and the London County Council.

Mr. FITZGERALD, K.C., who appeared for the St. Marylebone Borough Council with Mr. Vesey Knox and Mr. B. Caine, traced the history of electric supply in Marylebone from the date of the granting of the provisional order to the Metropolitan Electric Supply Co. in 1889 down to the granting of the provisional order to the St. Marylebone Borough Council in 1901, the confirming act of which contained a clause stipulating the purchase of the Metropolitan Electric Supply Co.'s undertaking in Marylebone. After this came the arbitration proceedings, which fixed the price to be paid to the company at £1,212,000, and the first object of the bill was to obtain the necessary powers to borrow the money for the purpose of meeting the award. But under the judgment which the Metropolitan Company obtained subsequent to the date of the award, there were certain other sums to be paid, including the amount of the capital expenditure of the company since the date the valuation of the undertaking was taken—viz., Dec. 31, 1901—and the expenses incurred by the arbitration, and the total was now £1,365,000. The next important object of the bill was to enable the Council to borrow £460,000 for the purpose of purchasing the land necessary for the generating station. If this undertaking was to be made to pay in the hands of the Borough Council it was absolutely necessary that they should be placed in a position to generate electricity in the most economical manner and by the most improved methods. Two small generating stations were included in the portion of the undertaking which was to be purchased from the Metropolitan Company, but they were obsolete, small and insufficient for the needs of the district. In fact, the bulk of the supply which was now given by the Metropolitan Company came from their large works at Willesden, and he was instructed that supply by such a means, a long way from the centre of the district, involving transformation two or three times before the current reached the consumer, was not the most economical. Therefore the Council wished to borrow this additional £460,000 for the purpose of erecting a generating station in the area to be supplied. He mentioned this because, since the arbitration award, the Metropolitan Company had offered to work the undertaking for the Council. The site which the Council proposed for their generating station was an excellent one, being on the banks of the Regent's Canal, which would facilitate the supply of coal, and also only a short distance from the goods yard of the Great Central Railway Co. A considerable portion of the site was already the property of the Council and was occupied by them as a stone yard. With regard to the periods for the repayment of the loans, a report had been made by the Local Government Board, and he would deal with the items seriatim as they came up. But briefly, he might say that the bill asked for a period of 42 years which was the same as that given in the case of the purchase of the local company by the Liverpool Corporation, and there were other instances in which a similar number of years had been granted.

The CHAIRMAN intimated that he should ask the Local Government Board to give evidence on these points.

Mr. FITZGERALD, continuing, said that in this case there were special circumstances for this long period, as a considerable sum of money was being paid for the future profits of the company, which the present ratepayers would not get the benefit of, but which would only benefit future ratepayers. With regard to the opposition, so far as he was aware, there was only the London County Council and the Gas Light and Coke Co. As to the former, the Finance committee had now made a report which, if adopted at Tuesday's meeting of the London County Council, would settle the point between them and the promoters, and he would ask the chairman of the Committee to adjourn the proceedings at the close of the day until Wednesday, which would probably shorten the work of the Committee very considerably. He regarded the opposition of the Gas Light and Coke Co. as an abuse of Parliamentary procedure. When the bill was deposited the Gas Light and Coke Co. handed in a petition on the ground of competition. This petition was objected to by the promoters as being outside the statutory time allowed for depositing such petitions, and the Standing Orders Committee refused to allow the petition to be made. Since the depositing of the bill a proposal had been made by the General Electric Co. to take over the undertaking on terms which would provide that no loss fell upon the ratepayers. Such a proposition required careful consideration, and the promoters accordingly secured permission to introduce another clause into the bill by which they took powers to enter into any agreements with respect to their undertaking (not specifically with the General Electric Co.). In consequence of this, the Gas Light and Coke Co. entered a petition against the bill on the ground of competition, and introduced practically the whole of the original petition, which had been thrown out by the Standing Orders Committee. The new provision could not affect the Gas Light and Coke Co. at all, as Parliament had already authorised the competition to take place between the Marylebone Council and the gas company. He objected, therefore, to the Gas Light and Coke Co. being heard on anything but the new clause.

The CHAIRMAN agreed with this, and said that there was also a new petition by the Metropolitan Electric Supply Co. in respect of the same clause.

Mr. FITZGERALD said he had not yet seen this latter petition and apparently it had only been deposited that morning. A previous petition by the same company had been disallowed by the Court of Referees, and he certainly hoped the Committee would not allow this decision to be set aside in such a manner. In answer to the Chairman, Mr. Fitzgerald said

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that the company had obtained a judgment of the Court that it was to be paid, and the Council could not supply electricity until the purchase was completed. In the meantime, clause 34 of the bill provided for a supply of electricity in bulk by the company to the Council between the period of the completion of the purchase and the Council being in a position to supply itself.

Mr. E. DEBENHAM, chairman of the Electric Lighting committee of the Marylebone Borough Council, gave evidence in confirmation of counsel's opening statement, and the Committee adjourned until Wednesday.

On Wednesday, Mr. FITZGERALD said that the report of the Finance committee of the London County Council having been adopted by the County Council, he thought the result would be a complete agreement between the Borough Council and the County Council on all points between them. As the matter stood at present, without final adjustment, the County Council had arranged to help the Borough Council by borrowing for them in their money bill this year £1,365,000, and a further £100,000, which it was thought would be required for the purposes of the generating station during the first year.

Mr. DEBENHAM was then cross-examined by Mr. Pollock for the Gas Light and Coke Co. He admitted that a clause substantially the same as the "Bermondsey" clause had been inserted in the bill for the benefit of the Great Central Railway, which put the period for the adjustment of revenue and expenditure at three years.

The CHAIRMAN interposed to the effect that in view of the discussion in the House upon this matter, the Committee would reserve the right as to passing this clause or not.

Mr. DEBENHAM, further cross-examined, said the period of three years had been put in on the advice of Mr. Arthur Wright, their engineer, as he was of the opinion that until the Council had its own generating station a loss would be made. The bill also took power to postpone the payment of interest and sinking fund for two years. With regard to the new provision in the Bill, it was put in through offers having been received with respect to the undertaking from the General Electric Co. and the Westinghouse Co. The former company offered to take the undertaking upon a 10 years' lease and to guarantee no loss to the ratepayers, but the guarantee of the Westinghouse Co. was only as to the efficiency of the generating plant.

The CHAIRMAN: Have you an actual contract with a company, because if so, it would have an important effect upon the consideration of this bill?—No, there is no contract.

Mr. POLLOCK pointed out that any agreement entered into under the new provision of the Bill was not to be subject to the approval of the Board of Trade. He would ask therefore that the clause be amended so that any such agreement would be subject to such approval, and also that any parties be allowed to be heard in opposition to any contract of this description.

Mr. FITZGERALD objected, because the obvious attitude of such people as the gas company was to put the Borough Council to great expense, and at the same time endeavour to put upon them conditions which would make the undertaking unworkable.

The CHAIRMAN said he did not think this question arose from the gas company's point of view, but rather from that of the Committee.

Mr. FREEMAN, for the London County Council, at this point announced that an agreement had been come to with the promoters, and what the County Council was prepared to do was to make provision in their money bill, which would shortly be before Parliament, to enable them, if the Marylebone Borough Council was authorised to borrow money this session, to borrow and lend the Marylebone Borough Council £1,365,000. To enable that loan to be granted temporarily power would be taken in the money bill to issue London County Council bills to an amount not exceeding £1,500,000, and that subsequently steps would be taken to make a permanent loan when occasion arose. The County Council would also be prepared to advance to the Marylebone Council £100,000, which was the amount it was estimated would be required for the first instalment of the electrical works during the current year.

The CHAIRMAN asked if the Borough Council could borrow the £100,000 independently of the County Council.

Mr. FREEMAN said this was so, but with the consent of the County Council. If this consent was unreasonably withheld, then recourse could be had to the Board of Trade.

The CHAIRMAN pointed out that there was a clause in the bill relating to the supply of electric energy "in bulk" from the Metropolitan Electric Supply Co.

Mr. DEBENHAM explained that this was to apply during the period that the Council did not own works, and also if any further supply were required after the works were running. If any agreement was entered into with another company the same thing would apply. In fact, a contracting company would be the agents of the Borough Council.

Mr. FITZGERALD said he would be willing to amend the clause in question, by which it would absolutely bind a contracting company to carry out the agreement in question.

Mr. DEBENHAM re-examined, said there was no intention of entering into any agreement with a company at present.

Mr. ARTHUR WRIGHT, consulting engineer to the Marylebone Borough Council, after describing the system of distribution now existing in Marylebone, said considerable disadvantages were inherent in such long-distance transmission. If his system was carried out, the longest feeders would be only 1¾ miles, and continuous current would be generated directly at low tension, distribution being on a three-wire system at 480 volts. He considered it quite impossible for the Metropolitan Company to supply as cheaply as the Council could itself supply. By having a generating station in the district all transformation losses would be saved as well as the interest on the heavy capital cost on mains. He estimated that the price at which the Borough Council could generate electricity was 2·2d. per unit, diminishing as the years went on down to 2d. per unit by 1910. This price included everything except interest, sinking fund or depreciation. The revenue would be about 5d., and these latter items would be met out of the difference. The Metropolitan Company had offered a supply in bulk, pending the erection of a generating station, at 2·65d. per unit in bulk at 1,000 volts. But there would have to be added to this the cost of transformation and distribution, and this would bring the price per unit equivalent to 3·65d. Upon these terms, so long as the company supplied the Council, a loss would be made.

Mr. BALFOUR BROWNE, for the Metropolitan Electric Supply Co., objected to these comparisons, as he was debarred from cross-examination upon them.

The CHAIRMAN agreed with this.

Mr. WRIGHT, therefore, gave some details of his own scheme. The cost of the land for the generating station would be £35,000, clearing, &c., of the land £63,160, cost of generating plant £190,000, cost of mains and conversion of existing system to three-wire continuous throughout £171,840.

In answer to the Committee, Witness said that there was no ground for anticipating that any contracting company would carry on the undertaking cheaper than the local authority. If anything perhaps a little worry would be saved during the difficult period of the undertaking—viz., the first few years. The generating plant put down by a company would be identical with his scheme.

Cross-examined by Mr. BALFOUR BROWNE for the Metropolitan Electric Supply Co., he did not deny that the Supply Co. had submitted terms upon a sliding scale which would bring the price down below the 2·65d. mentioned, but the basis upon which these charges were calculated was impossible for Marylebone.

Mr. BALFOUR BROWNE said the terms were as follows:—A 27 years' agreement, taking all the supply the Council needed for two hours a day 3d. per unit, three hours 2·25d., four hours 1·82d., six hours 1·5d., seven hours 1·39d. and eight hours 1·29d.

Mr. A. B. HOLMES, consulting electrical engineer to the Liverpool Corporation, said he agreed with Mr. Wright's evidence and his estimates.

Mr. BALFOUR BROWNE then addressed the Committee on behalf of the Metropolitan Electric Supply Co. He repudiated a statement made by Mr. Fitzgerald that complaints had been made as to the supply in Marylebone, for, as a matter of fact, the only occasion upon which a breakdown had taken place was in 1899. But the chief point of his opposition was to preserve the agreement between the company and the Council as to the supply of electrical energy during the construction of the Council's own works. If the new provision was allowed to remain in the bill, the Council could transfer their undertaking to another company and so evade the obligation placed upon them by another clause in the bill. Another point in his case was as to the money to be borrowed. The primary object of the measure was to give the Council power to borrow the amount of the award under the arbitration proceedings, and when that was obtained and paid over, the Council would be in the position of an undertaker under the general law, and would be free to borrow any further sums necessary. Therefore, he asked that only powers to borrow the amount of the award be granted. Referring again to the agreement for the supply of energy in bulk, he asked that it be scheduled to the bill.

Mr. POLLOCK, for the Gas Light and Coke Co., asked that the new clause should be so amended that any agreement with a contracting company should be subject to the consent of the Board of Trade, and also that parties be heard against it. The company made this request as a ratepayer.

Yesterday, Mr. H. LLOYD, for the Marylebone Borough Council, addressed the Committee, dealing first with the objection of the Metropolitan Electric Supply Co. to the additional provision. The impression seemed to be that the new provision would prejudice the position of the company under the heads of the agreement for a bulk supply. But the Borough Council did not intend that this should be the case in any way whatever. All the Council wanted was the option to contract with any company to erect the works and that only, and any balance of current required must come from the Metropolitan Electric Supply Co. In order to make it absolutely clear, the promoters were willing to make the following addition to clause 34 of the Bill:—"And in the event of the Council entering into any agreement with a working company under the next succeeding section of the Act [the additional provision] such agreement with the Metropolitan Electric Supply Co. shall be binding upon the working company as if the working company as well as the Council had been parties thereto."

At the request of the Chairman, Mr. BOYCE, of the Local Government Board, attended in connection with a report of that department upon the bill. He said the Board was of the opinion that the 42 years asked for by the Bill for the repayment of the £1,365,000 was a long period. There was, however, the special circumstance in this case, for the sum to be borrowed was a very considerable one.

Mr. FITZGERALD pointed out that the amount of the award included a large sum for prospective profits, something like £800,000 being claimed by the company on this head. The period of 42 years had also been allowed in connection with the Liverpool purchase, 42 years for Norwich, Leeds and Sheffield, and in the case of Glasgow, 51 years.

Mr. A. WRIGHT was recalled on this point. He said he had made calculations as to the probable earnings of the undertaking and the probable burden upon the rates. During the first year or two the Council would be bound to take a supply from the Metropolitan Company, and estimating at the price of 2·65d., with coal at the present prices, a loss of £25,500 would be incurred upon a 42 years' basis of repayment, and the suspension of the sinking fund for two years. With a 15 per cent. increase in the price of coal the loss would be £29,480. The revenue per unit would be 5·28d., practically the same average price as at present. After the Council's generating station was working a profit would be

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shown after the first year. The interest and sinking fund, on the 42 years' basis, upon the amount of the award would be £67,800, and upon a 35 years' basis £73,800, on the same conditions as before. The interest on the additional capital would be £30,600 upon the 42' years basis. In 1910, the profit would amount to £19,540 after debiting revenue with every charge.

The Committee then had the room cleared and deliberated for over an hour.

The CHAIRMAN then announced that the Committee found the preamble of the bill proved, but with the following amendments, that the period for the repayment of the loan be fixed at 38 years; that the new clause giving the Council power to contract with a company to work the undertaking be struck out; and that the views expressed in paragraph 25 of the report of the Select Committee on the subject of loans (*The Electrician*, Vol. LI., 709) be adopted.

POST OFFICE TELEPHONE SYSTEM.

"POURPARLERS" FOR BUYING THE NATIONAL TELEPHONE CO.'S SYSTEM.

In the House of Commons on Tuesday, a resolution was considered authorising the raising of £3,000,000 for the purpose of the Telegraph Acts.

Lord STANLEY asked that the resolution be taken formally on the understanding that full particulars would be given upon the second reading of the subsequent bill. The resolution was to allow the raising of £3,000,000 for extending and amplifying the present telephone service.

Mr. McCRAE asked if the money was in any way connected with a scheme for the acquisition of the National Telephone Co.'s system.

Lord STANLEY replied that it was not, but was for the extension of the Post Office system. Negotiations, however, were going on as to what was the best course in the future with regard to the absorption of the National Company's undertaking, and he hoped before long to come to the House with some proposition.

Mr. GIBSON BOWLES said that this new charge should not be imposed on the consolidated fund without explanation, and the time had arrived for the Postmaster-General to make a clean breast of his telephone policy. He was in favour of buying out the National Company, but wished to see that the present sum to be raised did not saddle the taxpayers with an enormously increased cost for that transaction.

Lord STANLEY said that under the Acts of 1892, 1896, 1898 and 1899, the sum of £4,300,000 had been voted for telephonic purposes, including what was required for the purchase of the trunk lines. Roughly, the expenditure had been £2,180,000 on trunk lines, £1,495,000 on exchanges in London, £262,000 on exchanges in the provinces, and £233,000 on stores and stock of telephone requirements, a total of £4,174,000, leaving a balance of £126,000, which would only suffice for the present financial year. The £3,000,000 now asked for would be distributed approximately as follows:—Trunk lines £1,300,000, London exchanges £1,500,000, provincial exchanges £200,000. This would carry on the system for five years, although if greater increase took place in the future than had been the case in the past probably a further sum would be asked for. The objects of the loan were to extend the trunk lines where required and to create exchanges in places where there was now a great demand for telephones. In London the present plant would serve 40,000 subscribers, but only one-third of the plant was in actual use, the number of subscribers being 15,299. These numbers were, however, rapidly increasing, and two new exchanges were about to be established at Hampstead and Ealing for 6,000 subscribers and 2,000 subscribers respectively. At present in London there were 110,128 miles of wires in 1,094 underground pipes actually in use. With regard to the provinces, at the end of 1899 the number of customers were 1,259, but at the present time they numbered 5,000. At present there was a considerable amount of capital unremunerative, but he anticipated that the next report of the Postmaster-General would show a considerable increase in the earnings. For the year 1902-3 the profit was £6,155,* but next year it was estimated that it would be £48,000. With regard to the absorption of the National Company's undertaking, notice of purchase upon arbitration terms or by agreement could be given before the end of the year. However, he was much more inclined to adopt the latter alternative, as arbitration would be a costly proceeding. But the matter was in no way bound up with the present resolution.

Mr. CALDWELL suggested that a strong Committee should be formed to consider the application for further funds, and also to consider what steps, if any, should be taken with a view to acquiring the undertaking of the National Company. Another view of the matter was the expediency of handing over the whole telephone system to the London County Council.

Mr. WARNER thought the present would be a very inopportune time for absorbing the National Company.

Mr. GIBSON BOWLES complained of the manner in which the telephone accounts were kept, and said it appeared that, whereas the company was making increasing profits, the Post office telegraphs and telephones were making a greater and greater loss.

Lord STANLEY, in reply to Mr. REDMOND, said that a portion of the money would be applied to Ireland.

Mr. HENNIKER HEATON having referred to the loss on the telegraph service,

Mr. McCRAE said that if the Government were going to purchase the National Company's undertaking this year, they would have to give six months' notice prior to Dec. 31. He hoped that until the Government had settled its policy in this direction, no part of the £3,000,000 now asked for would be spent upon competitive undertakings with the company.

After some further discussion,

Mr. LOUGH asked what was to be the policy of the Government with regard to the encouragement of local authorities in developing the telephone system in their areas. He also suggested that the terms of any agreement with the National Company should be referred to a Select Committee of the House for consideration.

Lord STANLEY thought that, notwithstanding certain difficulties, the right thing to do with regard to the National Company was to purchase by agreement, in connection with which, no doubt, a small Select Committee of the House would be appointed. No binding agreement should be made until it had received the assent of the House. He would be ready to help local authorities who wished to start telephone exchanges in every possible way, and when the general agreement had been come to he hoped that the difficulty that a municipal licence could not be extended beyond 1911 without a similar extension to the company, might be overcome.

The resolution was then agreed to, and was ordered to be reported to the House.

On the report of the resolution coming up on Wednesday, Lord STANLEY replied to several questions. He stated that no single application for a telephone exchange in Ireland had been refused, the Post Office desiring to make a complete network over the United Kingdom, and to extend lines to small places. He would do what was possible to separate the accounts of the telegraphs and the telephones, but it was difficult. He wished to correct what he had said with regard to the negotiations with The National Telephone Co. He should have said that "pourparlers" were going on which might lead to negotiations, but he would not be to blame if an understanding with the company was not arrived at. At present it was impossible to say the exact form which the arrangement with the company had taken, but in any case before the House was called upon to decide on the question, a select committee should report upon it. The committee would have to consider the terms of arrangement, there being no intention to have another inquiry into the telephone service generally. The resolution was then agreed to, and the Bill founded on the resolution was read a first time.

In the House of Commons last evening Lord STANLEY, in answer to a question from Mr. Lough, repeated the announcement previously made in the House that some preliminary discussions are proceeding between the Post Office and the National Telephone Co. with the view to the Postmaster-General exercising the option to take possession of the Company's system on Dec. 31, 1904, by giving six months' notice as from June next. Lord Stanley also repeated his promise that Parliament shall, by Select Committee or otherwise, have an opportunity of considering any proposed agreement with the company before it becomes binding.

COMPANY GRANTED RUNNING POWERS OVER MUNICIPAL TRAMWAYS.

TYNESIDE TRAMWAYS AND TRAMROADS BILL.

A House of Lords Committee, of which the Earl of Barnet is chairman, commenced consideration of this bill on Thursday, March 17.

Mr. BALFOUR BROWNE, K.C., for the promoters, said the bill sought powers to construct quite a short length of electric tramway to Gosforth, making a junction with the existing lines of the company. This part of the bill was unopposed, however. The remaining and most important part of the bill concerned the question of running powers over the municipal tramway system in Newcastle-on-Tyne. The Tyneside Company's lines at present terminated at the boundary of Newcastle-on-Tyne on the South Shields side, and the proposal of the company now was that the company's cars should run on the municipal lines and that the Corporation cars should run on the company's lines. The company wished to take none of the fares collected in Newcastle, with the exception of sufficient to pay for the working expenses, and they offered similar facilities to the Corporation. On the opposite side of the Tyneside Company's system terminated the Tynemouth and District Company's system, and, although this latter had a gauge of 3ft. 6in., instead of the 4ft. 8½in. on the Tyneside Company's lines, an arrangement was being come to whereby a third rail would be laid outside the existing line of the Tyneside Company, so that the full-gauge cars of his company could continue running over the Tynemouth Company's system. If, therefore, through running could be arranged over the Newcastle lines a continuous route would be available from North Shields to Newcastle.

Mr. W. McLELLAN, engineer and manager to the Tyneside Tramways and Tramroads Co., gave figures detailing the number of passengers transferred from his company's system to that of the Newcastle-on-Tyne Corporation at Walker and Wallsend. There was no difficulty in working in the manner asked, and it was done on a much larger scale in America than in Great Britain. One instance in this country was at Manchester, where the cars of the Salford Corporation ran over the Manchester lines without changing either conductors or drivers. The agreement for running powers on the Tynemouth and District Company had only awaited the consent of the South Shields Corporation.

On Friday, March 18, local evidence was called to show the need for through running, and representatives of many large works, such as Messrs. Swan, Hunter & Co., the Hon. C. A. Parsons & Co., expressed views to this effect.

Mr. STEPHEN SELLON, consulting engineer to the British Electric Traction Co., also gave evidence in favour of the bill.

On Monday the case for the Newcastle-on-Tyne Corporation was opened.

Mr. CAIL, chairman of the Tramways committee, said that the Newcastle Corporation had favoured a limited through running, but the present proposal of the company was much more than the Corporation

* This figure represents the balance of receipts over expenditure, and includes no allowance for the interest and depreciation, which is estimated in the Postmaster-General's report at £60,870.

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was prepared to accept, as, in their opinion, the district would not be benefited thereby.

Mr. A. E. le ROSSIGNOL, general manager of the Newcastle Corporation tramways, said that Newcastle did not lend itself to a complete through system, and persons coming from the east and wishing to go to the north had even now to change cars at the Central station. In working a large system of tramways, it was very important to have complete control over the men and the equipment. If, for instance, one of the company's cars broke down in Newcastle, it would either have to be taken to one of the Corporation's car-sheds to be repaired or else pushed back as a "dead" car outside the town. It had been stated that if these through running powers were granted, the Newcastle Corporation would be able to run its cars right through to North Shields. The lines of the Tyneside Company were, for the most part, single lines with passing places, and the wear and tear upon the rolling stock was much greater under these conditions than upon the double track of the Newcastle Corporation. Further, the present congestion in the Newcastle streets was such that any further traffic brought there by the Tyneside Company's cars would be a serious matter.

A large number of other witnesses were then called, including the general manager of the Glasgow Corporation tramways, and some local witnesses, who spoke against the proposals of the company.

Mr. H. LLOYD, K.C., for the Newcastle Corporation, contended that the primary object of tramways was for local traffic, and that through routes could necessarily only be over reasonable distances, say 3½ miles, which was the usual length for a single route of the Newcastle Corporation tramways. The North-Eastern Railway Co. was converting its lines in this district to electric traction, and any long-distance passengers would be carried quite as quickly on these lines as by tramway. At present both the Corporation and the Tyneside Company had powers to make agreements for through running, but he protested against this being done by force. Last year a similar proposal was made by some authorities outside Birmingham to run their cars compulsorily into the city, but they were not granted these powers by Parliament.

Mr. BALFOUR BROWNE said that the proposal with regard to Birmingham last year was an altogether different one to the present case. The outside authorities of Birmingham asked for powers, not only to run their cars over the Birmingham lines, but also to reconstruct the lines in the city for electric traction if the Corporation did not do so within six months. However, he did not care for precedents. This present application was a unique case, and even if such a thing had never been done before it ought to be done now, because it was in the public interest. After a short deliberation, the Committee decided that the bill might proceed.

ELECTRIC LIGHTING (LONDON) BILL.

This bill, which is being brought in by the Board of Trade with the object of making slight alterations in the London electric lighting areas where their boundaries are not quite coincident with those of the Metropolitan Boroughs, came on for second reading on Wednesday. Mr. Gerald Balfour explained the object of the bill, and there was a short debate upon it. Mr. Caldwell insisted that it was necessary to devise a scheme under which London might be supplied with electricity either by the London County Council or by some other single authority. Mr. Brigg proposed an Electricity Board analogous to the London Water Board. Mr. Burns supported the bill, and Sir W. Foster said that the lighting of London was disgraceful. The bill was read a second time and referred to a Select Committee.

RATING OF MACHINERY BILL.

In the House of Commons on Friday last week, Sir W. HOLLAND moved the second reading of this bill. He said the bill proposed a system of rating precisely similar to that now adopted in Scotland, by which machinery not permanently fixed would not be assessed as rateable property. The approval of Parliament of this measure was a matter of life and death to the employers and operatives in many large centres such as Oldham, Bolton, Blackburn, Preston and Leeds.

Mr. CHAPMAN supported the bill, and thought its adoption would prevent small industries from being seriously hampered.

Sir J. JOICEY said that the machinery to be exempted was that of mill-owners, and he opposed on the ground that it was a manufacturers' bill.

Col. KENYON SLANEY thought the measure was inopportune and unfair. The bill would increase the rates paid by the working classes.

Mr. EMMOTT and Sir S. HOARE supported the bill.

After some further discussion,

Mr. GRANT LAWSON said the Government was pledged to deal with the whole question of rating, but the opportunity had not yet arrived. The bill now before the House, however, was only supported by one rating authority in the country. This question had been before Parliament for many years, but he was of the opinion that the law was as certain on this matter as the law of any country could be on any matter.

A division was then taken with the following result:—For the second reading, 114; against, 94. Majority, 20.

An influential meeting of Member of Parliament favourable to the Rating of Machinery Bill was held on Tuesday in one of the committee rooms of the House of Commons. Sir William Holland presided. The meeting expressed their satisfaction at the result of the debate on the second reading of the bill. The desirability of removing the objection taken to the provisions of the measure by Members of Parliament representing particular localities in England was considered, and in view of the misconceptions which apparently exist in the districts as to the effect of the operation of the bill, it was decided to appoint a Sub-Committee immediately for the purpose of taking steps to satisfy these particular opponents that their apprehensions were without foundation. The final form of the Sub-Committee was not absolutely decided upon, but the following Members of Parliament were elected to act, with power to add to their number:—Sir W. H. Holland, Sir W. H. Houldsworth, Sir W. E. M. Tomlinson, Sir Edward Stracney, Sir John Rolleston, Mr. Alfred Emmott, Mr. D. J. Shackleton, Mr. George White and Mr. Edward Chapman. The feeling was also expressed that the Machinery Users' Association should, through its officials, act in direct co-operation with the above Sub-Committee.

THE TUNNEL UNDER THE THAMES.

NORTH AND SOUTH WOOLWICH ELECTRIC RAILWAY.

In our last issue (p. 872) the adjournment of the consideration of this bill was reported in order to give the promoters an opportunity to decide their course of action consequent upon the conditions attaching to the decision of the Committee in finding the preamble proved. Nothing further has been said about the matter to the Committee, which has completed all the bills before it. The Chairman of the Committee has now reported to the House, however, that the promoters do not intend to proceed further with the bill.

WEIGHTS AND MEASURES (METRIC SYSTEM) BILL.

The Select Committee of the House of Lords which is considering this bill held a further sitting on Monday, Lord Belhaven presiding.

Mr. O. R. H. BURY, general manager of the Great Northern Railway Co., thought that a great amount of difficulty would at first be experienced in connection with the recalculation of railway rates. Ultimately, however, enormous simplicity would result. There would be a considerable saving of labour and less liability of error. There would not be much advantage to the railway companies if they adopted the change for their own purposes and the public did not take it up.

The Committee then adjourned, and will not sit again until a date after April 19.

OTHER ELECTRICAL BILLS.

On Friday last week a House of Commons Committee, presided over by the Hon. de Tatton Egerton, considered the *Watford and District Tramways (Extension of Time) Bill*. The lines, for which an extension of time was now sought, were sanctioned by the Watford and District Tramways Act of 1901, and the time expired on Aug. 17, 1904. Opposition was offered by the Hertfordshire County Council and the Watford Urban District Council on the ground that the financial position of the company was not such as to warrant the construction of the lines, even if the extension of three years asked for were granted. One of the directors of the Watford and District Company was called, but failed to convince the Committee, which, the Chairman said, was absolutely unanimous that the preamble could not be found proved.

The *Charing Cross, Hampstead and Euston Railway Bill* came before Mr. Russell Rea's Committee of the House of Commons last week. The bill provides for the acquisition of a small portion of land in Tottenham Court-road, and the construction of an additional station at the Cobden Statue, Camden Town. No new capital powers are asked for. Opposition was offered by the London County Council in respect of this station, and also by Messrs. Reid & Co., brewers, in respect of certain of their cellars which the promoters propose to acquire. The preamble of the bill was eventually found proved, but certain protective clauses were inserted.

The Standing Orders Committee of the House of Lords has decided to allow the *North Wales Electric Power Bill* to proceed, notwithstanding a non-compliance with standing orders. In the case of the *Bristol Tramways (Extensions) Bill*, this will be allowed to go forward with the elimination of certain lines in Walmley for which the consent of the local authority has not been obtained.

In the House of Lords on Monday the *Hampden-on-Arden Gas Bill* was read a second time, and on Tuesday the *Preston, Chorley and Horwich Tramways Bill* was read a third time.

In the House of Commons on Tuesday the *Kettering Improvement Bill* was read a third time and the *Middlesbrough, Stockton and Thornaby Tramways Bill* a second time. Yesterday the *Torquay Tramways Bill* was read a third time.

The South-Eastern and Chatham Railway Co. has withdrawn its petition against the *East London and Lower Thames Electric Power Bill*.

The Victoria University of Yorkshire Bill was before the Unopposed Committee of the House of Lords on Tuesday, and was ordered to be reported for third reading. The object of the bill is to merge the Yorkshire College in the University of Leeds, and to transfer all the property and liabilities of the college to that University.

The Southport and Lytham Tramroads Bill, which is proceeding as an unopposed bill, has been ordered for third reading by the Unopposed Committee of the House of Lords. The bill proposes to extend the time for the acquisition of land and the construction of works as authorised by previous acts.

The *Barrow-in-Furness Corporation Bill* came before the House of Lords Committee presided over by the Earl of Crewe last week. Amongst other things, it provides for the construction of some additional tramways, and also for an opening bridge across the Walney Channel, over which it proposed to run the tramways in order to facilitate communication with Walney Island. The only means of communication at present across Walney Channel is a steam ferry owned by the Furness Railway Co., and the only opposition is at their hands, it being stated that the traffic upon their steam ferry would disappear if the bridge were constructed. After a hearing lasting several days the preamble of the bill was declared proved.

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MUNICIPAL TRADING.

Mr. BALFOUR, in a printed reply to Sir J. Rolleston in the House of Commons on Friday last week, said he would be very glad to see the re-appointment of a Joint Select Committee on Municipal Trading to complete the work of the Committees of 1900 and 1903, but the necessary steps would depend upon the state of business in the House.

WIRELESS TELEGRAPHY.

In a printed reply to Mr. Henniker Heaton in the House of Commons on Friday last week,

Mr. GERALD BALFOUR stated that arrangements were being made by the Trinity House for the fitting up of wireless telegraphic apparatus on certain of their lightships on the East Coast by way of experiment. The matter was being pushed forward, and an agreement for the use of patent rights had been drawn up and was now being considered by the various departments concerned. Permission had been granted to Lloyd's to establish a wireless telegraphic station at the Fastnet. He was unable to say at present to what extent the system would be applied to other light stations, many of which were already connected by cable with the shore.

LEGAL INTELLIGENCE.

Llanelly Tramway Co. v. Llanelly and District Electric Lighting and Traction Co. (Ltd.) and the British Insulated and Helsby Cables (Ltd.)

This case came before Mr. Justice Joyce in the Chancery Division on Wednesday, Thursday, Friday and Saturday last week, and was an action by plaintiffs asking for specific performance of an agreement dated Oct. 22, 1900, for the sale to defendants of a piece of land and a building thereon, in Robinson-street, Llanelly, also specific performance of an agreement by defendants to purchase the undertaking authorised by the Llanelly Tramways Order, 1880, certain tramcars, and the benefit of an agreement with the Great Western Railway Co. Plaintiffs claimed payment by the British Insulated Company of £5,000, with interest, and asked for damages.

Mr. HUGHES, K.C., said plaintiff company was incorporated in 1881 for the purpose of working tramways in Llanelly, and one of the provisions in their memorandum of association empowered them to sell the whole or any of the company's property. Plaintiff company took over the undertaking originally comprised in the Llanelly Tramways Order, 1880, which contained, in modified form, the provisions of the Tramways Act, 1870, under which the local authority had a right to acquire the tramways under certain conditions. In 1899 the British Insulated Company, whose business was the construction of electric cables and electrical engineering work generally, proposed to take over the tramway undertaking with a view to converting them to electric traction and also constructing electric light works, and working the two undertakings in conjunction. Negotiations ensued between plaintiffs, Llanelly Council and the British Insulated Company, and the Council obtained a provisional order, and the B.I.W. proposed to take over this provisional order under the Electric Lighting Act. Negotiations had now arrived at the point at which the B.I.W. Co. agreed to buy the tramway undertaking. When it came to drawing up a formal contract (counsel continued) the B.I.W. Co. said that, as a matter for their convenience, they proposed to form a subsidiary company, to be called the Llanelly District Electric Light and Traction Co., as this was more likely to attract local interest. It was proposed that the purchase should be carried out in the name of that new company, and accordingly the provisional agreement was entered into between plaintiff company and the Traction Company, the original agreement having been made by correspondence between plaintiff company and the B.I.W. Co. No difficulty arose for some time. The B.I.W. Co. had, however, changed its mind, and thought it would prefer not to carry out its bargain. They said, in fact, that they had not entered into any bargain with plaintiffs, but with the Llanelly and District Company. That was part of the defence in this action. With regard to the Traction Company, he could not see that they had any defence. The two companies had the same directors, and the latter was entirely managed by the former.

Mr. ADAMS (for the Traction Company) said his defence was purely technical.

Mr. HUGHES said the question in the action was whether the B.I.W. Co. were not also liable.

His LORDSHIP asked in what respect plaintiffs claimed damages?

Mr. HUGHES said plaintiffs had had to keep this undertaking going for four years up to the date of the writ.

His LORDSHIP: If you get a perfect judgment against the Traction Company you need not care about the other company. The approval of the Board of Trade had not been obtained.

Mr. YOUNGER (for the B.I.W. Co.): It has been alleged by plaintiffs that it has been obtained.

Mr. HUGHES suggested that the consent could be obtained by the B.I.W. Co.

His LORDSHIP: If the consent of the Board of Trade to the carrying out of the first contract be necessary, unless you can get it you cannot carry out that agreement, for you cannot convey. But you may be entitled to a decree for specific performance, and if the consent cannot be obtained you may have to pay all the costs.

Mr. HUGHES contended that if the consent was not obtained owing to the fault of the purchasers, although there might be a difficulty about specific performance, there would be no difficulty about damages for breach of contract. The position taken up by the Board of Trade was that they could approve of the transfer, but they retained to themselves the power, if circumstances altered, of withdrawing that approval. If the Traction Company would carry out the bargain plaintiffs did not want the B.I.W. Co. to do so. The Board of Trade acted on the view that the B.I.W. Co. was taking the responsibility. Plaintiffs were entitled to judgment against the Traction Company for specific performance of the agreement of Oct. 22, 1900. If that could not be carried out by reason of the approval of the Board of Trade not being obtained, then he asked for specific performance of the agreement contained in the letters between the B.I.W. Co. and plaintiffs.

Mr. YOUNGER protested against any such claim as that now set up against the B.I.W. Co, There was nothing in the original statement of claim or in the amended claim to suggest it as a ground of action.

After further discussion on Thursday, his lordship allowed the case to stand over for plaintiffs to amend their pleadings.

On Friday, Mr. HUGHES said the pleadings had been amended. In the amended defence the B.I.W. Co. said there was, prior to Oct. 22, 1900, a bona fine dispute between plaintiffs and themselves as to whether the documents mentioned in the statement of claim did or did not constitute a good contract between plaintiffs and the B.I.W. Co., and, by way of compromise and settlement of such dispute, the agreement of Oct. 22, 1900, was executed. In the amended defence of the Traction Company, the allegation that the agreement of Oct. 22 was void was struck out. The Traction Company now denied that they had no assets of their own, and said that no transfer had been tendered to the Traction Company, and the latter had no knowledge of the requirements of the Board of Trade. The case, therefore, came to thie: Assuming that plaintiffs had made out a completed contract with the B.I.W. Co. on the correspondence, that contract stood unless it had been rescinded by reason of any subsequent contract entered into that was inconsistent with the earlier one.

His LORDSHIP: What is the real reason why this cannot be carried through?

Mr. YOUNGER: The difficulties with the District Council have been such that the lighting order has not gone through, and the position is that the tramway company were left in possession of the tramway to work as they please.

Evidence was then given for plaintiffs.

Mr. ADAMS then said the Traction Company admitted the agreement of Oct. 22, 1900, but plaintiffs were unable to perform it, as they could not get the consent of the Board of Trade. The question, he submitted, was not properly raised in the action, but should be decided on an inquiry as to plaintiffs' title. He took the further point that plaintiffs could not ask for relief both as against the Traction Company and the B.I.W. Co.

Mr. YOUNGER said the B.I.W. Co.'s contention was that whatever the liability of the B.I.W. Co. in respect of their relation with the Traction Company, the liability was one which could not be asserted by plaintiffs, but could only be asserted at the instance of the Traction Company, and there was not disclosed in this action any liability of any kind on the part of the B.I.W. Co. towards the plaintiffs. He should call no witnesses for the defence.

Mr. HUGHES said the question his lordship had to decide was whether there was mutual rescission between the tramways company and the B.I.W. Co. of the agreement of Aug. 10. The authorities showed that when you found a subsequent agreement was not enforcible in law there could be no rescission of an earlier agreement. In order that the agreement of October should operate as a rescission of the agreement of August, it must be absolute and unconditional. But the October agreement was made subject to the approval of the Board of Trade to the transfer being obtained.

His LORDSHIP: The Traction Company object to perform it. They say you have not got the Board's approval.

Mr. HUGHES agreed and argued that the October agreement would operate unjustly if it was found that it was an absolute rescission for all purposes of the original contract.

His LORDSHIP: What order do plaintiffs suggest should be made?

Mr. HUGHES said he thought the order should be: "It appearing that the Board of Trade consent has not been obtained, and the Traction Company repudiate liability under the agreement of Oct. 22, 1900, this Court declares that in the events which have happened the B.I.W. Co. are bound by the contract contained in the letters of August, 1900, and decrees specific performance against the B.I.W. Co., with an inquiry as to damages and the costs of the action."

His LORDSHIP said he would consider his judgment.

Hunt v. National Electric Traction Co. (Ltd.)

This case came before Mr. Justice Ridley and a common jury on Monday. It was an action to obtain rescission of a contract to take shares in the City and Surrey Electric Railway Co. on the ground of mis-statements in the prospectus. Defendants did not appear.

Plaintiff's case was that the prospectus offered for sale shares in the City and Surrey Electric Railway Co., which was incorporated with a capital of £150,000. On the faith of the prospectus and a circular which stated that the railway company had already built a City terminus, electrically equipped with lifts close to the Monument; that it had already constructed approach lines fully equipped for running; and that it had already built and electrically equipped a tunnel under the Thames, the plaintiff bought 10 shares of £10 each. Plaintiff said these statements were false and fraudulent, the company not having built a City terminus equipped as stated.

The jury found for plaintiff for the return of £52. 10s., and expressed regret that any assessment as to damages would only be abortive.

Judgment for rescission was also entered for the plaintiff.

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Ferranti Limited.

The petition of Estler Bros. for the winding-up of this company was again before Mr. Justice Byrne on Tuesday, when Mr. Buckmaster, K.C., asked his lordship to allow the petition to stand over. His clients were willing that the arrangement at present existing should be continued for another three months on exactly the same terms.

His lordship directed the petition to stand over until the last petition day in June, on the same terms as before.

Infraction of Petroleum. Act.

Last week W. T. Henley's Telegraph Works Co. were summoned at the Guildhall (London) for having (1) on March 4 consigned and conveyed, between North Woolwich and the City of London, four drums containing petroleum without labels in conspicuous characters stating the name and address of the sender; and (2) for not having the vessels labelled with a description of the petroleum and the words "Highly inflammable."

Mr. T. G. VICKERY, who prosecuted, said it was practically one offence, although there were two technical infringements of the Petroleum Act, 1871. The company conveyed from their works at North Woolwich to their premises in Blomfield-street four drums of "petroleum." The definition of petroleum was a very wide one, but Prof. Redwood, who analysed the material, said it was indiarubber solution, and would come within the provisions of the Petroleum Act. The total quantity in the drums was nearly 50 gallons.

Mr. P. GRAIN, for defendants, pleaded guilty. His clients were ignorant of the fact that the material came under the definition of petroleum. It was a substance of which the chief constituent was indiarubber, and was used in the laying of cables. It had been in use for a great number of years, and no suggestion had ever before been made that it was petroleum, nor were defendants aware, until they received the result of the analysis, of its inflammable nature.

A fine of 40s. was imposed and costs.

National Telephone Co. v. Spencer.

At the Southwark (London) County Court, on Tuesday, plaintiffs sought to recover £6. 10s., telephone rental. Defendant (Dr. Spencer) pleaded that he entered into a contract for the message rate, and said he was willing to pay if the company would ensure him a reasonable service. From the first it had been unsatisfactory, and he had been put to expense in telegraphing and writing to the company asking them to put the matter right. He contended that that was good notice, and determined the contract between them.

Judge ADDISON held that defendant had not given proper notice to determine the contract. As to the irregularities complained of, they were subject-matter for an action, and did not constitute a breach of the contract. Judgment for plaintiffs, with costs.

MUNICIPAL, FOREIGN, & GENERAL NOTES

APPOINTMENTS VACANT AND FILLED.

The Municipal Commissioners of Singapore (Straits Settlements) require an electrical engineer, with experience in the management of three-wire continuous-current supply station, and qualified to superintend the laying and maintenance of underground cables on the solid system and to take entire charge of their electrical department. The appointment will be made for three years, at £360 for first, £390 for second and £420 for third year, with transport allowance. Applications to Mr. C. C. Lindsay, M.Inst.C.E., 217, West George-street, Glasgow, by April 19. See also advertisement.

Chester Corporation invite applications for the position of city electrical engineer at a salary of £300, rising by annual increments of £50 to £500. Applications to the town clerk (Mr. J. H. Dickson), Town Hall, Chester, by April 6. See also advertisement.

The Visiting committee of the Napsbury Asylum, near St. Albans, Herts., require an engineering clerk of works to supervise the fitting and erection of the whole of the heating and hot-water apparatus, electric wiring, distribution mains and cables, boilers, engines and dynamos, &c. Salary £3s. 3s. per week. Applications to the clerk of the committee, Mr. Walter George Austin, Guildhall, Westminster, S.W., by April 6. See also advertisement.

The Council of the University of Liverpool invite applications for the professorship of Physical Chemistry. Total guaranteed salary not less than £600 a year. Particulars from registrar, to whom applications by April 1.

The position of Director of Posts and Telegraphs of the Federated Malay States is vacant. The position will probably be filled from the ranks of the British postal and telegraph service. The salary is £780 per annum, rising by two triennial increments of £60 to £900. Candidates have to be not less than 30 nor more than 40 years of age, and the officer selected will be required to reorganise the postal, telegraph and telephone departments of the States.

An assistant electrician is wanted for Leeds City Hospitals. Wages 35s. Applications by 29th inst. to the town clerk (Mr. R. E. Fox).

An experienced signal inspector is required for the Ceylon Government Railways. Salary, R4,000 per annum. Applications to Crown Agents for the Colonies, London, S.W., by 31st inst.

Mr. W. J. W. Bullock, late mains superintendent and assistant engineer at West Ham, has been appointed borough electrical engineer, in succession to Mr. J. K. Bock, who has resigned in order to take an appointment in Buenos Ayres with Messrs. Livesey, Son and Henderson, civil engineers. Mr. Bock has been granted an honorarium of 100 guineas in recognition of his successful work at West Ham for many years.

Mr. Chas. W. Lund, A.I.E.E., of the London and North-Western Railway Co.'s electrical department, has been appointed by the Colonial Office to be assistant-superintendent of telegraphs in Ceylon, and will sail from London for Colombo by the P. and O. mail steamer "Australia" on May 13.

Mr. J. W. Plackett, controller of the telegraph office, Edinburgh, has been appointed telegraph traffic manager in succession to Mr. D. Mason, I.S.O., retired.

Acton.—The Board of Trade have deferred consideration of the question of revoking the Council's electric lighting order until Dec. 31 next.

Arbroath.—Messrs. Buchan and Hogarth, consulting electrical engineers, who claim 375 guineas for fees, have been offered £200.

Automobile Exhibition.—The ninth annual automobile exhibition now being held under the auspices of the Automobile Club at the Agricultural Hall, London, consists chiefly of a demonstration of the extraordinary advances which have been made recently in the petrol motor-car industry. Some of the best cars in the show, however, are the electric vehicles exhibited by the Anti-Vibrator Co. The accumulators are hidden under the seats or in the boot, being, nevertheless, just as accessible for examination or repair as if placed in a box. Special attention has been paid to the hubs and axles. The axle ends are of steel specially prepared and are ground to fit the steel liners of the wheel hubs. Two roller bearings, which carry the weight, and two sets of ball bearings for taking up the thrusts, are fitted to each wheel. This combined roller and ball bearing allows the carriage to run very smoothly and reduces friction to a minimum. The controller, of which the company possess the provisional patent, is compact, simple and efficient. It occupies only 15in. by 4in. and is fitted under the driver's seat. The operating handle or lever is at the driver's left hand. It provides three speeds forward, one speed reverse and one neutral or off positino. This controller enables the driver to start slowly, also to follow easily the ordinary London traffic speed and to increase that speed when on a clear road to between 13 or 14 miles an hour on the level. It commands a good speed even when mounting steep gradients. By a special contrivance it is impossible for the driver to start off with a rush or to change the speeds abruptly from first to third, a frequent source of damage to the motor and gear wheels. Every carriage is fitted with four brakes, two on the driving wheel and two on the motor shafts. Each brake is double-acting. A ratchet is fixed to the brake pedal, so that the carriage may be stopped and held firm on any inclination. Near the driver's left hand is a safety device, by which, on simply withdrawing a plug, all electrical connection with the motors is cut off, so that the driver may leave the box without danger of the carriage being accidentally or wilfully started off. The motors, of which there are two to each carriage, have been specially designed and are water and dirt proof. The armatures run on ball bearings which are automatically lubricated. Each motor is capable of developing 3 H.P. and, for short periods, double this load. Should either motor get damaged the carriage can be run on the other alone. The motor parts are all made interchangeable, and all parts are kept in stock, so that replacements are quickly effected. The carriages are primarily intended for use in the London district, where they can be run on roads of ordinary gradient at least 40 miles without being re-charged. They have, however, been used in country districts over bad and hilly roads with success. Other electric motor car exhibitors are the London Electromobile Synd., Messrs. W. Bath & Son, Lancaster Motor Garage, and Morgan & Co.

Among the exhibitors of accessories and sundries indispensable to motorists we may mention:—The Stern-Sonneborn Oil Co. (special lubricants, pastes, anti-rusts, polishes, &c.); Pfluger Accumulator Works (Pfluger ignition accumulators in all sizes, shapes and capacities); Sutherland and Marcuson (ignition batteries, carriage lighting batteries, storage battery hand lamps, inside electric carriage lamps, &c.; Geipel and Lange (Vulcan speed indicators, an electrical device for indicating speed at any moment without moving shafts, bevel wheels or friction driving; also distance recorders, sparking plugs, induction coils, &c., and the automatic accumulator which does not work when on open circuit); Joseph Kaye & Sons (the well-known serrated seamless steel, copper and brass oil cans, oil fiters, &c.); Crossley Bros. (an excellent exhibit of gas engine and dynamo combined, oil engine and dynamo combined, and several examples of Crossley gas engines); Sola Accumulator Co. (accumulators); F. C. Blake (electrical ignition distributors for sparking multi-cylinder motors, &c.); Messrs. S. Smith & Son, 9, Strand, London, W.C. (an interesting exhibit of motor timepieces, some fitted with electric light attachments; chronographic speed indicators, &c. At this stand a working model of the action of the speed indicator is shown); Electric Battery Co.

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(electric ignition batteries and apparatus. voltmeters, contact plugs, sparking plugs, &c.); Peto and Radford (New "Energy" battery, sparking plugs, motor generators, dynamos, Peto-Cadett patent accumulator, electrical testing instruments, &c.); Prested Miner's Gas Indicating Electric Lamp Co. (portable electric safety lamps, accumulators, primary batteries and ignition sundries); Max Accumulator Co. (batteries for electric cars, ignition batteries, portable lamps, &c.); A.B.P. Accumulator Co. (assortment of ignition cells, traction cells, insulating materials, &c.); J. C. Fuller & Son (the new "Fuller" ignition dry battery, accumulators, ignition coils, &c.); Van Raden & Co. (woven glass accumulators, charging dynamos, induction coils, electric safety lamps, &c.)

The exhibition remains open until to-morrow (Saturday) evening.

Barnstaple.—The salary of the borough electrical engineer (Mr. J. W. Hadfield) has been advanced to £200 per annum.

Basingstoke.—The Corporation have withdrawn their electric lighting bill. The question of establishing municipal electricity works or of leasing the Council's provisional order to a company is to be settled by a ballot of the ratepayers.

Battersea (London).—On Wednesday the Council affixed the borough seal to the agreement with the County of London Co. regarding the transfer of three areas, so as to make the districts within which the local authority and company are authorised to supply electricity coterminous.

Bedlingtonshire.—The Council have appointed a committee to prepare a scheme of public lighting. The colliery company intend to light Doctor pit rows electrically.

Beeston.—Owing to a satisfactory canvass, the new Council will be advised to take up the subject of erecting electricity works at an early date.

Belfast.—The Electric committee again recommend that an electrical inspector be appointed by the Board of Trade, but that the person appointed should not be a local man.

Bexhill.—Application has been made for sanction to a loan of £3,500 for electric lighting extensions.

Bournemouth.—The first exhibition of an electrical character ever held in this important town (which, besides being one of our leading health resorts, has a large area covered with the best class of residential properties) was held from 16th to 19th inst. at the Hotel Mont Dore, under the auspices of the Bournemouth and Poole Electricity Supply Co., whose undertaking was one of the earliest, as it is one of the largest and most important of the electricity enterprises in the provinces.

Commencing from very small beginnings, the company's undertaking has passed through many stages of trouble and difficulty, but is now in a prosperous condition, and is representative of the progress which has been made in electric lighting in this country during the past 12 years. Bournemouth is unquestionably an ideal centre for the exhibition of the latest novelties in electric lighting from both the utilitarian and the ornamental aspects, and few towns in the country offer a better market for high-class fittings, fixtures and apparatus for electric lighting, heating and cooking, and for small motors for domestic, trading and medical purposes. It is not surprising, therefore, that the exhibition has proved a great success. The opening ceremony included a luncheon, presided over by Mr. H. B. Renwick, secretary of the company, at which the mayors of Bournemouth, Poole and Christchurch were present. In the course of the proceedings Mr. Renwick referred to the work of the company in Bournemouth and district, and to the success attained, which he largely attributed to the intelligence, energy and capacity of the electrical engineers and contractors of the town, who had carried out their installation contracts from the first with the firm intention of putting in good work and of showing what excellent results could be effected where electric current is intelligently employed. Mr. Renwick concluded by forecasting a great future for the electric radiator. Mr. W. Haydon, replying to a toast on behalf of the engineers and contractors of Bournemouth and Poole, referred to the excellent relations which existed between the traders and the company. The displays made by a large number of exhibitors were on a considerable scale, and embraced an infinite variety of articles for which Bournemouth may be considered a particularly good selling centre. Perhaps no display at the Mont Dore Assembly Rooms was more prominent or instructive than that made by the Bournemouth and Poole Co., although where all was excellent it is difficult to particularise. Mr. H. J. Dowsing, too, was conspicuous with his fascinating exhibit of radiators, &c. Many local firms made some really fine displays of plain and artistic fittings, and the crowds of visitors were unanimous in voting the exhibition a brilliant success.

Bradford.—The general manager of the Corporation tramways department, Mr. C. J. Spencer, lectured to members of the Bradford Scientific Association on Friday last on the development of the municipal tramways.

The capital expenditure (said Mr. Spencer) had risen from about £80,000 in 1899 to nearly £800,000 in 1904, while the annual receipts had risen from £12,000 in 1899 to £198,000 in 1904. About 1,000 men were now employed. There were 230 cars, and the parcel traffic brought in about £1,000 annually. In Glasgow the current consumption for the year ended March, 1903, was 0·9466 units per car-mile, while in Bradford it was 1·511, which made the Bradford system an expensive one to operate. From the year ending March 31, 1903, they had spent at Bradford on electricity nearly £27,000, and on maintenance of cars £25,000.

Caerphilly.—A Board of Trade inquiry was held here by the Hon. T. H. W. Pelham on Wednesday into the application of the Council for a provisional electric lighting order. There was opposition by ratepayers.

For the promoters, Mr. A. H. Preece (Messrs. Preece and Cardew, consulting engineers to the Council) said that since last year there had been a great increase in the number of houses in the district, that the proposal to erect a generating station had been abandoned, and that an agreement had been entered into with the South Wales Electrical Power Distribution Co. to supply electricity in bulk at three points in the district at 1½d. per unit for a minimum supply of 50,000 units per annum. The application was supported by the whole of the members of the Council, and resolutions in its favour had also been passed at public meetings, including the Chambers of Trade and the Ratepayers' Association.

For the opposition Mr. R. Hammond was called, and it was urged that the scheme could not be commercially successful, that outside the railway and colliery companies, who would make their own arrangements for electric lighting and power, the great bulk of possible consumers would be colliers, and that to avoid showing a loss on the estimates the promoters had used exaggerated revenue figures.

Camberwell (London).—On Wednesday the Council decided to take electric current from the London Electric Supply Corp. for the lighting of the Camberwell Baths at 3¾d per unit.

Canada.—Immense sums are spent by the Dominion Government on canals. On the Cornwall Canal, which extends a distance of 11 miles along the north side of the St. Lawrence river, the lift of water is 48ft., in six locks. All the gates are operated by 5 H.P. electric motors fitted with ingenious mechanical devices, so that in case of accident they can still be operated by hand. The canal is lighted by 2,000 c.p. arc lamps placed 400ft. apart, making the working of the canal as easy by night as by day. There is room for considerable electrical development on these numerous Canadian canals, on which has been expended up to Dec. 31, 1902, £20,500,000.

Cardiff.—A special meeting is to be held to consider a report on the means to be adopted to obtain powers for wiring premises and for the purchase and supply on hire of electric motors, &c. At the same meeting the question of the adoption of incandescent electric lamps for street lighting will be discussed.

Chelsea (London).—After the town hall has been extended, the building will be wired for the electric light.

Chile.—Plans have recently been submitted to Congress for an extensive system of railway construction involving an outlay of £5,600,000 on main lines and £2,250,000 on branch lines. The main line (called the Longitudinal Railway) is 1,894km. in length, and the 24 branch lines (eight of which are narrow gauge) total 917km. in length. Nearly the whole of the main line is built to narrow gauge, while eight of the 16 branch lines are to 1·68 metre gauge. The total length of narrow gauge lines is 320km. The scheme of public works which Congress is considering includes extensive works for water power and irrigation.

Companies to be struck off Register.—The "London Gazette" for March 18 states that the following will be struck off the register of joint-stock companies in three months if cause is not shown to the contrary:—

Berrenberg Elec. Lamp. Synd.	Gas and Elec. Lighting Corp. (Mauritius).
City of Mexico Elec. Power Synd.	Joel Elec. Carriage Motor and Battery Synd.
Crystal Palace Light Railways and Tramways Co.	Love's Elec. Traction Co.
Elec. Battery Case and Fitting Synd.	Motor Omnibus Synd.
Electric Tested Lamp Co.	Wynne's Elec Closed-Tube Tramways.
Electric Works Co.	

Dartford.—The Council will supply electric current for lighting the market stalls at 1s. 2d. per 250 c.p. lamp per week and 10d. per 130 c.p. lamp.

Dockyard Electric Lighting and Power.—The Admiralty have accepted the tender of Lapthorn & Co., at about £35,000, for the erection of an electricity generating station at Devonport. Electric current will be supplied for lighting the whole of the departments of the Royal Naval Barracks, Keyham, and also for driving all the dock and constructive machinery, and for working the railway between the two yards. The contract for the whole of the installation has been secured by Messrs. W. J. Corse & Co., Plymouth. This firm have already successfully wired the Royal Engineer Students' College, Keyham, and are at present engaged in fitting up the old flagship "Indus" with the electric light, that vessel being intended for the training of boy artificers. It is expected that Messrs. Corse's contract will be completed in about 12 months. Current will, for a time, be taken from Devonport Corporation, but as soon as the Admiralty electricity works are completed, current for lighting will be taken from that source. The whole scheme is estimated to cost about £250,000.

Dorking.—Additional electric lighting cables are to be laid, and the amount of a loan being applied for has been increased to £3,000.

Dublin.—The estimates for the year to March 31, 1905, include £100 for the electric lighting of the wholesale food market. The estimated expenditure for public electric lighting is £9,416. 15s., compared with £12,625. 8s. 7d. in 1903-4. Estimated income from private consumers is £21,500.

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Durban (Natal).—At the second annual dinner of the staff of the Corporation electrical department last month, the borough electrical engineer (Mr. J. Roberts) presiding, the chairman of the Electric Light committee (Mr. Ferguson) said the electricity supply was started in 1898 with 196 private consumers and the equivalent of 9,320 8 c.p. lamps connected. There were now 2,209 connections and 90,000 lamps. They had four traction generators aggregating 1,800 H.P., three alternating-current sets aggregating 1,725 H.P. and one 800 H.P.set, or a total of 4,325 H.P. For public lighting they had in use 700 electric incandescents and 190 1,000 c.p. arcs. There were 17½ miles of tramway cable and 7½ miles of power cable laid underground and 48 miles of overhead wires. The staff numbered 94.

East and West Ham.—The Council have adopted a recommendation for the mutual working of the West and East Ham electric tramway systems so as to avoid changing at the boundary.

Electric Driving in Jute Works.—Messrs. Cox, Lochee, Dundee, recently adopted electric driving at their works, and James Scott & Son, Dundee, have now decided to substitute electric for steam power at their works. Westinghouse gas-driven dynamos will be employed. Other jute manufacturing establishments in the district are considering the advisability of adopting electric power.

Electric Signals for Speed Testing.—At Steyning Petty Sessions last week a charge of driving a motor car at excessive speed was dismissed on the ground that the stop-watch used in the test might be unreliable. Mr. Humphrys, for the defence, said the East Sussex chief constable now used an electric signal.

Electricity in Gold Mining.—Electric generating plant and motors are being put in at the New Moon Gold Mines, Bendigo, Victoria.

Exhibition.—An interesting exhibition is about to be held at the Agricultural Hall, London, at which a large and varied display of printing, stationery and allied trades' exhibits will be made. The exhibition will be open from April 30 to May 14 inclusive, and will offer many interesting features to others beside those engaged in the printing and allied industries. There is no branch of British industry to which the application of electric driving is so important, nor one that is taking greater advantage of recent improvements in and the standardising of electric motors than the letterpress and lithographic printing and bookbinding trades.

Factory and Workshop Act Amendment Bill, 1904.—At the meeting of the London County Council on Tuesday the Parliamentary committee recommended that this bill should receive the approval of the County Council. Amongst the provisions of the amending bill are clauses dealing with the means of escape in case of fire, and other matters which require the careful consideration of owners of factories and works premises.

Fife Electric Power Scheme—The Fife Electric Power Co. have taken a new site for a generating station at Dunfermline. The contract both for buildings and plant was given to Bruce Peebles & Co., and the estimated cost of the undertaking is put at between £20,000 and £30,000.

Fiume (Hungary).—The Hungarian Government have under consideration the immediate appropriation of a considerable sum for the provision of cranes for the harbour at Fiume. It is considered probable that preference will be given to those machines which give the maximum of power for the smallest overall dimensions with electric or hydraulic motive power. The largest number of cranes required will be of the portable type with lifting power of about 1½ tons. Particulars and offers should be addressed to His Excellency Tibor de Gaal, Vice-Governor of Fiume; or to the Royal Hungarian Minister of Commerce, Budapest.

Fremantle (Western Australia).—The Canning-street and Marmion-street route has been adopted for the new Fremantle and East Fremantle municipal electric tramways. £100,000 is being borrowed for tramways and electric lighting in the form of 4½ per cent. 30-year debentures.

Gillingham.—The Council have decided to adopt alternative methods of charging for electric current—maximum demand system 7d. per unit for first hour and 2d. after, or a flat rate of 4½d. per unit. The charge for current supplied through prepayment meters will be reduced from 6d. to 5½d.

Hammersmith (London).—The Council decided on Wednesday to apply to the London County Council for a loan of £10,640, to be expended as follows:—

£2,701. 10s. 6d. on mains, £514. 0s. 10d. on street boxes and culverts, £554. 5s. 11d. on trenching, £783. 14s. 9d. on sub-stations, £1,245 on transformers, £909. 7s. 1d. on switchboard, £255. 7s. 5d. on clerk of works and engineer's charges, and £3,677. 2s. 2d. on consumers' services.

In consideration of the borough electrical engineer (Mr. G. G. Bell) having undertaken to prepare plans and specifications for the extension of the generating plant, and also of his past satisfactory services, it was resolved to increase his salary from £500 to £600 a year from 1st prox., rising by two annual increments to £700. The salary of Mr. R. H. Paterson, station superintendent, was increased from £225 to £250 per annum, and 30 other officers of the electrical department were granted increases.

The Electricity committee recommended the extension of the generating station and plant at an estimated cost of £40,000, and that plans and estimates should be at once prepared. Previous extensions had been carried out according to plans prepared by the consulting engineer (Mr. A. H. Preece), whose total commission had amounted to £2,411. 13s. 3d. Mr. Preece had intimated that he would be prepared in future to accept a retainer of 50 guineas per annum, and when engaged upon work £2. 2s. per hour, or £10. 10s. per day of six hours in London, or £3. 3s. per hour or £15. 15s. per day out of London. The committee thought the extensions could be entrusted to Mr. Bell, and recommended that he be instructed to prepare plans and estimates for the proposed extension; also that Mr. Preece should be notified that the arrangements entered into between himself and the late vestry in 1896 would now be terminated. The recommendations were adopted.

Mr. CHAMBERLAYNE (chairman of the Finance committee) stated that the accounts of the electricity undertaking would show a satisfactory profit on the year's working, but it was improbable that there would be any sum available for relief of rates on account of the conservative policy of the Electricity committee in defraying what was really loan expenditure out of revenue.

Mr. BELL reported that, as the result of using hot air forced draught on one of the boilers a considerable saving had been effected, and he advised that one of the Babcock and Wilcox boilers be fitted with the same apparatus at a cost of £495, in order that cheap anthracite coal may be used instead of best Welsh. This was agreed to.

Hampstead (London).—The Lighting committee have been authorised to sell some of the old plant no longer required at the electricity station.

Hampton.—The Highways committee, who have been considering a tender of the Twickenham and Teddington Electric Supply Co. for public lighting, has requested the company to place experimental electric lights in lanterns. The company's plan for a proposed sub-station in the district have been approved. The Hampton Court Gas Co. has received notice to determine the contract for street lighting on Sept. 29.

Hanley.—It was reported to the Corporation on Tuesday, in regard to the recent application for sanction to a loan of £17,600 for the electricity department, that the Local Government Board had intimated that

They would defer giving sanction for the £5,000 for new generating plant, £600 for superheaters, and £200 for new switchboard until the tenders and full particulars were submitted to them. The Board learned that the proposed loan included a large sum for excess expenditure, a part of which was incurred seven or eight years ago. They had, however, decided to sanction the loan in respect of this excess expenditure, subject to the deduction of £649, approximately the amount of principal which would have been repaid if the loan had been raised at the date of the execution of the works. In accordance with this decision the Board formally sanctioned a loan for £11,151, to be repaid within 24 years.

Heckmondwike.—The price of electrical energy has been reduced to 4d. per unit.

Hindley.—The Council are applying for a year's extension of their provisional electric lighting order, 1901.

Honley.—The electricity works were opened on Monday.

International Motor-Boat Competition.—Regatta week at Kiel (Germany), which begins on June 22, will be notable for a series of motor-boat races. The boats will be divided for competition purposes according to tonnage and motive power adopted, and the prizes will include a valuable trophy given by the German Emperor. Particulars are obtainable from the Automobile Club, 4A, Sommerstr, Berlin. It is stated that the competition is directly inspired by the German Emperor, who will have an entry in one of the classes of a motor boat built in the United States.

Inverness.—Edmundson's Electricity Corp. have selected a site for the generating station, and it is expected a supply of current will be available at the end of 1904.

Leek.—The Council have fixed the following charges for current for power:—650 units and over per quarter, 1½d.; 520, 1¾d.; 390, 2d.; 260, 2¼d.; motors consuming less than 260, 2½d. per unit.

Liverpool.—Last year the Corporation electricity department supplied 26,015,062 units of current for lighting, power and traction at an average price of 1¾d. per unit. The reserve fund is now £104,277, £2,000 is annually contributed to the city fund and £29,910 granted in relief of rates.

Llanrwst.—The committee appointed to consider the purchase by the Council of the undertaking of the Llanrwst Electricity Supply Co. will report to the next meeting.

London County Council.—At Tuesday's meeting it was agreed to loan £25,451 to Hackney and £19,000 to St. Pancras for electric lighting purposes.

St. Marylebone Electric Lighting.—The Finance committee brought up an urgency report on the application of Marylebone Council for a loan of £1,365,000, purchase money for the Marylebone undertaking of the Metropolitan Electric Supply Co., and a further £460,000 for purchase of a site for buildings, mains, &c. Having regard to the view of the committee that it is desirable that the present system of finance, under which the Council practically provides the funds required on loan for the local authorities, should be continued, the Finance committee urge that

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the Council should seek powers in its Money Bill, 1904, to raise temporarily the loan of £1,365,000 by means of a special issue of London County bills. At a future date when the financial situation becomes sufficiently favourable, the Council could replace these bills by stock to provide for the permanent loan to Marylebone Council. The committee recommended that this course be adopted on condition that the Borough Council withdrew from its bill the clauses empowering them to issue stock. With regard to the moneys required for new works, the amount during 1904-5, would probably not be more than £100,000 and could be advanced out of the ordinary provision made for loans.—The report was agreed to.

Highways Committee.—The new Highways committee will consist of the following: Messrs. J. A. Baker, R. M. Beachcroft, E. Browne, A. F. Buxton, J. W. Cleland, Capt. F. Hemphill, N. W. Hubbard, W. C. Johnson, Sidney Low, Earl of Malmesbury, I. H. Mitchell, R. C. Phillimore, D. S. Waterlow, T. Wiles and T. McKinnon Wood.

Drury Lane Theatre.—The Theatres and Music Halls committee are serving a notice on the Drury Lane Theatre Co. containing 143 requirements, amongst them the substitution of electric lighting for gas throughout the building and the improvement of many of the present electric lighting arrangements.

Ludlow.—The Council are considering a communication from the Local Government Board stating that the electric lighting and refuse destructor scheme, for which the Board were asked to sanction a loan of £8,250, is incomplete, and that no evidence had been given that the scheme would be self-supporting.

Lytham.—A poll recently taken on the electric lighting question gave 133 ratepayers in favour of the electric lighting order being carried out by the Council and 797 against. Seventy-nine ratepayers promised to take electric current.

Manchester Southern Tramways Co.—Ashton-upon-Mersey Council have given notice of intention to purchase the undertaking of the company which lies within the Council's district.

Mansfield.—Application has been made for sanction to a further loan of £15,000 for electricity supply.

Mexborough.—When it was proposed to establish electricity works in this district much opposition was offered by those who feared the scheme might not be a financial success. We are, therefore, glad to learn that there is every sign of the undertaking proving a distinct success. The recent connection made with the G. C. Railway from the Council's works means an increased income, and this is only one instance of the favour in which electric lighting is held. The demand on the works leaves a reserve of between 70 H.P. and 80 H.P., which, whilst enough to carry the lighting through during the summer, will be totally inadequate to meet next winter's demand, especially as several large consumers are about to be connected. The demand for current and the number of private consumers have increased 100 per cent. during the past nine months. Extensions of the plant are therefore necessary. A further £4,000 to £5,000 will be required to carry out the necessary extensions. When these are completed a reduction in price from 5d. to 4½d. per unit and the abolition of meter rents will be announced, and this is expected to bring many property owners and householders on to the service. In large measure the progress and popularity of the undertaking is undoubtedly due to the Council's chief electrical engineer, Mr. J. Senior.

Municipal Telephony.—The Secretary for Scotland has sanctioned the borrowing of a further £50,000 by the Glasgow Telephone committee for connecting additional subscribers, &c.

Municipal Trading in the Far East.—According to an article in the "Celestial Empire," municipal trading is viewed with as much apprehension in Shanghai as in Britain. A numerously attended public meeting recently resolved that the Municipal Council had exceeded their rights in regard to the supply of electric fans and other fittings. It is stated that electrical contractors are condemned without cause by certain municipal officials, that contractors' wiring is only passed after repeated tests and that customers are thereby prejudiced and the contracting firms seriously injured. On the other hand, it is alleged that municipally-wired installations are at once connected, in many cases in spite of indifferent work and materials.

Musselburgh.—The Council have decided to erect about 20 arc lamps. Current will be supplied by the National Electric Construction Co. (who are erecting a generating station) at 2¼d. per unit.

Pembroke (Co. Dublin).—The District Council last week decided to adopt the electric lighting extension scheme prepared by the consulting engineer (Mr. Robert Hammond) and to apply for a loan of £25,000.

Portsmouth.—Messrs. Kincaid, Waller, Manville and Dawson have been asked to prepare a report upon the present condition of the electricity supply works.

Radcliffe.—The charge for electric current for private lighting has been fixed at 5d. per unit.

Saffron Walden.—The Board of Trade have granted the Council's application for a provisional order. Plans and specifications for the electricity works have been prepared by Messrs. Foote and Milne, and are to be submitted to Messrs. Preece and Cardew for report. Estimated capital expenditure £9,150.

Salford.—An inquiry was held on Wednesday into the application of the Corporation for power to borrow £25,000 for the electricity department. The town clerk (Mr. L. C. Evans) and the borough electrical engineer (Mr. C. D. Taite) gave evidence. The total capital expenditure of the electricity undertaking is now £566,884.

Scarborough.—A portion of the electric tramways system will be opened for traffic on 30th inst.

The Town Council have a small electric lighting plant at the refuse destructor, and Mr. J. Shiress Will, K.C., was consulted, advises that the Corporation are not entitled to supply electric energy from this plant for street lighting. Scarborough Electric Supply Co. are supplying current for lighting and power under their provisional order, 1891.

Slough.—In future the price of electric current will be 6d. per unit for private lighting.

Smokeless Fuel.—A claim is made by the Compagnie des Charbons et Briquettes of Blanzy, France, that they are the owners of a practical system for producing a briquette, the product of coal, which will give out the best quality of heat without smoke or dust, at a cost not greater than ordinary household coal. It is also stated that experiments are being made on a considerable scale for manufacturing briquettes for use in large firing operations. The new fuel is said to be made of coal dust and oil treated by a secret process which renders it smokeless.

Particulars have also been recently published of an electrical process by which peat can be converted into hard smokeless fuel, capable, it is said, of holding its own with the best Welsh coal. An initial plant is, according to one account, about to be erected in Ireland.

South Lancashire Tramways.—A new section of this tramway network will shortly be constructed, joining up the Farnworth Council's lines with Salford Corporation's system at Swinton, via Little Hulton, Worsley and Walkden.

Southend-on-Sea.—Alternative plans for lighting the famous pier have been submitted by the borough electrical engineer (Mr. W. E. J. Henan) and are under consideration by the Council. Extensions to the mains and feeders have been authorised at a total estimated cost of over £2,700.

Telephone in Buenos Ayres.—There has been some friction between the municipal authorities of this city and the telephone company on the subject of the placing underground of the telephone wires. Says the Buenos Ayres "Standard":—

The placing of telephone wires underground, desirable from every point of view, should be everywhere encouraged to the utmost extent, and especially in cities like Buenos Ayres, where overhead trolley wires extend in every direction. As these trolley wires have been permitted, the ordinance requiring their effectual protection should be thoroughly carried out by insisting upon the latest and most efficient methods of protection instead of the antiquated and very inefficient provision which has been allowed. Encouragement should also be given to the telephone companies to put their wires underground. The expense involved is, of course, great, and this should be taken into consideration. The practice, however, in Buenos Ayres at present is to discourage such work by special imposts, such as the charge of $100 per square [yard] for opening the streets and sundry other charges, in the aggregate reaching considerable sums if work is done on an extensive scale. It follows that without inducement telephone companies are likely to postpone laying down extensive systems of underground plant, and to omit them altogether when possible, if they find that instead of being encouraged they are, as is the case in Buenos Ayres, practically fined for so doing. The causes for a defective telephone service (continues our contemporary) are many, and increase with the number of subscribers. The trouble may be in the telephone itself, in the battery to which it is connected, in the installation, wires, &c., in the subscriber's house, in the line wire outside connecting with the exchange, in the jointings of this wire, in the insulators, in the innumerable connections, in the lightning arrestor and cross-connecting boards, or in that most complicated piece of mechanism known as the switchboard. Then the operators are not perfect in their duties, or the subscribers considerate in their demands; it, therefore, approaches the miraculous that communication is possible at all to any large number of the thousands connected, and it is only through constant watchfulness that the many recurring faults are ascertained and remedied. Duly-considered municipal encouragement should consequently be given with regard to such an expensive feature as the placing of wires underground.

In Latin countries the value of time is not greatly appreciated, and concentration of speech is not a characteristic. The result is, as shown by actual observation and test in Buenos Ayres, that communications occupy on an average twice the time they do in New York, and the average is about twice as many communications per day per subscriber. The practical outcome of this is that a switchboard operator in Buenos Ayres takes care of only half the number of subscribers that one in New York does, and is of but one half the value. The Union Telefónica has expended over £100,000 in the past five years in new switchboards and in appliances and underground plant in Buenos Ayres, and is preparing for a further expenditure of a like amount. It is changing its subscribers' single lines to metallic circuits, enlarging the central exchange and adding to the

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technical staff. This skilled labour it has been found impossible to obtain in Buenos Ayres to anything like the required extent, and experienced men are being continually engaged and sent in from Europe. The comparison of the rates in Buenos Ayres (our contemporary concludes) with those in force in London, where the service is certainly no better than here, and with those in New York, where the service is probably the best in the world, is certainly in favour of the subscriber in Buenos Ayres. The general rate per annum in each case is as follows:—London, £17 ($195 m(n.); New York, $183 gold ($430 m n.); Buenos Ayres, $180 m n. The Union Telefónica has nearly 9,000 subscribers connected with Beunos Ayres; the National Telephone Co. in London about 30,000. In New York there are nearly 120,000, which is an indication that the quality of the service and not the rates charged is the controlling factor.

Telephone Users' Protection Association.—Old times seem to be revived in the announcement that another Telephone Users' Protection Association is to be formed—and at Manchester, too. The promoters, it is stated, are anxious to "make the Association a national concern—a powerful organisation to withstand not only the National Telephone Co. but also the Mutual Telephone Co. and other competitive companies which might succeed in obtaining licences." Mr. F. F. Bennett presided over a meeting of the subscribers to the Associaton, and is reported to have said that "there is some terrible opposition at work to prevent the Manchester Corporation from allowing the establishment of a competitive system in the city."

Tipton.—The Council have refused consent to the South Staffordshire Tramways (Lessee) Co. using steam power on their lines for a further period, and the company have been asked to carry out their agreement to electrically equip the lines between Dudley and Wednesbury.

Tiverton.—The question of accepting a tender for the erection of electricity station buildings has been adjourned for a month to enable the engineer and surveyor to consider the advisability of including a refuse destructor in the scheme.

Victoria (Australia).—The "Australian Mining Standard" says:—

The Victorian Electric Light, Heat and Power Distributing Corp. and five other firms have formed a syndicate with a present capital of £10,000, and have offered to supply electric current in bulk to the Government and the municipalities at 1d. per unit. It is proposed to supply current for operating the suburban railways, &c. Victorian brown coal will be used in the generation of electric energy. If the Government undertake to consume 10,000,000 units per annum for 10 years the syndicate agrees to spend £500,000 on developing the brown coal deposits.

Walthamstow.—The work of constructing the permanent way of the Council's electric tramways has been started.

Watford.—The Board of Trade have declined to grant the Council's application for a provisional electric lighting order for extending the area of supply, except in respect of so much of the urban district as is not included in the 1897 order.

Willesden.—It is announced that a writ has been issued against the Metropolitan Electric Supply Co. to restrain them from supplying electricity in the parish, contrary to the provisions of their acts and provisional orders.

Windsor.—The charge for electric current has been reduced by the Windsor Electrical Installation Co. from 6½d. to 6d. per unit.

Workhouse Lighting.—A communication has been received by the Wolstanton and Burslem Guardians from the Local Government Board with reference to the proposal to adopt electric lighting at the workhouse.

The Board state that they are not prepared, as a matter of course, to sanction the substitution of electric for gas, in an existing building which is already sufficiently lighted, and they requested to be informed of any special reasons which render it desirable that the change should be made. With regard to generating plant, the Board consider that, where it is necessary that Poor Law buildings shall be lighted by electricity, it is desirable, under ordinary circumstances, that the guardians obtain current from a public source rather than from an independent installation.

Dinner.—The fifteenth annual dinner of the Birmingham Municipal Technical School Engineering Society was held on Saturday. Mr. T. C. Aveling (president) in the chair.

Dr. W. E. Sumpner, in reply to the toast of "The Municipal and Technical School," said the success of the schools was indicated by the fact that more students applied for admission than they had room for. The Government grant had been much more than doubled last year. That showed that the Government was beginning to realise that technical classes should be encouraged as much as purely scientific instruction. He was glad to announce that they had secured three new lathes of the latest pattern. One came from Germany, one from America, and one from Scotland. The fact that two of the lathes came from abroad had alarmed one of the city fathers, but that had not been done with a view to benefiting the foreigner, but with a view to learning how to beat the foreigner.

Electro-Harmonic Society.—The last smoking concert of the season will be given at the Holborn Restaurant, High Holborn, London, W.C., this (Friday) evening at 8 o'clock.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1904 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date, and the Directorial Division of the new volume has been corrected up to February 11th, 1904. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates over 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. A number of large sheet Tables, Maps, &c., are included in the issue. Digest of Contents will be sent post free.

TENDERS INVITED.

Westminster Electric Supply Corp. invite tenders for the supply and erection at their Duke-street sub-station of a high-tension and a low-tension switchboard. Specifications (for high-tension switchboard after 18th inst. and for low-tension switchboard after 25th inst.) with forms of tender, &c., from the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to the secretary (Mr. Frank Iago), Eccleston-place, Belgravia, London, S.W., by 10 a.m. April 18. Further particulars are given in an advertisement.

The directors of the *Lancashire and Yorkshire Railway Co.* invite tenders for the supply of various articles during the 12 months ending April 30, 1905, including signal and telegraph fittings, signal, telegraph and electric light wires, wire, screws, oil, crucibles, steel sheets, tubes, plates, &c., lead, sleepers, crossing timber, &c. Further particulars and forms of tender from Mr. Duffin, Stores Department, Osborne-street, Manchester, where samples can be inspected. Tenders, addressed to the directors, to the secretary (Mr. R. C. Irwin) by 10 a.m. April 4. See also advertisement.

Partick Town Council invite tenders for one 500kw. steam dynamo, one 75kw. steam balancer (dynamo only) and extensions to main switchboard. Specifications after 28th inst. Specification and plans may be inspected at (but not obtained from) the offices of the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson), 29, Great George-street, London, S.W. Tenders to the town clerk (Mr. James Donaldson) by noon April 12. See also advertisement.

Manchester Electricity committee invite tenders for the supply of two 750kw. turbo-generators and alterations and additions to high-pressure steam piping and valves at the Dickinson-street generating station. Specifications from the secretary of electricity department (Mr. F. E. Hughes), Town Hall, and further information from the chief engineer, Mr. S. L. Pearce, electricity works, Dickinson-street. Tenders (addressed to chairman) to the Town Hall, Manchester, by noon 18th prox. See also advertisement.

Manchester Electricity committee also require tenders for synchronous motor-generators and flue-fired superheaters. Tenders by noon April 7.

Barnes Urban District Council invite tenders for storage batteries, balancer-boosters and switch gear. Specifications, &c., from the Council's electrical engineer, Mr. C. S. Davidson, High-street, Mortlake, S.W. Tenders to the clerk, Mr. J. E. Anderson, Council Offices, High-street, Mortlake, by noon April 12. See also advertisement.

The Visiting committee of *Napsbury* Asylum (near St. Albans) are prepared to receive up to April 6 names of electric light wiring contractors willing to tender for the wiring and plain fittings required for about 2,500 points at this asylum, in accordance with the plan and specification prepared by the consulting engineer, Mr. W. H. Massey, M.Inst.C.E., 25, Queen Anne's-gate, Westminster, S.W. A selection will be made and a limited number of firms invited to tender. See also advertisement.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring certain installations for direct connection with fire brigades at Belfast and Dundee. Tenders close 30th inst. Particulars from the managing director, 49, Queen-street, Glasgow. See advertisement.

Burton-upon-Trent Corporation invite tenders for the supply and erection of a 500kw. steam generating set with condensing plant. Specifications from the electrical engineer and tramways manager (Mr. P. J. Pringle), Guild-street. Tenders (addressed to chairman of Electricity committee) by April 5. See also advertisement.

The Government of *Natal* invite tenders for the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, &c., from Sir Walter Peace, K.C.M.G., Agent-General for Natal,

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26. Victoria-street, Westminster, S.W., or from Mr. Chas. J. Crofts, M.Inst.C.E., harbour engineer, Natal. Tenders to the Agent-General, or to the chairman, Tender Board, Pietermaritzburg, Natal, by May 9. See also advertisement.

Melbourne City Council invite tenders up to 2:15 p.m. May 13, for supply and delivery of one 750kw. direct-current steam generator. Specification, &c., from the Agent-General for Victoria, 142, Queen Victoria-street, London, E.C. The town clerk is Mr. John Clayton. See also advertisement.

Glasgow Corporation invite tenders for mains, cables, switchboard, distribution boards, wiring and accessories for transmission of electric power to motors and for lighting the Dalmuir outfall works. Tenders by 28th inst.

London County Council invite tenders for the erection of the superstructure of the first portion of the tramways electricity generating station at Greenwich. Tenders by April 26.

Lancaster Tramways committee require tenders (until April 14) for the construction of permanent way of tramway extension, cable conduit and drain boxes and overhead trolley wire construction.

Stockport Gas and Electricity committee invite tenders for one 500kw. steam generator. Tenders to chairman, Gas and Electricity department, by March 30.

Handsworth (Staffs.) District Council invite tenders for permanent way, pavement and roadwork, and overhead equipment. Tenders before noon March 30.

Aberdeen Electric Lighting committee invite tenders for two water-tube boilers and accessories. Tenders to the city electrical engineer (Mr. J. Alex. Bell), by noon 31st inst.

Tenders are invited until 30th inst. by *French* Ministry of Posts and Telegraphs for 80 tons of bimetallic wire and 200 tons of copper wire. Tenders to 103, Rue de Grenelle, Paris.

Reading Corporation require six double-decked bogie electric tramcars and an electrically driven water-cart. Tenders by noon April 2.

Edinburgh Corporation invite tenders by April 23 for switchboard extension and steam and exhaust pipe-work.

Leeds Tramways committee invite tenders for 12 months' supply of stores. Tenders by noon April 6.

Foot's Cray District Council invite offers for leasing their provisional electric lighting order.

The *Norwegian* State Telegraph Administration invite tenders for insulators, telephone iron, post hooks, telegraph wire, bronze wire, copper wire, &c. Tenders to "Telegrafstyrelsen, Christiania," by 12 noon of April 2. Apart from the usual Customs duties, a preference of from 10 to 15 per cent. is given to Norwegian tenderers.

TENDERS RECEIVED AND ACCEPTED.

Poplar (London) Electricity committee have received the following tenders for two turbo-generators and condensing plant:—

Bruce Peebles & Co. *(recommended)* (Parsons turbine)	£13,351
Do. do. (Willans)	10,911
Mather and Platt (Parsons)	14,890
Do. do. (Willans)	14,098
C. A. Parsons & Co. (Parsons)	14,310
Richardsons, Westgarth & Co. (Westgarth)	13,150
Willans and Robinson (Willans)	12,074

Battersea (London) Borough Council have accepted the following tenders:—

Babcock and Wilcox, two water-tube boilers, £2,300.
Mather and Platt, electric pumps and piping, £825.
C. A. Parsons & Co., spare armature for steam turbine dynamo, £700.
De Grelle, Houdret & Co., 12 months supply of arc lamp carbons.
W. H. Willcox & Co., oils and engine room stores for 12 months.
Chamberlain and Hookham and British Thomson-Houston Co., electricity meters.
McKenzie Bros., arc lamp pillars and brackets, £172. 10s.
Gilbert Arc Lamp Co., arc lamps, with hoisting and lowering gear, £187. 1s.
Simplified Underground Conductor Co., telephones for switch pillars.
G. M. Marchant, valves.
Venner & Co., special meter.

An order has been placed with Electricité et Hydraulique, Charleroi, Belgium, and Jeumont Nord, France, for 40 electrical equipments for the Lyons electric tramways, comprising motors of 27 H.P. each. An order has also been placed with the firm for 16 motors, each of 125 H.P., for traction purposes on the Metropolitan Railway of Paris, these being controlled on the multiple-unit system.

The following tenders were accepted by Loughborough Council on Wednesday in connection with their electricity supply scheme:—

H. and T. Danks (two dry-back boilers)	£1,050	0	0
Brush Co. (steam turbines and dynamos)	2,850	0	0
Brush Co. (condensing plant)	895	0	0
Wm. Moss & Sons (chimney shaft)	678	13	4

The Scottish Office of the May-Oatway Fire Appliances (Ltd.) have accepted the tender of the Aberdeen Electrical Engineering Co. for wiring a fire-alarm installation at the Aberdeen University Press, for direct connection with the fire brigade, and similar work is to be carried out at the Darien Press, Edinburgh, by Wm. Douglas (Ltd.), and at Lloyd's Printing Works, Glasgow, by Carrick and Topping.

Hammersmith (London) Borough Council accepted on Wednesday the following tenders for annual supplies for the electricity department:—

General Electric Co., carbons; W. T. Henley's Co., house-service boxes (small size 11s. 6d., large size 17s. 6d.) and for meter boxes, (25-ampere 19s. 6d., 50-ampere £1. 4s.); British Thomson-Houston Co., meters (5-ampere £2. 5s., 10-ampere £2. 7s. 6d., 15-ampere £2. 10s., 20, 25 and 40-ampere £2, 12s., and 50-ampere £2. 15s.)

Pope, Maher & Co., Pyrmont, who held a contract amounting to over £10,000 for arc lamps, pillars, &c., for Sydney public lighting, have executed a deed of assignment, and it has been agreed to transfer the contract to the Clyde Engineering Co. for completion and to allow two months' extension of time (to June 27).

Camberwell (London) Council received 17 tenders for an engine and dynamo for the electric lighting of Camberwell Baths, and that of the Alliance Electrical Co. at £355 (with an allowance of £80 for the old engine) has been accepted.

West Ham Corporation have accepted an offer of the British Thomson-Houston Company to supply 200 open type arc lamps at £5 per lamp with iron cases or £5. 5s. with copper cases.

Crompton & Co. have obtained an order for the supply and erection of the whole of the plant required for one of the new stations of the Calcutta Electric Supply Corp. The plant will include three 400kw. steam-driven sets. The value of the contract is about £40,000.

The tender of W. T. Henley's Telegraph Works Co. has been accepted for supply of cable for connecting up the Swansea Corporation and the National Company's exchanges at £306.

West Ham Corporation received tenders (from three firms) for 11 motors, &c., for the tramcar shed tool equipment and that of Witting, Eborall & Co. at £474. 17s. has been accepted.

Wigan Electric Light and Tramways committee have accepted the tender of Tickle Bros. for steel girders for the Platt Bridge tramcar shed.

Preston Corporation have accepted the tender of the St. Helens Cable Co. for the supply and laying of Dialite feeder cables for their tramway extensions.

Croydon Corporation have accepted the tender of Callender's Co. for the supply of cable for the ensuing year, and that of Babcock and Wilcox for pipe work for condensing and cooling plant.

West Ham Corporation have placed an order with Messrs. Kelvin and James White for testing instruments for the laboratory at the new generating station at £209. 2s.

Radcliffe Council have accepted the tender of D. Firth & Sons for station lighting and testing instruments.

Croydon Guardians have accepted the tender of the Edison and Swan Co. for electrical fittings and appliances for 12 months.

Westminster City Council have accepted the tender, at £85. 18s. 6d., of Messrs. Belshaw & Co. for re-wiring the city hall.

Walsall Guardians have accepted the tender of C. Ross for wiring the new wing at the infirmary at £88. 5s.

West Derby (Liverpool) Guardians have accepted the tender of Perrin, Hughes & Co. for electric light fittings, &c., for 12 months.

Walthamstow District Council have accepted the tender of the General Electric Co. for electrical supplies for the ensuing 12 months.

Dundee Town Council are recommended to accept the tender of Thomas Parker (Ltd.) for electric generators at £1,500.

Aston Corporation have accepted the tender of the General Electric Co. for a 750kw. steam generating set at £6,435.

BUSINESS NOTICES.

We are informed that in future the firm of Lacey and Sillar, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester, will practice under the title of Lacey, Sillar and Leigh.

Rhodes Electrical Mfg. Co. have opened a branch office for Scottish business at 35, McAlpine-street, Glasgow, under the management of J. T. Donald & Co.

Newton Bros., electrical engineers and contractors, have removed to larger premises at 21, Market-place, Derby.

LIQUIDATIONS, &c.

At the London Bankruptcy Court on Tuesday, statutory meetings of creditors and shareholders of M'Guire Mfg. Co. (Ltd.) were held.

The company was registered in Feb., 1901, as the European M'Guire Mfg. Co., nominal capital £20,000. The present name was adopted in Sept., 1902, and the capital increased to £40,000. The company was formed to acquire and work patents for electric motors, trucks, &c., and the consideration for the purchase was the allotment of £11,000 in fully-paid shares. The number of shares issued for cash was 12,962, and business was commenced in Sept., 1901. The company has supplied trucks to the London County Council, Great Northern and City Railway Co., the Bury and Darlington tramways and others, but a loss has arisen upon the company's trading operations. The liabilities are £13,265 (£6,871 unsecured), while assets are estimated at £5,464. A liquidator is to be appointed by the Court.

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Braby and Tomlinson (Ltd.) is to be wound up voluntarily. Mr. A. B. Bryden, 23, Bucklersbury, London, E.C., is liquidator, to whom claims by April 9.

Norwich Mutual Telephone Co. (Ltd.) is to be wound up voluntarily, and Mr. Chas. Bussey has been appointed liquidator.

Sale by Auction.—Mr. T. Kinsman (Messrs. Kinsman & Coon), St. Austell, will sell by auction on Tuesday and Wednesday next, March 29 and 30, at St. Austell electricity station, the engines, machine tools and general plant and stores. Further particulars are given in an advertisement. Catalogues can be obtained from the auctioneers.

Premises, &c., to Let.—Messrs. Waring and Nicholson, 38, Parliament-street, Westminster, London, S.W., have premises to let in prominent corner position suitable for a factory or warehouse.

An advertisement contains particulars of a suite of offices to let at 64, Victoria-street, Westminster, S.W.

Electric Signal Bells, &c.—The International Electric Co., 55, Redcross-street, London, E.C., have placed on the market a gas and water-proof iron-cased bell, which can, without the insertion of a separate lamp or other resistance, be connected direct to any electric light supply up to 250 volts. In this way the source of supply is available at any moment, and the signalling is said to be very distinct and reliable. The bells are stocked for 100 or 110 and 200 and 220 volts, but can be made to suit any voltage up to 250.

Paints, Varnishes and Colours.—The Indestructible Paint Co., 31, Cannon-street, London, E.C., are well known to electrical engineers as the makers of a variety of colours, paints and varnishes, as oil boilers and refiners, and as contractors for numerous supplies used in electricity works and other engineering and manufacturing establishments. A useful list of this company's specialities has been issued in a form that admits of its being hung up in the engineer's office for purposes of ready reference. The company's record in connection with paints of a special character should make the list particularly useful at this season of the year.

"Technics."—In No. 3 of the monthly magazine with the above title, published by George Newnes (Ltd.), there will be found a Paper on "The Education of Electrical Engineers in London," by Dr. J. A. Fleming.

Canadian Trade Index.—We have received from Mr. Harrison Watson, Canadian section, Imperial Institute, London, S.W., a copy of the latest edition of the "Canadian Trade Index," issued by the Manufacturers' Association of Canada. The index is a valuable directory of manufacturing and trading firms in the Dominion.

Catalogues, &c.—The Westinghouse Company have ready two leaflets, dealing respectively with the Three-wire System for Variable Speed Motor Work, by N. W. Storer, and a description of the Washington, Baltimore and Annapolis Single-phase Railway, by B. G. Lamme. Both publications are in their second edition.

Messrs. Holden and Brooke, West Gorton, Manchester, have ready a new list (No. 60) describing Brooke's new steam trap. The list is well illustrated.

The International Steam Pump Co., Liberty-street, New York, have just issued a handbook on centrifugal pumps of a new type. The list contains an illustrated description, together with a large amount of general information, of the three types of pumps made by this firm. The conoidal centrifugal pumps, which are comparatively inexpensive and suitable for direct driving by electric motors, are designed especially for low lifts and large deliveries. On the other hand, the volute centrifugals, working at a moderate speed, are specially intended for medium lifts (say up to 70ft.) For very high lifts, even exceeding 2,000ft. the turbine type of pump is recommended. In construction, this machine is the converse of the reaction turbine waterwheel, and is said to have a good efficiency with the highest heads and runs at high speeds.

New sheet lists of wattmeters, electric water-level indicators, small dynamos and motors, &c., are issued by Siemens Electric Appliances (Ltd.), 61-2, Watling-street, London, E.C.

Messrs. Aiton & Co., 63, Queen Victoria-street, London, E.C., have issued a new illustrated leaflet of patent centrifugal exhaust heads, which, although only on the market for a short time, have proved a success. These heads are particularly suitable for steam hammers, being made of cast iron and having no loose internal parts. The heads are already in use in several electric lighting station at His Majesty's dockyards, and in a number of industrial works.

Messrs. Ernest F. Moy (Ltd.), Greenland-place, Camden Town, London, N.W., have ready two sheet lists of shunt-regulating resistances, two styles of which (A and B) are illustrated.

An exceptionally well-arranged and nicely printed catalogue is just published of the special makes of leather belting and belting accessories for which Messrs. Fleming, Birkby and Goodall, of West Grove, Halifax, and 39, Lime-street, London, are famous. The large number of articles catalogued have each a special interest for engineers and users of machinery, who can obtain copies of the list on application.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from March 16 to 22, with the ports of destination:—

Africa—Alexandria, £199; Cape Town, £291; Delagoa Bay, £1,788 (telegraph material); Durban, £2,222 (including £626 telegraph material); Mombassa, £23; Mozambique, £165 (telegraph instruments); Port Elizabeth, £29. *Australasia*—Auckland, £108; Fremantle, £404; Launceston, £160; Melbourne, £42; Sydney, £322; Wellington, £589 (including £510 telegraph material). *Brazil*—Rio Janeiro, £2,526. *Ceylon*—Colombo, £157. *Chili*—Antofagasta, £80; Valparaiso, £115 (including £31 telegraph wire). *China*—Shanghai, £26. *Fanning Island*, £20. *France*—Paris, £226. *Germany*—Hamburg, £17. *Gibraltar*, £733. *Holland*—Amsterdam, £90; Rotterdam, £12 (telegraph wire). *Hong Kong*—£21. *India*—Bombay, £108 (including £29 telegraph material); Calcutta, £1,158 (including £155 telegraph material); *Madeira*, £2,699 (telegraph instruments). *Malta*, £190 (telegraph instruments). *Peru*—Callao, £93 (telegraph cable). *Straits Settlements*—Singapore, £3,339. *Zanzibar*, £40 (telegraph material). Total £17,992, against £20,904 in the corresponding week last year (March 18 to 24).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1902.

23,389 SCHAULI and LOEWENSTEIN. Galvanic dry cell.

1903.

1,561 ANDERS and SMITH. Intercommunication of telephones.
1,717 DOULL. Drying materials which clog or matt under compression by electricity.
2,053A ARMSTRONG and ORLING. Electro-capillary relays and the like. (Date claimed Jan. 23, 1903.)
2,112 RUNG and LA COUR. Electrostatic apparatus for relay and other recording and operating purposes.
2,162 LODGE and LODGE. Electric ignition apparatus.
2,185 MECKENZIE (Smith). Electric operating mechanism for railway and tramway points.
2,192 RAWORTH Electrically-propelled tramcars.
2,256 BOULT (Osborn Morgan Co.). Electric distribution systems.
2,343 BILL and ABBOTT. Combined switches and electro-magnetic cutouts.
2,696 SWEETSER. Incandescent lamps and switches.
2,713 HEYS (Hutchinson Acoustic Co.). Telephonic transmitters.
2,857 CLOSE and RAMSEY. Ears for trolley wires.
2,921 CRAWFORD. Operating points of electric railways and tramways.
3,102 BOULTON. Devices for indicating stopping places for electric tramcars.
3,158 COROLAN (G.E. Co., U.S.). Making coils for electrical apparatus.
3,164 PARRY. Electric distribution and switchboards therefor.
3,244 ECKSTEIN and COATES. Electrical ignition for internal combustion engines.
3,603 HOGAN. Luminous vapour electric lamps.
4,346 CAROLAN (G.E. Co., U.S.). Insulated conductors and manufacturing same.
4,675 J. G. WHITE & Co. and FISHER. Construction of conduits and boxes specially applicable as containers for underground conductors of electric traction systems.
4,732 LEITNER and LUCAS. Reversing mechanism for dynamo-electric machinery.
5,492 EVERSHED and EVERSHED AND VIGNOLES. Apparatus for measuring electrical resistances.
5,646 EWART. Arc lamps.
6,113 PAUL. Moving-coil galvanometers.
6,262 ABEL (Compagnie Anon. Continentale pour la fabrication des Compteurs de Gaz et autres Appareils). Automatically extinguishing electric lights after they have burnt a given length of time.
6,415 SADLER. Electric indicators.
6,434 SPERRYN and WOOD. Two-way tumbler switches.
6,495 CAROLAN (G.E. Co., U.S.) Systems of electrical distribution.
6,513 VICKERS, SONS AND MAXIM and WILLIAMSON. Operation and regulation of electric motors.
6,528 LEA. Insulators.
6,735 O'CONNELL. Candle fittings of incandescent lamps.
6,951 BLOXAM (Luxsche Industriewerke A.G.). Alternating current meters.
7,135 CAROLAN (G.E. Co., U.S.). Devices for suspending overhead conductors.
7,286 SIMMONDS. Holder for electric light shades.
7,461 CAROLAN (G.E. Co., U.S.). Electric circuit protecting devices
7,568 HETHERINGTON and BRITISH ELECTRIC TRANSFORMER Co. (1903). Fusible cut-outs.
7,590 MOULD. Electromagnetic mechanism for producing reciprocatory motion.

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COMPANIES' MEETINGS AND REPORTS.

Direct Spanish Telegraph Co. (Ltd.)

The fifty-second ordinary general meeting was held on Tuesday, the Marquess of TWEEDDALE, presiding.

The SECRETARY (Mr. F. T. Preddle) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN said: Gentlemen, from the report you will observe that there has been a falling off in the receipts amounting to £1,797, which was accounted for partly by the general depression in trade which prevailed during the past year, and partly—perhaps to a larger extent—by the interruption to our cables and which lasted 73 days, recalling the misfortunes which we suffered from in 1901, when, however, the interruptions lasted no less than 128 days. The cost of these repairs, £10,591, has been debited to the reserve fund. Owing to the electrical disturbances created by the tramways in Bilbao it has been found necessary to convert what is now the landing place of our cables on the Spanish coast into a regular station, followed by the erection of overhead wires connecting the new landing station with the office in the town of Bilbao. This has been done at considerable cost, amounting to £1,467. Both this sum and that for repairs, of £10,591, have been debited to reserve, which now, together with the £5,000 placed to that fund on Jan. 1 last, amounts to £48,620. The International Telegraph Conference held last May led to a reduction in our rates to Spain, Portugal and Gibraltar of ½d. a word. We hope that a sufficient increase of traffic will thereby arise to recoup us for the loss which is certain to be entailed by that reduction, but I must say that our experience does not warrant us in being very sanguine in this respect. Turning to the accounts, it will be seen that there is a somewhat large increase—namely, £270—under the head of salaries at stations. This is due to the new office at Arrigunaga to which I have just referred—the station which it has been necessary to place there on account of the electrical disturbances which I have just mentioned. Happily, it was possible to effect substantial economies in stations abroad and also in London, thus reducing the net increase in the ordinary working expenses to an amount of £95. The only other matter of interest to which I have to refer is the expiring of our licence on the shores of this country, which occurred on 31 Oct. last. We have since been in negotiation with the Government, and it is hoped that before long we shall have entered into an arrangement which will be satisfactory to the Government and to ourselves. I may mention that the licence to land on the Spanish coast is without a time limit. In conclusion, I have only to say that our cables are in very good working order, and that the receipts show, since the commencement of the year, a marked improvement. I now move the adoption of the report and accounts.

Sir JOHN DENISON-PENDER, K.C.M.G., seconded the resolution, which was carried unanimously.

Resolutions approving the dividends, and re-electing the retiring director, Mr. F. Alexander Johnston, and the auditors, Messrs. Deloitte, Dever, Griffiths & Co., were carried, and a vote of thanks to the chairman and directors, terminated the proceedings.

British Insulated and Helsby Cables (Ltd.)

The eighth ordinary general meeting was held on Wednesday at Liverpool, Mr. E. K. MUSPRATT presiding.

The SECRETARY read the notice convening the meeting and the auditors' certificate.

The CHAIRMAN said all would agree that under the circumstances the report was very satisfactory. The gross profits were £129,446, against £127,695 in the previous year, notwithstanding lessened output and a competition even more severe than ever previously encountered. One adverse circumstance had been the increase in the price of rubber, an article which was largely used in the company's manufactures. Notwithstanding these adverse conditions they were able to present a better profit than in the previous year. Out of gross profits they had paid debenture interest, £22,500, against £16,400 in 1902, and as the plant had been increased they also thought it desirable to increase the amount written off for depreciation, which was £18,500, against £17,500. They had also provided £5,000 towards the reduction of debentures, making, with the sum previously put aside, £10,000. They had also placed £8,500 to a special reserve fund to meet contingencies. This was a conservative policy; and although they had earned it they did not recommend a dividend to the same amount as last year, the amount declared making the total dividend 8 per cent. for the year, against 10 per cent. for the previous year. In coming to this decision they had in mind the uncertain state of the money market and the depression of trade, and a further important reason was that they considered it desirable to increase the cash balance. The increase in expenditure on buildings, plant and machinery had been in regard to the erection of a telephone cable factory at Prescot, an entirely new building, and its equipment. The output they were now prepared to make from this department would be three times that of which it had been capable hitherto, and having regard to the statement of the Postmaster-General in the House of Commons that the Post Office proposed to expend some £3,000,000 upon the extension of the telephone service, he thought the shareholders would agree that the expenditure upon this department was justified. New machinery had been added to Prescot works, Helsby works and the new works at Edge-lane, Liverpool. Their new Edge-lane works had built a new switchboard for the central telephone exchange in London, which was a most admirable piece of electrical apparatus reflecting the greatest credit upon its designer and upon those who had executed the work. It had given great satisfaction, and the directors believed this was a part of the business which would grow. The investments of the company were principally in the Midland Electric Corp. for Power Distribution (Ltd.) and in Australia. The former investment had been reduced from £227,000 to £163,000, but on the latter (the Electric Supply Co. of Victoria) they had increased from £198,508 to £246,694. This expenditure had sufficed to practically complete the scheme of lighting and tramways at Bendigo, where the electric tramways were started in May last, and where the lighting had been gradually coming into operation during the remainder of the year. The monthly returns showed the undertaking to be earning good profits. Mr. James Taylor (their vice-chairman) had paid a visit to Australia during the year and would be pleased to give the shareholders information upon what he had observed in regard to the working of the undertakings in which the company was interested. The West Australian Company was earning a small profit, but with regard to Coolgardie, that place had, to some extent, been superseded by Kalgoorlie, owing to the discovery in the latter district of goldfields which offered greater attractions. Their special reserve fund now stood at £85,000, and would be available if required to meet depreciation upon the realisation of investments. It was difficult to say much with regard to the future, because, in face of the general depression of trade and the state of the money market, they ought not to be too sanguine. Owing to dear money municipalities and companies were not as ready to enter upon electrical undertakings as they had been. At the same time the increase in the applications of electricity would be very great in the future, and all things considered, he trusted the company would have in the current year as good business as was enjoyed last year. They could not have manufactured so cheaply except for the improved plant and machinery, nor could the economies effected have been realised but for the energy and efficient working of the managers, engineers and employés. The thanks of the company were due to them for the way in which they had carried on the business in the past year. He moved the adoption of the report and accounts.

Mr. J. S. HARMOOD BANNER seconded the motion.

Mr. JAMES TAYLOR referred to his visit to Australia for the purpose of examining the working of the undertakings in which the company held an interest. At Coolgardie, which he first visited, he had unfortunately found that, owing to the discovery of gold at Kalgoorlie, a large proportion of the population had migrated, and only some 4,000 persons were left in the former place. The electrical undertaking, though still running, was earning a small profit only. If the depletion at Coolgardie continued it might be necessary to stop the working, in which case he feared some loss would be involved to the company. A very different aspect, however, was presented at Bendigo and Ballarat. At the former place the electric car system had been got to work, and there was no doubt whatever that it would produce a good return. He was glad to report that the work had been so admirably done as to reflect the greatest credit upon all connected with it, and, in fact, all towns in Australia regarded it as a model of what an electric tramway should be. At Ballarat, when he arrived there, the tramway system was a horse system which had been running without profit. Since it had been taken over by the company, even in continuing the horse tram system, profits had been made. Not only had this been done, but the company had secured a concession for 30 years, and when the conversion to an electric system had been carried out he had no doubt it would prove as successful as that of Bendigo, and the company would possess two most valuable assets in Australia.

The resolution was carried unanimously.

The dividends were then agreed to, the retiring directors (Messrs. J. S. Harmood Banner and J. Carlton Stitt) were re-elected, and the retiring auditors re-appointed. The proceedings closed with a vote of thanks to the chairman and directors.

BRITISH ELECTRICAL SUPERANNUATION FUND.—At the annual meeting on 16th inst. Mr. Tegetmeier presided, Sir Ernest Spencer being absent through indisposition. During the past year the fund has made satisfactory progress; 12 new contributing companies have joined, the most important being the City of Birmingham Tramways Co. The number of members on the fund at the end of the year was 183, an increase of 38. Mr. Tegetmeier said he was sorry that expectations of a large measure of support outside the immediate circle of the British Electric Traction Co.'s organisation had not been realised. The total amount of contributions from members at Dec. 31 was £3,904. 18s. 7d., and to meet liabilities the fund had total assets £7,885. 2s. 7d., or more than double the amount necessary, even if the liabilities became an immediate claim. The investments yielded an average of nearly 4 per cent., and were in perfectly safe investments. Withdrawals had been rather considerable during the year, but it was not likely that this rate would continue. Expenses of management were small. The retiring managing trustees were Sir Ernest Spencer, M.P., Mr. W. J. Greer and Mr. G. Cornwallis-West (for the companies), and Mr. J. McLeod, Mr. B. Kingsford and Mr. W. G. Bond (for contributors). Their places have been filled by the election of the Hon. Sir C. Fremantle, Viscount Emlyn and Mr. W. Somers Schuster (for the companies), and Mr. E. A. Chudleigh, Mr. A. F. Harrison and E. Hopwood (for the contributors). He concluded by moving the adoption of the report, which was seconded by Mr. Raworth and adopted unanimously.

BRUCE PEEBLES & CO. (LTD.)—At the meeting on Wednesday Mr. W. C. Peebles said the results of the year's trading might be considered very satisfactory in view of trade generally being very much depressed, and that the profits were earned in the old works. Last month their new works at East Pilton were started, and manufacturing would be carried on under much more favourable conditions than formerly. At present they had work in hand to keep them fully employed for some time to come, including important Government contracts. A dividend of 6 per cent on the ordinary shares (less tax) payable 31st inst. was declared.

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CHATHAM AND DISTRICT LIGHT RAILWAYS CO.—At the meeting yesterday, the report for the half-year to Dec. 31 stated that the receipts were £16,252. 3s. 9d. and the expenses £11,546. 17s. 11d. The directors recommend payment of the preference dividend for the half-year, carrying forward £556. 6s. 9d. The receipts show satisfactory progress. 4,201,619 passengers were carried, the average receipts per passenger being 0·901d., compared with 3,344,522 passengers and 0·887d. in the June half-year. The track at Chatham Hill is being doubled. An agreement has been concluded with the Kent Electric Power Co. whereby in July that company purchases the power station plant and supplies current to the tramways on favourable conditions. £3,000 deposit has been paid on account of the purchase money.

CITY OF BIRMINGHAM TRAMWAYS CO.—At the meeting last week, the chairman (Mr. E. Garcke) said during the past year they had carried nearly 50,000,000 passengers, an increase of 2,000,000 for the year. The receipts had been £264,556, an increase of about £10,000. The net earnings were £81,978, increase nearly £30,000. Out of net profits they had paid £12,000 as preference dividends and £8,400 as dividend on the ordinary shares, leaving a surplus of £51,559, which was carried to reserve. They now ran more than 100 cars in the early morning at workmen's fares. The paid-up capital was £584,000. Their total capital outlay was £594,275. Their investments (£57,700) included a deposit with the British Electric Traction Co. of £50,000 against security of debentures in various tramways undertakings. On the subject of the municipalisation of the tramways, Mr. Garcke said it was not the desire of the directors to put any obstacles in the way of municipalisation, but the company could not afford to sacrifice any of its established interests in order to make municipalisation practicable. The company would have a not inconsiderable mileage of tramways outside Birmingham even after the leases from the city had expired; but the intention of the directors was to construct the newly-authorised lines and to convert all the lines outside the city as soon as possible to electric traction on the overhead system. The directors regretted the decision of the Corporation to municipalise the tramways within the city, the effect of which was to spoil what might have been one of the finest systems of electric tramways in the country. Whatever might be the advantages of municipalising the tramways in other cities, he failed to see how those advantages could be secured in the case of Birmingham, as the breaking up of the through routes at the boundary must necessarily cause inconvenience to the travelling public, and it was certain to militate against the best economic results. The company would endeavour to make arrangements with the Corporation for through running powers. An arrangement had been made with Aston Manor and Erdington Councils for leasing the tramways in those districts, and in the case of Erdington they would also supply electricity for lighting and other purposes.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—The directors' report for 1903 states that up to Dec. 31 the equivalent of 54,805 8 c.p. lamps was connected to the mains, compared with 40,699 in 1902. The net profit was £6,026. 13s. 3d. added to the profit from installation work, &c., and £202. 17s. 7d. brought forward from last year. After providing for interest, putting £1,000 to depreciation, and allowing for interim dividend at the rate of 4 per cent. per annum already paid, there is a balance of £2,452, out of which a dividend is recommended at the rate of 7 per cent. for the half-year, making 5½ for the year. £400 is put to reserve and £302 carried forward. The agreements with the Hythe and Sandgate local authorities for working their provisional orders have been carried into effect, and the capital expenditure for Hythe and Sandgate is now included in the accounts for the first time. A further issue of £25,000 preference shares has been made to cover extensions in Folkestone, Hythe and Srndgate, and to pay off the bank overdraft. These shares were offered to the share and debenture-holders of the company, and were well subscribed. There is £3,865 still unallotted.

HARROW ELECTRIC LIGHT AND POWER CO.—At the recent meeting the chairman (Mr. J. N. Stuart) said the equivalent number of 8 c.p. lamps connected during the year was 1,769, and the units sold to private consumers 229,462. Works costs amounted to 1·87d. per unit, against 2·24d. in 1902 and 3·02d. in 1901. The total costs were 2·87d. per unit for 1903, against 3·43d. and 4·32d. in 1902 and 1901. In view of the reduction in the charge for current, the directors did not consider it advisable to pay more than 3 per cent. They had decided to introduce the maximum demand system on Jan. 1, which meant a substantially reduced rate to all regular consumers. They had found it necessary to adopt a scheme of steam condensing and superheating at an expenditure of about £2,000, but there would be a considerable saving in fuel and an increased efficiency of their boiler power. The directors would have to issue £3,000 more ordinary shares to pay for the improvements.

LANARKSHIRE TRAMWAYS CO.—The chairman (Mr. A. R. Monks) at the meeting last week, said the profits, after deducting interest and contributions payable to local authorities, amounted to £5,219. 1s. 6d., of which £1,000 has been placed to depreciation. A dividend at the rate of 4 per cent. from date of opening (July 22) to Dec. 31 was declared. The company's power station not being quite ready for running at the time of opening, current was purchased temporarily from Motherwell Corporation. The station was now complete. They were now ordering 10 additional cars, and the extensions authorised by the Lanarkshire Tramways Order, 1903, would be proceeded with shortly.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The directors in their report for the year to Sept. 30 last state that an increase of profit has been made, notwithstanding that no revenue has as yet been earned by the stations for transatlantic telegraphy, the commercial working of which is looked upon as likely to prove the most profitable branch of the business. The report proceeds:—

"During the past year Mr. Marconi has been carrying on a number of experiments in connection with the long-distance work, the results of which make for the improvement and perfecting of the long-distance communication. The application of some of these improvements to a station equipped on a commercial scale would involve considerable outlay; and in the absence of those facilities from the Post Office which would alone render such an outlay of utility, your board has not thought fit to authorise the equipment of a new transatlantic station embodying all those improvements, which would render practicable good commercial working both by day and night, on a scale which, for speed and reliability, would compare with that of a transatlantic cable. The collection and distribution of telegrams throughout the United Kingdom being a monopoly of the Postmaster-General, it is obvious that it is impracticable for this company to carry on a transatlantic service of any advantage without the assistance of the postal telegraph service, upon which it is dependent for the collection and transmission of its messages. Such facilities, similar to those granted to the cable companies, have not yet been obtained, but the course of recent negotiations seems to offer some prospect of satisfactory arrangements. If and when these arrangements are concluded, the equipment of a transatlantic station on a commercial basis, capable of rendering a service at least equivalent in speed and reliability to the service rendered by any single cable, will be proceeded with. The actual erection of the station will, it is expected, occupy not more than six months; so that the shareholders may hope to see transatlantic wireless telegraph stations established on a commercial basis, and earning the very considerable revenues which may be anticipated from this source, within a few months of our obtaining from the Post Office the facilities for which we ask. Should satisfactory arrangements not be offered by the British Government, the European station will be erected in one of those Continental countries which have already agreed to give facilities for inland distribution and collection of our telegrams, similar to those which we are asking from His Majesty's Government.

"In July last a new contract was entered into with the Admiralty, covering the use of our system throughout His Majesty's fleet. Provision is made in the contract for the payment annually of a royalty, considerable orders for further apparatus have already been placed, and it is hoped that the relations which now obtain between the Department and ourselves will result in mutual benefit. In pursuance of the contract a number of H.M. ships have already been equipped with tuned apparatus, and, in a demonstration which took place of long-distance wireless telegraphy, messages were received from Poldhu on H.M.S. 'Duncan' throughout her voyage from Portsmouth to Gibraltar. These tests were watched by naval officers on the ship at Poldhu, and in the report to the Admiralty testimony was borne to the fact that other ships of H.M. navy, within range of Poldhu station, but not similarly tuned, were unable to intercept the messages, and were not interfered with in their own work by them.

"In Canada a bill has passed the legislature providing for the equipment of wireless telegraph stations in the St. Lawrence. All these stations, subject to the approval of the Imperial Government, to whom all proposed wireless telegraph schemes are submitted by the Colonial Governments, are to be equipped on the Marconi system, under a contract to be entered into with our Canadian company.

"The Italian Government has been very active in the extension of wireless telegraphy throughout Italy. A number of stations have been erected during the past year which are available exclusively for the use of ships equipped with the Marconi system, and we have again to record our gratitude for the continuous support and assistance of the Government of His Majesty the King of Italy. The site for a high-power station near Pisa, for communicating with the Argentine Republic and with the company's high-power stations in the United States and Canada, has been selected by Mr. Marconi, and some of the plant for this station is already on order.

"Arrangements have also been made for a wireless telegraph service between Italy and Montenegro, in the benefits of which your company participates.

"A wireless telegraph station has recently been erected in Amsterdam in close proximity to the Stock Exchange, and press and other messages are being transmitted between that station and a station in England. It is hoped that when the necessary facilities have been obtained from the Post Office here, the service already entered upon will be greatly extended, and that a considerable revenue will result. The company is able to transmit messages at a lower rate than they can be transmitted by existing arrangements, and as there is often considerable delay in the telegraph service between England and Holland, it is hoped that both on the score of cheapness and despatch our service will represent considerable advantages.

"Negotiations have for some time past been going on between the company and the Board of Trade for the equipment of lightships with wireless telegraph apparatus, and we are informed that a contract relating to this service is in preparation.

"Negotiations with a group of Danish financiers were entered into for the connection of Iceland with Europe by wireless telegraphy, that country being at present isolated from the world so far as telegraphic communication is concerned. The negotiations are at present temporarily suspended, partly owing to the inability to obtain from the English Post Office the facilities for an inland service which are necessary, and partly to other difficulties which it is hoped will be removed. A deputation of the National Sea Fisheries Protection Association waited upon Mr. Austen Chamberlain in March last to ask for inland postal facilities for a wireless telegraph connection with Iceland, which, however, were not granted. It is hoped that this question of inland postal facilities for the Iceland

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connection will receive settlement as part of the general questions under discussion with the Post Office.

"The natural extension of our business in the last three years and the general adoption of the Marconi apparatus as the standard system of wireless telegraphy for ship to shore service throughout the world have attracted the special attention of the German Government, with the result that a conference for the regulation by international legislation of wireless telegraphy for shipping purposes was proposed to the Powers by that Government in May, 1903, and took place at Berlin in August. The proposal for this conference, while indicating recognition of the very powerful commercial position which our company has secured, was in itself a menace to our interests, and engaged the serious attention of the directors. As a result of representations to the British Government, they accepted the invitation of the German Government on the condition that the conference should take the form of a preliminary discussion only, and that the delegates should not have power to pledge their Governments to any particular course of action. The majority of the Powers represented were, in the main, in favour of inter-communication between all ships equipped with wireless apparatus, irrespective of the so-called system employed, but there were two most significant reservations—those of His Majesty's Government and of the Government of His Majesty the King of Italy. Having regard to the important part played by these countries in the shipping of the world and to the shipping routes which they with their Colonies command, it is felt that even if the recommendations of the other parties to the preliminary conference should be adopted at a subsequent conference, the effect upon our business will not be of great consequence while England and Italy remain outside the arrangement.

"The international organisation of ship and shore stations for sea telegraphy has been very greatly extended. [A long list of shipping lines whose principal vessels are equipped with Marconi apparatus follows.]

"Fifty-four shore stations are now installed commanding the principal shipping routes, these stations being available exclusively for communication with ships equipped with the Marconi system. Among them are stations worked by the British Admiralty, the Italian Admiralty and Lloyd's. As the stations worked by the Governments and Lloyd's are increased, an extension of the arrangements for working exclusively with ships equipped with our system will ensue.

"The factory at Chelmsford is now more fully employed than in any previous era of the company's existence. Orders for apparatus on a large scale have been executed, and the work now in hand, without further orders, will keep the factory fully employed for many months to come.

"On Feb. 18, 1903, a committee of members of Government departments, presided over by Mr. Bonar Law, sat for the consideration of evidence on wireless telegraphy. The nature of any decision arrived at has not yet been communicated to us.

"The powers given to the directors in March last for increasing the capital of the company have not yet been exercised.

"The receipts for the year (£36,376. 3s. 2d.) are £10,607. 7s. 8d. in excess of the general charges."

MYSORE GOLD MINING CO. (LTD.)—At the meeting last week the chairman (Capt. W. B. McTaggart) said that they had found electricity so economical in the working of their mines that they almost wondered how they were ever able to do without it; but large as their supply under the existing scheme was, it was not sufficient to meet all their requirements. It has occurred to the managers and directors that a great saving of labour could be effected if a central power station could be established for the leading mines in the field, and the electricity be generated by steam, thus supplying all the scattered mines with power. In order to effectually carry this out a small company, called the Colar Mines Power Station (Ltd.), had been formed, capital £30,000, and the five leading companies of the field took up all the shares. The scheme would effect a considerable saving in the future working.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—The report for 1903, presented at the meeting on Wednesday, stated that in Blyth, Spennymoor, Alnwick, Hebburn, Thirsk and Whitley (the three last having been in operation for a portion of the year only) 2,482 consumers were connected, representing 39,639 8 c.p. lamps and 344,781 units were sold. Ashington supply was commenced towards the end of the year, and Hartlepool and Morpeth power stations have since been started. Malton and Shildon generating stations and Felling sub-station will be in operation during the current year. At Ashington and Whitley the company is taking supply in bulk, and current is to be taken in bulk from the Cleveland and Durham Electric Power Co. for the north-west Durham area, including Consett, Annfield Plain, Benfieldside, Stanley and Leadgate; it is expected this area will be in operation during this year. There is a credit balance of £1,000. 12s. 4d., which has been carried forward. 50,000 new shares have been issued to existing shareholders at par, and 35,463 have been taken up. To pay off existing loans and complete the stations in hand the directors propose to issue debentures. They are now supplying public lighting at Hebburn, Felling, Spennymoor, Hartlepool, Ashington, Sowerby and Thirsk, and expect to get the public lighting in certain of the North Durham group of colliery districts shortly. They are getting for lighting 4½d. to 6d. per unit, for power 1½d. to 1¾d., and for public lighting 2½d. to 4½d.

OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAYS (LTD.)—Mr. E. Garcke, at the meeting on Friday last, said the reduced dividend of 1 per cent. was due to special circumstances. It was evident that the new lines they had acquired would not at present pay working expenses, and the directors were negotiating with the local authorities with a view to making some re-arrangement which would remove the loss. The additional capital expended during the year was £14,918, mainly in providing extra cables, which, they hoped, would enable them to economise largely in the consumption of electricity. Extra cable had also been required for the additional mileage being run. Four additional cars had been purchased.

ROBEY & CO. (LTD.)—The directors' report for 1903 states that, owing to severe competition, depression of trade and other causes, the past year's profit has not been satisfactory. The directors, however, have every confidence that the steps taken for the future management of the business will produce more satisfactory results. After writing off £5,000 for depreciation of buildings, machinery and plant, £7,641. 14s. is available for distribution, and the directors recommend payment of a dividend of 5s. per share, tax free, on both preference and ordinary shares, absorbing £7,368. 18s., and carrying forward £272. 15s. 11d.

SLOUGH AND DATCHET ELECTRIC SUPPLY CO. (LTD.)—The first annual report states that the revenue from the sale of current was £605 14s., and, after adding other receipts (£411. 10s. 7d.) and deducting expenses, the net profit was £605. 17s. 8d. The directors recommend the writing off of preliminary expenses (£310. 19s. 11d.), and that the balance (£294. 17s. 9d.) be carried forward. The price charged for electricity is 7d. per unit for lighting and 3½d. for power, but a revision of prices is under consideration. 11,524 units of current were sold to the Windsor Electrical Installation Co. during the year.

WINDSOR ELECTRICAL INSTALLATION CO. (LTD.)—At the meeting last week the directors reported that the number of lamps and motors connected at the end of the year was equal to 27,886 8 c.p., an increase of 2,648. The capital expended during the year was £2,622. 11s. 2d., bringing the total expenditure to £64,844. 2s. 3d. A further dividend at the rate of 5½ per cent. makes the total for the year 8 per cent. A supply of current had been taken during the year from the Slough and Datchet Electric Supply Co. From April 1 the company will reduce the price of current and will allow large consumers discounts. The charge will be 6d. net per unit and the discounts will range from 2½ to 20 per cent. The installation department has not been so profitable as usual because the directors have pursued the policy of carrying out the work at very trifling profit, with a view of increasing the number of consumers.

NEW COMPANIES.

ELECTRIC HEATING CORP. (LTD.)—Reg. March 15, capital £25,000 in £1 shares, to acquire business of the Electric Heating Corp., to construct, deal in and repair electric stoves for heating, cooking and other purposes, and to carry on the business of electricians, manufacturers, &c. First directors, H. Binko (managing) and N. Mayer. Reg. office, 34, Leadenhall-street, London, E.C.

MADRAS ELECTRIC TRAMWAYS (1904) LTD.—Reg. March 16, capital £100,000 in £1 shares, to purchase, lease, construct or otherwise acquire any tramway or tramways in Madras or elsewhere, to equip, maintain and work by electricity or other power, any tramways belonging to the company and to carry on the business of tramway proprietors, carriers of passengers and goods, builders of tramway and railway carriages, trucks, locomotives, rolling stock and plant, mechanical engineers, electricians, producers and suppliers of electricity, &c. First directors, Sir H. C. Mance, J. W. Barclay, J. I. Courtenay and J. Gray.

SIR HIRAM S. MAXIM CAPTIVE FLYING MACHINE CO. (LTD.)—Reg. March 19, capital £30,000 in £1 shares, to acquire any interest or rights to use any invention relating to captive flying machines or rotating cars for public recreation or experimental purposes, and for apparatus for actuating same, in particular to acquire from the Sir Hiram Maxim Electrical and Engineering Co. the benefit of certain existing inventions in relation to rotating cars and apparatus, to construct, erect, equip and maintain such captive flying machines and rotating cars, &c. First directors Sir H. S. Maxim, Kt., A. Hardie, J. Woolf, jun., and A. Davidson. Reg. office, 44, Gillingham-street, Westminster.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 25⅛d. per oz. (March 24). Consols 85⅞—86 for money, 85⅞—86⅛ for account; 2½ per cent. annuities 85⅝—86 (March 24). Consols Pay Day April 7; Stocks and Shares Continuation Days, March 26 and April 12; Ticket Days, March 28 and April 13; Pay Days, March 29 and April 14; Mining Share Carry-over Days, March 25 and April 11.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—After paying the balance preference dividend, the directors have declared a dividend of 6 per cent. on the ordinary shares.

BLACKPOOL ELECTRIC TRAMWAYS (SOUTH) (LTD.)—In the Chancery of Lancaster at Liverpool on Monday, the Vice-Chancellor (Sir S. Hall, K.C.) granted the petition for the reduction of the capital from £350,000 to £100,000.

CLEVELAND AND DURHAM COUNTY ELECTRIC POWER CO.—An issue of debentures has been authorised by the shareholders. The company's business has made considerable progress during the last few months, and the power stations at Bishop Auckland and Consett are nearing com-

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pletion. It is expected that supply of current from both stations will be available in about six weeks' time.

CORK ELECTRIC TRAMWAYS AND LIGHTING CO. (LTD.)—A dividend of 5 per cent. on the ordinary shares has been declared.

DIRECT UNITED STATES CABLE CO. (LTD.)—An interim dividend of 3s. per share, tax free (at the rate of 3 per cent. per annum), for the quarter ending March 31, is announced, payable April 26.

DOVER ELECTRICITY SUPPLY CO. (LTD.)—Applications were received during 1903 for an equivalent of 3,700 8 c.p. lamps, the total connections amounting at Dec. 31 to about 27,400 8 c.p. lamps. The output to private consumers was 566,506 units, an increase of 68,685 units over 1902. The continued expansion has necessitated a capital expenditure of £7,714. 17s. The profits on the year's working (for which Dover Corporation will be entitled to take credit upon completion of purchase) were £6,872. 11s. 9d. The amount available for distribution by the company is £5,669. 2s. 5d., being interest at the rate of 4 per cent. per annum upon purchase price, payable by the Corporation under the contract of sale. After providing for interest charges, the directors recommend payment of the preference dividend and a dividend of 6 per cent. on the ordinary shares, leaving £120. 5s. 4d. to be carried forward.

EASTERN TELEGRAPH CO. (LTD.)—Payment will be made on April 15 of dividends at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ended March 31, and an interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the quarter ended Dec. 31 last. The transfer books will be closed from April 8 to 15 inclusive.

ELECTRIC LIGHTING AND TRACTION CO. OF AUSTRALIA (LTD.)—For the year ended Aug. 31, 1903, the capital expenditure in Australia on buildings, plant and mains was £27,622. 17s. 8d. (£10,217. 8s. 6d. on Melbourne undertaking, £15,572. 19s. 3d. on Adelaide, and £1,832. 9s. 11d. on Geelong). The profit from the undertakings in Australia was £6248. 17s. 5d. The business during the year has been seriously prejudiced by general depression in Australia, consequent upon the prolonged drought. The present outlook is more hopeful. Substantial economies have been effected in working expenses, the average cost per unit sold showing a reduction of 25 per cent. compared with the previous year. The total connections in Australia on Aug. 31 amounted to the equivalent of 89,600 8 c.p. lamps, an increase of 23,000 8 c.p. lamps. During the first four months of the current year the equivalent of 12,500 8 c.p. lamps has been connected. The engineer and manager in Australia (Mr. F. W. Clements) reports that there is a growing demand for the use of electric power, over 400 H.P. having been added during the year.

EVERED & CO. (LTD.)—After providing for interest charges, &c., a net profit of £14,688 (added to £5,111 brought forward) has to be dealt with. The directors propose a dividend of 8 per cent. for the year, absorbing £13,679 (of which £6,402 has been paid as interim dividend), to write off buildings £1,000, to write off plant £1,000, and to carry forward £4,142. During the past year the scheme of electrifying the plant at the company's Surrey Works, Smethwick, has been completed.

GENERAL ELECTRIC CO. (U.S.A.)—A quarterly dividend of 2 per cent. has been declared.

HOUGHTONS LIMITED.—This is the title of a new combination of the leading photographic apparatus and material manufacturers and dealers, embracing the firms of George Houghton & Son, Joseph Levi & Co., Spratt Bros., Holmes Bros. and A. C. Jackson. The chairman of the new combination is Mr. George Houghton, and the vice-chairman Mr. M. L. Isaacs (of Joseph Levi & Co., Hatton-garden, London, E.C.)

MERSEY RAILWAY CO.—During the half-year ended Dec. 31 the train mileage run was 401,046, compared with 155,039 in the corresponding half-year of 1902. The passengers conveyed were 4,153,777, against 2,844,708, exclusive of season ticket holders. The total receipts were £37,357. 19s. 8d., compared with £29,470. 6s. 5d., and the working expenses (exclusive of exceptional charges for pumping, ventilation and lifts) £28,203. 11s. 10d. (equal to 75·50 per cent.), against £21,992. 3s. 7d. (equal to 74·63 per cent.) for the corresponding six months. The exceptional charges for pumping, ventilation and hydraulic lifts amounted to £4,237. 8s. 10d. (equal to 11·34 per cent.), compared with £6,089 9s. 6d. (or 20·66 per cent.) for the corresponding period of 1902. Working expenses include a number of items of exceptional expenditure, owing to delay on the part of the contractors in completing their contract, and questions which have arisen between the company and the contractors have been referred to arbitration.

RIO DE JANEIRO TRAMWAY, LIGHT AND POWER CO.—This company was recently incorporated in New Jersey (U.S.A.), capital £40,000. The incorporators are Horace S. Gould, Otto S. Lee, jun., Edgar E. McWhitney, John R. Turner and Charles A. McCreedy. The company is established to construct and maintain railways, to operate telegraph and telephone lines, and engage in the business of electric lighting and power. It is stated that the consolidation of the local tramways of Rio de Janeiro is in contemplation.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—An interim dividend at the rate of 5 per cent. per annum has been declared on the ordinary shares.

MADRAS ELECTRIC TRAMWAYS (1904) LTD.—Applications are invited to an issue at par of £50,000 of 5 per cent. debenture stock of this company, redeemable at 105 per cent. by a sinking fund commencing in 1906, or at the option of the company at six months' notice at 105 per cent. Stock and shareholders of the Electric Construction Co. have prior right of allotment.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to the scrip (fully and partly paid) of a further issue of £1,000,000 4 per cent. debenture stock of the *National Telephone Co.* (*Ltd.*), and to allow the further issue of £89,593 4 per cent. debenture stock of the same company to be quoted.

TYNEMOUTH AND DISTRICT ELECTRIC TRACTION CO. (LTD.)—The directors propose to increase the capital of the company by the creation of 4,000 ordinary shares of £5 each; 3,000 of these shares will be issued at first. Owing to the difficulty in obtaining a reasonable quotation for third party insurance from insurance companies, it has been decided to join other companies associated with the British Electric Traction Co. in forming a mutual insurance fund, which, although drawn upon for the first year owing to several heavy claims quite out of the common, has worked well, and will, it is hoped, be the means of keeping down expenses in future years, as any surplus profits will be distributed among the companies who have joined the mutual scheme.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount	Inc. or Dec. (*a*)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (*a*)
		£	£		£	£
Aberdeen Corporation	Mar. 19	1,082	+ 257	42	50,578	+ 10,052
Airdrie	,, 11	182	...	5	900	...
Ayr Corporation	...	...	...	...	...	...
Barnsley	,, 11	147	— 18	10	1,496	— 76
Barrow	,, 11	135	+ 78	5	727	+ 445
Bexley District Council	,, 18	157	...	24	3,545	...
Birkenhead	,, 20	981	— 5	...	...	...
Birmingham Corporation	,, 19	290	...	11	3,198	...
*Birmingham Tramways Co.	,, 19	5,127	+ 93	11	¶5,707	+ 2,743
*Blackburn Corporation	,, 18	767	+ 97	§51	42,432	+ 2,210
Blackpool Corporation	,, 17	293	— 60	§50	41,063	— 392
Blackpool and Fleetwood	,, 19	181	— 22	13	2,124	— 1 7
Blackp'l, St. Anne's & Lytham	,, 17	152	+ 152	‡20	2,945	+ 2,366
Bolton Corporation	,, 20	1,615	— 61	51	91,599	+ 8,867
Bournemouth Corporation	,, 16	874	...	50	50,525	...
*Bradford Corporation	,, 20	3,572	+ 251	49	188,773	+ 13,038
Brighton Corporation	,, 20	732	— 54	50	44,868	+ 2,410
Brisbane Tramways	Feb. 3	2,986	— 28	5	11,192	— 218
*Bristol Trams & Carriage	Mar. 18	4,603	+ 359	17	76,111	+ 2,925
*Buenos Ayres & Belgrano	Feb. 21	2,934	— 86	18	59,836	+ 2,937
Burnley Corporation	Mar. 19	885	+ 218	51	49,544	+ 9,601
Burton Corporation	,, 20	287	...	38	11,122	...
Calcutta Tramways Co.	,, 19	R35,414	+ R4,639	12	R419,690	+ R72,618
Camborne-Redruth	,, 21	98	...	20	2,187	...
Cardiff Corporation	,, 19	1,795	+ 119	51	98,638	+ 23,801
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 19	7,062	— 80	12	84,546	+ 677
Chatham & Dist. Lt. Rys.	,, 17	496	+ 54	12	5,437	+ 1,016
City & South London Rly.	,, 20	2,973	— 66	12	38,250	— 594
Cork Electric Trams Co.	,, 17	414	— 20	11	4,234	— 98
Darwen Corporation	,, 18	202	— 6	51	11,356	— 293
Devonport & Dist. Trams	,, 11	448	+ 48	10	4,530	+ 707
Dover Corporation	,, 19	165	— 12	†51	10,977	— 41
Dublin & Lucan Railway	,, 20	93	— 5	12	1,054	+ 60
Dublin Southern District	,, 18	729	+ 5	¶11	47,787	+ 666
Dublin United	,, 18	3,702	— 104			
Dudley—Stourbridge	,, 11	727	+ 10	10	7,260	+ 209
Dundee Corporation	,, 16	764	— 7	43	86,528	+ 2,167
East Ham Council	,, 19	625	+ 43	†51	33,256	+ 8,780
Gateshead & Dist. Trams	,, 11	835	+ 78	10	8,607	+ 518
Glasgow Corporation	,, 19	13,823	+ 753	42	569,065	+ 54,883
Gravesend—Northfleet	,, 11	216	+ 27	10	2,076	+ 323
Gt. Northern & City Rly.	,, 19	965	+ 18	5	4,606	...
Greenock & Port Glasgow	,, 11	418	+ 14	10	4,650	+ 647
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 11	231	+ 11	10	2,431	+ 278
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 19	2,020	+ 264	†51	97,528	+ 8,057
Ilkeston Corporation	,, 16	127	...	18	2,157	...
Ipswich Corporation	,, 19	884	...	11	5,088	...
Isle of Thanet Co.	,, 19	270	— 22	...	...	...
Kidderminster & District	,, 11	99	— 7	10	981	— 58
Kirkcaldy Corporation	,, 16	193	...	3	567	...
Lanarkshire Trams Co.	,, 17	563	...	11	6,274	...
Leeds Corporation	,, 19	4,938	+ 135	51	274,248	+ 15,508
Liverpool Corporation	,, 12	9,317	+ 6	11	103,639	+ 3,051
*Liverpool Overhead Rly.	,, 20	1,512	— 35	12	18,190	+ 297
*London County Council	,, 12	10,130	‡ 1,525	†51	498,363	+ 86,618
	,, 19	10,614	+ 1,897			
Lowestoft	...	...	...	...	...	...
Manchester Corporation	,, 19	10,754	+ 2,321	39	456,542	+ 195,757
Mersey Railway	,, 19	1,423	+ 346	11	15,700	+ 3,703
Merthyr	,, 11	184	+ 3	10	1,875	+ 154
Middleton	,, 11	237	— 24	10	2,400	+ 161
Newcastle-on-Tyne Corp.	,, 19	3,444	+ 365	11	38,035	+ 5,233
Newport (Mon.)	,, 19	427	+ 171	25	10,922	+ 5,495
Oldham, Ashton & Hyde	,, 11	468	— 57	10	4,853	— 289
Perth (W. A.) Elec. Trams.	,, 18	1,333	+ 128	11	15,332	+ 2,009
Peterborough	,, 11	110	— 6	10	1,089	— 171
Poole and District	,, 11	242	— 11	10	2,221	— 65
Portsmouth Corporation	,, 19	1,441	+ 48	†51	961,664	+ 5,610
*Potteries	,, 11	1,631	+ 151	10	16,203	+ 1,269
Reading Corporation	...	...	...	...	...	...
Rothesay	,, 11	40	+ 1	10	429	+ 39
Salford Corporation	,, 21	3,669	+ 666	51	198,116	+ 52,112
Sheerness	,, 9	46	...	10	447	...
Sheffield Corporation	,, 20	4,326	+ 129	†52	231,309	+ 18,749
*Southampton Corporat'n	,, 17	206	— 48	11	9,180	+ 120
Southend Corporation	,, 16	218	+ 1	50	15,216	+ 2,251
Southport Tramways	,, 11	223	+ 8	10	2,346	+ 234
S. Staffordshire Trams.	,, 11	734	+ 15	10	7,254	+ 370
Sunderland Corporation	,, 20	1,084	+ 54	51	60,789	+ 2,975
*Swansea Trams	,, 11	431	— 23	10	4,557	+ 161
Taunton Trams	,, 11	49	+ 4	10	465	— 18
Tynemouth and District	,, 11	193	— 33	10	2,014	— 52
Tyneside Trams Co.	,, 16	304	+ 37	11	3,009	+ 522
Wallasey District Council	,, 19	576	+ 35	†51	34,115	+ 3,990
West Ham Corporation	,, 17	291	...	3	785	...
Weston-super-Mare	,, 9	23	— 3	10	222	— 19
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 11	324	— 30	10	3,257	— 135
Worcester	,, 11	228	+ 87	5	1,389	+ 542
Wrexham	,, 11	92	...	10	972	...
Yorkshire Woollen District	,, 11	480	+ 341	10	4,942	+ 1,478

(*a*) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 8 days. ‡ Minus 2 days. ¶ Plus 8 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., Mar. 23.	RATE PER CENT. YIELDED.	DIVIDEND DUR.	BUSINESS, WEEK TO MAR. 23.	SHARE.	LAST DIVIDEND	NAME.	Price Wed., Mar. 23.	RATE PER CENT. YIELDED.	DIVIDEND DUR.	BUSINESS WEEK TO MAR. 23.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.		Highest. Lowest.			**TELEPHONES.**		£ s. d.		Highest. Lowest.
£5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4¾–5¼	4 15 3	April, Oct	4¼ 4⅛	£5	3/0	Chili Telephone (fully paid)	4¾–5¼	5 14 3	August ..	5¼ ..
St.	6%	Do. Permanent 6% Deb. Stock	125 –130	4 12 4	..	129½ 128	St.	6%	National Co. Pref. Stock	100 –102	5 18 3	..	100½ 99½
St.	3½	Auckland Elec. Trams 5% Deb. (red.)	98 –100	..	..	.. ..	St.	5%	Do. Def. Stock	74 –77	6 10 9	..	75½ 73½
£10	10/0	Barcelona Tramways Ord.	6 –8	6 5 0	..	.. ..	£10	6/0	Do. 6 per Cent. Cum. 1st Pref.	13 –14	4 5 9	Feb, Aug	14 ..
£10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	.. ..	£10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	13½–14½	4 2 9	Feb, Aug	14⅛ ..
St.	4¼%	Do. 4½% Deb. Stock (red.)	90 –95	4 14 9	..	.. ..	£5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 –5½	4 15 3	Feb, Aug	5⅛ 5
£100	5%	Do. 5 per Cent. Debs.	95 –98	5 2 0	..	96⅛ 95½	St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	94 –96	3 13 1	June, Dec	94½ 93
£5	..	Brisbane Electric Trams. Invest. Ord.	1½–2½	..	..	.. ..	St.	4%	Do. 4 per Cent. Deb. Stock (red.)	97 –99	4 1 8	..	99 97½
£5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4½	5 17 8	..	4 ..	£1	0/7½	Oriental	¾–1	6 13 4	April, Oct	.. ..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 –102	4 8 3	..	98⅜ ..	£1	..	Do. 6 per Cent. Cum. Pref.	1 –1⅛	..	..	.. ..
£10	8%	Bristol Tramways and Carriage Ord.	19 –20	4 10 0	Feb, Aug	.. ..	£5	3/0	United River Plate	5⅛–6	5 16 8	July	.. ..
£10	4%	Do. Cum. Pref. (fully paid)	10⅛–10⅜	3 15 11	..	.. ..	£5	2/6	Do. 5 per Cent. Cum. Pref.	4½–5½	4 15 3	June, Dec	.. ..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 0	Feb, Aug	.. ..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 –105	4 15 3	June, Dec	.. ..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	90 –93	3 5 11	..	91½ 91			**ELECTRICITY SUPPLY.**				
St.	5%	Do. Pref. Ord. Stock	98 –101	5 0 9	..	99½ ..	£1	..	Blackheath & Greenwich Dist. Ord.(f.p.)	⅛–¼	..	..	.. ..
£10	5/0	Do. 5% Cum. Perp. Pref.	10⅛–10¾	4 13 0	..	10⅜ ..	£1	0/8½	† Do. 7% Cum. Pref.	1⅛–1⅜	..	..	.. ..
£40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝–105⅞	4 7 0	..	.. ..	St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	115 –118	3 17 4	..	.. ..
£100	4½%	Do. Vancouver Power Debs.	98 –101	4 9 1	..	.. ..	£10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12½–13½	5 18 6	..	.. ..
£10	6/0	British Electric Traction Ord.	8½–9½	8 8 6	..	9⅜ 8¾	£10	4/6	Do. 4½ per Cent. Cum. Pref.	9½–10½	4 5 9	..	.. ..
£10	6/0	Do. 6 per Cent. Cum. Pref.	9½–10½	5 14 4	Feb, Aug	10⅜ 9⅞	£10	6/0	Do. 6% Cum. Second Pref.	10½–11½	5 4 4	..	.. ..
St.	5/0	Do. 5 per Cent. Perpetual Debs	120 –123	4 1 4	..	122½ ..	St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 –104	4 6 7	..	102 101
£5	..	Buenos Ayres and Belgrano Ord.	2¼–3¼	..	..	3⅜ 3	St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 –103	4 7 5	..	.. ..
£5	3/0	Do 6 per Cent. "A" Cum. Pref.	5¼–5⅝	5 4 0	..	5⅜ ..	£5	4/6	Brompton & Kensington Elec. Sup. Ord.	10½–10¾	4 13 0	..	.. ..
£5	3/0	Do. "B"	4½–5½	5 14 3	..	5⅝ 5⅛	£5	3/6	Do. 7 per Cent. Pref.	9½–10½	3 8 4	Mar, Sept	.. ..
St.	5%	Do. 5 per Cent. Debs.	104 –107	4 13 6	..	.. ..	£5	3.0	Calcutta Electric Supply Ord.	6½ –7	4 12 10	..	.. ..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 –101	4 19 6	..	100½ 99½	St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 – 109	3 13 8	..	.. ..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 –100	5 0 3	..	.. ..	£5	4/0	Charing Cross & Strand Electric Sup.	7½–7¾	5 3 2	Feb, Aug	.. ..
£5	2/6	Calcutta Tramways	6½–7½	4 9 8	..	6⅛ 6⅛	£5	2/3	Do. 4½ per Cent. Pref.	5½–5¾	4 5 9	Feb, Aug	5¼ ..
£100	4½%	Do. 4½% 1st Deb. Stock (red.)	104 –107	4 4 2	..	106⅛ ..	£5	2/3	Do. City Undertaking 4½% Cm. Pref.	4¾–5	4 10 0	..	.. ..
£1	1/0	Cape Electric Tramways Shares	1⅞–2⅛	8 0 0	..	2 1⅛	£5	1/7	Do. Do. (1903)	4¾–5	..	..	4¼ ..
St.	4%	Central London Ordinary Stock	92 –95	4 4 4	June, Dec	93⅜ 93½	St.	4%	Do. 4% Deb. Stock (red.)	101 –103	3 18 5	..	.. ..
St.	4%	Do. 4 per Cent. Pref. Stock	98 –101	3 19 9	..	99½ ..	£5	2/0	Chelsea Electric Supply Ord.	5⅜–6¼	4 8 0	March ..	6¼ ..
St.	4%	Do. Deferred Stock	86 –89	4 9 11	..	.. ..	St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 8 1	Jn, Dec ..	.. ..
£100	4%	Do. 4 per Cent. Debs.	110 –113	3 11 8	..	.. ..	£10	5/0	† City of London Electric Lighting Ord.	10¼–10¾	4 13 0	Feb, Aug	10⅜ 10⅛
£5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾–5¼	4 15 3	..	4⅞ ..	£10	6/0	† Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	13⅜ 13⅛
£100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	.. ..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 –126	3 19 4	Jn, Dec ..	123⅜ ..
St.	2½%	City and South London Rly. Con. Ord.	49 –52	4 11 4	Feb, Aug	52 51	St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 7	..	.. ..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	123 –126	3 19 4	Feb, Aug	.. ..	£10	4/0	County of London & Brush Prov. Ord.	7½ – 8¼	4 14 2	..	.. ..
St.	5%	Do. (1896)	119 –122	4 2 0	..	121½ 121	£10	6/0	Do. 6 per Cent. Cum. Pref.	11 –12	5 0 0	Mar, Sept	11⅞ 11⅝
St.	5%	Do. (1901)	118 –121	4 2 8	..	.. ..	St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	103 –109	4 2 11	..	107 ..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 –112	3 11 7	May, Nov	.. ..	St.	27/6½	Do. Second Deb. Stock Prov. Certs.	99 –102	..	..	.. ..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 –104	4 18 1	..	.. ..	£5	2/0	Folkestone Electricity Supply Co. Ord.	5⅜–6¼	4 0 0	..	.. ..
£10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½–13½	4 1 6	..	.. ..	St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 3	..	.. ..
£10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	.. ..	£10	..	Havana Electricity Co. Shares	9½–10½	..	..	.. ..
£5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	1½–2½	12 0 0	..	.. ..	£5	3 6	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	.. ..
£5	5%	Do. 5 per Cent. Deb. Stock (red.)	92 –97	5 3 1	..	.. ..	St.	..	I of W. Elec Lt. & Power 4½% Db St (red.)	100 –105	..	..	.. ..
£10	..	Gt. Northern & City Rly. Prf. Ord. (4%)	5½–6¼	4 12 2	..	6⅛ 6	£1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛–¼	..	..	.. ..
£10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 –10	..	..	.. ..	£5	7/0	Kensingtn & Knghtsbdge Ord.	11 –12	5 0 0	..	.. ..
£10	10¾	‡ Imperial Tramways Ord.	18½–19½	4 12 4	Mar, Sept	.. ..	£5	6%	Do. 6 per Cent. 1st Pref.	6¾–7	4 5 9	Jan, July	.. ..
£10	6%	‡ Do. 6 per Cent. Pref.	14 –14½	4 2 10	Mar, Sept	.. ..	St	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	103 –106	3 16 2	..	104½ ..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	.. ..	£3	..	London Electric Supply Ord.	1 –1½	..	..	1⅜ ..
£5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	.. ..	£5	3/0	† Do. 6 per Cent Pref.	4½–5	6 0 0	..	.. ..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	..	.. ..	St.	4%	Do. 4 per Cent. 1st Mort. Deb.	95 –98	4 2 1	Mr, Jn, S, D	.. ..
£10	1½%	†Liverpool Overhead Railway Ord.	4⅛–4½	2 16 5	Feb, Aug	.. ..	£10	8 0	Metropolitan Electric Sup. Ord.	18 –19	4 1 7	April, Oct	18⅜ 18⅛
£10	5%	† Do. 5 per Cent. Pref.	9⅞–10½	4 17 6	Feb, Aug	.. ..	£5	..	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅜	..	..	5⅜ ..
St.	4%	† Do. 4 per Cent. Deb.	98½–100½	3 19 10	Jan, July	.. ..	St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	3 19 6	Jn, Dec ..	.. ..
£10	5/0	London United Trams. 5% Cum. Pref.	11 –11½	4 7 0	..	11⅛ 11⅛	St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –98	3 11 9	..	96⅛ ..
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 –103	3 18 5	..	.. ..	£100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	95 –98	4 11 9	..	.. ..
St.	..	Mersey Con. Ord. Stock	6 –9	..	..	.. ..	£10	6.0	Notting Hill Electric Ord.	13 –14	4 5 9	March	.. ..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	.. ..	£100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	.. ..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	.. ..	£5	4 0	†Oxford Electric Ord.	5½ – 6	5 8 4	March	.. ..
£1	..	Metropolitan Electric Trams Def	⅜–½	..	..	.. ..	St.	4%	Do. 4% Deb. Stock	96 –99	4 0 9	..	.. ..
£1	0/6	Do. 5% Cum. Pref.	½–1	5 0 0	..	1⅛ ..	£1	..	Rand Electric	¾–1	..	..	.. ..
£100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	101 –103	4 17 3	..	.. ..	£100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 –102	4 8 11	April, Oct	.. ..
£100	4½%	Do. Sterling 4½% Debs. (1922)	104 –106	4 4 11	..	.. ..	£5	9 6	St. James' & Pall Mall Elec. Ord.	14 –15	4 16 8	Feb, Aug	14⅜ 14⅛
£5	..	New General Traction Ord.	⅛	..	..	.. ..	£5	3 6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	.. ..
£5	..	Do. 6 per Cent. Cum. Pref.	1½–2½	..	May	.. ..	St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 –100	3 10 6	..	.. ..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 –102	4 18 0	..	100 ..	£5	4/0	Smithfield Markets Electric Sup. Ord.	3 –3½	5 14 3	..	.. ..
£10	10/0	Potteries Electric Traction Ord.	8½ – 9½	5 5 3	..	.. ..	St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	.. ..
£10	5 0	Do. 5 per Cent. Cum. Pref.	9 –10	5 0 0	Feb, Aug	.. ..	£5	3/0	†South London Electric Supply Ord.	3 –3½	4 5 8	..	.. ..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 –106	4 5 11	..	.. ..	£5	2/6	Urban Electric Supply Ord.	4¾ – 5	5 0 0	..	.. ..
£1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	.. ..	£5	2,6	Do. 5% Cum. Pref.	4¾–5⅛	4 17 7	..	.. ..
£1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	.. ..	£5	7/0	Westminster Electric Supply Ord.	12½–13½	5 0 0	Mar, Sept	13⅛ 12⅞
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	.. ..	£5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6⅜	3 16 11	..	.. ..
St.	3%	Waterloo and City Ord.	83 –91	3 8 8	June, Dec	.. ..			**ELECTRIC MANUFACTURING &c.**				
							£1	6d.	Alliance Electrical Co. 5% Cum. Pref.	⅜–½	6 13 4	..	.. ..
							£1	..	Aron Electric Meter 6% Cum. Pref.	⅜–½	..	Mar, Sept	.. ..
		TELEGRAPHS.					£5	4/0	British Insulated & Helsby Cables Ord.	6 –6¼	7 13 10	July, Feb	.. ..
£100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 –102	3 18 5	Jan, July	.. ..	£5	3 0	Do. 6 per Cent. Pref.	5½–5¾	5 4 4	Jan, July	.. ..
£10	..	Amazon Telegraph	2½–3½	..	Jn, Dec ..	.. ..	St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –107	4 4 1	..	.. ..
£100	..	Do. 5 per Cent. Deb.	..	..	..	.. ..	St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 –103	4 7 5	..	.. ..
St.	16/0	Anglo-American	48 –51	5 18 8	F, My, Ag, N	48½ ..	£5	3/0	British Westinghouse 6% Pref.	3¾–4½	7 1 2	..	4⅛ 3¾
St.	30/0	Do. Preferred	91 –93	6 9 0	F, My, Ag, N	92½ 91½	St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 –96	4 3 4	..	.. ..
St.	2/0	Do. Deferred	6¼–7¼	1 7 6	F, My Ag, N	7 ..	£2	..	Brush Electrical Engineering	½–1	..	March ..	.. ..
£100	$2	Commercial Cable Capital Stock	180 –190	4 4 5	Jn, Ap, Jy, O	182 ..	£2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾–1½	9 12 0	Mar, Sept	.. ..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –92	4 7 11	Jn Ap, Jy, O	91 90	St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –99	4 10 11	Mar, Sept	97 ..
£10	7/0	Cuba Submarine Ord.	7 –8	10 0 0	Feb, Aug	7⅜ 7⅛	St.	4½%	Do. Perpetual 2nd Deb. Stock	72 –77	5 18 4	Jan, July	.. ..
£10	10/0	Do. Preference 10 per Cent.	16 –17	5 17 8	Feb Aug	.. ..	£5	5/0	Callender's Cable Construction Ord.	10½–11½	6 10 5	Jan, July	.. ..
£5	2/0	Direct Spanish Ord.	2½–3½	5 14 4	April, Oct	.. ..	£5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5¾	4 6 11	Jan, July	.. ..
£5	5/0	Do. 10 per Cent. Cum. Pref.	7⅛–8½	5 17 8	April Oct	.. ..	St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 –108	4 3 3	Nov, May	.. ..
£50	4½%	Do. 4½ per Cent. Deb.	98⅝–101⅞	4 9 1	Jan, July	.. ..	£1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅜–½	6 17 2	..	⅝ ..
£20	3/0	Direct United States Cable	1⅝–1¾	6 3 10	Ja, Ap, Jy, O	10⅛ 10⅜	St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 14 9	..	.. ..
£100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 –101	4 9 1	Jn, Dec ..	.. ..	£1	0/7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March ..	.. ..
St.	25/0	Eastern Ordinary	117 –122	5 14 9	Ja, Ap, Jy, O	121 118½	£1	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½–2	7 10 0	Jan, July	1⅝ ..
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 –89	3 19 1	Ja Ap, Jy, O	86½ 86	£100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 –99	5 2 0	Jan, July	99 98½
St.	4%	* Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 –107	3 15 8	May, Nov	106⅛ 104½	£5	..	Dick, Kerr & Co. Ord.	7¾–8½	..	..	.. ..
£10	2/6	Eastern Extension	10¾–11½	6 4 5	Ja, Ap, Jy, O	11⅛ 10⅞	£5	..	Do. 6% Cum. Pref.	5¼–5⅝	..	..	.. ..
£8	4%	Do. 4 per Cent. Deb. Stock	103 –106	3 16 0	Feb, Aug	.. ..	St.	4½%	Do. 4½% Deb. Stock	102–104	4 7 2	..	.. ..
£100	4%	* Eastern & S. African 4% Mrt. Deb. 1909	98 –101	4 0 0	Feb, Aug	.. ..	£5	..	Edison & Swan United ("A" Sh.) (£5 pd.)	¼	..	Feb, Aug	.. ..
£25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99⅝–102⅞	3 18 11	May, Nov	.. ..	£5	..	Do. (£5 paid)	½–1½	..	Feb, Aug	.. ..
£10	5/0	Great Northern of Copenhagen	2¼–2⅝	4 18 1	Jan, July	.. ..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 –77	5 3 11	June, Dec	.. ..
£100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 –101	4 9 6	June, Dec	.. ..	St.	5%	Do. 5 per Cent. 2nd Deb. Stock	76 –81	6 3 5	..	.. ..
£25	12/6	Indo-European	38 –41	6 1 11	May, Nov	41 ..	£5	2/6	Edmundson's Elec. Corp. Ord.	5⅜–6½	5 12 0	H'lf-yearly	5⅜ ..
£100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 –100	4 0 0	June, Dec	.. ..	£5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜–6½	4 16 0	..	5⅜ ..
£10	2/0	West African Telegraph Shares	5 –6	1 13 4	..	.. ..	St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 –106	4 4 11	..	105⅛ 104⅝
2½	..	West Coast of America	⅛–¼	..	..	.. ..	£2	1/2½	Electric Construction Co.	1½–1⅝	6 7 1 2	Jan, July	1⅝ 1½
£100	4%	Do. 4 per Cent. Debs.	95 –98	4 1 8	Jan, July	.. ..	£2	2/9½	Do. 7 per Cent. Cum. Pref.	2¾–3	4 13 4	July	.. ..
£10	..	West India and Panama	⅝–¾	..	May, Nov	.. ..	St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –100	4 0 0	Jan, July	.. ..
£10	8/0	Do. 6 per Cent 1st Pref.	5⅞–6⅛	9 12 0	May, Nov	5⅛ ..	£1	..	Electrolytic Alkali Ord.	½–¾	..	..	.. ..
£10	..	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	.. ..	£1	7%	Do. 7 per Cent. Cum. Pref.	¾–1	..	..	.. ..
£100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	100 ..	St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 3	..	.. ..
£10	3/0	Western Telegraph	11¾–12¾	5 14 8	Mr, Jn, O, D	12⅜ 12	£10	5/0	General Electric (1900) 5% Cum. Pref.	8⅛–8¾	5 5 3	..	.. ..
£100	5%	* Do. 5% Debs. (2nd Series, 1906)	100 –103	4 18 2	June, Dec	102⅜ ..	St.	4%	Do. 4 per Cent. 1st Mort. Debs.	94 –99	4 2 6	..	.. ..
St.	4%	Do. 4% Deb. Stock (red.)	98 –101	3 19 3	..	99 ..	£5	6/0	Henley's Telegraph Works Ord.	12 –13	7 13 10	Feb, Aug	12⅜ 11⅞
							£5	2/3	† Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	5 ..
							St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 –111	4 1 5	Feb, Aug	.. ..
		FINANCIAL, INVESTMENT, &c.					£10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 –19	5 5 3	Feb, Aug	18⅜ 18⅛
							£100	4%	Do. 4 per Cent. 1st Mort. Deb (red.)	100 –103	3 17 4	Mar, Sept	.. ..
£5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 –5½	5 9 1	..	.. ..	£10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10¼–11	4 10 11	Mar, Sept	.. ..
£10	2/0	Globe Telegraph and Trust	8 –8½	4 14 2	Ja Ap Jy O	8⅛ 8¼	£12	36/0	† Telegraph Construction & Mainten'ce.	33 –36	6 13 4	Mar, July	.. ..
£10	3/0	Do. 6 per Cent. Pref.	12 –12½	4 16 0	Ja Ap, Jy, O	12⅜ 12⅛	£100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –104	3 17 8	Jan, July	.. ..
£5	4/0	Reuter's	6¼–7¼	5 6 8	April, Oct	.. ..	£5	3/0	Willans and Robinson Ord.	3 –4	8 2 6	Apr, Oct	3⅜ 3⅛
£100	6%	Submarine Cables Trust (Cert.)	115 –120	5 2 2	April, Oct	119½ ..	£5	3/0	Do. 6 per Cent. Cum. Pref.	4½–5	6 0 0	Apr, Oct	5⅛ 4⅞
							St.	4%	Do. 4 per Cent. 1st Mort. Debs.	97 –101	4 0 3	May, Nov	.. ..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. ‡ ½% Dividend. † The London Stock Exchange Committee have refused to quote these.

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NOTES.

WE are glad to notice that the criticisms made in our pages and elsewhere on the regulations with regard to the application of electricity in coal mines have had their effect. It was, we believe, the original idea of the Home Office to adopt these regulations as they stood and have them enforced. This would have imposed some hardship on mine owners, as, although in its general lines the code of rules is excellent, there are some matters of detail, already alluded to in these columns, which must certainly be modified before the regulations are definitely adopted. It will be seen in our "Parliamentary Intelligence" that the Home Secretary has now definitely stated that, having regard to the number and complexity of the rules, some time will be allowed for their consideration and for suggestions and amendments before they are formally enforced. The owners of mines and their engineers will, therefore, be well advised to peruse carefully the Departmental Committee's report and draft regulations (see *The Electrician* for February 5th, p. 608, February 12th, p. 650, and February 19th, p. 689), and thereupon send in to the Home Office any suggestions and remarks they may deem necessary.

THE application to Parliament by the Tyneside Tramways and Tramroads Co. for compulsory running powers over the Newcastle Corporation Tramways, which was reported in our Parliamentary columns last week, has aroused a considerable amount of interest. The decision of the Committee of the House of Lords to pass the preamble of the bill creates a precedent in the matter, for, although there are, of course, many instances in which through running takes place over several systems of tramways, these have all been by mutual agreement and not by statutory compulsion against the wish of one of the owners, in similar circumstances to those obtaining in Newcastle. In the case in question, the Newcastle Corporation was practically unanimous that through booking with the Tyneside Company was all that it could agree to, and the success of the Company's bill is therefore notable, although the Corporation will have another opportunity of opposing the proposal when the measure comes before a Committee of the Lower House.

THE subject of distribution of energy is one which never fails to command attention, and Mr. C. A. SMITH'S Paper, an abstract of which we publish elsewhere, proved no exception to the rule. It received a good deal of attention, as may be gathered from the discussion, and the author's views did not attract universal approval. The Paper itself is a mass of statistics, not based on actual practice but on mere hypotheses, which Prof. THRELFALL characterised as "pious hopes," and not at all likely of fulfilment. Apart from the statistical side of the question, however, there are serious engineering difficulties in connection with gas distribution which are not present with distribution of electricity.

MR. SMITH compares two systems: one in which producer gas is consumed by engines at one large station with electrical transmission of energy to five sub-stations, and the other in which the producer gas is generated as in the first case and transmitted to five sub-stations equipped with gas engines coupled to dynamos. In each case, of course, the sub-stations distribute by means of an ordinary network. The author arrives at the conclusion that the gas sub-station method is the more economical, but his results are based on figures concerning an imaginary undertaking built on a conveniently large scale. It is a pity, among minor questions, that Mr. SMITH did not deal at sufficient length with the difficulties encountered when transmitting high-pressure gas over long distances. This is a very serious matter, especially when dealing with a gas containing a relatively large amount of carbon monoxide. It remains to be seen, also, whether the

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gas-engine sub-stations would be tolerated by persons residing in the vicinity. Although there is really very little cause for complaint in this direction, yet, in view of recent legal actions, there is undoubtedly a strong popular prejudice against gas engines, and it therefore behoves promoters of electrical schemes to make thoroughly sure of their ground before embarking on an undertaking likely to prove troublesome both to themselves and others.

A FANTASTIC suggestion was made by Mr. T. TOMLINSON in a recent Paper on "The Supply of Electricity to Small Towns," read before the Dublin Local Section of the Institution of Electrical Engineers. It would not pay, he considered, in ordinary circumstances to light towns of less than 8,000 inhabitants by electricity if there were no traction or power load, but he proposes to obtain the deficient load as follows:— Instead of the usual horse-drawn vehicles for the collection of dust and refuse, Mr. TOMLINSON proposes to employ a cart running on the ordinary road without rails, but taking its current from a trolley line. He estimates that one mile of route would be sufficient to cover the main streets of such a town, but he does not suggest how the dust-bins in the side streets are to be emptied. This line, he concludes, would cost about £1,000, and "a large proportion of the work, time and cost of labour of men and horses" would be saved, each man and horse displaced meaning a gain of £90 per annum! Moreover, the station would, of course, be combined with a refuse destructor, so that the cycle of operations should be complete. The idea of erecting and maintaining an overhead equipment at £1,000 per mile and building a generating station, in order to have a one-car traction load perhaps for one day a week, and an admittedly non-paying lighting load in the evening, is decidedly entertaining. Unless what the Germans are pleased to call "the rail-less street railway" is given a better chance than this, we fear that it is foredoomed to failure.

So much was written in the American technical journals a few years ago on the advantages of distributing inductance in long telephone lines, that it was but reasonable to infer that much more had been done than merely translating this prescription of OLIVER HEAVISIDE'S into American Patent Office English. A little more has been done, it is true, but not much. According to a recent article in the *Electrical World* of New York, the experiments on overhead lines in that country have not yet been sufficiently successful to warrant the general adoption or even the immediate extension of what the Americans call the "Pupin" system:

> Unforeseen difficulties in the nature of cross-talk and leakage effects were encountered, and while they are not sufficient to prevent ultimately the extension of the system to overhead lines, they have called attention to a number of features in line construction which must be attended to before complete success in overhead loading is attained. A vast amount of work in overcoming these temporary difficulties has already been done, and although many points still require investigation, it is safe to say that this phase of the problem presents no difficulties which are insuperable and which cannot be expected to yield to patient and intelligent research.

To judge from recent articles in our columns, better success has attended the experiments in Germany. A 94-mile overhead line was considerably improved by the addition of inductance coils at equal intervals throughout its length, and an amelioration was obtained by similar means in the speaking through a 20-mile underground cable with wire of 1mm. diameter (0·04in.). Experiments on short underground and overhead cables have also given satisfactory results in America, but they represent no advance on the figures already quoted. We trust, however, that the matter will not be dropped at this stage, for, although there may be initial difficulties, further systematic and intelligent trials of this method of increasing the speaking distance on telephone circuits should eventually lead to important developments in practice.

THE annual report of Marconi's Wireless Telegraph Co., published in our last issue, shows that considerable progress has been made with regard to the equipment of ships and shore stations with wireless telegraphic apparatus. We are glad to see this, for we have always maintained that it is for communication between ships, and from ship to shore and *vice versâ*, that Hertzian wave telegraphy has its largest sphere of utility. Unfortunately, the profits on this part of the business are not sufficient to pay a dividend on the large capital expenditure of the Company, for, although the accounts for the past year show receipts of £48,262, as against an expenditure of £37,654, the difference between these totals is not so great as the balance of £32,457, which represents "sundry expenditure in excess of receipts" up to September 30, 1902. Moreover, included in the £48,262 of receipts there is a round sum of £20,000 "received on entering into a new agreement, dated June 24, 1903, with the Admiralty" which payment presumably will not be made annually.

WHATEVER may be the prospects of the Company, however, we can see no reason for the violent attack on the Post Office, made in the report. The grievance against the Post Office is apparently no more than the old complaint that the Department will not act as receiving agents for telegrams until the reliability of the service is demonstrated, and we fear that we cannot sympathise with it. Should wireless telegraphy across the Atlantic prove practical commercially, there is a large amount of work for the Company to perform before it need come to the general public for ordinary telegrams. *The Times* is still waiting for a resumption of its short-lived "Marconigraph" service, and, doubtless, other newspapers and large business firms would be willing to give the Marconi Company a trial if messages could be transmitted and received with secrecy, accuracy and despatch. Moreover, there is nothing to prevent the general public from telegraphing, from any telegraph office in the United Kingdom, messages to Poldhu with a request that they be transmitted to America by wireless telegraphy. Nor does the Post Office do anything to prevent the Company from receiving American messages at Poldhu and telegraphing them through the ordinary telegraph service to individuals in this country. The real difficulty, we are convinced, is still that of maintaining a good and practical telegraphic service without connecting cables between Cornwall and New York. Should these technical and scientific difficulties be overcome the other difficulties could soon be disposed of. At the shareholders' meeting on Wednesday, in fact, it was announced, as

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will be seen in our report on another page, that the Post Office has just signified its readiness to conclude an agreement with the Company which "will not only give satisfaction to the public generally, but will also fully safeguard the interests of the shareholders of the Marconi Company." No particulars with regard to the terms or even the nature of this agreement were divulged at the meeting, as the details of the agreement have still to be considered by the legal advisers on both sides.

Fall of a Chimney.—A steel chimney shaft 80ft. in height collapsed, without warning, at Alderley electricity works on March 24th. Serious damage was done to the roof of the works, and some workmen had narrow escapes.

Personal.—We are officially informed that the reports which have recently appeared concerning Mr. Marconi's health are entirely without foundation. Mr. Marconi is staying at present at Pontecchio, Bologna, and is in his usual state of good health.

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
New York—Hayti	Apr. 13, 1903
Tourane—Amoy	Nov. 10, 1903
Tarifa—Tangier	Jan. 18, 1904
Cape St. Jacques—Haiphong	Mar. 7, 1904
Bakar—Conakry	Mar. 24, 1904

Street Lighting by Inverted Arcs.—A correspondent has called our attention to a suggestion made in all seriousness by the *British Journal of Photography* that some of our municipal authorities should try, *for street lighting*, inverted arcs surmounted with "some form of an inverted cone of porcelain" as a reflecting surface, "which would at the same time protect the naked carbons from the rain." This our contemporary suggests as an alternative to cutting off "a good 50 per cent." of the light of the arcs by the globes now employed.

A New Alloy.—In a recent issue of the *Engineer* there is a note to the effect that magnalium, an alloy of aluminium and magnesium, is being used especially in the manufacture of scientific instruments. It is lighter than aluminium, is easily worked with cutting tools, can be obtained in good castings, is durable in contact with moist air in closed vessels, but corrodes in water. Two alloys were examined containing respectively Al 85·9 per cent., Mg 12·7 per cent., and Al 96·5 per cent., Mg 1·9 per cent., the impurities being Si 0·7, Fe 0·5, Cu 0·1 per cent. The former alloy had a density of 2·538 and a coefficient of expansion at 10–40deg. Cent. of 0·0000238. Our contemporary does not say where the alloy may be obtained.

Wireless Telegraphy and the War.—*The Times* special correspondent sent a message from Chemulpo, via their dispatch boat "Haimun," on Thursday to the effect that, owing to a temporary breakdown of the wireless telegraphy receiving mast, he had been obliged to return there without making his intended trip to the scene of hostilities. By Saturday, however, it appears that the repairs were quite completed and the system working with efficiency, for "wireless" telegrams addressed from "off Port Arthur" and "at sea," and dated Saturday and Sunday respectively, were published in Monday's *Times*. The distance from Port Arthur to Wei-hai-Wei is 100 miles.——It is reported from Berlin that an order from Russia has been received by the Gesellschaft für Drahtlose Telegraphie for a system of wireless telegraphy for use on Lake Baikal, and the apparatus has already been despatched.

Opening of the Malvern Electricity Works.—The municipal electricity works at Malvern were formally opened by the chairman of the District Council on Thursday last week. The Council obtained a provisional order as far back as 1890. Mr. J. H. Crowther, the consulting engineer, has designed a high-tension single-phase system at 50 ~ per second, with transformers in boxes under the footpaths, and two-wire distribution, the station pressure being 2,000 volts and the voltage of supply 100. About 15 miles of Glover concentric mains have been laid. The generating station, which has been erected on the site of the old gas works, contains two Lancashire boilers, one working in conjunction with a refuse destructor; and two Belliss and Morcom engines coupled directly to two Dick Kerr alternators, the latter having an aggregate capacity of 200kw. Up to the present, between 50 and 60 applications for connections have been received. Mr. H. P. Maybury, the Council's gas engineer, is acting as resident engineer to the electricity works.

"The Central."—The second number of *The Central*, the magazine published by the Central Technical College Old Students' Association, has just appeared. It maintains the same high standard as the first number, and the magazine is now to appear three times a year—in March, June and November. The frontispiece is an excellent photogravure of Prof. Henrici, and the number also contains a review of his elementary book, "Vectors and Rotors, with Applications," which will be welcome to his first-year students, and forms an introduction to a larger work on vector analysis upon which, we understand, Prof. Henrici is engaged. Among other articles are two from old students in Canada and East Africa, and a description of the engineering laboratories and workshops at the Central Technical College by Prof. Unwin and Prof. A. G. Ashcroft. We may remind those old students who have not yet joined the Association that the hon. sec. is Dr. E. Frankland Armstrong (Central Technical College, S.W.)

The Transvaal Technical Institute.—The Johannesburg correspondent of *The Times* states that the formal opening of the Transvaal Technical Institute took place on Tuesday in the presence of the Governor and the Lieutenant-Governor of the colony. The Institute is intended to form the nucleus of a future University. The chief feature of the Institute will, of course, be the teaching of mining engineering, and the Kimberley School of Mines, which for eight years has covered the third and fourth years' courses prescribed by the Cape University for obtaining a degree in this subject, has been absorbed in it. A course in general engineering has now been added at the Johannesburg Institute to enable students to put in their whole time there, while evening classes for others will shortly be begun. The question of the development of the Institute is occupying the attention of Prof. Hele-Shaw, the organiser and of the Council for Technical Education, on which devolves the decision regarding the permanent housing of the Institute. In the meantime it has started in temporary premises in the former Boys' High School.

The Engineering Standards Committee.—The Engineering Standards Committee have for some time past been considering the question of screw threads and limit gauges, and a large amount of information has already been collected. With a view to obtaining a more general expression of opinion, it is proposed to hold a conference at the Institution of Civil Engineers, on April 19th and 20th, to give the Committee an opportunity of meeting the leading mechanical engineers of this country who are directly affected. It is proposed to ask for evidence on screw threads from users and makers of screws, and makers of tools for making or gauging screws. A series of questions have been drafted under these three heads dealing with: Whether the present Whitworth and B.A. screws are sufficient for all practical purposes; questions affecting the interchangeability of screws; questions affecting the angle, pitch, thread form, &c., of screws; and systems of gauging screws. Evidence will also be taken as to whether it would be be feasible to lay down a series of standard limits for various classes of work, and if so, what these limits should be. The question as to whether the male or female gauge should be taken as a basis for standardisation will also be discussed. The Committee are particularly desirous that the conference should be as representative as possible, and include representatives of all classes of mechanical engineering. Gentlemen willing to attend and give evidence are invited to communicate with the secretary, Mr. Leslie S. Robertson, 28, Victoria-street, Westminster, S.W. Lists of questions have been drafted by the Committee to serve as a guide to witnesses giving evidence, and copies of the questions will be forwarded to those gentlemen signifying their willingness to be present at the conference.

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A New Frequency and Slip Meter.—Mr. A. Bianchi, of Milan, has perfected an ingenious device for measuring the slip of induction motors. The whole apparatus is self-contained in a box of small size. Its construction is based on the following principle: A small electromagnet, having a polarised armature, is connected in shunt to the line through a contact breaker. The latter consists of a disc of insulating material having (for a bipolar machine) one metal contact piece on its periphery, the disc being directly rotated by the rotor of the induction motor to be tested. Every time this contact piece passes beneath the brush the shunt circuit referred to is closed and the electromagnet is energised. Since the frequency (r_2) corresponding to the speed of the rotor is lower than that of the line (r_1), it follows that contact is made each time at a different point of the primary wave. Each successive contact corresponds to a slightly advanced value of the line wave. It is obvious, therefore, that the electromagnet is energised by a current wave having a frequency $r = r_1 - r_2$. Since the armature of this electromagnet is polarised, it will be actuated in accordance with this wave of comparatively low frequency. The revolutions of the rotor are recorded by a speed counter and the frequency r is recorded by means of the electromagnet. The slip in per cent. is calculated from the equation: Slip $= \frac{100r}{r + (pN/60)}$, and the impressed frequency $r_1 = r + (pN/60)$, N being the revolutions indicated by the counter and $2p$ the number of poles. If the induction motor has more than two poles, the rotating disc must have more than one contact; in fact, the number of contacts must be equal to the number of pole pairs. In Mr. Bianchi's apparatus, six different contact rings are provided, allowing motors with nearly every number of poles between two and 36 to be tested

North-Eastern Railway "Electrification."—The first section of the North-Eastern Railway's lines to be electrically equipped was opened for public traffic on Tuesday. The first train was started by Lord Ridley at 12:5 in the afternoon, and from 12:50 onwards the full electric service between Newcastle and Benton was opened to the public and has since been regularly at work. The outward journey took 11 minutes, the return 12 minutes, being a reduction of 25 per cent. on the steam time. The line is an old-established and busy branch of a great railway with a large goods and mineral traffic and a frequent, if somewhat irregular, suburban service, while at one end of the line is the Newcastle Central station, one of the most complicated junctions in the North of England. The conversion of the remainder of the Tyneside branch of the company's system is practically complete. There are 37 miles of double and four-way track, equivalent to some 82 miles of single track. For the present the goods traffic will be mainly operated by steam, although two electric goods locomotives are to be used on a portion of the system. The stopping trains between Newcastle and Tynemouth (about 8½ miles) have hitherto taken 35 minutes, but this will now be reduced to 23 minutes, while the express train will perform the journey in 15 minutes, and a regular service will be given every 15 minutes. The standard train consists of three coaches, with a first class carriage at one end, a third class smoking carriage at the other end and a third class non-smoking carriage in the middle, and indications are placed on each platform to inform passengers as to the points at which each of the coaches in the train will be brought to a stand. The time allowed for each station stop is 20 seconds. Full technical details were given in *The Electrician*, Vol. XLIX., pp. 712 and 721, Vol. LI., p. 237, and on January 22nd last, p. 519. In a pamphlet issued to the public, the company urges passengers to "move quickly, travel often and take little luggage."

Telephone Service in Baltimore.—In connection with the recent Baltimore (U.S.A.) fire, the *Electrical World* of New York states that the principal office of the Chesapeake and Potomac Telephone Co. and some 7,500 of its telephones were destroyed. It was not thought that a complete restoration could be accomplished within four weeks from the date of the fire. On the Saturday night before the fire two new central offices had been opened. On the Sunday night following, while the fire was still raging, it was decided to enlarge one of the new offices, which had been equipped to serve about 4,000 telephones, so as to serve over 12,000 lines. Parts of a new switchboard then in Washington ready for installation in that city were immediately shipped to Baltimore, and the necessary cables were ordered from the Chicago factories of the Western Electric Co. Within two weeks the equipment for 4,000 telephones was in place, and the telephones were rapidly connected. The entire installation was completed on February 29th, 21 days after the fire originated. To accomplish this men were taken to Baltimore from Philadelphia, Washington, New York, Boston and other cities, and worked in three shifts of eight hours each. The new switchboard is 135ft. in length, and contains 160,000 jacks. In constructing the board 500,000 hand-soldered connections were made and 35 miles of switchboard cable, containing 2,000 miles of wire, were used. The loss to the telephone company was not confined to the property actually destroyed, as its cables and lines in the burned district were rendered useless for the time being. As much as 8,000 miles of wire was taken to Baltimore, drawn into the subways and spliced. This work was interfered with to a considerable extent by the wrecking gangs who were engaged in tearing down walls in the vicinity of the manholes. None of the work done in the restoration of the system is of a temporary character, the cables and the equipment used being of the most modern type and the work of installation being done in the most skilful manner.

Royal Commission on Coal Supplies.—The second report, dated February 24, 1904, of the Royal Commission on Coal Supplies has just been issued. In their first report the Commission stated that they had grouped the known coalfields into seven districts and placed each district in the charge of one or more of their members. After receiving the reports of the district commissioners they proposed to investigate the available coal resources so far as they are contained in Kent and in concealed or unproved coalfields lying outside the areas covered by the above seven districts. The Commission proceeded to take evidence of mining engineers and colliery managers, and to inquire into the amount of coal lost in working. They examined a number of witnesses as to the limit of depth in mining, the minimum thickness of workable seams of coal, and the waste in working. Generally, coal owners cordially co-operated with the district commissioners, and rendered them invaluable assistance. In their second report the Commission state that from January 27 to October 21, 1903, they examined a number of witnesses with regard to possible economies and improvements in the working, preparation, transport and use of coal, and with regard to the possibility of substituting other kinds of fuel and of adopting power derived from other sources. They "are not yet in a position to make recommendations upon the information received, but the great possibilities of economy indicated by the witnesses, affecting as they do every class and every trade, make it of the utmost importance that the evidence should be carefully studied, not only in the interest of individuals but in the interests of the nation as a whole." The investigations into the available resources of the known coalfields which are being made locally by the district commissioners are now rapidly approaching completion, and it was expected that most of their reports would have been received by the end of March, and the latest of them by the end of June next. Substantial progress has also been made with the investigations into the available resources of the concealed coalfields, a subject which, involving, as it does, the consideration of geological problems of supreme importance, must necessarily occupy a considerable amount of time; every possible care, however, is being taken to avoid undue delay. In connection with each report is a volume containing the minutes of evidence and a second volume of plans and diagrams.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

THURSDAY April 7th.

RÖNTGEN SOCIETY.

8:30 p.m. Meeting at 20, Hanover-square, W. Exhibition Evening.

FRIDAY, April 8th.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at Westminster Palace Hotel. Paper to be read: "The Heating and Ventilation of Factories," by K. Gray.

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NEW ELECTRICITY WORKS AT WEST HAM.

Next Wednesday the county borough of West Ham will celebrate the formal opening of a new electric generating station, which will rank amongst the largest English municipal undertakings. This borough, with a population of close upon 300,000 inhabitants and embracing an area of 4,707 acres, was granted an electric lighting order in 1892, but nothing definite was done towards providing a supply of electricity until November, 1896, when a loan of £50,000 was sanctioned by the Local Government Board for this purpose. Supply was commenced in December, 1898, and the demand increased so rapidly that it was considered advisable to extend the plant immediately. A further loan of £51,000 was authorised, and extensions amounting to 2,400kw. were commenced forthwith. The Corporation was advised on all this work by the then borough electrical engineer (Mr. John J. Steinitz), who prepared and carried out the original scheme and the extensions before mentioned. Mr. Steinitz resigned in July, 1899, to take up an appointment with the Electrical Power Distribution Co., and Mr. James K. Bock, at that time chief assistant, succeeded him, and has since advised the Corporation on all electrical work in connection with the lighting and tramway undertakings.

In 1898 and 1900 the Corporation obtained Parliamentary powers to enable them to purchase the North Metropolitan Tramway Co.'s lines within the borough, and also to reconstruct and electrically equip these lines and to construct and equip an additional 7¾ miles of route. The introduction of electric traction and the rapid growth in the demand for electricity for lighting purposes necessitated considerable additions to the generating plant. The existing buildings being fully occupied, and the supply of water for condensing purposes being uncertain, the Council, acting on the advice of their electrical engineer and the borough engineer, Mr. John G. Morley, decided to erect a new generating station on the site of the old sewage pumping station at Canning Town, and to transfer the plant from the Abbey Mills works thereto.

The system of supply already in use for lighting was single-phase, with a frequency of 50 ~ per sec., and in preparing the new scheme special consideration was given to the advisability of adopting a two or three-phase system of distribution for lighting and traction, but owing to the extent to which the Corporation were already committed to the single-phase system, the advantages of the three-phase system were not sufficient to justify the very heavy additional expenditure which would have been entailed in the conversion. It was consequently decided to retain the single-phase system for lighting purposes and to instal a continuous-current supply for traction purposes.

The new power station is situated on the banks of the River Lea, on the site of the old sewage pumping station, the buildings being erected on a space formerly occupied by settling tanks, the remainder of which are now used as cooling ponds for condensing purposes. From the old station to the new is about 1¼ miles, and consequently the work of changing over was attended with many difficulties. Although some trouble was at first experienced in synchronising the two stations, they now work perfectly in parallel, the interchange of current being scarcely perceptible.

Boiler House.

The whole boiler-house equipment, with the exception of the fans and engines, has been supplied and erected by Messrs. Babcock and Wilcox, the fans and engines being supplied by Messrs. Allen & Son. Space for 22 boilers is provided, 17 being at present installed in two rows with a roomy firing floor in the centre, overhead coal bunkers and underground ash tunnel. The installation is divided into four self-contained units, each unit including a Green economiser with 480 tubes and scrapers, driven by a 3 H.P. continuous-current motor, a 60in. "Sirocco" fan driven by a 60 H.P. compound Allen engine, a battery of boilers, flues, pumps, &c. Two chimneys have been erected, one for each side of the boiler house. These chimneys are 125ft. high by 9ft. 6in. and 7ft. internal diameter respectively. They are constructed of steel, self-supported and lined with firebrick throughout. Induced or natural draught can be used as required. The boilers are of the water-tube type with a heating surface of 4,896 sq. ft. and 76 sq. ft. grate area each. They contain 224 tubes of 4in. internal diameter each, and Messrs. Babcock and Wilcox's superheater's are fixed under the steam drums; the temperature of the steam is raised 100° F., and the pressure is 150lb. per square inch. 13 of the boilers are hand-fired, and the remaining four are provided with B. and W. chain grate stokers. Purifiers are fitted to each boiler as an additional safeguard to arrest any particles of solid matter or oil which might chance to escape the softening and purifying plant. The ashes from the fire bars drop into a sloping firebrick-lined chamber, from which they are discharged into trucks in the ash tunnel underneath the firing floor. The ash tunnel is open at either end, and the ashes may be picked up by a Temperley coal transporter and delivered into carts or barges as required. Overhead bunkers are provided capable of holding 1,600 tons of coal, which is discharged into the chain-grate hoppers or on to the firing floor as required, by means of travelling weighing shoots, which are carried by a pair of overhead rails and are propelled by hand. The coal used is Welsh washed peas in the hand-fired boilers and washed nuts in the chain-grate boilers. Coal is delivered to the bunkers direct from barges by means of the Temperley transporter driven by a 30 H.P. continuous-current motor, the whole operation of lifting, weighing, travelling and tipping being performed by the crane driven from the motor house. We hope to publish a detailed description of this transporter in an early issue. Two Hall compound-tandem pumps, two Weir single pumps, each capable of delivering 60,000lb. of water per hour, and four Weir single pumps, capable of delivering 30,000 lb. of water per hour each, supply water to the boilers. The pumps are situated round the feed tank in a space in the centre of one side of the boiler house. Feed water is delivered through a Green economiser to the boilers. The exhaust steam from the feed pumps and fan engine discharges through two copper heating coils, composed of 4in. copper tube 90ft. long, in the feed tank.

Engine Room.

The arrangement of the machinery in the engine room, as shown on p. 937, has been very carefully thought out, great attention having been given to the minutest details. The engines are arranged in two lines, one on each side of the engine room, with the condensers and air pumps in a capacious trench in the centre and below the floor level. At one end of the room the switchboard gallery is erected at about 15ft. above the floor level, with an office for the engineer-in-charge opening off at one end and a door at the opposite end from which an iron stairway gives access to a raised platform running along the end of the boiler house; the engineer-in-charge consequently has the whole system under easy supervision. Underneath the switchboard gallery and on the engine floor level is a space reserved for four Ferranti rectifiers and the traction negative and differential boosters. Beneath this space in the basement are placed four centrifugal pumps which supply the circulating water to the condensers. A travelling crane driven by an electric motor and capable of lifting and carrying 30 tons, spans the engine room. Space has been left in which to erect three additional generators of about 2,000 H.P. each, as required. The generators at present installed consist of two 300kw. engines and alternators running at 250 revs. per min.; two 600kw. at 225 revs. per min.; two 1,200kw. at 250 revs. per min.; and three 500kw. at 175 revs. per min. The engines have all been manufactured by Messrs. Ferranti, and are cross-compound, vertical, condensing, fitted with this firm's patent valve gear and grid valves. Messrs. Ferranti also made the alternators, of the single-phase copper type generating current at 2,000 volts and a frequency of 50 ~ per sec. The continuous-current tramway generators were manufactured by Messrs. D. Bruce Peebles & Co., and are compound-wound.

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Condensing Arrangements.

The condensing plant has all been supplied and manufactured by Messrs. W. H. Allen, Son & Co. The air and circulating pumps for the new plant are electrically driven by means of continuous-current 500-volt motors. No gear is used, the motor armatures being connected directly to the pump shafts, which arrangement, although necessitating larger motors, practically eliminates noise. The plant consists of four surface condensers of 4,000 sq. ft. cooling surface each, fitted with Edwards type three-throw air pump with auxiliary force pump; four 15in. electrically-driven centrifugal circulating pumps; two surface condensers of 2,000 sq. ft. cooling surface each, fitted with combined air and circulating pumps, driven directly by compound steam engines. The air pumps on the large condenser are driven directly by 15 H.P. shunt-wound 500-volt continuous-current motors. These pumps discharge into a cast-iron tank fitted to each condenser from which an auxiliary force pump, driven off the air-pump crank shaft, discharges the greasy water to a Harris-Anderson purifier situated outside the engine room. This purifier separates the oil from the water, after which the pure water runs directly into the boiler feed tank. The purifier is capable of dealing with from 10,000 to 16,000 gallons of water per hour, and is entirely self-regulating. An article describing this plant in detail appeared in *The Electrician*, Vol. XLIX., p. 782. The cost of treating the water by this process is about ¼d. per thousand gallons, and we are informed that the results are extremely satisfactory, there being absolutely no perceptible trace of oil in the water after treatment. Circulating water is taken from the cooling ponds previously mentioned. A pipe, 3ft. in diameter, is laid from the channel into which all the ponds drain to a suction tank outside the end wall of the engine room. Four 15in. centrifugal pumps directly coupled to 15 B.H.P. motors take the water from this tank, each pump having an independent suction pipe. These pumps are all below the level of the water in the suction tank, so that there is no difficulty in flooding them, and they discharge into two 20in. mains, each of which supplies two of the large condensers. The steam condensers have independent suction pipes.

After passing through the condensers the circulating water is discharged through two 24in. pipes over a weir at the end of the cooling ponds opposite the channel from which the water is drawn. These 16 tanks form ideal cooling ponds, being divided into a series of basins, each having an area of 2,600 sq. ft. Consecutive basins in a series are connected by holes at the bottom of the divisions, so that the cooler water from each flows into the next tank. The tanks can be filled at high tide from the River Lea, and there is also a supply available to them from the artesian well.

Steam, Exhaust and Drain Piping.

In designing the arrangement of piping, great pains have been taken to ensure as economical working as can possibly be obtained consistent with reliability. The steam piping is arranged on the by-pass system, each engine being directly connected to a pair of boilers. To prevent any possibility of a rush of water finding its way to the engine cylinders, the pipes are arranged to drop the whole way from the boilers to a separator fixed in the basement 3ft. below each engine from which a steam pipe rises vertically to the engine stop valve. A main header having an internal diameter of 14in. runs the length of the boiler house, and each steam pipe has a branch into the header, so that if desired the boilers can all feed into this common main. Fitted to the header underneath each branch supply pipe are cast-steel pockets, these being provided with gauge glasses and shut-off cocks and are connected through Geipel steam traps with by-pass pipes to a main 4in. drain running parallel to and immediately beneath the main header. The main header is divided in the middle by four 9in. expansion bends. A main 24in. exhaust pipe is fitted in the condenser pit and runs the whole length of the engine room, each end being connected through Blake and Knowles automatic relief valves to an atmospheric discharge pipe. The drain piping consists of three main 4in. engine room drains and one 4in. drain in the boiler house referred to above. The boiler house drain and one engine room drain, to which the separators are connected through Geipel steam traps, both convey pure water and return it direct to the feed tank. The remaining drains, connected through steam traps to the high-pressure and low-pressure cylinders respectively, convey greasy water discharge into a tank which receives the air pump discharge from the steam condensers. From this tank water is delivered to the purifier by means of a small centrifugal motor-driven pump. Every drop of water is therefore returned to the feed tank, and we are informed that, even after having passed through the purifier, the loss of heat is exceedingly small. The feed-water piping is arranged in four ring mains, one to each section of the boiler house. A softening plant to deal with 8,000 gallons of water per hour on the Archbutt-Deeley process has been installed by Messrs. Mather and Platt.

Switchboard.

The lighting switchboard has been installed by Messrs. Ferranti, and is of their high-tension cellular type with three 'bus bars. There are nine 300-ampere alternator panels and 17 150 ampere circuit panels, the former being used two in parallel for the 1,200kw. alternators. The old switchboard from Abbey Mills is being transferred to the new station, and will be built up with the new board. The traction board, with the boosters, has been supplied by The British Thomson-Houston Co., and is built of slate slabs polished in front. It is fitted with a spare positive 'bus bar and all the switches are arranged to throw over to either 'bus bar. There are four 1,000-ampere generator panels fitted with maximum and reverse-current circuit breakers, integrating wattmeters, and the necessary switches and instruments. In addition there are also eight feeder, Board of Trade, main, battery, negative and station circuit panels. A differential booster manufactured by the Lancashire Dynamo and Motor Co. is used in the battery circuit, and there is also a 12kw. booster for one of the longest negative returns. An auxiliary board to control the station motors and lighting, made by Messrs. Geipel and Lange, has been fitted and is fed from the circuit panel. A battery having an output of 200 amperes at 500 volts for four hours has been supplied by the Tudor Accumulator Co. This battery will be used for a great variety of purposes. Its principal function will be to insure the supply to the station motors so that these auxiliaries will be entirely independent of the public supply.

Distribution.

The system of supply for lighting is high-tension single-phase at a frequency of 50 ~ per sec., with a 100 and 200-volt low-tension distributing network. All high-tension cables are concentric paper-insulated lead-covered drawn into 3in. earthenware conduits fitted with Stanford joints. Sub-stations are chiefly used which are divided into two sections, one containing the transformers and the other the switch gear, with an iron door between. Ferranti high-tension switch gear is employed and only concentric cables are used in making connections. No disconnecting boxes are used in any of the high-tension cables nor are these broken anywhere excepting in transforming chambers. The original mains were broken every ¼ mile by plug switch disconnecting boxes, but it was found that the only breakdowns that ever occurred in the mains were caused by the very boxes which were installed with the object of localising such faults. All the old boxes have been removed and the cables jointed through, and no trouble has been experienced with this system for the past three years. There are at present 100 rectified arc lamps, 45 parallel enclosed, and 15 series enclosed lamps. The tramway routes will all be lighted by continuous-current series open-type lamps, arranged 6 to 11 in series and supplied by mains direct from the switchboard, the rails being used for the return. The rectified lamps were supplied by the Brockie-Pell Company and all enclosed and continuous-current lamps by the British Thomson-Houston Co.

Electrical Equipment of Tramways.

The West Ham Corporation are also owners of a system of overhead electric tramways worked on standard principles. The sizes of the positive feeder cables are 0·75, 0·6, 0·4 and 0·2 sq. in., the negative 0·75 sq. in., and the line sub-feeders 0·2 and 0·15 sq. in. section. All the cables are single paper-

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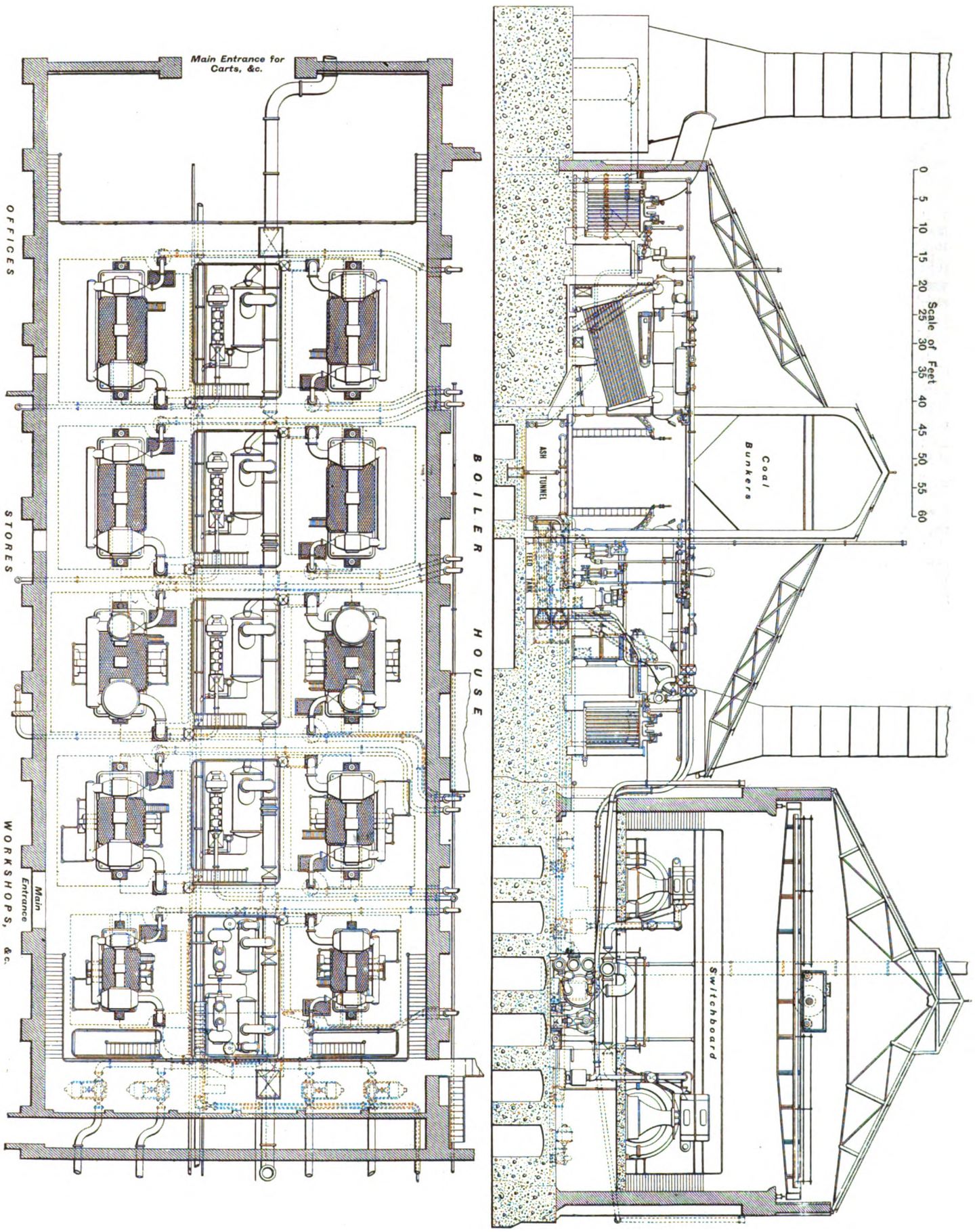

Cross-section of Works and Plan of Engine Room.

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insulated, manufactured by the British Insulated and Helsby Cables (Ltd.), and have been drawn into 3in. earthenware conduits with Stanford joints. The mains for lighting and tramways have been laid simultaneously, but the conduits and pulling-in boxes have in each case been kept distinct. The contractors for the overhead equipment are Messrs. Macartney, McElroy & Co. Very heavy trolley-wire (No. 0000 S.W.G.) has been used, and the fittings are proportionately heavy. The trolley-wire is anchored on either side of each section insulator and splicing ear on the "vertical plane system," and this system has also been adopted on curves by anchoring the bracket-arm to the pull-off pole and the trolley wire to the bracket. Side-pole construction has been used throughout, except at curves, crossings and roads necessitating a bracket-arm of over 20ft. Alternate poles are arranged to carry arc lamps. The length of the bracket-arm varies from 6ft. to 22ft. Flexible bow-string suspension with double insulators has been adopted throughout. 24in. straight and 30in. and 33in. curved cars are used, all of which are soldered. 7/14 S.W.G. stranded galvanised steel guard wires are used, and every alternate pole, every pole carrying feeder wires, and every fourteenth ordinary pole are bonded to the rails.

A complete system of telephones has been installed on the General Electric Co.'s system, each feeder and section pillar being provided with a small door in the upper panel, which, when open, exposes a plug contact, to utilise which portable telephone sets are provided on each car. Pilot wires are run to the end of each route from the generating station, and these register the drop of pressure between the extreme points and the station. A contract for 50 cars was given to Messrs. Witting, Eborall & Co. (Ltd.), the sub-contractors for the car bodies being Messrs. G. F. Milnes & Co., for the trucks the Brush Electrical Engineering Co., and for the controllers, &c., the British Thomson-Houston Co. The cars have a seating capacity of 56—34 outside and 22 inside. Each car is fitted with a 25 H.P. Witting series motor, specified to have a drawbar pull of 1,200lb. at the periphery of a 30in. wheel at a speed of 8 miles per hour for a period of one hour with a maximum temperature rise of 75°C. Tidswell life-guards, hand and rheostatic brakes, Blackwell swivelling trolleys and British Thomson-Houston series parallel controllers are fitted, and also Garton lightning arresters and automatic switches. The track was laid by Mr. Fred Osman to the specification of Mr. J. Edward Waller, the work being superintended for Mr. Osman by Mr. William H. Davis. Mr. H. E. Blain is tramways manager, to which position he was appointed in July, 1903. We are indebted to Mr. James K. Bock, the borough electrical engineer, for the above particulars and for his courtesy in conducting us over the works.

RADIO-ACTIVITY OF CERTAIN MINERALS AND MINERAL WATERS.*

BY HON. R. J. STRUTT.

PART I.

A considerable number of minerals are known in varying degrees to be radio-active. Lists have been given by M. and Mme. Curie†, and by Sir W. Crookes‡. Except in the case of pitchblende, little has been done to determine the nature of the radio-active constituents, or to decide whether any hitherto unknown radio-active body is present. To obtain complete information on these subjects, the only method available would be to analyse the mineral completely, and examine every precipitate and filtrate for radio-activity. This process is, of course, very tedious, and the results have to be interpreted with care, since traces of radio-active elements may often be carried down in the groups to which they do not properly belong, and thus cause confusion. A much easier method is to heat the crude mineral, and to examine the rate of decay of the emanation which it gives off. Each emanation has a characteristic time constant of decay, and by determining this we can identify it. The method is, of course, useless for testing the presence or absence of radio-active elements such as uranium,§ which do not give off a characteristic emanation. But the great facility with which it may be applied to a small quantity of material and the definiteness of the results are great merits.

In any case, when a material suspected to contain radium is obtainable in abundance, it is better to test for the presence of emanation than to look for activity in the solid. For but little of the solid material can be advantageously used in the test. Thick layers give no larger effect than thin ones, since the upper layers absorb the radiation from the lower. But the emanation can be extracted from any desired bulk of material and the effect proportionately increased. If carbonic acid or any other gas is evolved at the same time in inconvenient quantities, it can be absorbed with a suitable reagent, and the emanation contained in it thereby concentrated.

The present Paper gives the results of an examination of certain radio-active materials by this method. No new emanation has been recognised. The results have in all cases been attributable to thorium and radium. If any emanation decidedly more permanent than that of radium existed in the evolved gas, the method could not fail to detect it. For in every case the activity of the gas was watched until it became comparable with the very small activity due to the walls of the vessel. If a more durable emanation had been present, even in small quantities, the proportion of it present would have increased relatively to the radium emanation, and its presence would have become apparent towards the end, by a diminished rate of decay. Small quantities of an emanation less durable than that of radium might have escaped detection. For they would have been masked by the much greater quantity of the latter.

By measuring the rate of leak due to the accumulated emanation from a weighed amount, the proportion of radium present may be estimated. A comparison with the leak due to the emanation of a known weight of radium must of course be made. For this purpose it would be best to weigh out, say, a milligramme of radium bromide, dissolve it in a litre of water, and evaporate a small measured quantity of the solution in a suitable tube. In this way the effect due to a standard quantity could be determined.

The method of experimenting was as follows:—The powdered mineral was placed in a hard-glass combustion tube, drawn out and sealed at one end, connected to a mercury gas-holder at the other. The mineral was heated to redness and the gaseous products collected in the gas-holder. When the evolution of gas had ceased, the point was broken off and air drawn into the gas-holder up to a standard volume. For measuring the electrical effects an electroscope was used. This was exhausted and the gas extracted from the mineral, together with the air, which had been used to make up its volume to a sufficient amount, was admitted. After a few hours, enough for the deposited activity to attain its full value, the rate of leak was read. The day and hour was noted, and the gas was pumped out into a test tube and stored over mercury. After a sufficient time had elapsed it was again introduced into the apparatus by means of a syphon gas pipette* and the rate of leak again measured. In the meantime the apparatus had been available for making measurements with other gases.

In some cases the emanation was initially so strong that it could not be conveniently investigated. In such cases a portion of the gas was diluted with air for measuring the rate of decay at first. The concentrated material was kept until, by lapse of time, it had become weak enough to be conveniently used. Its activity was followed until it had become too small for measurement.

With this preface the results for the various minerals tried may be given in the form of a table. The rates of leak are given in scale divisions per hour. When air alone filled the apparatus the rate of leak was 2·25 scale divisions per hour. This was in each case subtracted.

Mineral.	Locality.	Quantity taken in gr.	Rate of leak due to emanation (scale div. per hour).	Rate of leak per 100 gr.	Days taken by emanation to fall to half initial value.
Samarskite.	N. Carolina, U.S.A.	20	20,600	103,000	3·48
Fergusonite	Norway (?)	7	4,280	61,000	3·80
Pitchblende	Cornwall	40	11,900	29,800	3·50
Malacone..	Hitteroe, Norway..	20	1,440	7,200	3·81
Monazite..	Norway	51	2,060	4,000	3·50
,, ..	North Carolina ..	82	37	45	3·81
,, ..	Brazil	54	11	24	3·80
Zircon	North Carolina ..	60	24·6	41	4·05

All the minerals give radium emanation, though in very varying quantity. These tests were not started quickly enough to give information as to the presence of a very quickly decaying emanation. This was tested for independently.

* Paper read before the Royal Society, March 10, 1904.

† Thèse présentée à la Faculté des Sciences, Paris, p. 19.

‡ Roy. Soc. *Proc.*, Vol. LXVI., p. 411.

§ I have found a distinct, though feeble, emanation from re-crystallised uranium nitrate, having a rate of decay equal to that of the radium emanation. Whether this is really due to uranium, or to traces of radium which the uranium still contains, must be left for the present an open question.

* The methods of manipulation used in storing and transferring the gases without loss were those described in Dr. Travers' book, "The Study of Gases."

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The mineral malacone is of peculiar interest, because it has been found to contain argon as well as helium.* Helium is formed by the degeneration of radium, and it is reasonable to assume that the other kindred gases have had a similar origin. It was hoped, therefore, that malacone might contain some new radio-active element. It is still possible that it does so, but, if so, this substance gives no emanation distinct from that of radium. The meteorite of Augusta Co., Virginia, has also been found to contain argon and helium. But no emanation at all could be obtained from 20 grammes of it.

The minerals were all tested for thorium emanation by drawing air over them in the cold; the only one in the above list that gives it is the Norwegian monazite, and even this does not yield it very abundantly. A crystal of thorite, however, kindly lent me by Prof. Lewis, was found to give torrents of thorium emanation. Air drawn over it in the cold possesses strong discharging power. It was not permissible to heat the specimen, which might have injured it, so that the presence or absence of radium emanation in thorite could not be investigated.

There can be no doubt that the other specimens of monazite contained thorium, for they were given me by the late Mr. W. Shapleigh, who was connected with the thorium industry, and used these varieties of monazite for preparing thoria. They were, moreover, markedly radio-active, while the amount of radium emanation obtained from them was so small that their activity could not be mainly due to radium. They probably contain the thorium in what Rutherford and Soddy call the de-emanated condition—that is, the thorium emanation, though formed, is not able to escape.

It is a remarkable fact that these varieties of monazite, though they contain practically no radium, yield helium in fair quantity. There are several explanations possible. The radium originally present may have almost completely decayed into helium, and any other products which it may yield; or it may be that thorium, as well as radium, yields helium by its decomposition; or, lastly, the helium may not, in this instance, have been generated by radio-active changes at all.

It is interesting to know whether the minerals retain all the radium emanation which they generate when heat is not used to expel it. Two cases were examined. 114 grammes of powdered samarskite were kept for three weeks in a sealed glass tube. The air was pumped out and tested. It was found to contain about $\frac{1}{150}$th part of the emanation which could have been extracted by heat. A similar experiment with malacone showed that about one-fiftieth of its emanation was able to escape in the cold. It appears, therefore, that these minerals retain nearly all their emanation. The same is probably true of the helium produced by the emanation. Samarskite which had been heated to redness was found to retain its emanation in the cold about as well as before.

Part II.

I happened to possess a small sample of a red deposit, coloured by iron, which is left by the water of the King's Spring, at Bath. It occurred to me that it might be worth while to test this for radio-activity. The result was to show that the deposit was markedly active. On leaving it in the testing vessel (which was closed airtight) for a few days, the activity was found to increase to several times its initial value. This shows that the deposit gives off an emanation freely, even without heat. Experiments were then made to test the rate of decay of this emanation. It proved to be identical with the rate of decay of the emanation of radium.† The activity is wholly due to that element.

This deposit was collected inside the King's Well itself, where the hot water issues from the ground. Other deposits are left in the tanks and pipes. They are less active than that collected near the source. Deposits from another of the hot springs at Bath, that known as the Old Royal Spring, have also been tested. These were found to be active also. In this case there was no opportunity of collecting the deposit at the well-head itself, but it was found that the deposit left in the channel near the source was more active than that in the tanks further from it.

It was interesting to determine whether the water itself contained any radium in solution. There could be little doubt that there must be traces left in solution, after the deposit had settled out. But, since the Bath water contains abundance of sulphates, and since radium sulphate is one of the most insoluble salts known, there could not be more than the merest traces present. The sulphate of barium is very much less soluble than that of strontium. And presumably the sulphate of radium is much less soluble still. Barium sulphate requires half-a-million times its weight of water to dissolve it; radium sulphate perhaps several hundred million times its own weight.

About 10 litres of the Bath water were evaporated to dryness. The resulting saline residue was sealed up in a hard-glass tube and left for about a fortnight to generate a stock of emanation. On heating, a distinct emanation was obtained, giving several times the rate of leak that air did. A deposit, similar to that from the Bath water, but black in colour, can be collected from the source of the hot springs of Buxton. It has been analysed by Dr. J. C. Thresh,* and I am indebted to his kindness for a specimen of it. This deposit was found to contain radium also, the proportion present being not very different from what was found in the case of some of the Bath deposits.

The following table gives the quantitative data for these emanations from these deposits. The rates of leak are on the same scale as those in the preceding table. It will be seen that the richest of the deposits is some 36 times more active than the salt obtained by evaporating the water.

Material.	Quantity taken in grammes	Rate of leak due to em'nation (sc. div pr hr)	Rate of leak due to em'nation from 100 gr.	Days taken by emanation to fall to half initial value
King's Spring, Bath—				
Deposit from inside of well....	10	250·0	2,500	3·60
,, tank.....	12	78·2	650	..
Saline residue from water	18	12·4	69	..
Old Royal Spring, Bath—				
Deposit from channel near well.	10	63·5	635	..
,, bottom of tank ..	15	60·0	400	..
Hard deposit from sides of tank	25	43·0	173	3·58
Buxton deposit	26	356·0	1,370	3·81

Although the agreement in the rate of decay of the emanation seemed sufficient to prove that the activity was really due to radium, yet it was thought desirable to show that the chemical properties of the active constituent were in agreement with this conclusion. 200 grammes of the richest deposit were treated with dilute sulphuric acid. The activity was all in the insoluble residue, which was dirty white in colour, and amounted to about half of the entire quantity of deposit. The residue was boiled with strong sodium carbonate solution. This was washed away, and the mass extracted with hydrochloric acid. The hydrochloric acid solution gave a slight precipitate with sulphuric acid. This precipitate was collected, and found to be strongly active, so that there is every reason to conclude that the activity of the deposit is due to the presence of radium.

The presence of radium in the Bath water and deposits is of special interest because of the occurrence of helium in the gas which rises with the spring.† There can be little doubt that the helium owes its origin to the same store of radium that supplies the water.

It is interesting to estimate the quantity of radium annually delivered by the spring. Part of this is in the deposit. Part in the water. But the annual yield of deposit does not exceed a few cwt. at the most. And although it is much richer in radium than the dissolved salt, the quantity of the latter is so enormously greater, that the deposit may be neglected. According to the estimate of Sir A. C. Ramsay, the late director of the Geological Survey, the salt annually delivered by the spring would be equivalent in volume to a column 9ft. in diameter, and 140ft. high. Taking the density to be twice that of water, this would weigh about 500,000kg.

Now the saline residue gives about $\frac{1}{1,000}$th part of the quantity of emanation that samarskite gives. Let us assume that the latter contains one-millionth part of radium, which is, I think, an outside estimate. At that rate, the annual delivery of radium by the spring amounts to about $\frac{1}{2}$ gramme. The volume of gas which the spring delivered is about 100 cubic ft. per day.‡ About $\frac{1}{1,000}$th part of this is helium, so that about 3 litres of helium is given off daily, or about 1,000 litres per annum. The proportion of helium to radium thus indicated is of the same order as in the radio-active minerals, though somewhat larger. This is in accordance with the view that the spring draws its supplies from the disintegration of such minerals.

In obtaining the various materials from the Bath springs, I have had the great advantage of Mr. Sydenham's help. His knowledge of everything connected with the springs has been of great assistance.

In addition to the Bath and Buxton waters I have examined several others. A sample of the Cheltenham saline water, and also a deposit left in the pipes, was kindly sent me by Mr. G. Ballinger. But no emanation could be obtained, either from the dissolved salts or from the deposit. The boiler crust from a domestic hot-water pipe, Terling, Essex, was examined, but the result was again negative.

* Ramsay and Travers, Roy. Soc. *Proc.*, Vol. LXIV., p. 131.

† In the first experiment made, I obtained a small residual leak when the radium emanation had decayed. This was attributed to a new emanation, of greater durability. But I have failed to repeat the experiment, and am forced to conclude that the leak was due to a failure of the quartz insulation, owing to the presence of moisture. It is very difficult to understand how this can have happened, for the gas was passed through drying tubes. When the rate of leak was tested with air in the apparatus, it had always a perfectly definite and constant small value.

* *Proc.* Chem. Soc., January 17, 1882.

† Rayleigh, *Proc.* Roy. Soc., Vol. LX., p. 56.

‡ Williamson, Brit. Assoc. Reports, 1865, p. 380.

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THE LIVERPOOL-SOUTHPORT ELECTRIC RAILWAY.

(Continued from page 899.)

Undoubtedly one of the most interesting parts of the new electrical equipment of this line is the system of train control. The advantages of motor cars over locomotives for suburban traffic are now widely recognised, and with them the gain of employing a dual or multiple-unit system—that is to say, a motor car at each end of the train or a number of motor cars

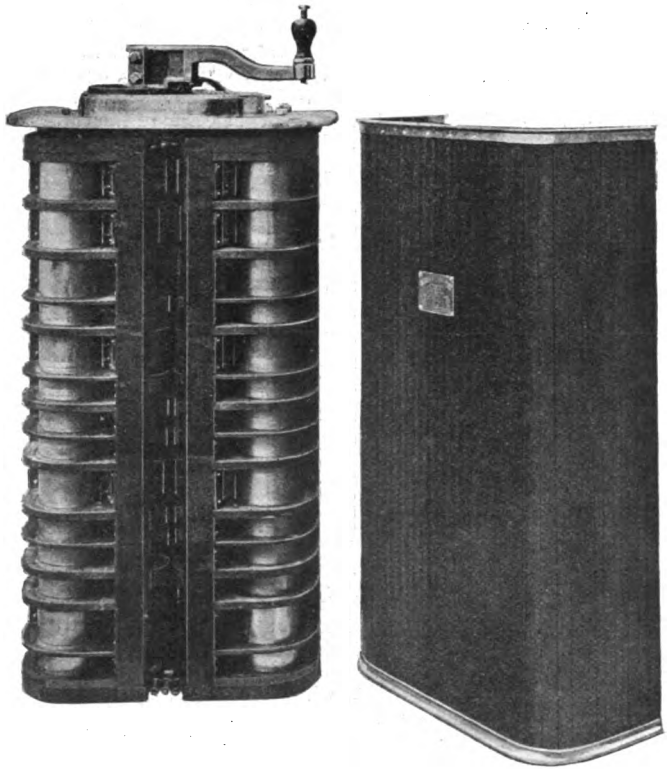


FIG. 10.—CONTROLLER WITH OUTER CASE REMOVED.

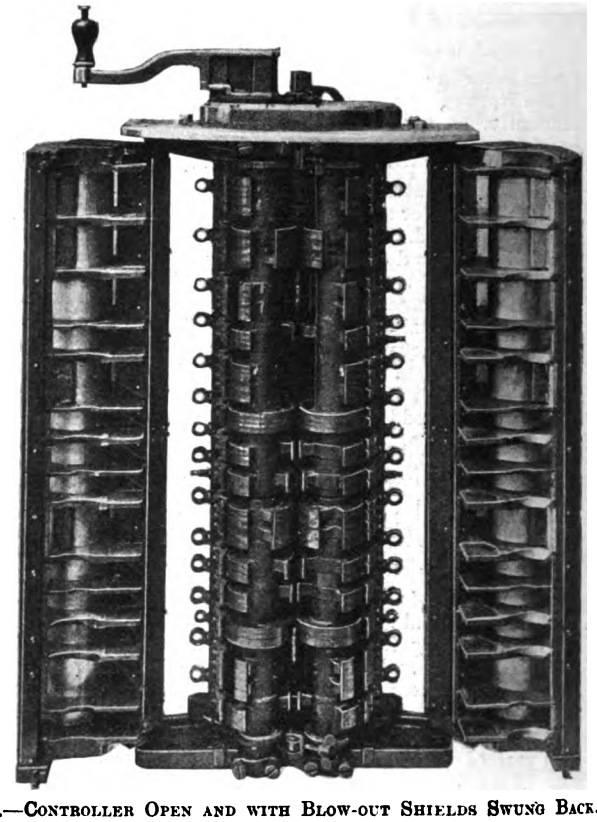
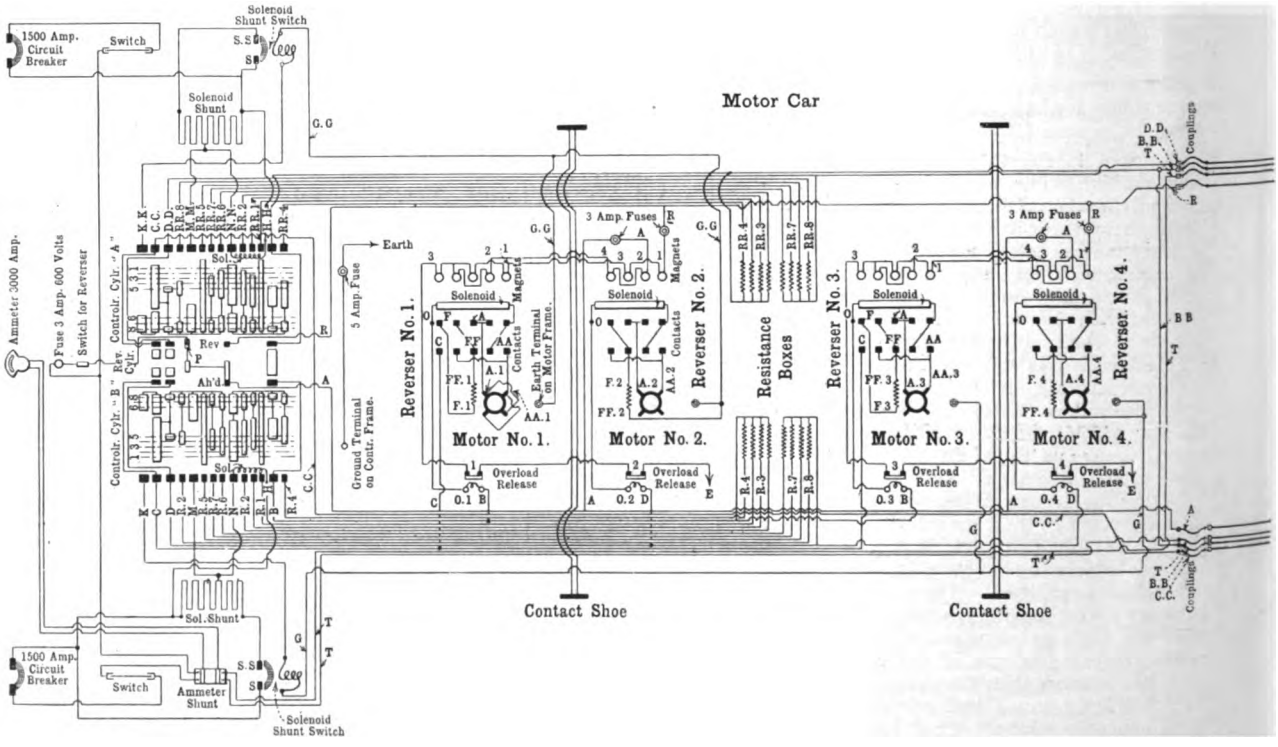


FIG. 11.—CONTROLLER OPEN AND WITH BLOW-OUT SHIELDS SWUNG BACK.



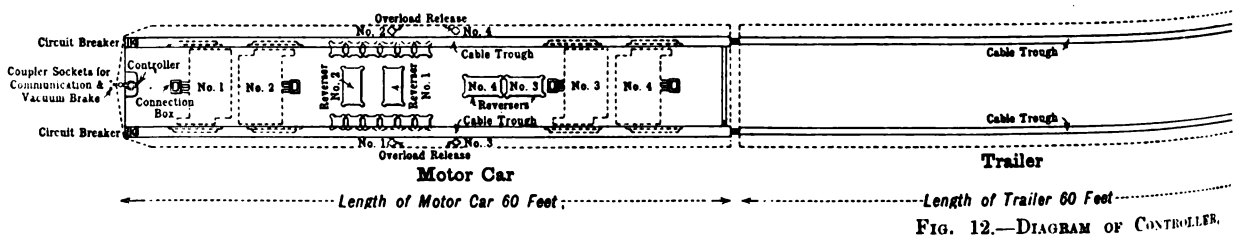


FIG. 12.—DIAGRAM OF CONTROLLER.

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distributed at equal distances throughout the train. The term "multiple-unit control" is now generally taken to imply also an indirect system of control: the controller in the front car closes the contacts of electromagnetic or electro-pneumatic devices on the several motor cars, each set of which devices makes the series parallel control connections for the motors on its particular motor car. Such an indirect system is apparently necessary if there are a number of motor cars on each train, but if there

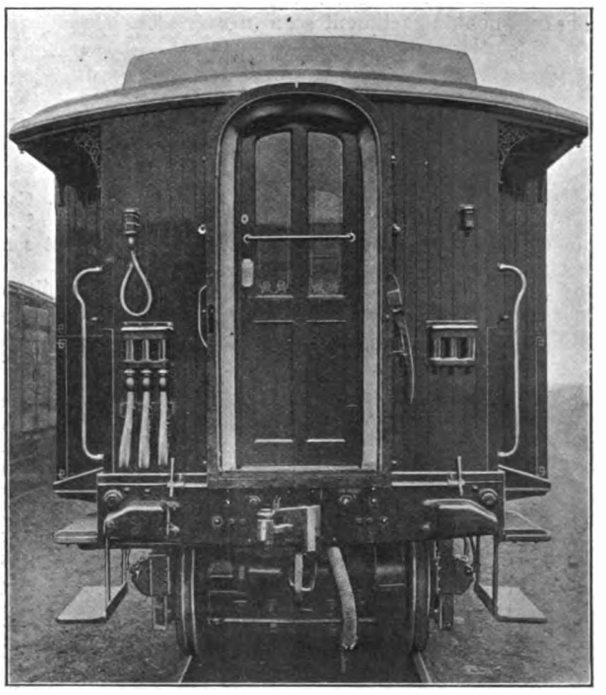


FIG. 13.—END VIEW OF COACH, SHOWING COUPLINGS.

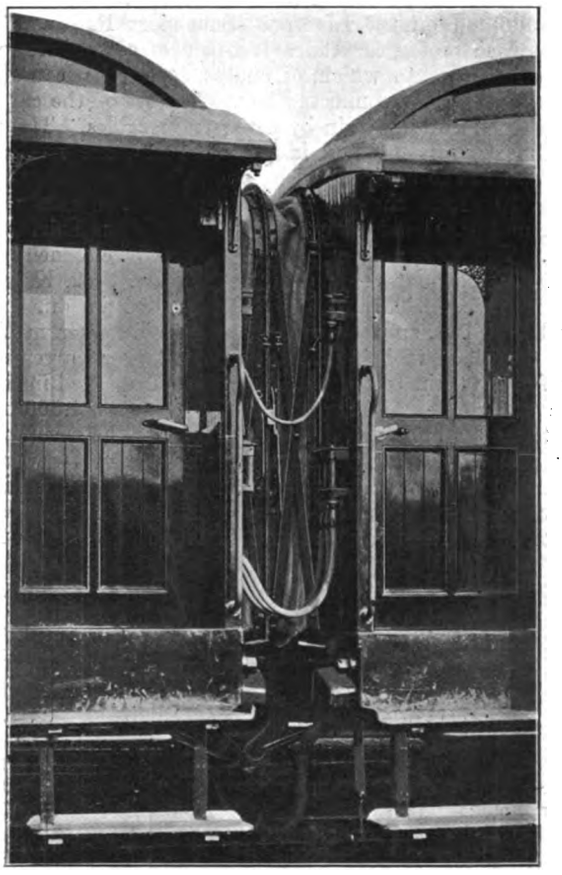
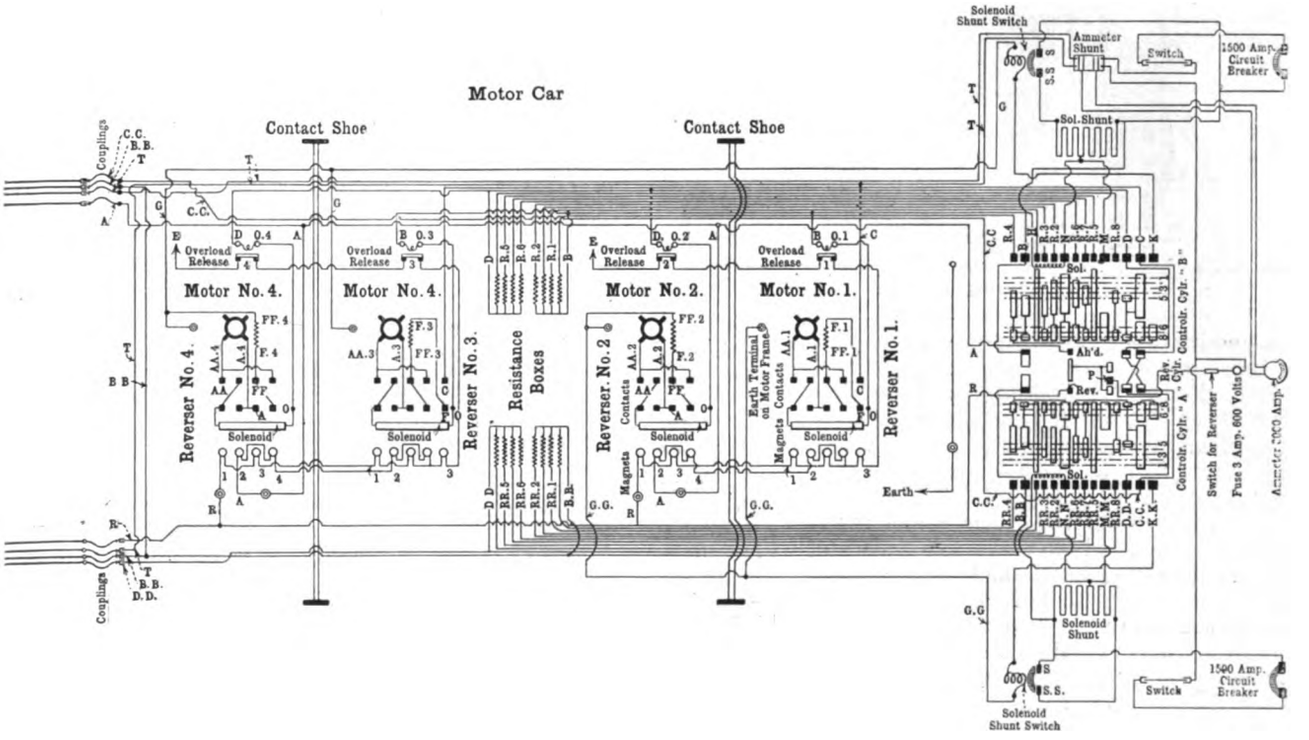
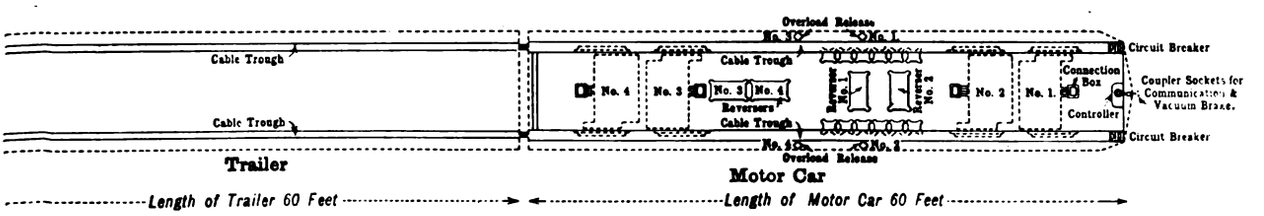


FIG. 14.—SIDE VIEW, SHOWING COUPLINGS.





MOTOR, AND REVERSER CONNECTIONS.

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is only a motor car at each end, a direct system of control is quite feasible by coupling a few main cables from one end of the train to the other. This method of "dual" control has been adopted on the Liverpool–Southport Railway. In the cab of each motor car there is a pair of controllers, one for its own motors, to which, of course, connection can be made directly, the other connected to the motors of the car at the opposite end of the train by three train cables. The pair of controllers are contained in one case and are mechanically coupled so as to be operated by one handle.

Fig. 10 shows the controller with its outer case removed, while in Fig. 11 it is shown with the blow-out shields swung back. The design is on the ingenious development of the magnetic blow-out principle which Messrs. Dick, Kerr & Co. have evolved. This was fully described in our issue of April 24th last, and the controllers only differ from the one then described in being made for the larger currents necessary for the train as compared with those employed in ordinary tramway work. As currents in the order of 1,500 amperes are taken at starting (divided, of course, between the two controllers), the compactness of the design is worthy of special praise, and during the trial runs which we witnessed it was evident that the blow-out arrangement acted quite effectively. Reversing the motors is not done directly, but

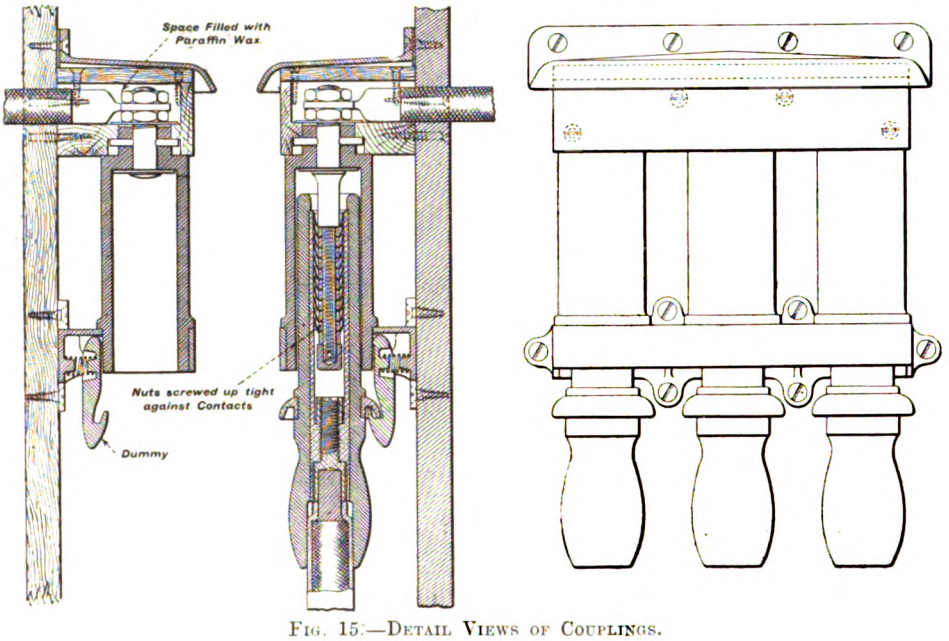

Fig. 15.—Detail Views of Couplings.
Scale: One-fifth full size.

through electromagnetically-operated reversing switches near the motors, the comparatively small current to operate these switches being sent through a special circuit requiring a fourth coupling between the cars, thus bringing the total number of couplings for the control of the motors to eight —four in each direction. This auxiliary circuit is made and broken at the controller-reversing barrel.

Fig. 12 is a diagram of the controller, motor and reverser connections, which is so detailed as to be self-explanatory. The one set of four couplings connect the motors and reversing switches on the rear motor car to the front controller, and the other set of couplings connect the front motor car to the rear controller. When the couplings are disconnected the two motor cars are independent, and nothing further than this is required for running them separately with any desired number of trailers. The ordinary unit will comprise only one trailer and the motor car, and the usual train will thus be made up of two motor cars with two trailers between. In Fig 12, TT are the main positive train cables, and the other circuits, &c, are also lettered so that they may be traced without too much difficulty.

Fig. 13 is an end view of one of the coaches, showing the couplings, Fig. 14 is a side view of two coaches showing the method of connection, while Fig. 15 gives the detail of the couplings themselves. These it will be seen consist of male plugs within an insulating socket fixed permanently to the car, the movable part in each case being a hollow copper cylinder likewise covered with an insulating sleeve or handle. The moving part is carried on the end of a flexible cable connection, and when not in use is pushed into the dummy socket seen at the left of Fig. 15. In Fig. 13 the flexible coupling plugs are held up by the dummies on the left hand, and on the right hand the fixed sockets are seen. In both cases the coupling is prevented from shaking out and is held tight home by the spring and hook attachment seen in Fig. 14.

(To be continued.)

THE WESTINGHOUSE STEAM TURBINE.

The following is an abstract of a report by A. B. Canaga, Commander U.S.N., and E. N. Janson, of the Bureau of Steam Engineering, Navy Department, on tests carried out last summer with a Westinghouse steam turbine:—

The trial was made with one 1,000kw. steam turbine built for the Cleveland, Elyria and Western Railroad. It is of the two-stage type, directly connected to the revolving field of a three-phase generator, 400 volts, two-pole, 50 cycles per sec., the appearance of which is shown in Fig. 1. The general design of the turbine in question is, with the exception of various details, substantially the same as that of Parsons. A re-heater between the high-pressure and low-pressure turbine was not used in this machine, but substituted with an ordinary receiver pipe and separator. Steam at a pressure of 150lb. per square inch and superheated by 25°F. entered the casing of the high-pressure turbine through a series of valves. There is first an automatic stop valve, then a throttle valve and a steam strainer, as shown in Fig. 2. The admission valve is composed of a double poppet, actuated by a piston and a small relay valve, which receives its reciprocating motion from levers connected by an eccentric through gears to the turbine shaft. The movement of the relay valve is controlled by a ball governor, and the steam is admitted in puffs, the exhaust being taken out at the bottom of the low-pressure turbine and led through a 30in. exhaust pipe to the bottom of an ordinary surface condenser. The lower part of this pipe was formed into a hot-well, at the bottom of which was placed a nozzle with a by-pass valve, connecting the suction pipe of the pump either direct to the condenser or to the hot-well. A gauge glass, with means provided to ascertain the water-level line, gave readings of the amount of water contained in the hot-well when beginning and finishing the trial. The hot-well pump discharged directly into either one of the two weighing tanks placed on scales to ascertain the amount of water condensed. After passing through transformers, the electrical energy was absorbed in a water rheostat, and readings obtained on the usual instruments. The weights of the turbine may be cut down to some extent by substituting steel castings where now cast iron is used—for instance, in bed-plate and casing. The revolving drum and shaft is made of forged steel. The grooves containing the moving blades are slightly dovetailed; each blade and distance piece, after being dropped in place, is subjected to pressure sufficient to upset the end and thus fill out the dovetail, thereby firmly gripping the blades. For the stationary vanes the grooves are parallel. The edges are caulked after the blades are all assembled. The free ends of the longer blades are lashed with brass wire, then soldered, forming a sort of shroud or continuous band at the outer end. The blades are made from brass, drawn in long lengths to actual section required. They are afterwards cut off to any length desired.

The bearings are loaded to a pressure of slightly more than 50lb. per square inch, against from 300lb. to 400lb. in a reciprocating engine; the peripheral velocity amounts to about 50ft. per second, against about 10ft. for battleship engines.

When analysing the figures given on the following page, it should be borne in mind that the turbine cylinders were not lagged, but simply covered over temporarily with felt roughly tied in place.

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Fig. 3 shows the results of the tests in graphical form, the dotted lines representing the tests with saturated steam and the full lines those with superheated st am.

Summary of Results.

Kilowatts	1,510	1,019
Equivalent electrical horse-power	2,023	1,365
Revolutions per minute	1,456	1,480
Steam pressure per gauge above throttle, lbs.	149·4	146·2
Steam pressure per gauge below throttle, lbs.	148·8	101·1
Vacuum, in.	27·5	27·83
Dryness of steam at throttle	0·994	0·995
Steam per hour per electrical horse-power	13·99	15·31

The following particulars of a Westinghouse-Parsons 5,000kw. steam turbine appeared in recent issues of American technical journals:—The space occupied by the 7,500 H.P. turbine is approximately 27ft. 8in. by 13ft. 3in. and the height to the top of the hand railing is 12ft. This is equivalent to 0·049 sq. ft. per electric horse-power capacity, or 20·2 H.P. per square foot of floor area required. For the complete unit a rectangular area of 47ft. 4in. in length and 13ft. in width is required, which is equivalent to 0·084 sq. ft. per electrical horse-power capacity, or 12 E.H.P. per square foot of floor space.

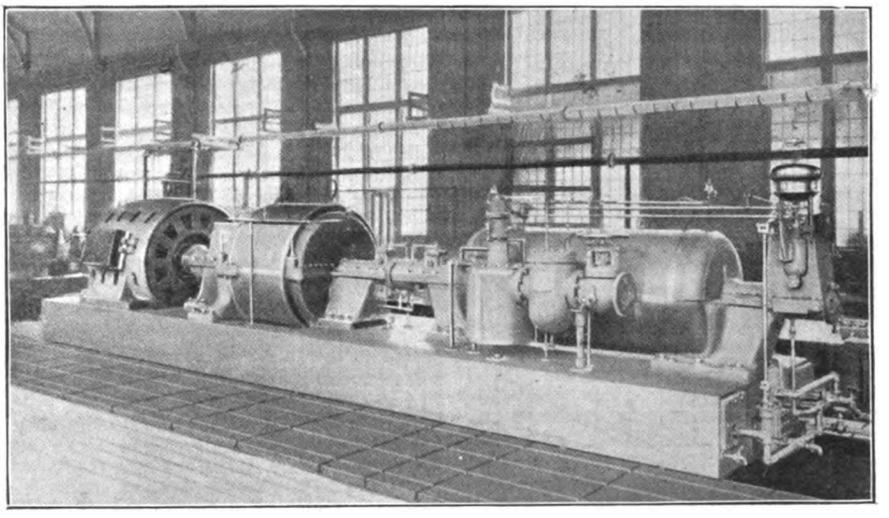

Fig. 1.—General View of 1,000kw. Westinghouse-Parsons Turbo-generator.

The speeds for the several sizes of turbines manufactured are: For the 5,000kw., 750 revs. per min.; for the 2,000kw. unit, 1,200 to 1,560 revs. per min.; and for the 1,000kw. unit, 1,500 to 1,800 revs. per min., depending upon the frequency desired. The unit rests upon a single bed-plate in two sections, which are secured by shrunk links. To the bed-plate, which is heavily ribbed to secure rigidity, are bolted the pedestals, generator casing and turbine body, but the bed-plate itself is not secured to the foundation by other means than the weight of the unit. Steam and exhaust connections are made beneath the floor level.

In the smaller machines of this type the cylinder barrel and both journals are cast in a single casting, thus largely minimising machine work. In the large machine, however, the barrel is cast in two sections, united by links, the outboard section carrying the journal and worm casing, and the inboard section the journal and exhaust opening, which extends through the bed-plate. As in former types linear expansion and contraction of the turbine are provided for by a sliding foot. The inboard journal pedestal is bolted securely to the bed-plate, but the outboard pedestal is free to slide between parallel machined ways. The main body of the casing is heavily lagged with non-conducting material, secured in place by sheet-steel casings. Leakage of air from the atmosphere into the exhaust spaces of the casing at the entrances of the shaft is prevented by frictionless packing glands. In shaft construction great rigidity has been secured with minimum use of metal. A central steel quill carries the entire rotating parts, both blades and balance pistons. Hollow-forged steel ends are forced into the two ends of this quill under hydraulic pressure, and are, in addition, secured by arrow-head links. High-pressure steam is conveyed to all parts of this quill structure in such a manner as to eliminate stresses and the consequent distortion, due to highly-superheated steam.

Power is transmitted to the generator shaft through a split flexible coupling, which is housed partly by the turbine and partly by the generator inboard journal. The coupling is split at the junction of the two shafts, so that by removing one bearing cap and the coupling bolts, either section of the unit may be lifted out without disturbing the adjustment of the remaining section. In the smaller sizes, the engagement surfaces of the coupling consist of the squared or hexagonal ends of the shafts, but in the larger machines a crow-foot sleeve is keyed to each shaft, and the power is transmitted by

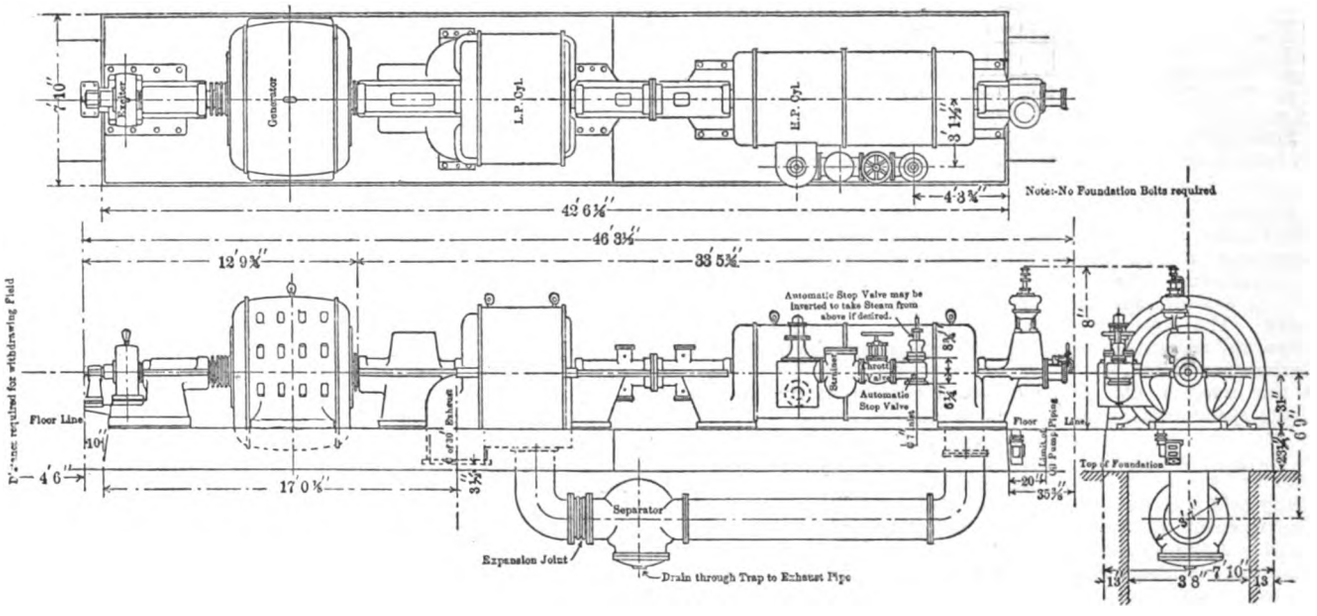

Fig. 2.—Plan and Elevations of 1,000kw. Westinghouse-Parsons Steam Turbine Generating Unit.

an outside quill engaging the crows-feet. The journals in the larger machines are of the solid self-aligning type, similar to that employed in generators and cross-compound engines. The departure from the familiar oil-cushioned journal employed in the small machines is occasioned by the speed reduction secured. The journal shells are babbitt lined, and are split horizontally, the two halves being united by bolts with shim adjustment. Oil from a central system is introduced at the centre under slight pressure, thoroughly flushing all parts. Axial adjustment is provided by metal shims arranged in quarter-box fashion. The diameter of the shaft

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at the journal of a 5,000kw. machine is 15in., strikingly small in comparison to the 34in. shafts required for a cross-compound reciprocating engine of corresponding capacity.

Longitudinal adjustment to preserve proper side clearance is secured by a thrust bearing, located next to the outboard bearing. The bearing is not subjected to longitudinal thrusts from the action of the steam, and is, consequently, of small size. The two half-shells are advanced in opposite directions by graduated set screws, so that the actual running clearances are measured in thousandths of an inch. Once set, these adjustments are permanent, and do not require frequent "taking up."

Steam enters the turbine successively through an automatic quick-closing throttle, hand-throttle, strainer and the main admission valve. A circular port surrounding the entrance to the initial stage conveys this steam to all points, so as to avoid stresses incident to more localised admission of highly superheated steam.

An important feature of the steam distribution system is the provision of a by-pass valve. This valve admits high-pressure steam to the second stage of the turbine on overloads, in order to increase its capacity up to 50 per cent. in excess of full-rated load. By properly proportioning the by-pass steam to the overload on the turbine, maximum economy may at all times be secured, together with reserve overload capacity. This results in a slight rise in the economy curve on heavy overloads, resembling, in some respects, the engine economy curve on loads exceeding that of maximum economy. The turbine, however, only suffers in economy at heavy overloads, while the engine economy decreases progressively from 75 to 80 per cent. for full-load capacity.

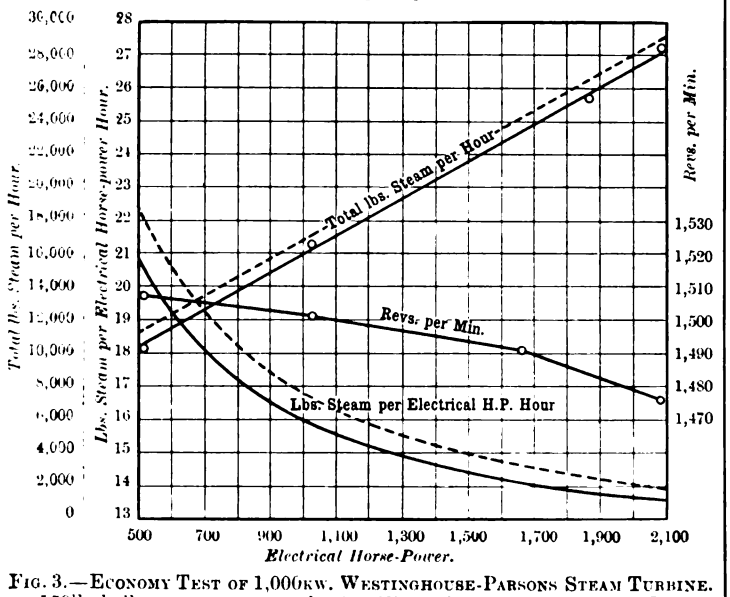

FIG. 3.—ECONOMY TEST OF 1,000KW. WESTINGHOUSE-PARSONS STEAM TURBINE. 150lb. boiler pressure; superheat 25°F.; 27in. vacuum; 1,500 R.P.M.

At the extreme outer end of the turbine shaft is a worm driving a short horizontal cross shaft. This drives the oil pump and governor. An eccentric provides the reciprocating motion necessary for the valve mechanism. The governor is of the fly-ball type, with 90deg. bell crank ball levers mounted on knife edges and fitted with roller contacts. The governor sleeve and spring is mounted on ball bearings, and adjustment of the spring tension may be made while the turbine is running.

At the extreme end of the outboard pedestal is mounted an auxiliary speed-limit governor. It is likewise of the centrifugal type, and may be set to release, at any predetermined speed, a small plunger valve which controls, with high-pressure steam, the operation of the quick-closing throttle before mentioned. This is normally held open by means of an over-balanced differential piston. At the moment the speed limit operates the excess pressure is removed and the throttle closes. This device is employed purely for ensuring absolute immunity from accident from excess speeds due to the possible disablement of the governor mechanism.

Copious lubrication is supplied to all journals by means of a plunger pump driven from the worm shaft. The warm oil returning from the bearings passes through a copper coil cooler in the bed-plate and thence to a reservoir from which the pump draws its supply. The cooled lubricant is circulated at slight pressure, sufficient to ensure positive flow. At no point is oil under high pressure employed for preventing erosion of rubbing parts, bearing areas being sufficient for supporting the weight of the rotating parts.

In general construction the 5,000kw. turbo-generators conform to those now building for smaller machines. The field or revolving element is built from a solid cylinder of steel, slotted for the reception of the bar windings, and provided with ventilating openings corresponding with openings in the laminations of the stationary element.

DIRECT-READING MEASURING INSTRUMENTS FOR SWITCHBOARD USE.*

BY KENELM EDGCUMBE AND FRANKLIN PUNGA.

(Continued from page 913.)

HOT-WIRE AMMETERS AND VOLTMETERS.

The oldest instrument of this type—namely, the voltmeter due to Major Cardew—is too well known to need description. At a later date Messrs. Hartmann and Braun introduced hot-wire instruments in which, by an ingenious double-sag arrangement, great magnification was obtained. Recently attempts have been made by various Continental firms to obtain the enormous magnification which is necessary by various combinations of levers and so forth but, as a rule, with rather doubtful success. The chief difficulty in the design of a hot-wire instrument is that the expansions dealt with are so minute that when the necessary magnification has been taken into account the available power is very small. In the case of ammeters, also, it is necessary to reduce the size of the wire employed to a minimum in order to avoid excessive sluggishness. It is, of course, possible to place several wires in parallel or to connect up a single wire in several parallels, but in any case for currents above, say, 10 amperes, a shunt becomes necessary with all its attendant drawbacks of large power consumption, high temperature errors, contact troubles and so forth.

Amongst the disadvantages possessed by hot-wire instruments as a class must be mentioned the following, though it must not be thought that all types suffer equally—errors 2 and 3, for example, have been rendered almost negligible in some makes of voltmeter, at any rate:—

1. Large power consumption. The drop in ammeters ranges from 0·1 to 0·5 volts, and the current taken by voltmeters from $\frac{1}{3}$ to $\frac{1}{8}$ ampere.
2. Uncertainty of zero.
3. Gradual increase or decrease of reading when left in circuit. In order to render the reading of the pointer independent of external temperature, the supports of the hot wire are usually mounted on a base having a coefficient of expansion equal to that of the wire itself, but as the latter takes up its temperature much more rapidly than the former a gradually decreasing deflection is obtained when the instrument is left in circuit.
4. The scales are usually excessively open at the end owing to the fact that the extension is roughly proportional to the square of the current or voltage, as the case may be. While in the case of ammeters this is a distinct disadvantage, in the case of voltmeters, which are as a rule only used at the upper part of their ranges, it gives a very useful scale.
5. The wires are usually worked as hot as possible so as to get the maximum possible extension, hence a comparatively small overload may destroy the wire. A fuse or cut-out in the circuit will not, as a rule, save the instrument, as the mass of the hot wire is so small that it takes up its temperature more rapidly than the fuse. The employment has been suggested of a small cut-out inside the instrument worked by the expansion of the wire itself.

On the other hand, the advantage of being able to employ a shunt for various ranges, and of being able to calibrate with direct current and then to use the instrument with a fair degree of certainty for alternating current of any frequency has proved of great importance, particularly for laboratory use. It should be remembered, also, that hot-iron instruments are unaffected by stray magnetic fields.

ELECTROSTATIC VOLTMETERS.

The chief advantages which can be claimed for electrostatic voltmeters are that they consume no power, and that they are unaffected by stray magnetic fields. The great difficulty met with in the design of electrostatic instruments is that the forces dealt with are so small that frictional errors are difficult to avoid. In order to increase the power, the distance between the fixed and moving parts has to be reduced to a minimum, with the result that considerable trouble is often experienced with the ordinary electrostatic voltmeter, owing to sparking across, should there be any abnormal rise of voltage such as may be caused, for example, by switching a dead main into circuit. In order to prevent this, the segments should be lined with mica, and a high resistance should always be provided in series with the instrument. This is a much better safeguard than a spark-gap, which is at best a weak point in what is probably otherwise a most carefully insulated system. A liquid resistance sealed into a glass tube is very handy for this purpose. Messrs. Ferranti have recently installed some high-tension electrostatic voltmeters, connected through liquid resistances so arranged that should a short circuit occur, the water with which they are filled is boiled away by the heat generated and thus the circuit broken.†

In order to increase the range of electrostatic voltmeters and at the same time to avoid sparking access, Dr. Benischke employs a

* Abstract of a Paper read before the Institution of Electrical Engineers on March 24th.

† See *The Electrician*, Vol. L., p. 13.—ED. *E.*]

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system of condensers which may be compared to a volt box.† Voltmeters on this principle can be constructed up to 40,000 volts.

Dynamometer Type Ammeters and Voltmeters.

During the last few years several firms have introduced direct-reading dynamometers, both as ammeters and voltmeters. The object in view has usually been to produce an instrument which could be used with both direct and alternating current, and whose indications were independent of frequency. These advantages are possessed by the well-known Siemens dynamometer ammeter, whose chief drawback is that its field is so weak that the readings are seriously affected by stray magnetic fields. The earth's field alone may cause an error of as much as 2 per cent., when using the lower half of the scale. The usual mercury cups are also a source of trouble, and have in the more recent modifications been dispensed with. As the result of this, however, not more than, say, 1 ampere can pass through the moving coil, so that a shunt becomes necessary in the case of ammeters. It is, moreover, imperative that the ratio of the self-induction to the ohmic resistance be the same both in the moving coil and in the shunt, or the readings will clearly be different with direct and alternating current, and will also depend considerably on the frequency and wave-form of the latter.

Owing to the weak field employed (usually not more than one-tenth of that of a permanent-magnet instrument), the ampere-turns of the moving coil must be considerable, so that a much greater fall of potential is required over the shunt. Moreover, the power necessary to overcome friction is usually greater than that required by a moving-coil instrument owing to the greater weight of the moving parts. As a rule, 20 or 30 ampere-turns are employed in the moving coil, and in order to keep down the temperature coefficient of the moving system, a drop of nearly ½ volt is required. Messrs. Siemens and Halske obtain good results by a sort of compromise. This consists in including the fixed coil of the instrument as part of the shunt to the moving coil (as shown in Fig. 9). By this means the shunt not only posseses a certain amount of self-induction but its temperature coefficient is also appreciable; and both coefficients can be made about equal to those of the moving coil. As was pointed out, however, when speaking of permanent-magnet moving-coil instruments, it is

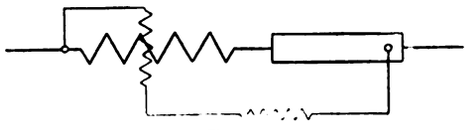

Fig. 9.

impossible, owing to the unequal heating of shunt and moving coil, entirely to eliminate temperature errors by this means; although as the temperature coefficient of the moving system is in itself not more than, say, th per cent. per degree Centigrade, the error is very small.

Another method of increasing the range of such an instrument is to employ a series transformer. This, however, as a rule, introduces errors with changes of frequency, and is, therefore, chiefly of use for switchboard instruments.

In the case of voltmeters, the fixed and moving coils are connected in series, which means that the self-induction and also the temperature coefficient are by no means negligible for low-range instruments. In the case of a 100-volt instrument, however, the temperature coefficient need not exceed $\frac{1}{10}$th per cent. per degree Centigrade, while the difference of reading between direct current and alternating current of 100 ~ due to self-induction would amount to perhaps $\frac{1}{10}$th per cent.

The Allgemeine Electricitäts Gesellschaft construct such an instrument, but they surround the fixed coils with a laminated iron shell, so that the return path of the magnetic lines lies wholly in iron. This has the effect of increasing the power and reducing the disturbing influence of stray magnetic fields.

It is worth noting that the errors likely to be introduced by eddy currents in the various parts are extremely small owing to the fact that the eddy currents lag practically 90deg. behind the currents producing them; and, since the currents in the fixed and moving coils are in phase with one another, the eddy currents are out of phase with both. Further reference will be made to eddy currents when dealing with wattmeters.

Induction-type Ammeters and Voltmeters for Alternating Currents.

These instruments, which are variously spoken of as being of the "Induction," "Ferraris" and "Rotary Field" type, were due to Ferraris, who devoted a great deal of attention to the application of rotary fields to measuring instruments. In fact, owing, curiously enough, to the low efficiency which he regarded as inseparable from induction motors, he believed that the latter could never become a commercial success. In spite of his work, however, it was not until several years later that the subject of induction instruments received much attention.

Undoubtedly the first ammeters and voltmeters constructed on this principle were due to Mr. James Swinburne. The principle of action is shown in Fig. 10. The actual winding shown in the figure is that of a wattmeter. Supposing the instrument to be constructed as a voltmeter, the coils A1 and A2 are highly inductive, so that the flux in the limbs on which they are wound lags nearly 90deg. behind the voltage producing it. An E.M.F. is thus produced in the small coil, which, being pivoted at C, is free to swing in the air-gap. The third fixed coil (which is also connected across the mains whose voltage it is required to measure) has a considerable non-inductive resistance in series with it, so that its current is

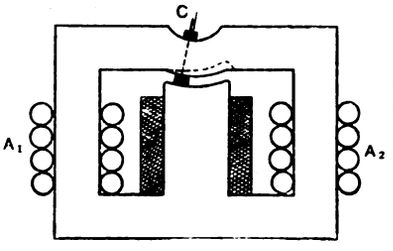

Fig. 10.

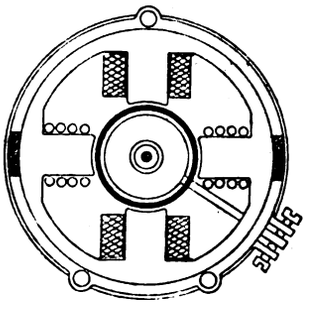

Fig. 11.

practically in phase with the voltage and, therefore, also with the current in the moving coil. A torque is thus produced which is practically proportional to the square of the voltage. If an even scale is required, the air-gap can be so shaped as to lengthen out gradually towards the upper end of the scale (as shown by the dotted line), so that the flux gradually falls off as the deflection increases. Ammeters and wattmeters can be constructed upon the same principle.

Following the lead of Ferraris, most of the ammeters and voltmeters consist of a disc or drum of copper or aluminium which is caused to rotate owing to currents induced in it by means of a rotary magnetic field. The motion is usually opposed by a spring. In the case of voltmeters the necessary splitting of phase is, as a rule, produced, as in the Swinburne instruments, by connecting one coil in series with a non-inductive resistance and the other with a choking coil. In ammeters the current is split in like manner into two parts, one circuit being as inductive and the other as non-inductive as possible.

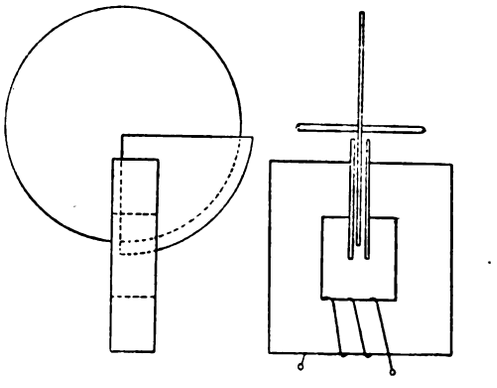

Fig. 12.

A disadvantage common to all rotary field instruments consists in the fact that the torque is dependent on the frequency. In the case of ammeters where the total current is, of course, fixed, any increase of frequency means a corresponding increase of torque; so that the deflection produced is almost proportional to the frequency. With voltmeters, on the other hand, any rise of frequency means also a decreased current through the choking coil; the two effects oppose each other, so that the resulting deflection is less affected.

Fig. 11 shows an instrument of this type as constructed by Messrs Siemens and Halske. Four coils are used on a frame resembling a four-pole dynamo. The opposite coils are connected in series, one pair being inductive and the other non-inductive. In another type of induction instrument the rotary field is produced by means of a short-circuited winding, often consisting (as in the case of the instruments of the Allgemeine Elektricitäts Gesellschaft) merely of a sheet of copper or soft iron. Fig. 12 shows this instru-

† Since writing the above, a Paper has been read by Prof. Marchant and Mr. Worrall before the British Association (1903) [*The Electrician*, Vol. LI., p. 1,000] drawing attention to the possibilities of this method, which was originally due to W. Peukert (*E.T.Z.*, No. 39, 1898).

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ment diagrammatically. In this case only one coil is required, whilst of the lines of force some go directly through the movable copper disc, whereas the remainder have to pass through a thick sheet of metal. Eddy currents are induced which react on the field, causing it to lag, so that a rotary field is produced. Benischke finds that an increase of frequency from 40 to 60 ~ per second produces an error of from 3 to 4 per cent. in the case of voltmeters, but of as much as 20 to 25 per cent. in the case of ammeters.

As regards wave-form, on the other hand, unless the iron cores are saturated, variations cause but small errors in the readings, for reasons which have been already stated. Since the magnetic fields employed in induction type instruments are strong, the effect of stray fields is extremely small, and moreover, it is easy to so arrange the various coils that any external fields which may exist have the effect of strengthening one set while weakening the other, so that the total effect is nil. Changes of temperature also have a very small influence on the readings.

Wattmeters.

The dynamometer type has been by far the most employed, and for accurate work is undoubtedly to be preferred. Rotary field wattmeters, however, possess many advantages for switchboard work, while hot-wire wattmeters have been suggested, notably by Mr. Michael B. Field, and are chiefly of interest owing to the fact that the range of the instrument can be easily varied by means of a shunt.

Dynamometer Type Wattmeters.—It was at one time thought that practically the only error of any importance was that due to the self-induction of the moving coil. It is now recognised, however, that not only can this be rendered quite negligible, but that care has even to be taken that the series resistance introduces no capacity. Thus the ordinary non inductive method of winding, in which two wires are laid on a bobbin or frame in parallel, possesses not only the disadvantage that neighbouring wires have often a large difference of potential between them, but also that it has a

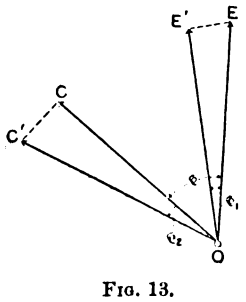

Fig. 13.

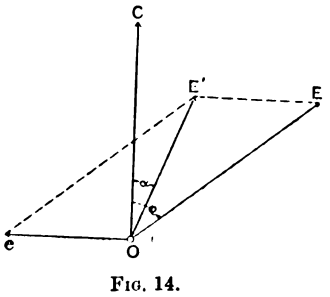

Fig. 14.

very considerable electrostatic capacity. The series resistance of wattmeters, and, in fact, of all alternating-current instruments, should always for this reason be wound in sections. The capacity is then inversely proportional to the square of the number of such sections into which the resistance is divided. The self-induction of the moving-coil circuit of a well-designed wattmeter should not exceed 10 millihenrys. The current taken at full load would be about $\frac{1}{10}$th of an ampere, and in that case the error in a 100-volt instrument would be less than $\frac{1}{2}$ per cent. with a power-factor of 0·2, and becomes quite negligible for all power-factors greater than, say, 0·6.

The errors due to eddy-currents, which have often been neglected, are usually the more serious of the two. The effect of these eddies is to cause the magnetic flux, which should be proportional to and in phase with the current in the fixed coils, to lag behind it by an amount depending upon the frequency. In a badly-designed wattmeter the error from this cause may easily amount to as much as 10 per cent. with a power-factor of 0·5, and becomes more and more marked the smaller the power-factor, owing to the fact that the eddy-currents lag practically 90deg. behind the current in the fixed coil, and are, therefore, more nearly in phase with the current in the moving-coil the greater the lag between current and voltage.

The effect of self-induction on the moving-coil circuit and of eddy currents on the fixed field will be more clearly seen from Fig. 13. Let OE and OC represent in magnitude and phase the voltage and current respectively. The power to be measured is equal to $OC \times OE \times \cos\phi$ assuming a sine-wave. Owing to self-induction in the moving-coil circuit the current in it will lag by an angle ϕ_1, and let it be represented by OE', EE' being the E.M.F. of self-induction. Moreover, owing to eddy currents in the metal parts of the instrument, including the fixed coil itself, the field due to this latter coil will lag behind the current in it by an angle ϕ_2. Let it be represented in the diagram by OC', assuming the eddy currents to be in phase with the E.M.F. producing them. Thus the wattmeter, instead of measuring $OE \times OC \times \cos\phi$, actually measures $OE' \times OC' \cos(\phi - \phi_1 + \phi_2)$.

Now it can be shown that if W = the true power and W' the wattmeter reading

$$W = W'\left(\frac{\cos\phi_2}{\cos\phi_1}\right) \times \left(\frac{\cos\phi}{\cos(\phi - \phi_1 + \phi_2)}\right).$$

From this expression it is clear that if $\phi_1 = \phi_2$, then W = W'. That is to say, that if the lag in the moving-coil due to self-induction is equal to that in the fixed coil due to eddy currents, then the indications of the wattmeter will be correct. This result holds good no matter what be the wave-form, and if the adjustment be made at any given frequency, it will be correct at all frequencies. It is impossible to predetermine the effect of eddy currents, but the induction error is readily calculated. If L = self-induction of moving-coil circuit in henrys, R = its resistance in ohms, and $n = 2\pi \times$ frequency. We have approximately

$$W = W'\left[1 - \left(\frac{nL}{R} \times \tan\phi\right)\right],$$

where ϕ is the angle of phase displacement.

To give an idea of the probable error, we may assume a coefficient of self-induction L = 0·02 henry and the resistance for a 100-volt instrument to be 3,000 ohms. Then, at 50 ∽, $nL/R = 0{\cdot}0021$. Hence the percentage error is 0·21 tan ϕ, which gives the following result:—

Power-factor	1·0	0·8	0·6	0·1	0·2	0·1
Error	0·00	0·15	0·28	0·47	1·03	2·00 per cent.

These errors will be reduced in direct proportion to any increase of voltage. Thus, a 500-volt instrument will show a fifth of these values. In any case, the error is seen not to be serious, and, if required, the self-induction can be reduced very much below the value assumed.

Owing to the fact that the field due to the fixed coil is usually enormously stronger than that of the moving coil, it follows that in certain positions of the latter an E.M.F. is induced in it which is often 20 times as great as that due to the self-induction. It can be shown, however, that it cannot possibly have any effect on the readings. As this point does not appear to have been fully understood, it may be well to enter into the matter somewhat more carefully. In Fig. 14 let OC represent the current and OE the voltage to be measured. An E.M.F. will be induced in the moving-coil lagging 90deg. behind the current OC. This is represented in the diagram by O *e*. Hence the voltage actually available in the moving-coil system is OE', and, assuming the self-induction of the circuit to be negligible, the power measured will be $OC \times OE' \cos\alpha$; but this can be readily shown to be equal to $OC \times OE \cos\phi$, that is to the true power.

The errors caused by external magnetic fields are often considerable, unless the instrument is constructed astatically, and are only to be obviated by taking a second reading after reversing the current in both fixed and moving coils. This precaution should always be taken, whether the instrument be used for direct or alternating current. In the former case, the earth's field has often a quite appreciable effect. The stray field error may be roughly determined by short-cuiting the current coil of the instrument, while leaving the voltage on the shunt coil. If a deflection is produced, a corresponding amount (in watts) is to be added or subtracted, according to its direction, from the observed power. For low-current measurements the last method will usually be found sufficient, but for heavy currents the effect of the conductors leading the current to and from the instrument have usually some effect on the readings, and this can only be eliminated by reversing, as explained above.

Dynamometer type wattmeters are difficult to construct for currents greater than, say, 200 amperes, as, unless very carefully laminated, eddy currents are produced in the fixed coils, and the effect of the leads just alluded to becomes excessive. In order to increase the range above, say, 400 amperes, or in order to obtain an instrument with more than one current range, recourse must be had either to a series transformer or to a shunt. In both these cases there will be an appreciable phase difference between the current to be measured and that flowing through the fixed coil of the wattmeter. So long as this phase-difference is constant, its effect is easily eliminated by so adjusting the self-induction of the moving coil that the current in it lags behind the voltage by just the same angle as the current in the fixed coil lags behind that to be measured, as already explained (Fig. 13). For high-tension working the transformer method is much to be preferred, owing to the fact that the instrument can be entirely insulated from the high-tension system. The power consumption also is considerably less, but for laboratory use the shunted wattmeter is very convenient and somewhat more accurate, though wattmeters with several ranges are seldom so reliable as those with only one.

Induction Type Wattmeters.—These instruments are similar to the induction ammeters and voltmeters already described, the non-inductive coil being replaced by a winding carrying the current, while the supply voltage is applied to the terminals of the inductive coil. The latter induces a current in the rotating disc or drum which is practically 180deg. out of phase with the voltage, and as the current coil produces a flux practically in phase with the cur-

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rent, it follows that the torque will be proportional to the product of the instantaneous values of amperes and volts; that is to say, to the true watts. In a similar way the current induced by the current coil reacts on the flux due to the volt coil, and again produces a torque proportional to the true watts. As was mentioned when dealing with induction ammeters and voltmeters, the indications are much affected by changes of frequency, though almost independent of wave form. They are, therefore, chiefly of use for switchboard work where the frequency is practically constant. For high-tension systems, also, they lend themselves readily to the use of series and voltage transformers.

(*To be concluded*).

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Comparison of Heat and N-ray Effects.—R. Blondlot found recently that the effect of N-rays upon a faintly luminous fluorescent screen consists not so much in an increase of the luminosity as in a change in the direction of emission. Thinking that the well-known effect of heat in increasing the luminosity of fluorescence might show a similar behaviour, he observed the emission of heated screens in various directions. He found, however, that the emission increased in the same proportion in all directions, and thus obtained a valuable criterion for distinguishing between the effects of N-rays and those of heat. He describes a striking experiment which serves to clearly bring out the essential difference between heat and N-rays. He covers a screen measuring 5cm. by 12cm. uniformly with calcium sulphide, and makes it feebly luminous. He heats a portion of it, whereupon it becomes brighter than the rest. After that, he expeses one-half of the same screen to the action of N-rays given out by a Nernst lamp. The intensity of the rays is so feeble that no visible effect is produced upon the screen. Then he brings a small metallic object, such as a key or a perforated sheet of metal, in front of the screen where the N-rays impinge upon it. The shadow of the object is then clearly seen on the screen. On moving it towards that part of the screen which is not exposed to the rays, the outline becomes dim and indefinite. On moving the object to and fro over the screen, the transition from the portion illuminated by N-rays to the portion not so illuminated is clearly marked. On looking at the screen in a tangential direction the phenomena are reversed.

[R. BLONDLOT, *Comptes Rendus*, March 14, 1904.]

Physiological Effects of N-rays.—A. Charpentier has observed that N-rays exert a direct effect upon the human ear, and increase the sharpness of hearing while they act. On the other hand, the newly-discovered N′-rays diminish the sharpness of hearing, and generally have the opposite physiological effects to the N-rays. Some human tissues emit N′-rays, such as a muscle kept in a state of tension without actual contraction. It may be supposed that all physiological activities give rise to N-rays and N′-rays, and that in some of them one species predominates and in others the other species. This is the physiological analogy to the mixture of N-rays and N′-rays given out by a Nernst lamp.

[A. CHARPENTIER, *Comptes Rendus*, March 7, 1904.]

Heavy Ions.—Several attempts have been made to explain the fact, observed by W. Wien, that the positive ions constituting canal rays have a continuously varying deflection under the influence of a magnetic field. This might be supposed to be due to the subdivision of the electron, or the formation of larger molecular aggregates having a single positive elementary charge each. To avoid either of these suppositions, Stark supposed that positive ions were neutralised at various points along their paths by taking up a negative electron, and, since such neutralisation would withdraw them from any further action of the magnetic field, the magnetic spectrum produced would be a continuous one. Now, W. Wien has found an experimental method of testing these various hypotheses, and the results lead him, on the whole, to decide in favour of the large molecular aggregates. He employs a wide tube with several protected electrodes, one of which lies directly in the path of the canal rays, while another lies in the path of a portion of the deflected beam. If Stark's hypothesis were correct, then, on establishing the magnetic field, the charge received by the first electrode should be reduced to zero, since none but neutralised molecules would be able to reach it. It is found, however, that even in the strongest magnetic field the charge cannot be reduced below one-fifth of the original amount. This cannot be attributed to diffusion, since the other protected electrodes under ordinary circumstances never receive more than 1 per cent. of the charge. The author proceeds to draw some interesting conclusions from the deflections observed in hydrogen in certain fields. The ratio e/m comes out as 15·5 instead of 10,000, as in the electrochemical hydrogen ion. Regarding this as a new molecule, its molecular weight would be 650, which is heavier than the molecule of any known substance, though still of the order of known molecular weights. It is to be supposed, however, that these heavy ions are in an unstable condition, and break up on impinging upon the glass wall.

[W. WIEN, *Ann. der Physik.*, No. 4, 1904.]

Atmospheric Radio-activity in High Latitudes.—G. C. Simpson has obtained some remarkably high values for the radio-activity induced by the atmosphere in the extreme north of Norway, at Karasjoh. He used the method described by Elster and Geitel. A wire was stretched between an insulator in the open and another in a room. The part exposed to the open air, 10 metres long, could be detached from the rest. The wire was charged to a negative potential by means of a small influence machine, and the potential of the wire was regulated by a variable resistance made of a piece of ebonite with a pencil line drawn on it. The potential was maintained at about 2,250 volts. The wire after being charged for two hours was wrapped round a cylinder of wire netting and its radio-activity determined by means of a dissipation electrometer. The radio-activity was estimated by the arbitrary unit devised by Elster and Geitel, unit radio-activity being possessed by the air when, after a two hours' exposure, a metre of the wire reduces the potential of the dissipation cylinder by 1 volt in one hour. The mean value of the radio-activity at Wolfenbüttel in 1902 was 18·6, the extreme values being 64 and 4. The numbers for Karasjoh are very much higher than the corresponding ones for Germany, the mean for the month being 102, which is nearly six times as great as the German mean (for the year); and the highest value, 432, being nearly seven times greater than the German highest. There is a marked daily period. The maximum falls in the evening, there being little difference between the morning and afternoon means. Not only is the mean value greatest for the evening, but the absolute maximum falls in the evening each week, and on 13 out of 22 days on which three observations were taken the evening values were the greatest. There is no direct relation between the radio-activity and the potential gradient. There does not appear to be any close connection between the aurora and the radio-activity, the greatest value of the radio-activity having been obtained when no aurora was visible. During the whole time these observations were being taken the sun did not rise above the horizon. The place of observation is 140 metres above sea level. The ground for 100 miles round is hard frozen to a great depth and covered with a coating of snow the average depth of which is over 2ft. Sudden changes in radio activity are sometimes observed to take place, as, for example, on December 17th, when with a rising barometer the activity rose for a few hours from the low value of 66 to the exceptionally high one of 384. There is some difficulty in reconciling these observations with Elster and Geitel's view that the activity is entirely due to a diffusion of a radio-active emanation from the soil.

[G. C. SIMPSON, *Proc. Roy. Soc.*, March 13, 1904.]

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Science Abstracts," March, 1904. Section A, Physics; Section B, Electrical Engineering. (London: E. and F. N. Spon.) 1s. 6d. each.

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THE ARCHITECTURAL DESIGN OF ELECTRICITY WORKS.

An interesting Paper on this most important subject was read by Mr. C. Stanley Peach before the Royal Institute of British Architects on Monday. The subject is one to which much attention must have been paid, since there are hundreds of generating stations in this country, and cases have not been numerous in which trouble has been experienced owing to the buildings being insufficiently strong or not properly suited to the purpose for which they are built. Yet few Papers have been written on the general subject hitherto. The design of foundations and buildings to support and protect machinery, which includes not only fixed portions of heavy weight, but also large moving masses, may appear at first sight essentially an engineer's problem; but it is one with which the electrical engineer, jack-of-all-trades though he may sometimes have to be, is seldom competent to deal unaided. The design of work of this character comes on the borderland between mechanical and civil engineering, and although the principles upon which it is based are simple, and are, in fact, those which must form part of the education of every engineer, no matter in what branch he may practice, a knowledge of detail of a particular class is required which is essentially of a character for the specialist. Some consulting engineers, it is true, have designed the buildings of their generating stations from start to finish without the aid of an architect; but these cases are rare, and, even if the buildings are to be no more than four square walls and a plain roof, the collaboration of a member of the sister profession is usually found desirable. These four-square-walls stations are happily rare, at all events in large sizes, for while we are willing to allow that the waste of money on some of the palaces built to receive electrical generating plant is deplorable, yet the size of central stations is such that it is a great mistake to erect a building for them devoid of any architectural ornament. Mr. Peach went further than this, for he even advocated the ornamentation of the chimney, and showed among the numerous photographs and drawings which he exhibited reproductions of the elaborate chimney of the power station at Munich, and the chimney of his own design at the works of the

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Central Electric Supply Co. in St. John's Wood. The latter shaft is 260ft. high and of square section (18ft. by 18ft. inside), and a fairly heavy ornamentation in blue brick has been adopted for the upper part, the lower portion being left quite plain and unadorned. To quote Mr. PEACH'S description: "In the architectural treatment of the upper part an attempt has been made to take advantage of the iron bands which sooner or later are required round the upper part of all shafts, and of the recesses formed by placing the set-offs, when the brickwork is reduced in thickness, on the outside instead of the inside of the wall. By these means some relief is obtained, and the upper part is designed as an enriched feature which, in contrast with the plain wall below, forms the whole composition." Similar principles have been followed in the general treatment of the principal façades of the building. The question of external appearance is even more important in the case of large sub-stations which have naturally to be placed in the centre of populous parts of a district, and whose position frequently falls near to other buildings having distinctive architectural features. Here, of course, there being no steam plant, no means to provide for the conveyance of coal and ash, and a minimum of auxiliary apparatus to accommodate, the problem presents more nearly the same aspects as that of an ordinary building. An enormous sub-station, eventually to accommodate 14,000 H.P. is to be built by the Westminster Electric Supply Corporation in Duke-street, Mayfair, and an interesting elevation of it was shown, as well as a pretty photograph of the model made of the entrance pavilion. As at present projected, it is a long narrow building—about 250ft. long—consisting of only a basement floor, the front of which, with its 18 windows, rises only some 7ft. or 8ft. above the surface of the roadway, and an entrance pavilion at either end with steps leading up to the "Italian Garden" placed on the flat roof of the sub-station.

Coming now to the actual arrangement of buildings and the position of the machinery and plant: In this country it has been the custom to have all the plant with the exception of the switchboard on the ground floor, and Mr. PEACH still favours this plan. The small space occupied by turbine-driven machinery, however, renders it necessary to modify existing designs in the case of works employing this class of machinery. The method employed by the Newcastle-on-Tyne Electricity Supply Co. in its new works at Carville for supplying the North-Eastern Railway has recently been illustrated in our columns, as also the power station which is being built by the Yorkshire Electric Power Co. We believe that Mr. PEACH, who has been the architect for a large number of Prof. KENNEDY'S stations among others, has not yet had occasion to tackle this problem. From his remarks, it appears that he will not follow the example offered at the Metropolitan-District Railway power house at Chelsea, and place the boilers on two floors—a survival of the old American practice of a separate floor for each class of plant: switchboard, dynamos, engines, boilers, coal bunkers, auxiliary plant, offices and, finally, the lodgings of the employés in the attic. Finally, the question of foundations and the prevention of vibration is of the utmost importance, and a difficult one for the solution of which the engineer and the architect may well combine. The foundations for the generating sets should have broad bases, large in comparison with the height of the foundation, and many recommend that the sides should slope upwards considerably, so that the area of the top is much less than the base. This concentrates the effect of the load towards the side of the block and prevents vibration about an edge, as frequently happens when the foundation is of a plain square shape like a brick set on edge.

Thus it is seen that there is plenty of scope for collaboration between engineers and architects in the design of an electricity works. One point which Mr. PEACH did not mention in his Paper is the question of cost; but we feel sure that we may safely warn those of our readers whose appreciation of the "practical" side of things is fully developed, that an ugly building is not necessarily cheaper than a handsome one.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

Modern Electric Practice. Edited by MAGNUS MACLEAN, M.A., D.Sc., Vol. I. (London: The Gresham Publishing Co.) 9s.

It is proposed to issue this treatise in five sections, but these sections will appear in six volumes, which will be published from time to time. Contrary to the practice usually followed in compiling books on electrical engineering, Prof. Maclean has not attempted to undertake all the work himself, but has secured the services of gentlemen who have made a special study of the subject on which they write. This plan is certainly to be preferred to the "one-man" method, and Vol. I. gives evidence that it has been attended with a certain amount of success. There are, however, disadvantages which must be unavoidable when several different contributors adopt different points of view and when each is at liberty to give publicity to some of his own pet idiosyncrasies. For instance, some writers have adopted the Centigrade scale and others the Fahrenheit; yet others pin their faith to centimetres while their colleagues prefer the archaic feet and inches. It is true that the various constants for conversion are given early in the book, but the mere fact that this divergence of method has been permitted to exist detracts from the value of the work.

The first volume of the series deals with electric, magnetic and alternating-current measurements, continuous and alternating-current generators and the continuous-current motor. These subjects are divided into five sections and 30 chapters. The authors of the respective sections are Messrs. Alfred Hay, E. W. Marchant, W. C. Mountain and J. Leggat, E. J. Berg, and A. T. Snell. The book is admirably suited to the requirements of central station engineers and those engaged in eminently practical work, but it lacks the orderly arrangement so essential to a first-class text-book. A paragraph setting forth the principles of moving coil galvanometers is sandwiched in between one on "Work Done in Increasing Magnetic Flux through Circuit" and another on "Practical Realisation of Absolute Unit of Current." In another case, there is an illustrated description of the Duddell oscillograph, *followed*, at an interval of four pages, by a chapter on "The Sine Wave and its Representation." It is true that the description is prefaced by a couple of pages of introductory matter on wave form and frequency, but, nevertheless, the arrangement obviously admits of considerable improvement. From many points of view, however, the work is a useful one, and we await, with interest, the publication of the remaining five volumes.

The Story of the Atlantic Cable. By CHARLES BRIGHT. (London: George Newnes.) 1s.

This little volume describes, in popular language, the history of the first Atlantic cable. Technical matters have, unfortunately, been touched on occasionally. We read, for instance, that: "The retardation of the electric current through an insulated wire due to induction—a phenomena (*sic*) practically unknown with bare aerial wires suspended on posts—and of no consequence with quite short cables—was overcome by using a succession of opposite currents." The book is profusely illustrated, and some of its information is both interesting and accurate.

Die Einrichtungen zur Erzeugung der Röntgenstrahlen. By Dr. B. DONATH. 2nd edition. (Berlin: Reuther and Reichard.) 7m.

The publication under review is a revised and enlarged edition of the first, a review of which appeared in our columns

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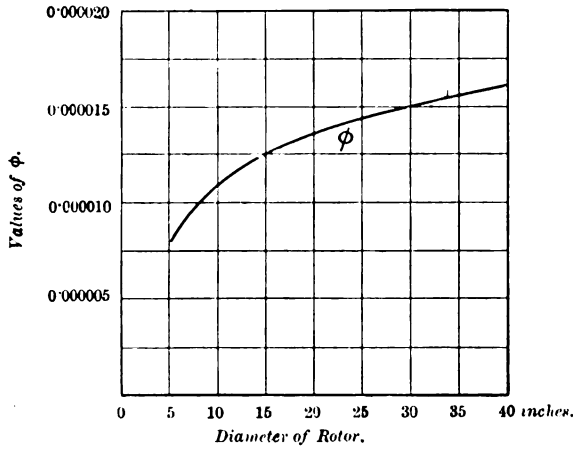
three years ago. From the way the subject is treated, it may safely be inferred that the book is chiefly intended for the medical profession, and as such it is excellent; the book may, of course, be read with advantage by the educated general public also. Original points or investigations do not appear in the book; in fact, they would not be expected in such an elementary treatise, and would hardly be of any use to the readers for which it is intended. But the well-known facts and figures relating to the medical use of Röntgen rays are cleverly compiled, clearly rendered and well illustrated.

In the edition under review, the subject is treated on the same approved lines as in the preceding one, but much new matter has been introduced with regard to the recent advance of this branch of applied science. A new feature, valuable to the student, consists in the introduction of numerical examples at the end of various chapters. A number of good Röntgen photographs are embodied in the book.

THE RATED SPEED OF ELECTRIC MOTORS AS AFFECTING THE TYPE TO BE EMPLOYED.

Mr. W. B. Esson, who was prevented from attending the meeting of the Institution of Electrical Engineers on March 10th, when Mr. Hobart's Paper on the above subject was read and discussed (see *The Electrician* of March 11th and 18th), sends the following contribution to the discussion:—

This Paper, like all Mr. Hobart writes, is very interesting. The main proposition of the author is that the speeds at which motors have to run may constitute the factor which chiefly determines the system to be adopted in order that the requirements may be met at minimum cost, and it may be taken that, with certain limitations, the case has been proved. The first limitation comes from the frequency, and it does not seem that the same weight should be given to the lower frequency as to the higher. This arises from the fact that a frequency of 21 is quite unsuitable for the lighting which is generally associated with motor



driving, and the cost of the motor-generators or whatever transforming devices may be required for the lighting portion of the installation might, from the cost point of view, turn the scale against the low-frequency motors, or, at any rate, reduce the advantage shown by one system over the other.

Mr. Hobart, in his conclusions, sums up accurately the case for alternating versus continuous current as regards the motors, but in deciding in favour of one system over another, it is also necessary to take into account the cost of generators, wiring, starters and all other equipment, and which side the consideration of these further factors would favour depends on circumstances. In working out his examples, the author confines himself to one size of motor, and though the results may be considered indicative of how the advantage will lie, it must be remembered that most installations have a mixture of big and little motors, several different sizes running at different speeds, and this, together with the presence or absence of the necessity for speed variation, would influence the decision as to what should be installed.

When dealing with design, Prof. Silvanus Thompson shows great ingenuity in devising new formulæ, but I cannot say that his present venture gives us anything more than is given by the old $D^2LR\phi$ expression. The latter is not empirical in any sense, as it takes into account the field density, pole area, conductors on armature and current in them, giving to all these factors their proper value in one coefficient ϕ, a very usual thing in engineering formulæ. It is not, apparently, recognised that the expression above mentioned applies to induction motors just as to continuous-current motors. The value of the coefficient ϕ in this case depends on the slip, on the number of conductors on the rotor, on the induction in the air-gap, on the pole-pitch and other constructional details and has, for small machines, of course, a less value than for large ones. This arises, chiefly, from the fact that in the latter the pole-pitch is smaller and the gap induction less; in the smallest size of motor for instance, the pole-pitch will be only about 4¾in., while in motors of 150 H.P. it will reach 10in. or so. This means, in effect, that the coefficient increases in value with the diameter of the rotor, and in the figure is given a curve showing the relation between ϕ and the diameter for normally designed motors. The coefficient is chosen to give horse-power, thus, $HP = D^2LR\phi$. It will be seen that the output of each of Mr. Hobart's 63 cycle motors is, as nearly as exigencies of design will allow, proportional to D^2L, with the coefficient in each case of the same value. The reason why, in the examples given, the value of the coefficient does not diminish as the diameter of the rotor is reduced, is because for all these sizes the author selects a diameter which gives the same pole-pitch. But in each case the coefficient is high, reaching 0·000024 as against 0·000016, the highest shown on the curve and presented by the best European practice. In the three machines referred to the ampere-turns on the stator per inch of circumference are also similar, but reach close on the high figure of 800. This is from 30 to 40 per cent. greater than the usual standard practice, while the field density in the air-gap is also above the normal. As figured, these motors offer such deviations from normal types as would necessitate the complete designs being carefully looked into in all their details before one could say whether they would be quite satisfactory. But whether they would require modification or no, they serve very well to bring out the main point of Mr. Hobart's Paper.

About the relation between the cost and DL, I need not say anything. A curve showing the relation may approximate a straight line, or it may not; but I do not think it matters in the least. It would certainly be handier for estimating purposes if it were a straight line, but, apart from that, it appears to me to be unimportant.

ENERGY DISTRIBUTION TO SUB-STATIONS.*

BY C. ALFRED SMITH, B.SC.

This Paper may be divided into two sections. The first is the transmission of electricity from a gas-engine station, situated under favourable conditions, at a distance of 5 miles from the centre of the city, and its subsequent distribution by means of sub-stations. The figure to be arrived at is the actual cost per B.O.T. unit at the sub-station switchboard. The second section of the Paper assumes the same demand at the direct-current switchboard, and seeks to arrive at the actual cost of producing a B.O.T. unit when it is generated under exactly the same local conditions by means of sub-stations containing gas engines, and supplied with their motive power from a central producer station situated on the same site as the producer and electrical station in the first case. In order to give local colour to this Paper, the load for the city of Birmingham was estimated; this was a very difficult thing to do, and, in fact, could only be arrived at approximately. At the present moment the average revenue per unit sold = 4·15d. in Birmingham, which certainly compares very unfavourably with other towns from a consumer's point of view. Since it will be generally agreed that the present load figures are almost useless for comparative purposes owing to the high tariffs for consumers, the probable demand has been worked out as follows:—

1. *Traction.*—An up-to-date system of electric traction would require at least 500 cars. This is based upon the actual number of cars per 50,000 population in Glasgow and two other large cities. On an average each car will take 10kw., or the total average load will be 5,000kw. with a maximum of 10,000kw. for traction purposes.

2. *Lighting.*—The demand in other large cities in Great Britain for public and private lighting seems to aggregate about 25,000 8 c.p. lamps per 50,000 inhabitants. In Birmingham the population is 528,181, and we obtain a probable maximum demand of 4,000kw. (that is, full load on half the lamps wired), and the load-factor might be from 10 to 12 per cent.

3. *Motor Load.*—The motor load is estimated at 8,000kw., of which 4,000kw. is assumed to be taken by comparatively small consumers, and is therefore direct current, while 4,000kw. is three-phase low-pressure alternating current.

The total is therefore 22,000kw., or 32,000 B.H.P. to be supplied by engines. Taking 25 per cent. for reserve plant, and allowance for any losses, we get a station for 40,000 B.H.P.; or, with a gas-engine efficiency of 80 per cent., of some 50,000 I.H.P.. Dividing this load of 22,000kw. into five sub-stations, we obtain at each sub-station—

Nature of load.	Kilowatts.
Traction	2,000
Lighting	800
Direct-current motors	800
Three-phase alternating-current motors	800
Total	4,400

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers on January 27th.

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The load-factor may be taken on such a scheme at 25 per cent., but it might be a good deal higher in this district, where, among other industries, electrolytic work is done considerably.

Fuel Used.—The author has been informed by the Birmingham Canal Co. that slack, as suitable for the Mond process, can be delivered at Smethwick—which seems incidentally to be the ideal place for a central station of the size suggested—at from 4s. to 5s. per ton. The figure taken is the latter, and allowing 4s. 6d. for the selling price of the ammonia recovered per ton of coal gasified (the present market price is 8s.), the net price of the coal used comes out at 6d. per ton. The coal required to be gasified per year to supply gas for engines of 40,000 B.H.P., at 25 per cent. load-factor, with a consumption of 70 cubic ft. of gas per brake horse-power hour, and taking 140,000 cubic ft. of gas per ton of coal, would then be 43,800 tons. This brings the cost of fuel to £1,095 per annum. Now, the total number of B.O.T. units metered at the sub-station switchboard is 60¼ millions per annum. This assumes 25 per cent. load-factor on the total station plant (including reserve) of 27,500kw., so that the actual net cost for fuel is 0·004d. per unit. This, of course, is neglecting all attendance charges. Taking for this extra cost of attendance charges for working producers, recovery and sulphate plant, the Winnington figures quoted by Mr. Humphrey in a Paper read before the Institution of Mechanical Engineers in 1901 (see *The Electrician*, Vol. XLVI., p. 548)—viz., 3s. 6d. per ton of coal gasified—then the net cost of the coal per ton becomes 4s., which will give 0·032d. per unit for the cost of fuel. This neglects the units wasted in the case of electrical transmission. It also neglects the capital cost, rent, rates and taxes for the station. For producers and recovery plant (allowing 20 per cent. reserve), for acid towers, recovery and sulphate plant, and for steam-raising plant and sundries, Mr. Humphrey quotes for a 20,000 E.H.P. station the sum of £62,600. On the same basis a 22,000kw. plant comes out at £91,000. Since 25 per cent. is taken for reserve, and to give a liberal estimate in a figure which will not affect the main issue—viz., the comparison of the two schemes for using producer gas—the capital cost of the producer plant is taken at £100,000. Since the 3s. 6d. per ton of coal for cost of working producers, &c., includes repairs and maintenance, 5 per cent. on this capital should cover for interest. This means £5,000 a year, or 0·02d. unit at direct-current switchboard. For a 15,666kw. station the cost of the land and buildings for boiler-house and (steam) engine-room is estimated by Mr. Earle, in his address as chairman last year (*The Electrician*, Vol. L., p. 605), to be £30,000. Since practically the whole of the Mond gas plant is unprotected by buildings, &c., the figure taken to cover the cost of land, &c., is £40,000. At 5 per cent. this makes an annual charge of £2,000, or 0·008d. The rates and taxes for the central station site are taken to be 3s. in the £, and they are calculated on 4 per cent. of the cost of producer plant; or 0·6 per cent. on £100,000. This means £600 per annum, or, 0·0024d. per unit, so that the total cost per unit, so far as producer plant is concerned, is made up as follows :—

Cost of gas per B.O.T. unit	0 032d.
To interest on capital for producers	0·020d.
,, ,, for land	0·008d.
Rates and taxes	0·0024d.
Total	0·0624d.

Hence the cost of producing per 1,000ft. of Mond gas can be arrived at, because the combined efficiency of the generators was taken at 0·8, which gives the remarkable low figure of 0·53d. per 1,000 cubic ft. Since the South Staffordshire Power Gas Corporation are going to sell (presumably at a profit) at 2d. per 1,000 cubic ft., and they will have to pay interest, &c., on the mains, this is not altogether an unlooked for figure. It does, however, neglect the cost of promotion and parliamentary expenses and insurance, which, together with management expenses, Mr. Earle, for a steam-driven station, places at 0·025d. per unit sold. The management expenses were, however, included in the estimate of 3s. 6d. per ton for working the producers. Hence, if 0·02d. per unit be allowed for insurance and promotion expenses, the cost per B.O.T. unit becomes 0·0824d.. or the cost per 1,000 cubic ft. of gas becomes 0·70d., or, say, ¾d. per 1,000 cubic ft. This, therefore, holds good for either of the two alternative schemes. It neglects the cost of generating the wasted units, it is true, but to include that cost would merely complicate the main issue and affect the ultimate result in a very small manner. It is now advisable to return to the previous division of the Paper into two sections—(A) Considering the central station at the same site as the producer station, and using the customary electrical sub-stations. (B) Considering the transmission of the producer gas for use in gas-engine sub-stations.

Section A.

Messrs. Richardson and Westgarth of Middlesbrough say that they are prepared to build and guarantee 5,000 B.H.P. gas engines to drive alternators in parallel. The engine is of the type built by John Cockerill & Co., and is a four-cylinder tandem engine, each cylinder developing 1,250 B.H.P. The alternator is placed between the two cranks. The cylinders are 51in. in diameter, with a 55in. stroke, and the engine runs at 80 revs. per min. The fly-wheel is 26ft. in diameter and weighs about 40 tons. This will give a regularity of $\frac{1}{1\frac{1}{6}}$, which is quite suitable for three-phase work. The price of the engine comes out at £4 per B.H.P., so that using the engines of this type the cost of 40,000 B.H.P. comes out at £160,000. Taking the cost of gas engines and generators of the heavy flywheel alternator type as £12. 10s. per kilowatt throughout, or, say, £13 per kilowatt, in order to include for cost of auxiliaries for excitation purposes, in round numbers the engine-room machinery costs £357,000. (*Note.*—Mr. Earle takes the cost of steam engines, generators and exciters for a 30,000 I.H.P. plant as £8. 4s. per kilowatt, according to which gas engines cost £4 per kilowatt more than steam engines, or 50 per cent. in the equipment of the station. It would be interesting to learn the source of Mr. Earle's figures.) Allowing £15,000 for main switchboard and fittings, £25,000 for station valves, piping and cables, the total machinery costs are £392,000. At 7½ per cent. interest and depreciation this is £29,400 per annum, or 0·118d. per B.O.T. unit, while at 10 per cent. it is 0·158d. per B.O.T. unit metered at direct-current switchboard. The wages and professional staff are taken at £8,000 a year, or 0·0318d. per B.O.T. unit. Rates and taxes on the central-station machinery at 4s. in the £ reckoned on 4 per cent. of the capital cost of engine-room equipment amount to 0·0126d. per B.O.T. unit. Added to this there should also be the cost of oil, waste and petty stores, which Mr. Humphrey puts at 0·030d. per unit. The cost of the land and buildings for this electrical station is taken at £15,000, which means, at 5 per cent. interest, a yearly charge of £750 per annum, or 0·003d. per B.O.T. unit metered. The total costs for the electrical central station are therefore made up as follows :—

Table I.—*Scheme A: Total Cost per Unit for Electrical Central Station.*

	Per unit.
Producer plant	0·0624d.
Machinery (generating sets, &c.), interest, &c	0·1580d.
Wages and professional staff	0 0318d.
Oil, waste and stores	0·0300d.
Rates and taxes	0·0126d.
Buildings, interest on	0·0030d.
Total	0·2978d.

To this may be added 0·02d. per unit for promotion and insurance expenses.

The remainder of this scheme "A" now divides itself into two parts. They are: (1) The "line" or transmission costs. (2) The sub-station costs.

For 3 miles' transmission through a large city it will be agreed that underground cables must be used. On the three-phase system, with say 10,000 volts between two of the three wires, there are 5,775 volts between any wire and the central point. Dividing the load of 22,000kw. between five sub-stations, we get 4,400kw. at each. The problem, therefore, is to transmit this load 3 miles. The line efficiency can be taken as 96·5 per cent. at full load, as will be seen below. The efficiency of large transformers, such as would be used here, is as high as 97 per cent. at full load, or 95 per cent. at half load. The efficiency of a rotary converter at varying loads can probably be taken at 90 per cent., giving a total combined line and sub-station efficiency of only 82 per cent. This will mean the supply of 5,150kw. delivered at the high-tension terminals of the sub-station. Taking a current density of 1,000 amperes per square inch and a power-factor of 0·95, the total sectional area of copper required for each feeder cable is 3 × 0·313 sq. in. The price of the mains is most important, but it is very difficult to get at. The desirability of using 1,000 amperes per square inch is questionable, but it appears to correspond with the present practice. Messrs. Glover have kindly given the writer permission to use the following estimate for a cable in their opinion suitable for supplying 4,400kw. at 10,000 volts. For this purpose they consider a 3 × 0·29 sq. in. core advisable. This cable would cost £1,310 per mile, which figure should be doubled on account of the necessity of running cables in duplicate. The probable cost of laying this cable in cast-iron troughs in bituumen with suitable junction-boxes would be 11s. a yard, including the excavations, laying and filling in through a town. Taking, therefore, the cost per mile at £3,680, or £11,000 for 3 miles, and allowing 10 per cent. for interest and depreciation, we obtain 0·022d. per unit as the cost of the cable. To this we must add the cost of generating the extra units lost in the line and sub-stations—viz., 21 per cent. of those metered. The cost of producing a unit at the central station is 0·318d., so that the lost units will increase this by 0·067d. Therefore the total line costs must be regarded as (0·022d + 0·067d.) = 0·089d. per unit; and the total cost per unit, exclusive of capital charges on account of sub-station plant, is 0·407d.

The next point to be considered is the *cost of the sub-stations* and their plant. Each sub-station must be large enough to accommodate 5,150kw. plant, of which amount 1,000kw. is to be transformed

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with static transformers and 4,150kw. to direct current. Assuming rotaries at £4 per kilowatt we obtain—

4,150kw. rotaries at £4 per kilowatt	£16,600
5,150kw. transformers at £2 per kilowatt	10,300
Total	£26,900

The switch gear, instruments, cables, &c., for each sub-station may be put at £3,000. The cost of the sub-station building is another debatable point. Mr. Earle assumes £500 for a 2,000kw. station, not in the area of a large city. For the size sub-station assumed, and in consideration of the price of land in a city like Birmingham, it is probable that the cost of each sub-station, land and buildings will be 10 times that figure. Placing it at £3,000 at 5 per cent. this means £150 a year. The total cost per sub-station of the equipment is £29,900, which, being machinery, is to be reckoned at an annual charge of 10 per cent., or £2,990 per sub-station. So that the annual cost of each sub-station for buildings and plant is £3,140=0·0628d. per unit sold. To this should be added about £440 per annum for rates and taxes, which is 0·009d. per unit, or a total of 0·072d. per B.O.T. unit for sub-station cost, without attendance charges. Placing wages at £4 a week for each sub-station, or, say, £1,000 a year for the five, and superintendence, &c., at £500 a year, we get a charge to each sub-station of £300 a year, or 0·006d. per unit. This gives a total cost for sub-station working of 0·078d. per B.O.T. unit. We may now tabulate as follows the total cost per B.O.T. unit metered at the sub-station 'bus bars :—

1. Cost of producing power gas for central station ..	0·0824d.
2. Central station costs (excluding above producer gas costs)	0·2354d.
3. Line costs (interest and depreciation, &c.)	0·022d.
4. Generating wasted units (21 per cent.)	0·067d.
5. Sub-station working	0·078d.
Total cost of B.O.T. unit at sub-station switchboard	0·485d.

This is a figure much below that of any station running at present on this large scale and distributing the current for 3 miles. It means that a handsome profit may be made if a selling price of 1d. per B.O.T. unit is obtained.

Section B.

The Gas Engine Sub-stations.—It is now necessary to get at the costs for the alternative scheme. We have the same figure of 0·0824d. for producing gas for 1 B.O.T. unit. This means, at a consumption of gas of 70 cubic ft. per brake horse-power and efficiency of 80 per cent., a cost of 0·53d. per 1,000 cubic ft. The sub-station (using gas engines for generating continuous current, or, of course, if it is required for some of the motor load, three-phase) is to be large enough to accommodate machinery for 5,500kw. plus 25 per cent. reserve plant. It will, therefore, be possible to use units of 1,000 B.H.P. or even under, with the consequent greater certainty of running. This plant will be all on the ground floor of the sub-station, and in the roof it is suggested there might be carried a by-reservoir for storing the gas. The size of such a sub-station will be considerably greater than that used with scheme A. Turning first to the financial part of the "line costs" in scheme B, this could be split up under two headings. They are (1) Interest and depreciation on capital expended; (2) Cost of working the line. These are quite analogous to (1) the interest, &c., (2) cost of generating the units wasted with electrical transmission. Now the average hourly load for each sub-station will be 1,375kw. (25 per cent. of 5,500kw.), while the maximum demand is for 4,400kw., or say, 6,000 B.H.P., which gives a full load working efficiency of the dynamo at 97 per cent. The average efficiency for the dynamo is taken at 92 per cent. Allowing 5 per cent. for excitation purposes, it is required to have enough gas supplied throughout the 24 hours to meet an average demand of 2,112 B.H.P. So that there will need to be sent from the producer station, taking 70 cubic ft. of gas per brake horse-power hour, a quantity = (70 × 2,112) cubic ft. of gas per hour = 147,840.

To work the compressors, if, as is assumed to be the case, they are gas-engine driven, will take 400 B.H.P. This assumes the efficiency of the compressor to be 0·8, and that the initial pressure for the gas is to be 1½ atmospheres, which, for a short transmission scheme, seems to be about the most desirable. Adding this 400 B.H.P. (about 4 per cent.) to the total 10,560 B.H.P required, a total consumption of gas for 10,960 B.H.P. must be provided for. Taking the same figure right throughout of 70 cubic ft. of gas per brake horse-power hour, then the fuel consumption for supplying the gas for sub-stations and compressors will be almost exactly 5 tons per hour—as with the scheme A. There will also be the fuel for steam-raising purposes for the producers. In scheme B this was not included, because it can be shown clearly that the heat of the exhaust gases from the adjacent gas engine station is quite sufficient to produce the steam required for the producers. This, indeed, seems to be about the only argument which can be advanced in favour of the adjacent electricity generating station. For every 5 tons of coal gasified there is required in the producer an extra 8·3 tons of water, of which approximately 5 tons is to be raised in steam boilers, the remainder being used each cycle and recovered from the ammonia towers. Taking a bank of gas-fired boilers of 10 units at a capital cost of £6,000, and allowing 10 per cent. interest and depreciation on this plant, this means £600 a year. Add £400 a year for extra rates, interest on capital for boiler house, &c., and the result is £1,000 a year for steam-raising plant. If coal be fired under the boilers, there will therefore be required 20 per cent. more fuel for this purpose, or 1 ton of coal per hour, or 8,760 tons per annum. Taking this at 5s. a ton (ammonia recovery being impossible), this means £2,190 per annum coal bill extra. If gas be used, assuming double quantity of coal used in this case, at a net cost of 6d. per ton, the cost of extra coal for gas-firing boilers is, say, £400. This makes the total extra cost up to £1,400 a year, which means 0·0056d. per B.O.T. unit.

Gas Transmission.—Now, 6,000 B.H.P. means, with 70 cubic ft. of gas per brake horse-power hour, 420,000 cubic ft. of gas as a maximum through the main. The density of the producer gas is taken at 0·78 that of air, the temperature assumed is 60°F., and the coefficient of friction of gas and pipe is taken as 0·003. Taking an initial pressure of 1½ amospheres, the diameter of the main works out at 1·2205ft.—say 1¼ft. The efficiency of the line—namely, the ratio of the gas delivered to the gas generated—is 95·9 per cent. The velocity of the gas works out at 68ft. per second, which is permissible.

Cost of the Main.—For the low pressure used, a riveted steel pipe of ⅜in. thickness, with riveted flanges which would ensure a perfect joint, the cost per foot run in £'s equals £0·02 dx, when x is the cost per ton of metal and d the diameter of the main in feet. Take x = £10—here again the figures are difficult to arrive at—and we find the cost of a main comes to £3,960 for 3 miles. The cost of excavation, laying, jointing and filling in—assuming there is left 1ft. clearance all round for flanges, &c.—is taken at an outside figure of 5s. per cubic foot complete, and amounts to about £1,100. This makes a total capital outlay of about £5,000 for this section of the line costs. Taking 10 per cent. interest, depreciation and upkeep, this makes £500 a year = 0·01d. per B.O.T. unit for the main.

Capital Cost of the Compressor.—The indicated horse-power for the compressor for 6,000 B.H.P. is 257, which, at a cost of £7. 10s. per indicated horse-power, gives a capital outlay of, say, £2,000. At 10 per cent. this means an additional £200 a year.

Cost of Running Compressor.—Since the compressor will run at practically the same load as the sub-station, gas will need to be supplied to run 64 I.H.P. The size of the units will be small, and, assuming that the consumption of Mond gas in such a case is 70 cubic ft. per indicated horse-power, the cost of running the compressor is the cost of generating 4,480 cubic ft. of gas per hour for 8,760 hours. This was shown earlier to be 0·53d. per 1,000 cubic ft., which is £86 per annum. The total line cost—*i.e.*, the sum of the interest, &c., on main, the cost of the interest or cost of compressor, and the cost of running the compressor for each sub-station—comes to £786 per annum, which is 0·0157d. per B.O.T. unit.

The Gas Engine Sub-stations.—Each station—assuming, as with scheme A, that the load is equally distributed over five sub-stations—will require machinery, including 25 per cent. reserve plant, of 7,500 B.H.P. Taking a figure of £13½ per kilowatt—namely, 10s. per kilowatt more than that assumed for scheme A—we get the total cost of the plant for one sub-station to be £74,200. Allowing £4,000 per sub-station for switch-gear, instruments and cables, £3,800 for piping, valves and the gas-holder, and the machinery equipment of the sub-station is £82,000. At 10 per cent. for interest and depreciation, it is £8,200 per annum, or 0·163d. per B.O.T. unit. The cost of the building for an electrical sub-station was taken at £3,000, and assuming, for the same output, that the gas-engine sub-station takes double the area, this makes £6,000 for the building, which, at 5 per cent., is £300 per annum, or 0·006d. per unit. There is, as before, 1·5 per cent. rates and taxes on the capital cost for machinery—*i.e.*, £82,000; this item means 0·026d. per B.O.T. unit. Mr. Humphrey gives labour and attendance at 0·068d. per unit, and oil, waste and petty stores at 0·030d.

Table II.—*Scheme B: Total Costs per Unit for Gas-engine Sub-station*

	Per unit.
Machinery, interest and depreciation on	0·163d.
Wages and professional staff	0·068d.
Oil, waste and stores	0·030d.
Rates and taxes	0·026d.
Buildings, interest on	0·006d.
Total	0·293d.

It is now possible to compare the two schemes as in the following table.

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Table III.—*Comparison of the Two Schemes.*

	A Pence per unit sold.		B Pence per unit sold.
Central Gas Producing Plant.			
Producer plant	0·0624	....	0·0624
Extra steam for producers, Scheme B	—	....	0·0056
Central Electric Generating Station.			
Machinery (not including producers), interest and depreciation on	0·1580	....	—
Wages and professional staff	0 0318	....	—
Oil, waste and stores	0·030	....	—
Rates and taxes	0·0126	....	—
Buildings, interest on	0·003	....	—
Transmission.			
Cable	0·022	....	—
Gas mains	—	....	0·010
Cost of electrical units wasted	0·067	....	—
Compressor costs	—	....	0·005
Sub-stations.			
Electrical: Total costs	0·078	....	—
Gas: Machinery, interest and depreciation on	—	....	0·163
Gas: Wages and professional staff	—	....	0·068
Gas: Oil, waste and stores	—	....	0 030
Gas: Rates and taxes	—	....	0·026
Gas: Buildings	—	....	0 006
Promotion and Insurance	0·020	....	0·020
Total	0 485	....	0·396

There is, therefore, an advantage in using scheme B of about 0·1d. per unit; or, on the assumed annual load of 60 million units, of £23,000 per annum. In order to bring out clearly the real difference between the two schemes—namely, that brought about by the mode of transmitting the power—the following items, which may be considered as common to both, have been subtracted:—

Producer plant	0·0624d.
Interest and depreciation on machinery	0·158d.
Oil, waste and stores	0·03d.
Promotion and insurance	0 02d.
	0·270d.

Subtracting, therefore, 0·27d. from both figures, we obtain the results 0·215d., as compared with 0·126d. From which it would appear fair to conclude that gas transmission, in a case like that chosen, does not necessarily cost much more than one-half the cost of electric transmission by means of underground cables. Should these figures be compared with those for a steam engine station, and the probability of the gas main being used for transmitting gas for heating purposes be considered, the advantages of using producer gas are yet more striking.

DISCUSSION.

The CHAIRMAN (Mr. J. C. Vaudrey) said he thought that even to-day the question was whether a gas engine of sufficiently large size was obtainable, or was going to be obtainable. In his costs Mr. Smith had assumed somewhat low figures, both in the capital charge and the cost per unit. Of course, in dealing with the question of gas distribution they were really dealing with absolutely theoretical figures. The number of units assumed by Mr. Smith as possible for a town of the size of Birmingham was exceedingly large. Glasgow at the present moment was reported to be using only 14,000,000 units for tramway purposes, the total in Liverpool for both lighting and tramways was not more than 24,000,000 units, and he thought they could take it with regard to both those towns that they were not likely to very largely exceed the unit output for tramway purposes. Coming to the figure for lighting there was no question that in our larger towns the cream of the lighting had mostly been already taken up, and the increase would be a gradual one. He did look for the load in the direction of motors. No doubt in manufacturing towns there was an untouched field if the unit could be brought down to under 1d. With lower prices manufacturers would put down motors for their smaller work, and there would be a gradual increase of power used.

Prof. THRELFALL said that as far as the estimate of the gas-making went, they none of them yet had any experience of anything like a 20,000 H.P. station, and these estimates at best were only a sort of pious hope as to what might be accomplished under such conditions. There were one or two points in which, as it seemed to him, Mr. Smith had not been justified in adopting Mr. Humphrey's result. Mr. Humphrey gave a series of figures based on coal of a certain calorific value, and which would yield 80 to 90 per cent. of sulphate of ammonia per ton. He said if the cost of the coal was 7s., or 6s., or 5s, and so on, certain results would be obtained. He was rather afraid Mr. Smith was taking the coal which the Birmingham Canal Co. could deliver at Smethwick as compared with Mr. Humphrey's coal costing, say, 5s., and, if so, that vitiated the whole thing. First of all they would not get at Smethwick anything like the quality of coal that Mr. Humphrey was referring to; it would be very much finer. Secondly, they would not have the same amount of ammonia from it. Thirdly, it would not burn in the producer at anything like the same rate. Fourthly, it would not make nearly so much gas. Fifthly, the gas would not be of so good quality. Mr. Humphrey had never done more than take the allotted steam which Dr. Mond estimated was used by his plant; he (Prof. Threlfall) did not know that there was ever any direct measurement of the quantity of steam used. The quantity and quality of the gas fell off amazingly as the quality of the fuel diminished. He had known coal companies able to produce a kind of coal which was poorer than the Mond producer could burn. The cost of the Mond producer was extremely high, and it was not economically possible to burn any sort of rubbish. Again, if the coal were poor, or if it were extremely fine slack with rough lumps in it, it gave rise to great irregularity in the burning, the labour of stoking it down was greatly increased, holes were blown through, and the ammonia was lost. Mr. Smith had taken the figure of 70 cubic ft. of gas per brake horse-power for gas engines. He was afraid that was another pious hope. The best result published by Mr. Humphrey was about 69

Mr. SMITH, of Messrs. Richardsons and Westgarth, said they were quite willing to guarantee the 70 cubic ft.

Prof. THRELFALL replied that he would be very glad to accept it if he had any reason to suppose it would be carried out. On a trial they would get those figures, but they would not get anything like them on continuous running.

Mr. CHATTOCK agreed with the author that gas engines were certainly not any good for driving alternators. They did not run steadily enough, and he thought it would be a considerable time before they would be made to do so. Mr. Smith mentioned the variation of 1 in 120 which could be obtained in the large engine he described with a flywheel of 40 tons weight. It seemed to him that variation was rather against good parallel running of alternators. He should not be inclined to adopt a greater variation than 1 in 200, and he knew as little as 1 in 300 could be easily obtained on the steam engine. He also thought that gas engines of large power were hardly suitable for direct-current working when you had several machines running in parallel together on one circuit, as owing to the danger of back-firing there was a liability to throw the load off one engine momentarily and overload the others on the circuit, which might have very serious results. He could not agree with Mr. Smith that the dual control of gas and electricity undertakings in one municipality was a disadvantage. He thought both undertakings could get along very well side by side, and they stimulated each other to a great extent. Turning to Mr. Smith's comparison of the two schemes, he did not agree with the values he had assigned under the various headings. Mr. Chattock went on to give calculations, and the result he arrived at was that the total cost would be 0·768d. per unit sold at the sub-station switchboard. This figure was a good one, he admitted, but in his opinion it could be approached, if not equalled, by well-designed steam generating plant.

Mr. TAYLOR said the first thing that struck one about the gas supply system was its inflexibility. There were five sub-stations in the scheme proposed, consequently they had to consider, emanating from the central generating station, five mains each of 1½ft. diameter, or else one huge main equivalent to the five. They would probably run foul of the water scheme, and get landed in all sorts of difficulties. In connection with a scheme of compressed air in Birmingham some years ago, where steel riveted pipes were laid, 45 per cent. of the air escaped by leakage under a pressure of five atmospheres. It would be interesting to know what was going to happen as the result of the saturation of the soil with gas leaking on a corresponding scale. He also saw technical difficulties in riveting the pipes with the amount of space allowed by Mr. Smith, and leakage was sure to occur. He thought the nuisance attaching to the sub-stations was not to be neglected, and they had to consider the widely-varying requirements that would be made on sub-stations, those in the central situations being the very ones which would have to be on the larger scale. The electric sub-stations were undoubtedly much better.

Mr. GROVES said Mr. Smith had provided for the duplication of his cables but not of his pipe lines. It was an open question whether the pipe line should not be duplicated to put it on all-fours with a high-pressure cable. Nothing was so certain as that in some aggravated cases the pipe line might break down owing to subsidence or earthquake, say, and it would not be safe to have only one line. Of course, if a fault occurred in a high-tension cable, it generally rendered it entirely inoperative, whereas a leakage on a gas main would not have that effect. But a fault in a cable was not difficult to locate, while the location of a leakage in a badly-damaged pipe line would be a very dangerous matter. Again, the same catastrophe that caused the breakage of one pipe line would probably have a similar effect upon another pipe line alongside it, and, therefore, the question arose as to whether it would not be better to provide alternative route sfor the duplicate pipes.

Mr. SMITH, in reply, said he did not think that the figures quoted in connection with the city of Birmingham were unduly optimistic. Prof. Threlfall had alleged that makers would guarantee almost anything on a gas engine, and that sometimes the results were not up to guarantee. But that was perfectly true of steam engines too, from what he had seen of them. Mr. Chattock disagreed with him on the question of dual control. It seemed to him (Mr. Smith) that if a municipality had both the gas and electric supply under its thumb the effect was to stifle competition, and it was generally accepted now that competition was to be desired in everything. He thought Mr. Taylor would agree that if one big gas main were put down in communication with small branches it would reduce the cost of the five sub-stations very much. With regard to the question of leakage, Mr. Taylor must remember that when he quoted the leakage in connection with the compressed air scheme at Birmingham that those figures were 10 to 12 years old. Engineering had advanced since then, and it was possible to make far better joints now. He granted there might be a little leakage, but he did not think it would be anything like 10 per cent. He did not quite see how duplicating the main would remedy the evils caused by earthquakes. There was no denying the fact that the gas engine sub-stations would be a great nuisance, but so were many of the electrical works now running. He reminded the members of the early failures at Belfast, and the present success at Cadbury's and other works in the district.

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ON THE MAGNETIC DISPERSION IN INDUCTION MOTORS, AND ITS INFLUENCE ON THE DESIGN OF THESE MACHINES.*

BY DR. HANS BEHN-ESCHENBURG.

(Concluded from page 822).

(*b*) We adduce two further examples in which for similar types of motor, with equal numbers of poles, the number of slots was altered.

Motor Type 360:

$D = 38$; $b = 24$;
δ effective $= 0{\cdot}08$; $P = 6$;
$N_1 = 54$; $N_2 = 72$; $X = 0{\cdot}2$: then σ (observed) $= 0{\cdot}054$.
$N_1 = 108$; $N_2 = 144$; $X = 0{\cdot}1$: then σ (observed) $= 0{\cdot}039$.

The no-load currents in the two cases were approximately alike. In the first case each slot held four conductors; in the second case, two conductors.

The difference of the peripheral leakage was reduced to zero by the slit in the slots being in the first case double as wide as in the second case.

Therefore, we have

$$\sigma - \sigma' = 2(\sigma_1 - \sigma'_1) = 0{\cdot}022,$$

according to the formula.

$$2\sigma_1 = K_1 \times 2{\cdot}6 / N^2,$$

and according to this observation

$$K_1 = 1{\cdot}3\ ;\ 2\sigma_1 = 0{\cdot}03.$$

By the earlier formulæ: The flank-dispersion, $2\sigma_3 = 0{\cdot}021$; the peripheral-dispersion, $2\sigma_2 = 0{\cdot}002$.

$$\sigma = 2\sigma_1 + 2\sigma_2 + 2\sigma_3 = 0{\cdot}052\ ;$$

while observation gave $\sigma = 0{\cdot}062$.

Motor Type 3071;

$D = 150$; $b = 22$;
$\delta = 0{\cdot}15$; $P = 16$.

(i.) $N_1 = 144$; $N_2 = 192$; slots closed.
$J_0 = 12{\cdot}5$ amperes at 3,000 volts, 50 ~, for 14 conductors in each stator slot.
$J_k = 55$ amperes (for saturated slot bridges), at 980 volts.
$\sigma = 0{\cdot}075$.

(ii.) $N_1 = 192$; $N_2 = 216$; slots open, $X = 0{\cdot}25$.
$J_0 = 6{\cdot}5$ amperes at 5,000 volts, 50 ~, for 20 conductors in each stator slot.
$J_k = 40$ amperes at 2,000 volts.
$\sigma = 0{\cdot}065$.

The no-load current is in case (ii.) 20 per cent. greater than in case (i.), if both cases are reduced to the same number of conductors. Hence, in case (ii.) there is, of necessity, an increase of the coefficient of flank-dispersion. The flank-dispersion in case (i.) amounts, according to the previous method of calculation, to

$$2\sigma_3 = 0{\cdot}043\ ;$$ and in case (ii.) to $0{\cdot}052$.

Similarly, the peripheral-dispersion is, in case (ii.)

$$2\sigma'_2 = 0{\cdot}0015.$$

If, following our earlier calculation, we estimate the peripheral-dispersion of case (i.) as four times greater, we get

$$2(\sigma_2 - \sigma'_2) = 0{\cdot}0045.$$
$$2(\sigma_3 - \sigma'_3) = -\ 0{\cdot}0090.$$

Observation gave $\sigma - \sigma' = 0{\cdot}010$.

Taking into account the differences of the dispersion coefficients σ_2 and σ_3, one therefore has

$$2(\sigma_1 - \sigma'_1) = 0{\cdot}015 - K_1 \times 2{\cdot}6\left(\frac{1}{110} - \frac{1}{180}\right),$$

from which it follows that $K_1 = 1{\cdot}65$; $2\sigma_1 = 0{\cdot}039$:

$$\sigma = 2\sigma_1 + 2\sigma_2 + 2\sigma_3 = 0{\cdot}088\ ;$$

while, as observed, $\sigma = 0{\cdot}075$.

From the course and results of these calculations, and the precise comparison of them with the values directly observed, a practically satisfactory agreement may, in our experience, be attained. As already stated at the outset of these researches, it not unfrequently happens that in different motors of exactly the same type with exactly similar windings the observed values of σ differ from one another by as much as 10 and even 20 per cent., and it requires, therefore, great experience to deduce admissible comparative tables from the partially contradictory observations.

According to the scientific tests and the estimations made by the author, the examples used in the researches here presented afford, in general, data of entirely substantial character; but withal it must not be straightway concluded that more fundamental and systematically elaborated series of investigations will not reveal new sources for determining the dispersion-coefficient σ. According to the previously fixed state of knowledge, and with the previously attained degree of precision of the observations, we may put together the results for motors with the ordinary winding arrangements and forms of slots in the following expression

$$\sigma = \frac{3}{N^2} + \frac{\delta}{X \times N \times \tau} + \frac{6\delta}{b}\ ; \quad \ldots\ldots\ (9)$$

where N is the mean number of slots for stator and rotor within one pole-pitch; δ the width of air-gap, which is the determining factor in the no-load current; X the value of the slit at the summit of the slot; τ the pole-pitch; and b the length of the iron core-body, all expressed in centimetres.

Values inconsistent with this final formula will occur in individual cases:—(i.) in consequence of special influences of the neighbouring iron parts upon the parts of the windings at the flanks, (ii.) in consequence of special arrangements of the parts of the windings at the flanks, (iii.) in consequence of special proportions in the numbers and forms of the slots in the stator and rotor which influence the winding-coefficient, (iv.) in consequence of special dispositions of the winding elements in the stator and rotor, which alter the uniformity of the magnetic field, (v.) in consequence of particular winding-pitches of the coils in stator and rotor which affect the coefficients of self-induction and mutual induction of these elements, (vi.) in consequence of diverse actions which the particular dimensions of slots and air-gap exercise upon the reluctance of the magnetic circuit of which the magnetic system of the stator and rotor consists.*

Let it be assumed that the dispersion-coefficient σ may be deduced with extreme accuracy from the constructive data, on the basis of the concluding formula, then there remains as the final task for the constructor, using this value of σ for a prescribed output and speed, with a prescribed voltage and frequency, to build a motor which shall possess the highest possible efficiency and power-factor, and a sufficient capacity for overload and without attaining a harmful temperature-rise. Yet each single one of these conditions must in its effect on the technical quality of the motor be brought into accord with the expense in material and labour, by which success can be attained. But before all things, the motor must in its mechanical relations not be weakened by any regard to purely electrical values, nor even by any regard to the cost. In a concluding chapter the process of the calculation of a motor shall be set forth in short general steps.

IV.—Basis for the Design of Motors.

We shall here entirely exclude any entrance on such topics as the proportions between the weights of active and constructive material, or the relations of insulation and cooling, or the various considerations which the economical construction of much smaller or much larger, much quicker or much slower motors require. Further, the analytical theory of the equations of currents will be assumed as known. Neglecting in this theory the ohmic resistance of the winding of the primary system, we considerably simplify thereby, as is known, the formulæ for the currents and phase-displacements. The influence of this resistance can subsequently be indicated, by introducing between the voltage of the mains and that at the terminals of the motor, a drop of potential due to an equivalent non-inductive resistance equal to the actual resistance of the primary winding. Accordingly we insert as the terminal voltage of the motor the voltage of supply reduced by the amount of this drop. In that which follows we shall calculate with this reduced value, and all the strengths of currents and phase-displacements will be correlated with this value of the terminal voltage. In the diagram, Fig. 8, we denote the reduced terminal voltage of the motor by E, the current by J, the phase-angle between E and J by ϕ, the ohmic resistance by r_1, the voltage-drop Jr by e; so then we obtain the connection between the voltage of the supply mains E_0, that of the reduced voltage E, and the current J directly from the figure.

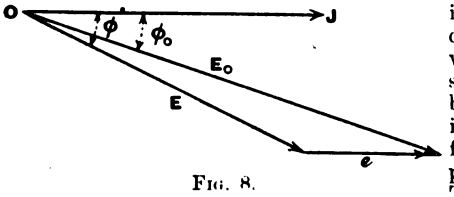

Fig. 8.

We designate by S the slip of the motor, by r_2 the ohmic resistance of one phase of the secondary system, by m the transformation-ratio

* The researches described in this communication were imparted in April, 1903, to Prof. Silvanus P. Thompson, on whose suggestion they were communicated in their present form to the Institution of Electrical Engineers in the summer, and have since been translated into English. The Paper was read in abstract by Prof. Thompson at the meeting of the Institution on January 15, 1904.

* The new winding system applied by the Oerlikon Company to its motors with variable numbers of poles has contributed some very interesting new points to the theory of the winding coefficient, and its dependence upon the shortening or lengthening of the winding pitch. The author reserves for the present the publication of this matter.

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of the windings of the primary and secondary systems. J_0' denotes the magnetising current, which, for simplicity, we will regard as coincident with the no-load current. An expression which often recurs in the theory we will write, for brevity

$$\frac{SE}{J_o r_2 m^2} = a.$$

Then we have for the primary current

$$J_1 = J_o \frac{\sqrt{1+a^2}}{\sqrt{1+a^2\sigma^2}}; \quad \ldots\ldots\ldots \quad (1)$$

for the secondary current

$$J_2 = J_1 \times m \times a \frac{\sqrt{1-\sigma}}{\sqrt{1+a^2}}; \quad \ldots\ldots \quad (2)$$

and

$$\cos\phi = \frac{a(1-\sigma)}{\sqrt{1+a^2+\sigma^2 a^4}}. \quad \ldots\ldots\ldots \quad (3)$$

For a rapid determination of the characteristic curves of the motor we discriminate the following five cases, which correspond directly to five points on the load-curve, and which suffice in general to characterise the motor with certainty:—

First point:

$$\left.\begin{array}{l} a = o \\ J_1 = J_o \\ J_2 = 0 \\ S = 0 \end{array}\right\} \quad \ldots\ldots\ldots \quad (4)$$

If there is a very small load of the amount of the no-load losses A_o, then there is further given the relation

$$\cos\phi_o = \frac{A_o}{3EJ_o}.$$

Second point:

$$\left.\begin{array}{l} a = \dfrac{1}{2\sqrt{\sigma}}; \\ J_1 = \dfrac{J_o}{2\sqrt{\sigma}}(1+1{\cdot}9\sigma); \\ \cos\phi = 1 - 3{\cdot}12\sigma. \\ S = \dfrac{r_2 J_o m^2}{2\sqrt{\sigma}E}. \end{array}\right\} \quad \ldots\ldots\ldots \quad (5)$$

σ^2 will be in general negligibly small relatively to unity.

The input of power is

$$A = 3EJ_1 \cos\phi = \frac{3EJ_o(1-1{\cdot}2\sigma)}{2\sqrt{\sigma}}.$$

The torque developed, including that which is used in producing the no-load work (friction, &c.) is, in kilogrammetres,

$$D = \frac{A}{T_o \times 1{\cdot}03};$$

where T_o signifies no-load speed.

Third point:

$$\left.\begin{array}{l} a = \dfrac{1}{\sqrt{\sigma}}; \\ J_1 = \dfrac{J_o}{\sqrt{\sigma}}; \\ \cos\phi = 1 - 2\sigma; \\ A = \dfrac{3EJ_o}{\sqrt{\sigma}}(1-2\sigma); \\ S = \dfrac{r_2 J_1 m^2}{E}. \end{array}\right\} \quad \ldots\ldots\ldots \quad (6)$$

This point gives the load with maximum power-factor. Now a rationally-built motor will obviously be so dimensioned that its normal load approximately corresponds to this point, always provided that the conditions of capacity for overload do not conflict with it.

Fourth point:

$$\left.\begin{array}{l} a = \dfrac{1{\cdot}5}{\sqrt{\sigma}}; \\ J_1 = \dfrac{1{\cdot}5 J_o}{\sqrt{\sigma}}(1-2\sigma); \\ \cos\phi = 1 - 2{\cdot}3\sigma; \\ S = \dfrac{J_1 r_2 m^2}{E(1-2\sigma)}; \\ A = \dfrac{3EJ_o}{\sqrt{\sigma}} \times 1{\cdot}5(1 - 4{\cdot}6\sigma). \end{array}\right\} \quad \ldots\ldots\ldots \quad (7)$$

Fifth point:

$$\left.\begin{array}{l} a = \dfrac{1}{\sigma}; \\ J_1 = \dfrac{J_o}{\sqrt{2\sigma}}; \\ \cos\phi = \dfrac{1-\sigma}{\sqrt{2}}; \\ S = \dfrac{J_o r_2 m^2}{\sigma E}; \\ A = \dfrac{3EJ_o}{2\sigma}(1-\sigma). \end{array}\right\} \quad \ldots\ldots\ldots \quad (8)$$

This point corresponds to the maximum torque which the motor can exert.

If we denote by D the torque which corresponds to the third point, at ideal normal load, then the maximum torque D_m is related to the normal torque according to the expression

$$\frac{D_m}{D} = \frac{1+\sigma}{2\sqrt{\sigma}} = y. \quad \ldots\ldots\ldots \quad (9)$$

This is the maximum capacity for overload of a motor whose normal load corresponds to the third point. The torque at the second point is very nearly equal to the half of the torque of third point, and that at the fourth point nearly 1·5 times that of the third point.

Now these five points determine the characteristic performance of the motor with adequate precision so far as practical design is concerned. For this purpose the influence of the primary resistance can easily be subsequently taken into account as a correcting term by reference to Fig. 8, since the voltage E used in the formulæ may be reckoned from the supply voltage E_o and the voltage-drop e. So long as e is small in comparison with E, then from the figure we have approximately

$$\left.\begin{array}{l} E = E_o - J_1 r_1 \cos\phi; \\ \cos\phi_0 = \cos\phi + \sin^2\phi \dfrac{J r_1}{E}; \end{array}\right\} \quad \ldots\ldots \quad (10)$$

The current J_o must be reckoned with respect to E.

We may remark also a correction for the coefficient σ. When σ is to be calculated from the no-load current J_o and the current J of the shirt-circuited motor, then with an accuracy of first order we obtain the formula

$$\sigma = \frac{J_o}{J_k}\sin\phi_o\left\{1 - \frac{J_k^2}{E^2}\left(\frac{r_2^2 m^4}{2} + r_1 r_2 m^2\right)\right\}. \quad \text{In practice } \sigma = \frac{J_o}{J_k}.$$

If we assign to the torque which corresponds to the third point the value 1, as being normal, the current at this point as the normal current J, and the corresponding slip at this load as S, then we may conveniently assemble the values for the five points in the following table:—

Point.	Torque.	Current.	Power-factor.	Slip.
1	$\frac{a_o}{T_o}$	J_o	$\frac{a_o}{3EJ_o}$	0
2	$\frac{1+0{\cdot}8\cdot\sigma}{2}$	$\frac{J}{2}(1+1{\cdot}9\sigma)$	$1-3{\cdot}12\sigma$	$\frac{1}{2}S$
3	1	J	$1-2\sigma$	S
4	$1{\cdot}5(1-2{\cdot}6\sigma)$	$1{\cdot}5\,J(1-2_o)$	$1-2{\cdot}3\sigma$	$1{\cdot}5\frac{S}{1-2\sigma}$
5	$\frac{1+\sigma}{2\sqrt{\sigma}}$	$\frac{J}{\sqrt{2}\sqrt{\sigma}}$	$\frac{1-\sigma}{\sqrt{2}}$	$\frac{S}{\sqrt{\sigma}}$

The determination of these five points requires only a knowledge of the total dispersion-coefficient σ, the no-load losses and the magnetising current J_o. If the efficiency also is prescribed, then the resistances r_1 and r_2 must be calculated.

The magnetising current J_o can only be exactly calculated if the numbers and dimensions of the slots are known in addition to the principal dimensions and winding data. The dependence of the exact distribution of the magnetic field upon the number of slots has been repeatedly discussed by others. The influence on the magnetising current of a voltage curve which departs from the simple sine form will not be here regarded.

Example 1.—To find the characteristic curves of a 4*-pole* 5 H.P. *motor*, of which we have observed the following data:—

At no-load, with E = 200 volts; J = 2 amperes; U = 1,500 revs. per min., at frequency f = 50 ~; input = 200 watts.

At short-circuit, with E = 100 volts; J_k = 23 amperes; frequency f = 50 ~; r_1 = 0·5 ohm; r_2 = 0·1 ohm; m = 2.

First we calculate σ.

$$\sigma = \frac{2}{200} \times \frac{100}{20} = 0{\cdot}05.$$

(We here neglect the small correction of σ due to the resistances r_1 and r_2, which can only alter the value of σ by 1 per cent.)

Next we determine the third point of the table. The maximum power-factor is such that $\cos\phi = 1 - 2\sigma = 0{\cdot}9$; and the corresponding intensity of current is $J = J_o/\sqrt{\sigma} = 9$ amperes. This current will give a torque of

$$D = \frac{3 \times 200 \times 9 \times 0{\cdot}9}{1{\cdot}03 \times 1{,}500} = 3{\cdot}15 \text{ kilogramme-metres.}$$

The slip is

$$S = \frac{0{\cdot}1 \times 9 \times 4}{200} = 1{\cdot}8 \text{ per cent.}$$

The loss in the primary copper is $3J^2 r_1 = 121$ watts.

The efficiency is

$$\frac{3 \times 200 \times 9 \times 0{\cdot}9 \times (1 - 0{\cdot}018)}{(3 \times 200 \times 9 \times 0{\cdot}9) + 200 + 120} = 0{\cdot}92.$$

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The other points of the table are calculated as multiples of this third point, and give the following result:—

Point.	Torque. Kilogramme-metres.	Current. Amperes.	Power-factor. Cos ϕ.	Slip. Percentage	Efficiency. Percentage
1	0·13	2·0	0·18	0	0
2	1·56	5·0	0·85	0·9	90
3	3·15	9·0	0·90	1·8	92
4	4·1	12·2	0·88	3·0	91
5	7·4	28·2	0·67	8·0	86

These values of torque, current, power-factor and efficiency are calculated without taking into account the drop of voltage due to the primary resistance r_1. Now, we have to correct these values in accordance with the diagram Fig. 8 and formula (10). The corrected table is as follows:—

Point.	Torque.	Current.	Power-factor.	Slip.	Efficiency.
1	0·13	2·0	0·18	0	0
2	1·5	5·0	0·852	0·92	90
3	3·0	8·8	0·905	1·87	92
4	3·9	11·9	0·886	3·15	91
5	6·8	27·0	0·74	8·6	86

For larger motors these corrections are obviously much smaller, since the loss in the primary copper is relatively smaller.

A few further formulæ are needed to complete the set for the calculation of motors.

The magnetising current of three-phase motors can be estimated, with a precision practically sufficient for the purpose of design, from the expression

$$J_o = \frac{\delta \times B}{1{\cdot}3W}; \quad \ldots\ldots\ldots \quad (11)$$

where δ is the air-gap, W the number of conductors of one phase within one pole-pitch and B the value of the amplitude of the maximum flux-density in the gap. In this expression there is assumed a customary width of aperture of slots, and, in addition, an increase of the magnetic resistance of the air-gap due to the iron teeth, amounting to about 20 per cent. If we denote by F the useful flux through one pole pitch, and by D the diameter of the bore, then B is defined* by the equation

$$B = \frac{3 \times FP}{2 \times \pi D b}; \quad \ldots\ldots\ldots \quad (12)$$

$$F = \frac{E \times 10^8}{2{\cdot}2 \times f P W}; \quad \ldots\ldots\ldots \quad (13)$$

where f is the frequency

$$PF = \frac{A' \times 10^8}{1{\cdot}1 \times U \times JL_o}; \quad \ldots\ldots\ldots \quad (14)$$

where A′ is the product of the volts and amperes which the motor takes at normal load; U the peripheral speed, in centimetres per second; and JL_o is the "specific load," or number of ampere-conductors per centimetre of periphery. This formula (14) is an important and very practical formula for electric machines of all types; but for continuous-current machines the coefficient 1·1 may be replaced by 1.

If now the problem is put of designing a motor for an output of A watts, with P poles, f cycles per second, then the product of volt-amperes A′, which the motor at normal load will take, is given with close practical approximation by

$$A = A' \times \eta \times \cos\phi.$$

The normal current corresponding to A′ is

$$J = \frac{A'}{3E};$$

so the problem is so to build the motor that the normal load is coincident with the load at the maximum power-factor. Then we must have

$$J_o = J \times \sqrt{\sigma} \quad \ldots\ldots\ldots \quad (15)$$

The weight and size of the motor is fairly determined by the total flux PF; and, by formula (14), this is so much the smaller the greater the peripheral velocity, and the greater the number of ampere conductors per centimetre of periphery.

By transposition of formula (12) we have

$$PF = \tfrac{2}{3}\pi D b B. \quad \ldots\ldots\ldots \quad (16)$$

For reasons of construction it is in general not possible to arrange more than 300 ampere-conductors in 1cm. of periphery, and, moreover, mechanical difficulties do not admit of a peripheral speed exceeding 4,000cm. per second. The gap-density B is limited by the saturation of the teeth, which ought not to exceed the limit beyond which the magnetising current increases faster than the flux-density. In order to afford a large winding space in the slot the teeth must be kept narrow. The air-gap δ must, for mechanical reasons, not be made less than about $\frac{1}{1000}$ of D. We will design the motor with the moderate values: U = 1,500, JL_o = 150, for motors of less than 10 H.P.; and U = 2,500, JL_o = 250 for motors exceeding 100 H.P. Then we at once can arrive at PF, and from it at the product bB. Having JL_o and U, W is determined. But, according to formula (11), W and B are connected with one another by the prescribed no-load current J_o, and so all the dimensions are thus determinate.

From the earlier discussion respecting σ it is known that σ distinctly decreases as the number of slots is increased; but a large number of slots can in general be accommodated only in a large pole-pitch; and further, σ diminishes as b, the core-length, is increased. One part of σ which depends on the number of slots amounts, for a mean number of slots, say 12, per pole, to about 2 per cent. An increase of the number of slots may involve difficulties. Another part of σ which depends on b has been shown to be equal to $6\delta \div b$; therefore for $\delta = 0{\cdot}1$, it follows that we must have $b = 30$ if this part of the dispersion is to have a value equal to that of the first part. Now, by changing the dimensions here and there, and balancing the difficulties and profits of one alteration in the dimensions against those of another, we find by successive approximations the most economic value of σ.

We now come to the point how to estimate beforehand values of the density B that shall be favourable.

The pole-pitch τ is equal to $\pi D \div P$. If L_o stands for the number of conductors per centimetre of periphery, and W the number of conductors, *in one phase*, per pole, then

$$W = \frac{L_o \pi D}{3P}.$$

Now, in order to be able to arrange a suitable number of ampere-conductors in a large number of slots, one will choose τ not less than 20cm. And since, further, $\tau = U \div 2f$, it follows that for ordinary frequencies where f is from 40 to 50 cycles per second, τ must not be more than about 30, otherwise the peripheral speed may be inconveniently high. As a good mean value, we may put for small motors $\tau = 15$, for large motors $\tau = 25$.

Then from the earlier formulæ (11) and (15) we obtain

$$B = \frac{0{\cdot}43 \times \sqrt{\sigma} \times JL_o \times \tau}{\delta} \quad \ldots\ldots\ldots \quad (17)$$

Inserting for JL_o, δ, and σ as mean values for small motors not exceeding 10 H.P., $JL_o = 150$, $\delta = 0{\cdot}05$ and $\sigma = 0{\cdot}05$; for large motors $JL_o = 250$, $\delta = 0{\cdot}1$ and $\sigma = 0{\cdot}04$, we have, as mean value, B = 5,000. This is a good average figure which may serve as a trial value in design.

From formulæ (14) and (16) the peripheral surface of the motor will then be

$$\pi D b = \frac{3 \times A' \times 10^8}{2{\cdot}2 \times U \times JL_o \times 5{,}000} \quad \ldots\ldots\ldots \quad (18)$$

And using the same mean values as before, we have

$$Db = \frac{5{\cdot}5A'}{100\pi}.$$

EXAMPLE II.—*To Design a Motor to fulfil the following specification:—*

To give 5 H.P. actual output at 1,500 revs. per min., the frequency being 50 ∿; cos ϕ to be not less than 0·9; the efficiency at normal full-load to be not less than $\eta = 0{\cdot}9$; capacity of over-load $y = 2$; the voltage in one phase to be E = 400 volts.

The maximum power-factor cos $\phi = 0{\cdot}9$ is obtained by making $\sigma = 0{\cdot}05$ (see Example I.). Further, $y = 1/2\sqrt{\sigma} = 2{\cdot}25$. The normal full-load current to meet the specification will be

$$J = \frac{5 \times 746}{3 \times 400 \times 0{\cdot}9 \times 0{\cdot}9} = 3{\cdot}83 \text{ amperes.}$$

Now the magnetising current J_o is determined by the condition

$$J_o = J \times \sqrt{\sigma} = 0{\cdot}86 \text{ ampere.}$$

For motors of a size so small as this, we apply in designing the mean values

U = 1,500cm. per sec.; JL_o = 150 amps. per cm.; $\delta = 0{\cdot}05$cm.

We will take D = 20cm. Formula (17) gives B = 4,200.

To fulfil formula (11), we calculate as number of stator conductors per phase per pole

$$W = \frac{0{\cdot}05 \times 4{,}200}{0{\cdot}86 \times 1{\cdot}3} \sim 180.$$

By formula (13) we have for the flux from one pole

$$F = \frac{400 \times 10^8}{4{\cdot}4 \times 50 \times 2 \times 180} = 0{\cdot}50 \times 10^6.$$

By formula (12) the length of the iron core-body will be

$$b \quad \frac{0{\cdot}50 \times 10^6 \times 3}{2 \times 4{,}200 \times 15{\cdot}6} \sim 12.$$

* The highest saturation may, for example with 15 slots per pole pitch, be 20 per cent. greater than this.

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Number of slots in the stator = 60.
" " in the rotor = 72.
Pitch of the slot in the stator = 10·4.
" " rotor = 8·7.
Number of conductors in one stator slot = 36.
Section of each stator conductor, 1·2 sq. mm.
Dimensions of stator slot, 6 × 25mm.
Saturation of iron core B = 7,000.
External diameter of the stator core = 330mm.
Weight of the stator iron will be 48kg.
Mean length of one primary conductor = 320mm.
Resistance of one phase of the primary

$$r_1 = \frac{4 \times 180 \times 0{\cdot}32}{55 \times 1{\cdot}2} = 3{\cdot}4 \text{ ohms.}$$

Loss in the primary copper $= 3 \times 3{\cdot}4 \times (3{\cdot}8)^2 = 137$ watts.
Rotor copper loss, estimated at 70 watts.
Iron and friction losses (at about 5 watts per 1kg. iron) estimated at 250 watts.
Efficiency at full load $\eta = \frac{3{,}700}{3{,}700 + 457} = 89$ per cent.

Now we take the following controlling test of our design :—

We calculate $JL_0 = \frac{12 \times 180 \times 3{\cdot}8}{20 \times \pi} \leqq 136$;

$$U = \frac{20 \times \pi \times 1{,}500}{60} = 1{,}550.$$

By formula (14)—

$$PF = \frac{5 \times 746}{0{\cdot}8 \times 1{\cdot}1 \times 155 \times 136} \backsim 2{\cdot}0 \times 10^6,$$

$$F = 0{\cdot}5 \times 10^6,$$

in accordance with the value previously given.
From formula (9) we should obtain for this motor the coefficient σ as follows

$$N = 16\,;\ b = 12\,;\ \delta = 0{\cdot}06\,;$$
$$X = 0{\cdot}1\,;\ \tau = 15{\cdot}6\,;$$

whence, finally

$$\sigma = \frac{3}{(16)^2} + \frac{0{\cdot}05}{0{\cdot}1 \times 16 \times 15{\cdot}6} + \frac{6 \times 0{\cdot}05}{12} = 0{\cdot}04;$$

which value for the dispersion-coefficient is distinctly lower than that which we found above would suffice, so that the motor will amply fulfil the specification.

ROYAL COMMISSION ON LONDON TRAFFIC.

Thursday, March 24.

Mr. C. T. YERKES continued his evidence. He said he was particularly opposed to tube railways near the surface and shallow tunnels for the purpose of tramways. His reason was chiefly because it was necessary to provide subways near the surface for electric mains, gas, water pipes, &c. The question of inconvenience through deep-level tube railways did not exist, as by the system of lifts which was adopted it was impossible for a passenger to tell whether he was going 40ft. or 80ft. below the surface. Another point in favour of tube railways was that, in the construction of tunnels the surface of streets was not troubled. All the railways which were now being built in New York were almost entirely tubes. Tramways on the surface were very desirable in suburbs or in new streets, where they should be located as to be feeders to the tube lines, the tube lines being so constructed that they could readily connect one with the other. The question of whether it was a public disadvantage to have the lines under one control was one which he was not prepared to answer in the affirmative. He knew, however, that if all the lines which were practically under the control of the Underground Electric Railways Co. of London were in reality owned and managed by that company, there would be much more likelihood of passengers being able to make connections between the different companies, and transfer from one company to another than there was under the present conditions. The question of finance in the construction of railways and tramways was one which had been a matter of very great consideration, and he had no hesitation whatever in saying that all railways should be built by private enterprise. In New York a remarkable condition of affairs existed, but he thought it was an advantageous one. There was a Commission named and appointed by the Legislature, and, as everyone knew, the gentlemen comprising this Commission were thoroughly ignorant of the business before them. Fortunately, the line of travel was already laid out, and the Commission was not obliged to do any guessing. The bill provided that the Commission should award a contract to parties who would not only build the railroad but would lease and operate it after it was built, paying the city a certain amount per annum, which amount formed such a sinking fund as eventually paid the principal of the bonds which the city issued during the period of construction for the building of the road. Thus private parties took the contract from the city, and the city, while they would eventually own the road, really became the capitalists for the promoters. He saw no reason why the example of New York could not be followed in London in a modified manner, for he was sure that a private company could purchase its material much more cheaply than a municipal corporation, it could get its work done more intelligently and more cheaply, and it could operate much more intelligently and cheaply, and if it were not a success it would be the loss of the parties who had gone into the operation and not that of the ratepayers. He was strongly in favour of physical connection of railways and tramways under one management and classification. The objection to this, that it put a large amount of power into the hands of one undertaking, he could not understand, and it appeared to him almost trivial. With regard to a special tribunal, to which he was favourable, he did not think it should exercise any power over railways.

Mr. J. S. BEALE, honorary solicitor to the Railway Companies' Association, did not agree with the suggestion that a permanent traffic commission should be appointed. In the first place street tramways, new streets, street improvements and subways, whether for tramways, vehicular traffic or foot traffic lent themselves to municipal promotion. Tube railways would have to be promoted by private enterprise, and new railways, other than the electrically-worked tubes, would have to be promoted by the existing railway companies. Having in mind, therefore, the various classes of schemes affecting London, the idea of forming a tribunal having complete legislative powers appeared impossible. It would also be a difficult matter to enforce the decisions of such a tribunal. For instance, the London County Council having already refused to accept the adverse decision of Parliament upon the Westminster Bridge and Embankment tramway, it could not be expected that the Council would accept an adverse decision from the tribunal in this matter. His suggestion was that Parliament, while retaining the sole control as at present, should modify its procedure so as to secure as far as reasonably possible uniformity in general principle and design and consistency of decision. A precedent for this existed in the Police and Sanitary Committee of the House of Commons. As an alternative, a Joint Committee of the two Houses to deal with all traffic schemes in London would ensure the most economic use of time and labour. Such a Committee could obtain advice from the Board of Trade and its office, or obtain, with the assent of the Treasury, expert advice from leading and disinterested engineers. Such a Committee would command much more universal confidence and respect than any of the independent tribunals which had been suggested.

Friday, March 25.

Mr. Ald. W. IVEY, chairman of the Electric Lighting and Tramways committee of the West Ham Corporation, and who has also been connected with the British Electric Traction Co., and is now interested in tramway promotions on his own account, spoke of the serious interference which would ensue if the London County Council carried its conduit system of electric tramways to the boundary of West Ham. The tramways of West Ham were on the trolley system, and there would necessarily have to be a change of car at the Bow Bridge boundary. There was an alternative—viz., that both the West Ham cars and the London County Council cars should be equipped with the overhead as well as the conduit attachment so that through running might take place, but that would be an expensive matter. The same state of affairs would exist at many points on the northern boundary of the London County Council area. Dealing with the question of locomotion generally, he contended that the primary use of the streets should be for the transport of the people, but at present the greatest congestion was created by the transport of goods. The only satisfactory solution of the London traffic problem would be a complete, efficient and satisfactory scheme of tramways, planned somewhat in the form of a wheel, all the spokes of which crossed near to, but not at the centre, each spoke being in turn connected up by a series of lines forming inner, outer and extra outer circles. Tramways were quite possible in some of the City streets provided specially narrow cars were employed with a width not exceeding 5ft. 6in., having cross seats instead of seats running from end to end. Further, no matter who were the promoters of tramway schemes in and around London, all statutory powers should be granted in one standard form, specifying the gauge, rail groove and the system of traction. Taking it for granted that electricity would be the motive power, he said that at present there could be no two opinions that the overhead trolley system was the best. At the same time, the progress in electrical science was such that it was not improbable that in two or three years it would be commercially possible to run all vehicles by electrical accumulators, and he himself regarded the trolley system merely as a bridge to carry us over the period of perfecting the storage battery. Therefore, it would be preferable to adopt the trolley system in the meanwhile, as, in the event of a conversion to accumulator traction, the equipment could be realised upon to a limited extent, whereas, in the case of conduit or surface contact construction, it would cost more to pull up the equipment and replace the roads than would be realised by the sale of the materials. Subways for tramways he considered out of the question for the ordinary traffic of a tramway service, and he made the following suggestions for the consideration of the Commission :—(1) That tramways on the surface were the most effective and economical method of conveying passenger traffic along congested or ordinary streets. (2) That the Tramways Act of 1870 and the Light Railway Act of 1896 require amendment. All vetoes should be abolished, a wide locus standi should be allowed to objections on merits and vexatious objectors should be compelled to pay the costs occasioned by their objection. (3) All street tramways and light railways, or questions relating to the construction and working of the same, should be dealt with by a permanent board or commission, similar to the Light Railway Commission, but with wider powers. Such a tribunal should consist of, say, seven members—three commercial, one legal, one with tramway experience, one electrical and one mechanical. This body should sit all the year round and deal with all the details, leaving the principle of the schemes to go before Parliament. Questions of junctions, running powers and the terms thereof should be referred to

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the tribunal, from whose decision there should be no appeal. He also advocated that a clause should be inserted in all tramway acts to limit the liability as regards third party passenger risk to £25 in each case. On the point of running powers, he said he knew of an instance in which two local authorities and one company had agreed upon this, and the principle upon which the agreement was founded was that each should run the same number of car-miles in each other's district, and that for the purposes of traffic all three districts were equal in value. Therefore, all the fares taken on the cars in another district were retained by the conductor on that car, and all clearing house difficulties were dispensed with. There was, consequently, no need to change conductors or drivers. He thought the question of the cost of construction should not be allowed to enter into the question of running powers, but it very often did.

Sir JAMES SZLUMPER, engineer to the Great Northern, Piccadilly and Brompton Railway Co., said that the time had passed for any entirely new comprehensive scheme of underground railways in London to be arranged without unfair detriment to the lines now existing, and he was of the opinion that the lines now being constructed, in conjunction with those already working, would be of very great assistance in solving the difficulty of transit in London when they were completed and opened for passenger traffic. He was a very strong advocate of tube railways, and an important scheme of this class for the relief of London, which had not yet been brought forward, was a line joining the lower end of the Great Northern and Strand Railway at the Strand and passing under the river through Southwark, Walworth, Peckham Rye and Dulwich to the Crystal Palace and Croydon. Short independent tube railways would do much to alleviate present congestion. With regard to the proper diameter of the tubes, he did not agree with the proposal which had been put forward that 13ft. 6in. should be the minimum. He believed that 11ft. 8¼in., which was the internal diameter adopted by most of the existing and authorised tube railway companies, was the most convenient, safe and economical size. He did not believe that any advantage would accrue by giving passengers the opportunity of walking along the tunnels in the case of breakdown. So much confusion would take place that he felt convinced that it would be better for the passengers to be compelled to remain in the trains. He considered that the innovation which had crept into Parliamentary Committees of recent years of insisting upon the capital of any tube railway scheme being subscribed before powers were granted, had not only acted as a great hardship upon promoters, but had resulted in a serious loss to the public of what would now probably have been valuable underground communications. Undoubtedly great difficulty had been found in providing the capital for many of the underground schemes passed by Parliament, but in his opinion the difficulty was caused by the uncertainty that underground railways could be made to pay, and the great delay in finding the capital was owing to financiers awaiting the result of the Central London Railway. With the exception of the City and Brixton Railway and the North-West London Railway, the capital for every tube railway sanctioned by Parliament had been found. With regard to tramways, he considered that the local veto should be abolished, and that through new streets shallow subway tramways could possibly be provided, but in old streets he agreed with previous witnesses that it would be impossible to construct these with anything like a minimum of cost and inconvenience. Finally, witness said he wished to emphasise the fact that, in his opinion, bonâ fide promoters should be permitted, as hitherto, to submit their schemes to Parliament, and not to a newly-formed tribunal, and, if generally approved, they should not be rejected on the ground that the capital was not absolutely secure.

The Commission adjourned until April 14.

CORRESPONDENCE.

A NEW "RADIUM" EFFECT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I enclose a picture of the portions in relief on one side of a threepenny bit, taken by radium rays. The coin was placed *directly in contact* with a photographic plate (Ilford ordinary) which was contained in an envelope opaque to light. Ten milligrammes of radium bromide, contained in the usual mica-covered box, were placed on cardboard at a distance of 6in. above the photographic plate, and the whole left for 10 days. After development it was found that the portions in relief on the underside of the coin were clearly seen on the plate. On the same plate was also a sixpence and a medal. The relief portions of the sixpence were quite clear, but only those portions of the underside of the medal that were in contact with the plate could be distinguished. Some of the portions of the medal were in high relief but, not being in contact with the plate, do not appear in the developed picture.

The coin reproductions remind one of the similar pictures obtained by electrifying coins when in contact with photographic plates.

The first picture of this radium effect was shown in a lantern slide exhibited at my last lecture on radium delivered at the College of Science, Newcastle, on January 16th. This slide was also subsequently shown at lectures at several centres in the North of England. The Queen's head and inscription on a sixpence were faintly seen. I was endeavouring to show the great penetration of the γ-rays from radium. The sixpence was placed in direct contact with the photographic plate immediately beneath a pile of 13 pennies, supported so that the lowest penny was about a quarter of an inch above the plate. The radium box was placed on the top of the pile of pennies, and the plate was developed after an exposure of three days.

It was not possible until recently to expose coins to the radium rays for long periods, and thus obtain, as in the case of the threepenny bit, practically perfect pictures of the undersides of the coins. I hope soon to have further examples of this effect, which is being studied.—Yours, &c.,

Newcastle-upon-Tyne, March 28. HENRY STROUD.

[The picture of the threepenny piece obtained by Prof. Stroud, is distinct, and although the characteristic design of the coin, including crown, date and figure 3, is plainly visible, yet it is not sufficiently sharp to permit of reproduction for purposes of illustration.—ED. *E.*]

PARLIAMENTARY INTELLIGENCE.

POWER COMPANY'S OPPOSITION TO MUNICIPAL TRAMWAY EXTENSIONS.

NEWCASTLE-ON-TYNE CORPORATION BILL.

A Committee of the House of Lords, of which the chairman is Lord Erne, considered this bill last week. Parts II. and VIII. of the bill dealt with tramway extensions, some of which were outside the municipal area. Objections were raised by some of the local authorities in the districts through which the lines would run, and by the North-Eastern Railway Co. on the ground of competition and interference with level crossings, and lastly, by the Newcastle-on-Tyne Electric Supply Co., who objected to the Corporation supplying current for tramway purposes outside the Borough of Newcastle and within the company's area of operations. The company argued that if another company were to construct the lines in question, the Supply Company, who made a speciality of power supply, would have been asked to furnish the energy for them.

Mr. W. CAIL, chairman of the Newcastle-on-Tyne Corporation Tramways committee, was of the opinion that the Corporation could generate its electrical energy cheaper than the company, notwithstanding an offer of the latter to supply at 1d. per unit. He considered it necessary for the security of the service that the supply of electricity should be in the hands of the Corporation. It was quite true that the North-Eastern Railway Co. was taking the necessary current for its electrified lines from the Newcastle Electric Supply Co., but the two cases were different. The Corporation already had its own generating station, whereas the railway company had not, and, therefore, should the experiment on the part of the latter, with regard to electrical working prove unsatisfactory, they would not run the risk of losing a large sum of money on generating plant.

Mr. C. H. MERZ, consulting engineer to the company, said the only way they could carry out their statutory obligations was to maintain a monopoly in the area outside Newcastle which was given to the company under their acts. If the Corporation were allowed to supply energy to their tramways, this monopoly could not be maintained. The public must suffer, as the company would not then be able to supply at the cheap rates which now obtained. He repudiated the suggestion that the Corporation could generate electricity cheaper than the company.

Mr. RAVEN, electrical engineer to the North Eastern Railway Co., said his company would eventually take from the Newcastle Electric Supply Co. between 12,000,000 and 13,000,000 units annually, and whereas they would get this quantity for 0·552d. per unit, it would cost them a penny to generate this quantity themselves.

Mr. S. Z. de FERRANTI supported the previous evidence, and said that the Newcastle Company was the only one in England supplying electrical energy upon such a scale and at such a price as was the case in America and Switzerland.

Mr. BALFOUR BROWNE, in addressing the Committee, said his company asked that, if the tramways were sanctioned, a clause should be inserted compelling the Corporation to take their current from the company. The Corporation had offered to insert a clause binding them to supply energy outside their own district for tramways only, but he would not accept this.

The case for the other opposition to the tramways portion of the bill was then proceeded with.

Finally the Committee struck out all the opposed lines with the exception of the line between Blaydon and Scotswood, in view of the local authority opposition. They did not grant the clause asked for by the Newcastle Electric Supply Co., but a provision in the bill that the Corporation should supply current for this line, but for no other purpose outside its area.

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ACTON URBAN DISTRICT COUNCIL BILL.

The Police and Sanitary Committee of the House of Commons considered this "omnibus" bill last week. Mr. Ram, K.C., Mr. Hutchinson and Mr. Keen appeared for the promoters. Part II. of the bill dealt with the supply and sale of electricity, and clause 8 of this section referred to the supply of fittings.

Mr. W. H. TRENTHAM, consulting electrical engineer to the Council, said he considered this a very necessary clause, as it would enable a much larger load to be developed than would otherwise be possible. They asked for £20,000 in order to supply fittings, &c., on the hire-purchase system. The clause also contained a proviso that the Council should put the work of fitting up premises upon this system out to contract, in order to avoid competition with the local manufacturers. Thus the Council would pay cash to the contractors and receive instalments from the consumers.

The CHAIRMAN (Mr. Heywood Johnstone) said the Committee thought it very undesirable that the hands of the Council should be tied, and they would delete the proviso from the clause. No doubt public opinion would be strong enough to prevent the destruction of private trade by undue competition. With regard to the amount to be borrowed, the Committee would not care to limit the amount to £20,000, but would prefer to insert a provision empowering the Local Government Board to authorise any loans which the Council might justify.

Mr. HUTCHINSON, for the promoters, pointed out that this decision of the Committee would involve the District Council in the expense of meeting opposition to this section of the bill in the next House.

The CHAIRMAN replied that the Committee was of the opinion that their decision was in the public interest.

REMOVAL OF SUPPLY MAINS UNDER TRAMWAYS.

Harrow Road and Paddington Tramways.

This bill came before the Hon. de Tatton Egerton's Committee of the House of Commons.

Mr. BAGGALLAY, K.C., for the promoters, said the Harrow-road and Paddington horse tramways were at present in the hands of a small company, which obtained powers last year to transfer them to the Metropolitan Electric Tramways (Ltd.), a company constructing a comprehensive system of electric tramways throughout Middlesex. The present bill sought to make some street widenings in connection with the conversion of their lines to double track, for which the company was granted powers last year. Both the Gas Light and Coke Co. and the Metropolitan Electric Supply Co. wished for protection in respect to their pipes and mains against damage and alteration during the construction of the tramways. With regard to the gas company, he had given them a clause which would enable the tramways company to alter or lay new mains in substitution for old ones consequent upon the alteration to the tramways under the gas company's supervision, but at the expense of the tramway company. With this the gas company was satisfied, but the Metropolitan Electric Supply Co. would not accept this clause. When the company's last year's bill was before Committee when the widening of the track was authorised, the Metropolitan Electric Supply Co. had not opposed.

Mr. STEPHEN SELLON, consulting engineer to the Harrow Road and Paddington Tramways Co., said he had never yet been obliged to give further protection than was given under the Tramways Act of 1870. The total length of the lines to be converted to double track was 1 mile 1 furlong along the Harrow-road.

In reply to Mr. BALFOUR BROWNE, K.C., (for the Metropolitan Electric Supply Co.), Witness stated that he did not agree that it would be necessary to alter the position of the cable of the supply company, although it would be under the tramway track.

The CHAIRMAN remarked that he thought this matter ought to have been raised in last year's bill.

Mr. BALFOUR BROWNE said he could not object last year, as the widening of the lines proposed could not have been carried out without street widenings, which were not authorised. All he asked now was that his cable should be removed from under the proposed lines and placed at the side, so that the company could get at it. A large part of London depended upon the cable in question for light.

The CHAIRMAN said he thought this would be a question for an arbitration under the Tramways Act to decide. The desirability of removing the cable was a technical question, with which the Committee was not competent to deal.

Mr. SELLON said that the gas company had some equally important mains under the proposed tramways, and under the act they had powers to lay new mains under the tramways. What was offered to both companies was that if they were put to extra expense in getting at their mains than would otherwise have been necessary, the tramway company would defray this extra money.

Mr. J. S. HIGHFIELD, the chief engineer to the Metropolitan Electric Supply Co., said that it was absolutely necessary to remove the cable before the tramway was laid, and he also asked that its removal should take place in summer. It was a dangerous matter to change the position of a 10,000-volt cable in the winter when the full load was on. The conduit at present laid had space for five cables and three were already laid, and to get at this underneath a tramway might lead to serious results in the case of a breakdown. The conduit would only have to be removed for a length of about half a mile.

The Committee refused to give the Metropolitan Electric Supply Co. the clause asked for, and found the preamble of the bill proved with the clause in it as offered by the promoters.

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

In the House of Commons on Thursday last week,

Sir F. BANBURY moved that it be an instruction to the Committee on this bill to omit tramway No. 2, which proposed a line over Westminster Bridge and along Victoria Embankment to Waterloo Bridge. In addition to the reasons which have been repeatedly put forward against this proposal since 1891, he said there was the additional reason that the Royal Commission on London Traffic was now considering the whole question of locomotion in London.

Mr. WHITMORE supported the instruction on similar grounds.

Capt. NORTON, Dr. MACNAMARA and Mr. W. RUTHERFORD opposed the instruction, as they considered the tramway would confer a great benefit to the working people of London.

Mr. BURDETT COUTTS supported the motion for the reason that the Royal Commission had not yet reported, and also that additional means of communication across the river should be by tube railways, and not tramways.

Mr. J. BURNS having spoken in opposition to the instruction,

A division was taken, with the result that a majority of 28 voted in favour of it.

Mr. WHITMORE then moved that it be an instruction to the Committee on the same bill to omit tramway No. 2A, a short link between the Battersea and Wandsworth tramways and the main system of the County Council, and this was also passed by a majority of 38.

SURFACE-CONTACT TRAMWAYS AND MOTOR OMNIBUSES.

Wolverhampton Corporation Bill.

The Police and Sanitary Committee in the House of Commons, of which the chairman is Mr. Heywood Johnstone, considered this bill on Monday. The object of the bill is to construct tramways and make further provision in regard to the Corporation tramways and electricity undertakings and for other municipal purposes.

Ald. CRADDOCK, deputy chairman of the Tramways committee, and Mr. Green, the borough engineer, explained to the Committee the proposals in the portion of the bill relating to the tramways. Power is sought to construct a continuation of the existing line along the Wolverhampton Road into the district of Wednesfield. This was promoted at the request of the Wednesfield District Council. The cost was put at £10,196, with an additional £2,000 for the reconstruction of a bridge over a canal. The system proposed to be adopted upon the tramway is the Lorain surface-contact system. Power is also sought to run motor omnibuses to act as feeders to the tramways, and for use during the construction of the tramways. An agreement has been arrived at with the proprietors of the existing omnibus services not to run these motor vehicles over the routes served by them during the next two years.

The Committee found that the preamble of this portion of the bill was proved.

SCOTTISH PROVISIONAL ORDERS.

A Commission under the Private Legislation Procedure (Scotland) Act held an inquiry in Edinburgh last week. The members of the Commission were Lord Herries (chairman), Lord Muncaster, Mr. Mitchell and Mr. Wilson.

Leith Corporation Tramways.

This order was promoted by the Leith Corporation and sought the reconstruction of the existing horse tramways to electric traction. Mr. Wilson, K.C., appeared for the promoters. Most of the opposition was of a clause discription, the most important being that of the Edinburgh and Leith Gas Commission in respect of damage to their pipes by electrolytic action.

Evidence was called on behalf of the petitioners.

Mr. WALTER HOLE, superintendent of the Leeds Corporation gas mains, said that the pipes at Leeds had been damaged in this way since the opening of the electric tramways. He declined to offer any opinion as to whether the Board of Trade regulations afforded sufficient protection.

Mr. J. G. NEWBIGGING, chief engineer to the Manchester Corporation gas department, did not think the Board of Trade regulations afforded sufficient protection. Frequent cases of "pitting" had occurred in Manchester due to electrolytic action. It was reasonable that protection should be given by the promoters of tramways in addition to that afforded by the Board of Trade regulations.

Prof. W. E. AYRTON, F.R.S., also gave evidence in support of the Gas Commissioners, and stated that the Board of Trade regulations were defective.

Mr. W. R. HERRING, chief engineer to the Edinburgh and Leith Gas Commission, having given evidence,

The CHAIRMAN announced that the Commissioners were not disposed to grant the protection asked for by the gas authority.

The preamble of the order was found proved.

Dundee and Broughty Ferry Tramways.

Mr. WILSON, K.C., in opening this order, said it was proposed to incorporate a company with the name of the Dundee, Broughty Ferry and District Tramways Co., to construct some 5½ miles of line between the towns mentioned. The proposed capital was £73,500, with borrowing powers at the rate of £4,900 for every £14,700 of capital. The cost of the tramways was estimated at £49,000. Early in the proceedings the Chairman intimated that the bill would not be thrown out purely upon competition with the railways, and eventually the preamble was found proved.

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POST OFFICE TELEPHONE SYSTEM.

TELEGRAPH (MONEY) BILL.

This bill, which was referred to in our last issue, and which seeks to vote the sum of £3,000,000 for the purposes of the Government telephone system, was read a third time in the House of Commons on Wednesday, and subsequently passed through all its stages and received Royal assent in the House of Lords.

OTHER ELECTRICAL BILLS.

In the House of Lords on Thursday last week, the *North Wales Electric Power*, the *Bristol Tramways (Extensions)*, and the *Great Northern and City (Extension of Time) Bills* were read a second time. On Monday the *Victoria University of Yorkshire Bill* and the *Victoria University of Manchester Bill* were read a third time and passed.

In the House of Commons on Monday the *Govan Burgh (Electricity) Bill* was read a second time.

Before the Court of Referees on Tuesday, the promoters of the *Lincolnshire and Yorkshire Electric Power Bill* objected to the locus standi of several petitioners against this measure. The Yorkshire Electric Power Co. petitioned against the bill on the ground that there were clauses in it which would enable the Lincolnshire and Yorkshire Co. to supply within the area authorised by the Act of 1901 as the area of supply for the Yorkshire Company. For the promoters it was urged that all the company proposed to do was to have the power to accept transfers of provisional orders from local authorities within the Yorkshire Company's area subject to conditions that might be imposed by the Board of Trade. The Court disallowed the locus. The Lincolnshire Ironmasters asked that the area within which they supplied electricity should be excluded from the company's area, but the locus was also disallowed. Two landowners' petitions were also objected to by the promoters, but the Court allowed one and refused the other.

ELECTRICITY IN MINES.

Mr. JOHN ELLIS, having asked the Home Secretary when the rules respecting the application of electricity to coal mining would be settled and published,

Mr. AKERS DOUGLAS, in a printed reply on Friday, said the rules suggested by the Committee on this matter had been circulated in the various mining districts and were now being considered by the coal owners, and he expected shortly to receive their views. Having regard to the number and the complexity of the rules, he thought it fair that some time should be allowed for their consideration and for the suggestion of amendments before he formally proposed them in accordance with the provisions of the Coal Mines Regulation Acts. He was, however, using his best efforts to expedite the matter, as it would be of the greatest advantage to everyone to get a set of rules into force as soon as possible.

LOANS UNDER PUBLIC ACTS.

In the House of Commons last week Mr. BARRAN asked the Secretary to the Treasury what was the estimated expenditure out of loans under the Pacific Cable Act, the Telegraph Acts and other public acts authorising loan expenditure in the years 1903-4, 1904-5, respectively; and what were the sums charged upon civil or revenue votes in those two years for interest on those loans, and for reduction of capital, respectively.

Mr. VICTOR CAVENDISH, in a printed reply, gave a table, of which the following is an abstract:—

	Estimated issues.		Annuities charged on votes.*	
	1903-4.	1904-5.	1903-4.	1904-5.
Pacific Cable Act, 1901.....	— ..	— ..	† ..	†
Telegraph Acts, 1892 to 1899..	£780,000 ..	‡ ..	£284,880 ..	£331,469
Light Railways Act, 1896 ..	57,695 ..	£50,000 ..	3,180 ..	5,467
Light Railways (Ireland) Acts, 1889 to 1893	— ..	— ..	47,038 ..	24,734
Tramways (Ireland) Act, 1895	— ..	— ..	13,586 ..	13,586

* To enable the annuities to be separated into interest and capital, longer notice would be required. The question only appeared on March 18.

† The annuity of £77,545 payable under this act is not chargeable directly on votes, but on the funds of the Pacific Cable Board, which receives a grant in aid of its expenses.

‡ The total authorised issues under existing acts will be completed in 1903-4, and issues in 1904-5 will depend upon further legislation.

TELEPHONIC FACILITIES.

LORD STANLEY, in a printed reply to Sir Frederick Dixon-Hartland, in the House of Commons on Wednesday said that it was not the policy of the Post Office to refuse to allow its subscribers to communicate with the subscribers of the National Telephone Co. in areas in which the two systems were in competition. On the contrary, he would be glad to arrange for intercommunication between the two systems, although he had no power to require the National Company to make such an arrangement.

MUNICIPAL TRADING.

In the House of Commons on Monday,

Mr. CHAPMAN asked whether it was proposed to bring in a measure this session to carry out the recommendations contained in the report of the Joint Select Committee on Municipal Trading of last session with respect to the audit of municipal accounts.

Mr. BALFOUR replied that the President of the Local Government Board, after very careful consideration, did not feel that he could accept the recommendations of the Municipal Trading Committee of last year in their entirety. With regard to the auditing of municipal accounts, however, the President of the Local Government Board thought and hoped that with some modifications it might be possible ultimately to adopt the Committee's recommendation. The matter was a controversial one, however, and he did not think it would be possible to deal with it in the present session.

LEGAL INTELLIGENCE.

Postmaster-General v. Croydon Rural District Council.

Judge Russell sat at Croydon County Court last week as arbitrator in a dispute as to the refusal of the District Council of Croydon to permit the Postmaster-General to erect poles for carrying overhead telephone wires in a portion of the district.

Mr. MARTIN ROBERTS, M.Inst.C.E., assistant engineer-in-chief to the Post Office, said that three telephone exchanges would be affected by the additional telephonic communication—Wimbledon, London and Croydon. The Post Office telephone charges had been fixed as low as possible, and any increase in cost of communication would mean that the charge to subscribers would have to be increased. If iron poles were placed everywhere they would not be able to carry on the exchange at the low rates now fixed. Square pitch pine had been suggested, but that would be quite impossible as they were as expensive in some cases as iron poles. The round poles came from Norway. The square poles were made of pitch pine, and had to be planed specially. The ordinary round pole would cost 9s. 4d., and the square pole £2. 12s. 6d. In the case of 30ft. poles the former would be 17s. 3d., and the latter £3. 0s. 9d. The Post Office proposed to erect certain creosoted poles which would cost £5. 5s. 6d., whereas square poles would cost £12. 9s. 10d. In another case the Post Office proposed to put up creosoted poles costing £8. 10s., whereas the square poles asked for by the Council would cost £18. 6s. 4d. In yet another case creosoted poles would be £38. 3s. 10d., and square painted poles £77. 17s. 3d. At West Barnes the Council wanted the wires affixed to the poles belonging to the National Telephone Co.

Judge RUSSELL: Cannot an arrangement be come to with the company.

Mr. ROBERTS said the existing line of poles was partly on private property. There would be a difficulty in coming to an arrangement with the company, and the Post Office wanted more poles. In addition there was the question of maintenance. Creosoted poles would cost £78. 11s. 10d., and iron poles £186. 11s. 1d. Creosoted poles would last about 30 years, and painted poles only about 12 years. Putting up creosoted poles costs £34. 11s., and putting the wires underground, in accordance with the wish of the Council, would mean an expenditure of £139. 19s. 11d. This expenditure would not be warranted. In another case the Council asked for underground wires. Creosoted poles would cost £58. 4s., and underground wires £355. 1s. 1d. This difference in cost would prevent the Post Office telephone system being extended to these places.

Judge RUSSELL: If a pole is to go up, whether it is painted, creosoted or iron I cannot think matters twopence. It is a question of expense not of beauty.

Mr. NALDIELL, for the Council, said the matter was one in which there was very strong local feeling existing. Creosoted posts put up in comparatively narrow streets would be a great nuisance. Painted poles were less objectionable, but the local authority had no particular wish to have them square; although the smaller they were the better. If the Post Office authorities could not put the wires underground in the places suggested, they should find other routes.

In giving judgment His HONOUR said, we cannot have the facilities of civilised life without some disadvantages. The telephone was almost a necessity at the present day. The Postmaster-General had been pressed to give a telephone service to London in addition to the service of the National Telephone Co., and, where there were enough subscribers he was willing to put the line underground. The view he (Judge Russell) took was that in some of the cases which had been submitted the wires should go underground. For other places he did not see any objection to the proposals of the Postmaster-General. On the question of painted or creosoted poles, it did not seem to matter which were adopted, and, having regard to the expense, he should sanction the proposal to put up creosoted poles.

Scullion v. R. Addie & Sons Collieries (Ltd.)

Last week the Lord Justice Clerk and a jury heard an action (at Edinburgh) brought to recover £500 damages for the death of pursuer's son, James Scullion, who was employed at the Shawhead Pit, Coatbridge. On Sept. 11 last deceased, along with two other miners, were proceeding along the main road of the pit, when pursuer's son and one of his companions fell to the ground, and were subsequently found to be dead from electric shock. The pit was equipped with electric power plant for pumping, &c. Electricity was generated by a dynamo at the pithead, and thence conveyed by uninsulated cables down the shaft and along the road. The cables in the roads were insulated. The electricity for signalling was produced by a battery at the pithead. There was no danger in touching the signalling wires although these were not insulated. It was believed that the cause of the accident was that the power cables and the signalling wires came in contact in the shaft, and that the latter thus became charged with electricity at a high voltage, and this proved fatal to Scullion and Bell, who were believed to have accidentally touched the signalling wires. The pursuer alleged that the cables in the shaft should have been insulated, and placed further apart from the signalling wires to prevent contact. Defenders denied that there was contact in the shaft,

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where the wires and cables were fixed at points distant from each other about 35ft. The electrical system in use was the customary and usual method employed in coal pits. The jury returned a unanimous verdict for pursuer, and awarded £100 damages.

Walsall Electrical Co. v. Campbell Gas Engine Co. (Ltd.)

At Birmingham Assizes last week, before Mr. Justice Wills and a jury, plaintiffs claimed damages for breach of contract in connection with the supply of an oil engine. It appeared that at the end of 1901 plaintiffs were putting down an electric light installation at a country mansion, and entered into an agreement with defendants to supply a 14 B.H.P. oil engine. In October, 1902, the installation was practically completed and a trial run was made. After the engine had been working some time there was a flash, and the engine house was found in flames. In addition to the engine house the battery house was destroyed, and also a quantity of expensive apparatus, and plaintiffs alleged that the fire and damage arose from the negligence of defendants and that the oil tank of the engine which defendants supplied leaked, with the result that the ground around it became saturated with petroleum. This vaporised under the heat given off by the engine, and the vapour ignited, either from the vaporising lamp or from a spark from the brush of the dynamo.

For the defence, it was urged that the tank was carefully inspected by defendants before it was sent out, and that the cracks which were subsequently discovered by the experts were the result of the fire and the cold water thrown upon the tank at the time. As to the origin of the fire, a careless man, who was sent to look after the engine, allowed the tap to run so that the oil overflowed right down to the lamp, which set it alight.

While evidence for defendants was being submitted, the foreman intimated that the jury had made up their minds in favour of plaintiffs, but the judge said he could not accept any such decision until the whole of the evidence had been heard.

Eventually the jury found for plaintiffs on all points submitted to them by his lordship, and judgment was given for plaintiffs for £315. 11s. and costs.

Sutton & Co. (Ltd.)

On Friday last Mr. Justice Byrne had before him a debenture-holder's action against Sutton & Co. (Ltd.), electrical engineers, on a motion for the appointment of a receiver and manager.

Counsel in support of the motion said a petition for winding up the company would be in next week's list; it was a case of jeopardy.

His Lordship made the usual order.

On Wednesday Mr. Justice Buckley ordered the petition to stand over to allow of its being advertised.

MUNICIPAL, FOREIGN, & GENERAL NOTES

APPOINTMENTS VACANT AND FILLED.

The Governors of Woolwich Polytechnic require a head of the department of mechanical and electrical engineering, also first and second assistant; acting head of department of mathematics and experimental physics, also senior and junior lecturers and demonstrators; head of department of chemistry and metallurgy and assistant lecturer and demonstrator. Further information is given in an advertisement. Particulars of duties and conditions of appointment from the principal, Mr. Wm. Gannon, M.A. Applications to the principal by April 26.

An assistant lecturer and demonstrator in engineering is required at Merchant Venturers' Technical College, Bristol. Salary £170, which may rise to £220. Particulars from the Registrar, to whom applications by April 30. See advertisement.

Chester Corporation invite applications for the position of city electrical engineer at a salary of £300, rising by annual increments of £50 to £500. Applications to the town clerk (Mr. J. H. Dickson), Town Hall, Chester, by April 6. See also advertisement.

York Electric Light committee require an assistant electrical engineer. Applications to city electrical engineer (Mr. C. A. Midgley), 18 and 19, Colliergate, York, by April 6. See also advertisement.

The Municipal Commissioners of Singapore (Straits Settlements) require an electrical engineer, with experience in the management of three-wire continuous-current supply station, and qualified to superintend the laying and maintenance of underground cables on the solid system and to take entire charge of their electrical department. The appointment will be made for three years, at £360 for first, £390 for second and £420 for third year, with transport allowance. Applications to Mr. C. C. Lindsay, M.Inst.C.E., 217, West George-street, Glasgow, by April 19.

The Visiting committee of Napsbury Asylum, near St. Albans, Herts., require an engineering clerk of works. Applications to Mr. Walter George Austin, Guildhall, Westminster, S.W., by April 6.

Malvern District Council require an electrical engineer and gas engineer and manager. Salary £400, with house, &c. Applications by April 23.

A chief traffic inspector is required for Leicester Corporation electric tramways. Applications by April 2.

Mr. A. J. Beckett, assistant electrical engineer, York, has been appointed electrical clerk of works at Bridlington.

Barking.—The Empire Electric Light and Power Co. have been notified by the Council that they are not disposed to proceed further with the company's proposal to acquire the light railway undertaking.

The Council have granted £25 each to the electrical engineer (Mr. A. H. Seabrook) and his chief assistant (Mr. R. J. J. Swan) for extra services rendered in connection with the Board of Trade requirements at the Beckton light railway bridge. Mr. Seabrook has reported that the loss on working of the light railway, exclusive of the bridge, is steadily decreasing.

The amount overdrawn on the electric lighting account is £3,530. 4s. 3d., and on light railway account £699. 4s. 4d. The result of February's working of the electricity department was a net profit of £127, against £17 for the corresponding month last year, due to the large demand for motive power.

Bedford.—The salary of the borough electrical engineer (Mr. R. W. L. Phillips) has been increased by £50 per annum.

Bermondsey (London).—On Wednesday the Borough Council authorised the expenditure of £1,164. 15s. 7d. for substituting electric for gas lighting in certain side streets, for short extensions of mains, &c. The Electricity committee reported that at present the charge of £20 a year is made for each arc lamp, including incandescent fittings, and that the annual charges for incandescent lamps are :—Two 16 c.p., £4; three 16 c.p., £5. 10s.; four 16 c.p., £6. 10s., inclusive of maintenance. These charges worked out at 2·49d. per unit, or, deducting maintenance, 2·20d., whereas the actual cost was 8·2d. per unit. The committee therefore recommended that the charge for street lighting be 3d. per unit, exclusive of cost of maintenance, and this was agreed to.

Bethnal Green (London).—The Council, on the recommendation of the Electricity committee, have decided to purchase some additional houses to extend the site for their proposed electricity generating station and destructor works site, at a cost of about £8,500. The consulting electrical engineer is Mr. Robert Hammond.

Bradford Exhibition.—Arrangements have now been made for the electric lighting of the forthcoming Bradford Exhibition. The Electricity committee have been authorised to lay new cables to the exhibition grounds. The contract for the wiring and fitting up of the exhibition buildings has been secured by Mr. G. A. Steinthal, Bradford, to the specification of the city electrical engineer (Mr. A. S. Blackman). About 560 H.P. will be required for the numerous arc and incandescent lamps and motors employed for various purposes in the exhibition. Energy will be supplied at the rate of 1½d. per unit, and will then be retailed by the exhibition authorities to exhibitors for lighting stalls and power purposes.

Canada.—Peterborough is a small town in the Dominion but has a local electric light and power company (who also own the local gas supply) and has been supplied with electric current since 1884. The company has 1,200 electricity consumers out of a population of 14,000. The generating station is run by water power, which is owned by the town authorities. The estimated flow of water is 100,000 cubic ft. per minute. There are numerous falls in this part of Canada.

Concession in Spain.—An advertiser is willing to dispose of a concession for the construction in Spain of 85km. of railway, which would traverse two mountain ranges, where abundant water power for electric generation of current is available.

Devizes.—The Council recently considered a report from their consulting engineer (Mr. E. Wingfield Bowles) recommending the erection of electricity works. It was decided to appoint a special committee.

Electric Power Transmission in France.—The Northern Railway Co. of France are erecting a transformer sub station at Amiens railway station. The direct current supplied by the power house is to be transformed here into single-phase alternating current, and transmitted over 5km. to Longueau, where it will be utilised for lighting the railway station. The Amiens sub-station will contain two 35kw. Westinghouse rotary converters which will be supplied with direct current at 125 volts, and will give out single phase current at 88 volts, 50 periods. By means of a 30kw. Westinghouse transformer the alternating voltage will be raised to 3,500. This transformer is fitted with multiple contacts by means of which the number of secondary coils can be varied, so that a constant pressure may be maintained at the consumption terminals. This will allow the primary voltage to vary 5 per cent. each way. At Longueau railway station pressure will be lowered to 115 volts by means of a 28kw. Westinghouse transformer. All the electrical plant is being supplied by the French Westinghouse Co.

Electricity in Gold Mining.—At the meeting of the Nundydroog (Kolar Goldfield) Co. last week, the chairman (Capt. W. B. McTaggart) said the various companies on the Kolar field had applied to the Mysore Government for additional electric power from Cauvery power station, and this would probably be available before the end of the year. Their company would then be taking 785 H.P. Up to August they paid £29 per horse-power year and £18 after that date. The water-power station was not able to supply all their wants, and, therefore, a steam-driven supply station was to be erected. There

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were a great many small and isolated engines supplying the power for saw benches, hoists, &c., which were only worked intermittently, and in order that they should be ready when wanted, they had to be fully staffed with three shifts of men and also fires banked ready for work, but by means of the proposed station a great saving of labour would be effected.

Exeter.—The Council have offered to supply electricity to Heavitree at 5d. per unit for private lighting and 2½d. for street lighting, power and heating.

Exhibition.—The seventh annual International Automobile and Bicycle Exhibition is to be held at the Crystal Palace, Leipzig, from Oct. 16 to 25 next.

Finchley.—The Council have decided to wire a block of workmen's dwellings at £245. Electrical energy is to be supplied at 1d. per 8 c.p. lamp per week.

Fleetwood.—Some time ago differences arose between the District Council and the Fleetwood and District Electric Light and Power Synd. as to the manner in which the latter were carrying out their contract for public electric lighting. The Board of Trade were asked to appoint an arbitrator.

The only penalty provided by the deed of transfer of the provisional electric lighting order is that an arbitrator may require the company to sell the undertaking to the local authority on specified terms, and it has been pointed out to the Council that as they do not desire to purchase the Board consider that no useful purpose would be served by a reference to arbitration. The clerk has, however, been authorised to prepare and deliver a suitable notice to the syndicate, intimating the intention of the Council to apply for revocation of the Fleetwood Electric Lighting Order, 1890, at the expiration of a period named unless the street lamps are lighted to orders issued by the officers of the Council.

Fulham (London).—The Borough Council have accepted the offer of the directors of the Granville Theatre of Varieties to allow the use of their engine room as a sub-station for seven years at £10 per annum, and the room is to be fitted up as a sub-station at an estimated cost of £950.

German Posts and Telegraphs.—In the German Budget for 1904 there is an increase of £767,824 under the heading of posts and telegraphs, to be devoted almost entirely to raising the salaries of the lowest paid subordinate officials.

Greenock.—The first annual supper and dance of the staff of the electricity works took place at the Town Hall on Friday. The borough electrical engineer (Mr. J. A. Robertson) presided over a company of between 70 and 80. The toast of the "Electricity committee" was given by

The town clerk (Mr. MacCulloch), who congratulated the staff on having such a meeting. He reminded them that the Electricity department reached its majority this year, it being 21 years since the Corporation resolved to apply for Parliamentary powers for starting an electrical installation.

Treasurer Brown, who replied, said the committee and the community had entire confidence in their engineer (Mr. Robertson), under whom the works continued to advance. The first year after the opening of the station the income amounted to £2,500, and the number of units generated was 226,668. At present the income reached £13,000, and the units generated were 1,500,000.

Replying to the toast of the "Works Staff," Mr. Robertson said that so far as reliability of supply went it had been, he thought, second to none, while for economy of working he was pleased to think that the Greenock undertaking was second only to two others in Scotland. He desired to say how much he was personally, and also how much the Corporation were indebted to the members of the staff for that success. A great help to himself and to the staff had been the fact that they had as convener a gentleman who had been able to devote a considerable amount of his time to the work of the department, and who had always shown a keen interest in everything pertaining to it.

Guatemala.—The Compania de Alumbrado Electrico de Quezaltenango supplies electrical energy at Quezaltenango, both continuous and alternating. The plant is turbine-driven. There are 275 consumers on the service and an equivalent of about 3,000 8 c.p. lamps Power is being used to an increasing extent for motor driving. The street lighting is electrical, and there are no gasworks in the district.

At Zunil, in the same district, there is large water-power available. The municipality of Zunil have control of the greater portion of this power, but Messrs. Aparicio, Hijos & Co. own the water-power works which generate current for the Compania de Alumbrada Electrico de Quezaltenango. The River Samalá is the source of this power. The construction and working of an electric railway to connect the coast railway line with the town of Quezaltenango is in contemplation, and there are indications that the numerous water courses which exist in Guatemala are to be exploited in the near future for electricity generating purposes.

Messrs. Aparicio Hijos & Co. also own the telephone service of the Quezaltenango district. This service has been working for 11 years and has now 600 subscribers.

Heckmondwike.—On Monday the Council were recommended to expend £5,000 further in providing additional plant at their generating station.

The chairman of the Electric Light committee (Mr. S. Wood) said that the cost per unit at Heckmondwike compared favourably with other places, and would be further reduced by the increased demand in the near future.

Mr. Hepworth moved that the minutes be referred back. He complained that the Council, when they recently reduced the price from 5d. to 4d. per unit, were known to be under the impression that they possessed ample plant.

The amendment was carried.

Hospital Lighting.—Watford Joint Hospital Board have decided to wire the isolation hospital and to contribute £200 towards the cost of laying a cable by the District Council.

Ilford.—The Council have increased the salary of the electrical engineer (Mr. A. H. Shaw) from £400 to £500 per annum, and that of Mr. G. R. Spurr, tramway manager, from £250 to £300, rising by £50 a year to £400.

Johannesburg.—A special meeting of the Council is to be held to consider tenders for supplying plant required for the proposed electric lighting and tramway power station.

The Tramway and Parks committee recommend the acceptance of the tenders of Poetter & Co. to supply and erect gas-producer plant and accessories at about £50,000, and that of Siemens Brothers & Co., to supply and erect gas engines and electrical generating plant (secs. B, C, D and E of specification No. 2) at about £154,000.

A lengthy report on the tenders was submitted by the consulting engineers (Messrs. Mordey and Dawbarn). For sec. A (gas-producer plant) 11 tenders (one incomplete) were received, and five different designs of plant were specified in the tenders, the prices ranging from £50,600 to £91,132. The lowest tender was that of Poetter & Co., Dortmund, Germany, and the next lowest tenders were: Allgemeine Elektricitats Gesellschaft (£57,740), Piggott & Co. (£75,250). W. F. Mason (Ltd.), British Westinghouse Co., Fraser and Chalmers, D. Y. Stewart & Co. and Richardsons, Westgarth & Co. also tendered. The tender of the Power Gas Corporation (Mond gas) was incomplete.

For the gas engines and electrical generating plant (secs. B, C, D and E) 17 tenders were received (one being incomplete) from 12 firms. There were three tenders each for Cockerill, Körting, Crossley and Deutz engines, two each for Oechelhauser and Westinghouse engines, and one for Nuremburg engines (incomplete tender). Nine of the tenders are for British manufactured plant throughout, five for foreign ditto, and two partly British and partly foreign. The tenders range from £140,810 to £212,010. The lowest tender (by Sanders, Rehders & Co.) was £140,810, and the next (Allgemeine Electricitats Gesellschaft) £152,740.

Leigh (Lancs.)—It is stated that the consulting engineer (Mr. G. F Metzger), who was recently called in by the Corporation to report upon the present condition of the electricity undertaking, recommends certain changes estimated to cost £6,500 or, alternatively, to have new works erected on a different site. Mr. Metzger reports that the undertaking is in a very unsatisfactory condition, and appears to have been designed as if extensions, which are now urgently required, would never be necessary.

Light Railway.—The Light Railway Commissioners have conditionally sanctioned the application of the Cheltenham and District Light Railway Co. for an order to construct a short extension of line.

Loch Leven Water Power Scheme.—The Loch Leven Water and Electric Power Co. is applying for further powers for the construction of works for water and hydraulic power and electrical energy, aqueducts and other water works and works in Argyll, for purchase of lands by compulsion and agreement, &c., extension of area of supply, extension of time for acquisition of lands for and completion of work, abandonment of other works, &c.

London County Council.—At Tuesday's meeting it was announced that the promoters of the North and South Woolwich Electric Railway Bill had withdrawn the measure.

Mr. Beachcroft expressed his disapproval of the action of the Council in opposing what would have given needed facilities to the public at no cost to the rates.

Mr. Sheppard said the Council might themselves build a tunnel, and they objected to a private company having a monopoly of tunnels under the Thames at Woolwich.

Tramway Traffics.—Mr. C. E. Collins called attention to the shortage in the tramway traffic receipts compared with the estimated figures for the year to March 31, and said that these figures represented nearly £80,000 less than the estimate.

Lord Welby, in reply, said the estimates for the year had been £578,500, and the actual receipts up to March 19 were £498,363. From that date up to March 31 it was estimated that the receipts would be £17,000, making the total for the year £515,316, which would mean a shortage of £63,137. The matter would be further dealt with after the recess.

Opposition to Bills.—It was resolved to seal petitions against the Electric Lighting (London) Bill, the Baker Street and Waterloo Railway Bill and the Charing Cross, Euston and Hampstead Railway Bill.

Highways Committee.—Mr. J. Allen Baker has been selected as chairman and Mr. D. S. Waterlow as vice-chairman, of the Highways committee.

It was agreed that the Highways committee be authorised to expend not exceeding £7,000 for the provision of a temporary electricity

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generating station at Bankside, and the purchase of plant and electrical equipment in connection with the electrical working of further portions of the Council's tramways situated in the boroughs of Southwark, Bermondsey, &c.; that the Committee be authorised to obtain tenders for the supply of such plant and equipment and to arrange for the erection, under the supervision of the chief officer of tramways, of the necessary temporary building at Bankside; and that the Committee be further authorised to enter into an agreement with the City of London Electric Lighting Co., providing (1) that the company shall permit the Council to erect a temporary building at the company's electricity generating station at Bankside, and to place therein all the necessary plant for the working of the tramways above referred to; (2) that this plant be worked by a staff in the employ of the Council; and (3) that the company be paid by the Council at the rate of 2d. per unit of electric current to be supplied for the working of such plant.

London County Council Tramways.—It is proposed to entirely suspend the tramway traffic from Kennington to Streatham for three months, commencing next week, to facilitate the work of converting the cable tramway to the electric conduit system. The work of reconstruction will be carried on day and night, 2,000 men being employed. It is claimed that by adopting this policy a whole month will be saved in the period of reconstruction, and that about £5,000 in money will also be gained. The diversion of the traffic will, it is further urged, save much inconvenience to travellers and to frontagers.

As Greenwich (London) Council decline to contribute to the cost of the street widenings in connection with doubling the track of certain tramways, the County Council has abandoned the portion of their scheme within the borough of Greenwich.

London United Tramways.—A successful trial trip took place on Monday evening over the new line connecting Hammersmith Broadway (District Railway) and the City with Acton, Ealing, Hanwell, Southall, Hayes, Hillingdon and Uxbridge Town. The depot and sub-station at Hayes will be completed within the next few weeks, and the line will then be ready for official inspection by the Board of Trade officials.

Macclesfield.—The Council have decided not to proceed with the electric lighting schemes submitted by Crompton & Co. and the British Westinghouse Co. Tenders are to be invited from firms willing to erect and maintain electricity works for a term of years.

Municipal Telephony.—Portsmouth Telephone committee consider that inter-communication with the National Co.'s system cannot be adopted with profit to the municipal enterprise. The committee claim that they have in operation double the number of direct wires used by the company, and that therefore the expense of inter-communication would not prove profitable. It is stated that the balance-sheet for February is satisfactory, and that the result of 12 months' working will show a large profit.

Paisley.—The eastern section of the electric tramway scheme was completed one Monday, when on of the Glasgow Corporation cars traversed the route.

Personal.—Mr. B. A. Behrend, who has been for some years chief engineer to the Bullock Electric Mfg. Co. of Cincinnati, U.S.A., has been retained as chief electrical engineer in the recent combination of interests between the Allis-Chalmers Co. of Chicago, and the Bullock Co. Mr. Behrend has been responsible for the design of the large alternating and direct-current machines with which the name of the Bullock Co. has been for some time past identified. The largest power unit at the forthcoming World's Fair at St. Louis has been designed by Mr. Behrend, who is yet only a young man, having attained his 29th year recently. In electrical literature he is the author of "The Induction Motor."

Perth.—The Council have decided to apply for increased borrowing powers to the extent of £80,000 in connection with the electricity supply and gas undertakings, &c.

Presentation.—Last week the staff of the Leicester Gas and Electric Light department, and the workmen who served in the South African war, presented to the manager (Mr. Alfred Colson) a silver loving-cup, in recognition of the way in which he looked after the welfare of the families of the men while they were away on active service.

Private Bill Legislation.—London County Council are applying for leave to bring in a bill to define the amount which the Council may expend during the ensuing year and to give power to raise the money by the issue of stock and bills. The purposes for which the money is required include electric lighting of Victoria Embankment and Waterloo and Westminster bridges, purchase of property in connection with road widenings under the London County Council (Tramways and Improvements) Acts, 1901, 1902 and 1903, construction of subway and tramway between Theobald's-road and Victoria Embankment, purchase of tramways and reconstruction of same for electric traction, provision of electric testing plant, and lending a sum not exceeding £1,365,000 to Marylebone Council for the purchase of the Marylebone undertaking of the Metropolitan Electric Supply Co.

Retford.—An arrangement has been come to with the Derbyshire and Nottinghamshire Electric Power Co. to supply electricity in bulk to the Council.

St. Anne's-on-the-Sea.—The Council have increased the salary of the electrical engineer (Mr. J. H. Clothier) to £225 per annum.

St. Pancras (London).—Last week the Borough Council were recommended, on the advice of the borough electrical engineer (Mr. Sydney W. Baynes), to replace four of the old steam dynamos by two steam turbines, each of 1,000kw.

Ald. Cox-Sinclair moved that the proposal go back, as they were asked to sacrifice £20,000 worth of machinery which had been laid down only seven years ago.

Ald. McGregor, who seconded, said that they might move from the site altogether, and a special committee was considering the whole matter.

Councillor Barnes did not want to move from King's-road, but to get rid of the injunction and put down the best possible machinery.

Councillor Hickling said that if the recommendation was passed that day they would gain three weeks, and in that time they could advertise and get figures for the Finance committee. It was ridiculous to say they were going to spend £20,000 on new machinery; the sum was £15,000. The new machinery would increase their power without any increase of buildings and they would be able to earn £33,000 in addition to the £68,000 they earned last year. Exactly what they proposed was done at Manchester. The recommendation was carried by a majority of 36.

On the motion of Councillor James, it was decided to approach all local authorities and companies having electricity undertakings in London and the provinces to petition the Board of Trade to obtain Parliamentary powers for compulsory purchase, and the repeal or modification of clause 17 of the Electric Lighting Act, 1882, relating to actions for nuisance and damage.

Southampton.—The works costs and management costs per unit sold for the current year will work out at 1·57d. per unit, against 1·63d. last year. The total cost per unit will be 2·59d., against 2·71d.

In reference to a report by the borough electrical engineer (Mr. H. F. Street), the Electricity sub-committee have resolved to recommend that the charge for electricity to the Tramways committee for power be reduced on and after April 1 next to 2½d. per unit in lieu of 2¾d.; that the charge for private lighting be reduced on April 1 to a flat rate of 4½d. per unit to those consumers on the 200-volt circuit; and that the borough electrical engineer be directed to submit a report based on the proposed new scale of charges.

Southport.—The Parliamentary Committee are considering a request of the National Telephone Co. for authority to place their wires underground.

Sunderland.—A Board of Trade inquiry was held on Tuesday into the application of the Corporation for authority to construct a loop electric tramway line at Roker to relieve congestion. The borough electrical engineer and tramways manager (Mr. J. F. C. Snell), gave evidence in support of the application, and said the line would cost about £2,000.

Tariff Modifications.—Increased duties have been imposed by the Cuban authorities upon dynamo-electric machinery of 25 per cent. ad val. upon the former rate of 20 per cent. ad val.; and the Mexican authorities have imposed a duty of 10 cents per kilo on dimmers and bulbs for incandescent electric lighting, commutators, contacts and terminals, fusible cutouts, mounted and unmounted, resistances, ceiling roses and detonators. On arc lamp globes, formerly imported free, a duty of 5 cents per kilo is now imposed in Mexico.

Torquay.—On Monday the town clerk (Mr. F. S. Hex) reported to the Council on the present position of the tramways bill.

Counsel to the Chairman of Committees in the House of Lords had, after the bill had passed the House of Commons, made certain material alterations in it. The electrolysis clause, inserted by agreement with the promoters, and retained by the House of Commons, not only on behalf of the Corporation, but also for the protection of the Torquay Gas Co., had been struck out on the ground that last year a similar clause was struck out in the Beckenham bill, and this notwithstanding that a similar clause was obtained last session in the cases of Exeter and Brighton. The third schedule of the bill, which contained the agreement between the Corporation and the Tramway Co. with reference to the promotion of tramways, had also been struck out. The agreement remained, so far as it went, but the striking out of the schedule was a serious matter for the Corporation, because it was one of the conditions that the agreement should be scheduled to and become part of the bill. Under those circumstances, steps would have to be taken to bring before the House of Lords the objections of the Corporation to the alterations made by counsel, and possibly a petition would have to be filed in opposition to the bill.

After a lengthy discussion at the Council meeting on Monday it was decided to refer back to committee for further consideration the question of the site of the proposed new electricity works.

Wimbledon.—Application has been made by the Council for sanction to a loan of £6,600 for extensions of the mains, additional transformers, meters, &c.

The Council have increased the salary of the chief electrical engineer (Mr. H. Tomlinson Lee) from £300 to £400 per annum.

Wisbech.—An agreement has been entered into by the Council with the National Electric Construction Co. for the erection and working for a period of years of electricity works.

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Workhouse Lighting.—Hammersmith Guardians, who are considering the question of adopting electric lighting at the new workhouse and infirmary buildings, have appointed a committee to inspect the electric lighting arrangements at Islington workhouse.

Dinner.—The first annual dinner of the Post Office engineering department, London, was held on Tuesday evening at the Criterion, with Mr. John Gavey, C.B., M.Inst.C.E., M.Inst E.E., engineer-in-chief, in the chair. The guests included Lord Stanley, C.B. (Postmaster-General), Mr. H. Babington Smith, C.S.I. (secretary), Mr. J C. Lamb, C.B., C.M.G. (second secretary for telegraphs), Mr. John Ardron, Sir Robert Hunter, Mr. S. C. Hooley, Mr. J. W. Willmot, Mr. A. J. M. Ogilvie, Major Turner, Dr. M. Walmsley, Dr. Drysdale, and a company numbering nearly 200. Lord Stanley proposed "The Engineering Department," and looked forward to the dinner becoming an annual function. He praised the work of the department in warm terms. Mr. Gavey responded.

Concerts.—A successful smoking concert was given on Friday last, at the Holborn Restaurant, by Veritys Limited (London) Athletic Club, under the chairmanship of Mr. C. S. Northcote, M.I.E.E. This club has, in this its first football season, had some good sport, and has been successful in a number of matches against good players, the record being eight wins, five loses and three drawn.

A concert was held last Saturday evening at the Robertson electric lamp works, Hammersmith, Mr. H. Hirst in the chair. The dining hall, in which the concert was held, was tastefully decorated and was filled to overflowing. The programme, executed largely by employés of the firm, was well received by the large audience. In the interval, Mr. and Mrs. Hirst distributed prizes won by the Robertson Fire Brigade, holders of the championship of the London Private Fire Brigades' Association.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1904 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date, and the Directorial Division of the new volume has been corrected up to February 11th, 1904. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates over 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. A number of large sheet Tables, Maps, &c., are included in the issue. Digest of Contents will be sent post free.

TENDERS INVITED.

The directors of the *Great Western Railway Co.* require tenders for the supply and erection of four 200kw. and 10 400kw. motor-generators (three-phase h.-t. to continuous-current l.-t.); four natural-draught cooling towers, each capable of dealing with 180,000 gallons of condensing water per hour; electrically and hand-driven overhead travelling cranes and runways; and coal and ash conveyors, coal hoists and ash hoppers. Specifications from the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders, addressed to the secretary (Mr. G. K. Mills), Great Western Railway Co., Paddington Station, W., must be in by April 26. See also advertisement.

St. Pancras (London) Borough Council require tenders for two 1,000kw. steam turbines connected to two continuous-current dynamos, switchboards, condenser, &c., for the King's-road power station. Specification from the electricity department offices, 57, Pratt street, N.W. Tenders to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras road, London, N.W., by noon April 12. See also advertisement.

Rhyl Urban District Council invite tenders for 12 months' supply of carbons, meters, lubricating oils, &c. Forms of tender, &c., from the engineer, Mr. E. H. Wright. Tenders to the clerk to the Council (Mr. Arthur Rowlands), Council offices, Rhyl, by April 18. See advertisement.

Lichfield Council invite tenders for a lease of their provisional electric lighting order. Plans of the district can be inspected and further information obtained at the offices of the solicitor to the Electric Lighting committee (Mr. George Ashmall), 20, Bore-street, Lichfield, to whom applications by April 16. See also advertisement.

The Visiting committee of *Napsbury* Asylum (near St. Albans) are prepared to receive up to April 6 names of contractors willing to tender for wiring and plain fittings required for about 2,500 points at this asylum, in accordance with plan and specification prepared by the consulting engineer, Mr. W. H. Massey, M.Inst.C.E., 25, Queen Anne's-gate, Westminster, S.W. A selected number of firms will then be invited to tender.

The directors of the *Lancashire and Yorkshire Railway Co.* invite tenders for the supply of various articles during the 12 months ending April 30, 1905, including signal and telegraph fittings, signal, telegraph and electric light wires, wire, screws, oil, crucibles, &c. Tenders (addressed to the directors) to secretary (Mr. R. C. Irwin) by 10 a.m. April 4.

Partick Town Council invite tenders for one 500kw. steam dynamo, one 75kw. steam balancer (dynamo only) and extensions to main switchboard. Tenders to town clerk (Mr. James Donaldson) by noon April 12.

Westminster Electric Supply Corp. invite tenders for the supply and erection at their Duke-street sub-station of a high-tension and a low-tension switchboard. Tenders to secretary (Mr. Frank Iago), Eccleston-place, London, S.W., by 10 a.m. April 18.

Manchester Electricity committee invite tenders for two 750kw. turbo-generators and alterations and additions to high-pressure steam piping and valves at the Dickinson-street generating station. Tenders to chairman by noon 13th inst.

Manchester Electricity committee also require tenders for synchronous motor-generators and flue-fired superheaters. Tenders by noon April 7.

Barnes Urban District Council invite tenders for storage batteries, balancer-boosters and switch gear. Tenders to clerk, Mr. J. E. Anderson, Council Offices, Mortlake, by noon April 12.

Burton-upon-Trent Corporation invite tenders for the supply and erection of a 500kw. steam generating set with condensing plant. Tenders to chairman of Electricity committee by April 5.

Stepney (London) Council require tenders for the erection of the second half of their electricity generating station. Tenders by noon April 14.

Grimsby Education committee invite tenders for wiring and fitting up the Ald. Dobson schools for about 538 lights. Tenders to the clerk, Leonard-street, Grimsby, by April 18.

Barrow-in-Furness Corporation invite tenders for one surface-condenser, air and circulating pumps, pipe work, &c., one electrically driven feed pump and connections. Tenders by noon April 20.

Gillingham Corporation invite tenders for engine and dynamo oil and electricity motors. Tenders by noon April 11.

Todmorden Corporation invite tenders by April 14 for electricity works and refuse destructor buildings.

Woolwich (London) Council require an electric crane. Tenders by noon April 14.

Glasgow Corporation require tenders for 12 months' tramway stores. Tenders by 10 a.m. of April 15.

The Government of *Natal* invite tenders for the equipment of ground and first floors of Railway Customs Bonded Warehouse, Port Natal, with a complete system of electric telpherage. Plans, &c., from Sir Walter Peace, K.C.M.G., Agent-General for Natal, 26, Victoria-street, Westminster, S.W., or from Mr. Chas. J. Crofts, M.Inst.C.E, harbour engineer, Natal. Tenders to Agent-General or to chairman, Tender Board, Pietermaritzburg, Natal, by May 9.

Melbourne City Council invite tenders up to 2:15 p.m. May 13, for one 750kw. direct-current steam generator. Specification from the Agent-General for Victoria, 142, Queen Victoria-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Wrexham Town Council have accepted the following tenders for annual stores for the electricity department:—

British Insulated and Helsby Cables, indiarubber strip 7s. per lb and linen tape 4s. per gross yards; W. H. Keys, bitumen, £6 per ton and joint box compound 2d. per lb.; Dunlop Rubber Co., composition I.E. tapes, 1s. 4d. per lb.; Edison and Swan Co., two-wire services; Reason Manufacturing Co., 5-ampere meters £1. 18s. and 10-ampere meters, £2. 7s. 6d. each; Sloan Electrical Co., carbons £4. 3s. 9d. per 1,000 pairs; Anglo-Bosphorus Oil Co., cylinder oil 2s. 6d. per gallon; dynamo oil 2s. 1d. and castor oil 2s. 11d. per gallon; Wynnstay Collieries, rough washed slack coal 7s.10d. per ton and rough slack 6s. 10d. per ton delivered; Rogers and Jackson, sandcloth, 4s. per 50yds., hammers 5½d. per lb., rope 4d. per lb.; Hy. Caldwell & Co., indiarubber cones and washers 1s. 6d. and brass joint rings, 6s. 6d. per dozen up to 5in.; J. Colmere Gittins (Ltd.), shellac varnish 6s. per gallon, fine solder 48s. per cwt., chisels 5d. per lb, 8, 16 or 25 c.p. incandescent lamps 9s. 9d. per dozen, 32 c.p. 14s per dozen, 50 c.p. 24s. per dozen, and 100 c.p. 54s. per dozen; Thomas Hayes, bleached rags £2. 5s. per cwt., shovels, 38s. per dozen, rammers 2s. each, bolts, all sizes, 2d. per lb., washers 1¾d. per lb, whiting 2s. per cwt., benzoline 1s. per gallon, resin 2d. per lb., spirits of wine 2s. 4d. per gallon.

Stepney Electricity committee have received the following tenders for supplying and erecting a steam turbine generator:—

Willans and Robinson (Siemens dynamos and Willans turbine), £7,198; Bruce Peebles & Co. (Willans turbine), £7,198; ditto (Parsons turbine), £7,978; Brush Co. (Brush turbine), £7,347; C. A. Parsons &

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Co. (*recommended*) (Parsons dynamos and turbine), £7,724; ditto (Siemens dynamos and Parsons turbine), £7,918.

For supplying and erecting four boilers and accessories, the tender of Babcock and Wilcox (Ltd.) is *recommended* at £9,375.

Greenock Corporation have accepted the tender of the British Westinghouse Co. for a 400kw. generating set at £3,473. The following is the list of the tenders submitted:—

International Electrical Engineering Co., £2,749 and £2,897; John Fowler & Co., £2,867 and £2,985; Dick, Kerr & Co. (six tenders) from £2,746 to £3,648; Brush Co., £2,910 and £3,060; India Rubber Co. £3,203, £3,283 and £3,636; Siemens Brothers & Co. (seven tenders) from £2,771 to £3,566; Industrial Electrical Engineering Co., £3,151 and £3,434; Ferranti Ltd., £2,567, £2,980 and £3,360; Davey, Paxman & Co. (four tenders) from £2,989 to £3,112; Thomas Parker (Ltd.), £2,915, £2,998 and £3,524; Lancashire Dynamo and Motor Co. (six tenders) from £2,454 to £3,620; Bruce Peebles & Co. (four tenders) from £3,063 to £3,667; Electric Construction Co. (five tenders) from £2,815 to £3,587; J. P. Hall & Co., £3,780; C. A. Parsons & Co., £3,000; Crompton & Co., £2,511 and £3,461; Johnson and Phillips (seven tenders) from £2,361 to £3,531; Browett, Lindley & Co. (six tenders) from £3,206 to £3,476; Lahmeyer Electrical Co., £2,964, £3,258 and £3,555; General Electric Co., £2,880, £3,020 and £3,457; Electrical Co. (four tenders) £2,943 to £3,350; Mather and Platt (five tenders) from £3,113 to £3,737; Mavor and Coulson, £2,691 to £3,576; Royce, Ltd., £3,690 and £3,950; British Westinghouse Co., £2,453, £3,150 and £3,473; J. and H. McLaren, £3,940; British Electric Plant Co., £3,559 and £3,951.

Lanark County Council have accepted the following tenders for Cambuslang refuse destructor and electricity works:—

Meldrum Bros., destructor plant, boilers and flues, £2,870; H. Pooley & Son, weighbridge, £29; Herbert Morris & Bastert, pulleys, £13. 12s.; E. and J. Birrell, for buildings in connection with refuse destructor works, £2,678. 9s. 2d., and buildings in connection with the electric lighting works, £961. Contracts for supply and laying of main and distributing cables and providing and erecting engines, dynamos, &c., have not yet been let.

Bermondsey (London) Council have accepted the following tenders for annual supplies:—

Birmingham Carbon Works, arc lamp carbons, £3. 12s. per 1,000 pairs; Johnson and Phillips, meter boards (28½in. × 19½in. × ⅝in.), £15 per 100 and lead-covered cables; Chamberlain and Hookham, meters; Reason Mfg. Co., demand indicators and cutouts; British Insulated and Helsby Cables, indiarubber cable and jointing material.

Six tenders were received for wiring the extensions of the generating station, varying from £269. 10s. to £525, and that of Sunderland & Co. at £430 has been accepted.

Amongst the contracts recently secured by the British Westinghouse Co. are:—

From the South Medomsley Colliery an order for a complete electric power and light installation for their pits; from South London Electric Supply Corp., 12 50kw. and six 18kw. transformers; from Coventry Corporation, 12 50kw. transformers; Islington (London) Council, 12 months' supply of electricity meters; Sydney Corporation, single and polyphase meters for 12 months.

A contract has been placed by Lanark County Council with Meldrum Bros. for a three-grate "Simplex" refuse destructor, with boiler plant, for Cambuslang.

Walsall Council have accepted the following tenders:—

Thomas Parker (Ltd.), dynamo, £180; Bumsted and Chandler, engine, £227; T. Tildesley, extensions to generating station, £777.

London County Council have received the following tenders for an electric jib crane at the Greenwich generating station:—

Ransomes and Rapier (*accepted*)	£3,105 0	Cowans, Sheldon & Co.	£3,402 0
George Russell & Co. ..	4,548 17	Joseph Booth & Bros...	3,334 0
		Jessop & Appleby Bros.	3,111 10

The manufacture of the motors and controllers will be sublet to the Electric Construction Co.

Sir Hiram Maxim Electrical Engineering Co. have placed an order with the British Westinghouse Co. for one 100kw. gas engine and generator, one 100kw. gas engine directly connected to two 50kw. generators, one balancer booster set and one switchboard.

The Metropolitan Asylums Board have accepted the tender of Gent and Hurley for fire-alarms and telephones at Caterham Asylum at £322. 15s. There were 19 tenders, varying from £580 to £298.

Cowans Limited have received orders for Andrews' duplicate main system from Exeter Corporation at £258 and from Hammersmith (London) Council at £124. 10s.

Gravesend Council have accepted the tender of Graham, Morton & Co. for a coal elevator at the electricity works at £99. 10s., and that of Zimmers & Co. for coal conveying plant at £178. 10s.

Hackney (London) Guardians are recommended to accept the tender of G. E. Taylor & Co. for wiring the casual wards and other buildings in course of erection at £661. 19s. 10d.

Aberdeen Gas and Electric Lighting committee recommend the acceptance of the tender of the British Westinghouse Co. for a 720kw. generating set at £5,576.

Poplar (London) Council have confirmed the recommendationt of accept the tender of Bruce Peebles & Co. for the supply of turbo-generators at £13,851.

Frank Suter & Co. have sub-let to the British Westinghouse Co. the contract for three additional 250 B.H.P. producer gas engines, to be used in the extension of the Walthamstow plant for the new tramway service.

On the recommendation of the city electrical and tramways engineer (Mr. H. Richardson), Dundee Tramways committee have accepted the tender of Thomas Parker (Ltd.) for three new generators.

Hammersmith (London) Council have placed an order with the British Thomson-Houston Co. for 100 type K induction meters.

Ipswich Corporation have accepted the tender of Reavell & Co. for a steam set (A.E.G. dynamo) at £3,572. 10s.

Coventry Corporation have placed an order with Templer and Ranoe for an oil separator at £91. 2s. 6d.

Barking Council have accepted the tender of Callender's Co. for 500yds. of cable at £59. 10s.

C. A. Parsons & Co. have received an order from Pullar & Sons for another 300 H.P. steam turbo-generator.

LIQUIDATIONS, &c.

Meeting of the Manchester Electrical Works (Ltd.) on April 28 at 147, Leadenhall-street, London, E.C., to receive an account of the winding-up.

Claims against O. Berend & Co. (Ltd.) by April 20 to Mr. Alfred Riley, 132, Wool Exchange, Coleman-street, London, E.C.

The sum of 5$\frac{1}{4}$d. per share is returnable to the contributories of the Electric Lamp Regenerating Co. (Ltd.) any day except Saturday at 33, Carey-street, London, W.C.

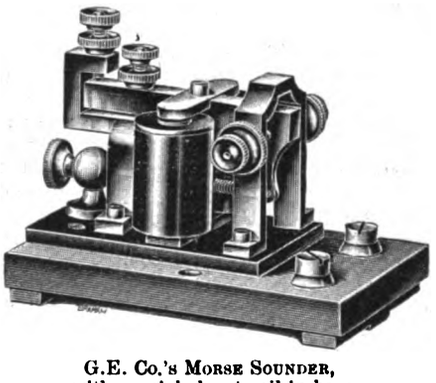
The Electro-Voelker Synd. (Ltd.) is to be wound up voluntarily. Mr. W. B. Saw, 1, Broad Street-avenue, London, E.C., is liquidator.

Plant for Disposal.—Westminster City Council invite tenders for some disused electric lighting plant at the Buckingham Palace-road baths. Further particulars are given in an advertisement. Tenders to the town clerk (Mr. John Hunt), City Hall, Charing Cross-road, W.C., by 10 a.m. April 13.

Electricity in Factories.—Messrs. James Keiller & Son have put down at their Dundee confectionery and fruit-preserving works an electric power and lighting installation, comprising three steam dynamos, Douglas Fraser surface-condensing plant and a Kelvin and White switchboard.

Automatic Voltage Regulator.—Mr. V. Bornand (Victor Bornand & Co., Birmingham) has perfected an automatic voltage regulator for alternators, consisting of a combination of a rheostat, small motor and voltmeter. The small motor (about $\frac{1}{10}$ H.P.) constantly actuates a click device which, at normal voltage, just clears the toothed periphery of a metal segment mechanically connected to the switch arm. When, however, the platinum wire of the voltage-measuring device is either elongated or contracted, as the result of an increase or decrease of the line pressure from the normal, the click mechanism is brought into play, and the toothed wheel, and consequently the switch arm also, is rotated in one or the other direction until the normal pressure is restored. The sensitiveness of the controller can be regulated by means of a screw, and it is stated that the whole range of the regulation is covered by the automatic device within 15 seconds.

Catalogues.—The 15th edition of section L of the General Electric Co.'s main list has just been issued, and comprises bells, indicators, pushes, telegraph instruments, lightning conductors, fittings, &c. Bells specially designed for traction, ship, and mining work are described, and also an all-metal bell, to which the name of the "Colonial" has been given. This bell is specially intended for use in tropical climates. The illustration shows the company's make of Morse sounder as used by the G.P.O. This instrument is provided with a special shunt coil in base, the combined resistance of coils and shunt being 20 ohms, and can be supplied with special windings if desired.



G.E. Co.'s Morse Sounder, with special shunt coil in base.

A new list of Waltham artistic electric light fittings, artistic switches, new designs in plug covers, ecclesiastical metal work and enamels for metal enrichment is issued by Waltham & Co., of 46,

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York-street, Buckingham-gate, London, S.W. We have on many occasions in the past called attention to the artistic character of this company's work, and may say that the catalogue now under notice contains some very choice designs.

A new pamphlet dealing with the "Angold" midget arc lamp can be obtained from the General Electric Co. Attention is called to the new form of magnetic control used in these lamps. The lamps are made for parallel working on circuits on 100-120 volts, for two in series on 200-240 volts, or three in series on 250 volts. The all-over size is not more than 12½in., the total weight 4¼lbs.

The British Westinghouse Co. have just issued a reprint from the "Journal" of the American Society of Naval Engineers of a report concerning "The Efficiency of Turbine Engines."

Gear wheels, belt pulleys, conveyor bands, spiral conveyors, &c., are subjects dealt with in three new lists issued by Gibbons Bros., of Dudley, Worcester.

A new type of air compressor is described in a pamphlet from the Laidlow-Dunn-Gordon Co. of New York, the chief distinguishing feature of the machine being a novel method of controlling the opening and closing of the exhaust ports. In this compressor the exhaust opens through poppit valves, which is claimed to be the most desirable arrangement where the pressure pumped against is variable. The closing of the exhaust is determined by Corliss valves located in the passages between the cylinder and the poppit valves. These prevent leakage of air back through the poppit valves while they are closing, and also, by providing a cushion of air under full pressure, allow them to seat easily and noiselessly. The opening and closing of the admission are determined by the Corliss valves entirely.

In keeping with the artistic character of the bulk of the advertisement literature issued by the Simplex Steel Conduit Co., is a new embossed trade mark showcard, which is just now being distributed. Copies can be obtained by members of the trade on application.

Ernest F. Moy (Ltd.) have ready a new sheet of Mordey patent fuses for pressures up to 550 volts.

"The Evolution of a Typewriter."—Amongst the numerous labour-saving devices which have come to stay, perhaps the typewriting machine is in most general use. There is, consequently, a general interest taken in particulars published concerning the evolution of this most useful business aid. Mr. W. J. Richardson, the energetic and up-to-date managing director of the Typewriter Company (who are the owners of the Royal Bar-lock typewriter), has prepared an interesting booklet, in which the evolution of the "Bar-lock" machine is treated in a manner calculated to interest present and potential users of typewriting apparatus. The fact that Mr. Richardson has been engaged in the manufacture and sale of typewriters and typewriting supplies for 21 years entitles him to attention for what he has to say, and endows his remarks with that enhanced value which unique experience always commands. Some of the illustrations of older types of writing machines given in the booklet show at a glance the vast strides which have been made towards perfection in mechanical writing apparatus. Users of writing machines will be interested in Mr. Richardson's little book, copies of which can be obtained on application to the company, either at their head offices, 198, Upper Thames-street, or at the showrooms, 12 and 14, Queen Victoria-street, London, E.C.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from March 23 to 29, with the ports of destination:—

Aden—£288 (telegraph material). *Africa*—Alexandria, £76; Cape Town, £2,147 (including £1,120 telegraph material); Delagoa Bay, £334; Durban, £1,555 (including £1,156 telegraph material); East London, £20; Port Elizabeth, £1,897 (telegraph material). *Argentina*—Buenos Ayres, £691 (including £435 telegraph material); Rosario, £909 (telegraph material). *Australasia*—Launceston, £166; Lyttelton, £180; Melbourne, £287; Perth, £260; Sydney, £321; Wellington, £421. *Belgium*—Antwerp, £396; *Canada*—St. John (N.B.), £78. *Ceylon*—Colombo, £138. *China*—Shanghai, £205. *France*—Paris, £670. *Germany*—Bremen, £110; Hamburg, £306 (including £290 telegraph material). *Gibraltar*, £1,927. *Holland*—Amsterdam, £20. *Hong Kong*—£228. *India*—Bombay, £976; Calcutta, £356 (including £130 telegraph material); *Madras*, £42. *Japan*—Yokohama, £1,044. *Mauritius*, £184. *Mexico*—Sulina Cruz, £14; Vera Cruz, £21. *Portugal*—Lisbon, £234; Oporto, £1,869. *Spain*—Granada, £27. *Straits Settlements*—Penang, £10; Singapore, £3,220 (including £153 telegraph material). *United States*—New York, £620 (telegraph instruments). Total £22,247, against £11,133 in the corresponding week last year (March 25 to 31).

Fire Tests.—The 79th publication of the British Fire Prevention committee just issued deals with tests of kharri wood for fire resistance purposes, the object of the tests being to obtain a record of the effect of a fire of two hours' duration at a temperature gradually increasing to 1,800° F.

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

January 3, 1904.

131 P. COUR. Regulation of electric currents. (Date applied for, Jan. 5, 1903, date of application in Denmark.)*
135 A. P. ZANI. Alternating-current generators and motors.
137 W. B. WOODHOUSE. Alternating-current distribution systems and apparatus.

January 4, 1904.

157 H. W. MURRAY. Dublin. Method and means of electric traction.
193 SIEMENS BROTHERS & Co. (Siemens and Halske A.G., Germany). Equipment of electrically-propelled railway cars.*
214 P. J. KAMPERDYK. Batteries.
226 I. LADOFF and JAMES MACNAUGHTON. Conductors.*

January 5, 1904.

232 G. HALL. Manchester. Trolley wires of electric tramways.
233 H. W. CLOTHIER. Manchester. System for connections to switchboards, mains, &c.
238 H. C. BROWN. Auto-copying telegraph.
253 H. F. CLOUGH (trading as Virginia Electric Co.) and H. ROBINSON. Manchester. Device for facilitating laying of wires, casing piping and the like.
266 A. H. STEWART. Ramsgate. Electrical alarm for carriage doors.
291 C. C. REGNART. Incandescent lamp.*
306 F. C. BLAKE. Trembler for induction coils.

January 6, 1904.

318 H. HIRST and T. H. BACON. Electric lamp fittings.
319 M. B. FIELD. Manchester. Cables.
327 E. D. HOPCROFT. Kings Heath. Electric tool for removing scale from boilers.
330 W. W. LACKIE and W. T. CALDERWOOD. Glasgow. Electric fuses.
341 C. NAYLOR and J. NAYLOR. Manchester. Overhead equipment of electric tramways.
351 W. GRIFFITHS and B. H. BEDELL. Safety device for stud contact system.
359 F. SEWELL. Electroscopes.
2,053A J. T. ARMSTRONG and A. ORLING. Electro-capillary relays and the like. (Date applied for, Jan. 28, 1903.)*

SPECIFICATIONS PUBLISHED.

NOTE.—All specifications can be obtained at the uniform price of 8d. each.

1903.

7,783 EDELMANN. Electrodes for arc lamps.
7,790 PARTRIDGE. Electric safety fuses.
7,827 PIEPER. Electric switch apparatus.
7,832 DAVIS, DAVIS and DAVIS. Connecting together the sections of pulling through rods for electrical conduits.
7,842 BUREAU. Arc lamp.
8,025 SCHRÖDER. Swan electric lamp fitting with transversely arranged plug sleeves for connection with the spring terminals.
8,605 KOLTMANN. Electric machines for sawing logs and the like.
8,811 BROWN AND MAY (LTD.) and FALCONER. Automatic ignition and exhaust valve combined for internal combustion engines.
8,854 MCLEAN. Brushes for electric machines.
9,390 VON DER POPPENBURG. Manufacture of accumulator plates or grids.
9,492 MATHESON. Wire stretchers. (Date applied for, April 25, 1902.)
14,551 SUNDH. Electric controllers for motors and the like.
14,555 LINDQUIST. Controlling devices for electric motors.
15,500 A.G. BROWN, BOVERI & CIE. Electric cutouts for alternating-current circuits. (Date applied for, Nov. 13, 1902.)
16,965 ROBERTSON. Electrical fire-alarm apparatus.
17,069 ROSSMAN. Autographic or facsimile telegraphs, applicable also for curve tracing.
17,185 FINZI and KOHRODI. Field magnets for alternating-current motors.
18,841 REED. Selective systems for electrical communication.
19,887 LAMME. Controlling apparatus for electric vehicles. (Date applied for, Sept. 29, 1902.)
20,916 PAGE (International Electric Controller Co.). Electric-current regulators.
20,921 HEAVY. Insulated conductors and producing same.
21,090 BOULT (Turner). Electric meters.
21,466 JEANNOT and BERMUDEZ. Arc lamps. (Date applied for, Sept. 12, 1903.)
22,696 WHITNEY. Electromagnetic motor for producing oscillatory movements.
23,161 FLESS. Electrically-heated handles and hand wheels for motor cars and other purposes.
23,254 BEARSE and CRONSE. Ground anchors for cables and wires.
23,663 SIEMENS BROTHERS & Co. (United Telpherage Co.). Telpherage.
24,444 GREEN and PRIOR. Ship's telegraph apparatus.
25,012 ADLER. Systems of electrical regulation.
25,222 HORNSBY and ANGER. Protective device for circuits.

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26,261 BAILLY. Magneto-electric igniting devices for internal combustion engines.
26,378 JOHNSON (E.A.G. vorm. W. Lahmeyer & Co.). Regulation of asyndironons, alternating or three-phase current electric motors and rotary converters.
27,131 WILKINSON. Trolley poles.
27,830 RENTSCH and SCHUBERT. Electric bell.
28,399 SNYDER. Magnetic ore separator.
28,417 WEINTRAUB. Operating mercury vapour electric lamps. (Date applied for, Dec. 26, 1902.)
28,769 EVANS. (A.E.G.) Brakes.

1904.

226 LADOFF and MACNAUGHTON. Electric conductors for illuminating purposes.

COMPANIES' MEETINGS AND REPORTS.

Marconi's Wireless Telegraph Co. (Ltd.)

The annual meeting was held on Wednesday, Col. Sir CHARLES EUAN-SMITH, K.C.B., C.S.I., presiding.

The SECRETARY (Mr. Henry W. Allen) read the notice calling the meeting, and

The CHAIRMAN said: I am sorry that Mr. Marconi cannot be with us on this occasion. His absence is in no way due to ill-health, and the reports which have been circulated that he was dangerously ill are without foundation. We had a telegram from him this morning, from Pisa, in Italy, informing us that he was quite well and was proceeding with his work. His absence is caused by the death of his father. With regard to the balance-sheet I do not think there is very much to be said. It is perfectly simple, and the entries speak for themselves. There is, however, the very satisfactory feature that for a second time since we came into existence our receipts are in excess of our expenditure, the excess this year being £10,607, against £5,489 last year. I would like to call your special attention to the fact that the shares in associated companies, which have a par value of £1,576,500, are taken at cost—viz., £5,239, and that the real value of these shares must certainly be represented by a sum considerably in excess of the sum in the balance-sheet. The progress that has been made during the past year has been persistent and sustained. In connection with all the revenue-producing branches which we had established at the close of the preceding year, there have been satisfactory developments and increased income therefrom, and during the year Mr. Marconi has, in connection with the long-distance work, been carrying on a series of experiments in improving the long-distance communication. If, as is possible, and, indeed, natural, some disappointment may have been felt that the transatlantic wireless telegraphy has not yet been established on a commercial scale—that the hope held out in the speech which was made last year that all the difficulties in connection with the transatlantic communication had been overcome, has not been fulfilled—it must be remembered that all scientific progress, before it rests upon a foundation of certainty and security, must be attended by many unforeseen incidents and difficulties. These difficulties have been twofold: certain technical difficulties which are now thought to be completely overcome, and difficulties in obtaining inland telegraph facilities, a matter which I shall deal with more fully later. The necessity of surmounting these difficulties has, however, compelled the board up to the present to postpone completion of the arrangements for transatlantic communication, which must necessarily be of a somewhat costly character. Our arrangements with Canada and Italy are of a very satisfactory character. The arrangements which are in progress or in contemplation with Montenegro, with Holland, with Iceland, and with other countries have been either explained or indicated in the report, and afford instances of the very numerous applications which have been received by the company for the extension of your system in all parts of the world, which, we hope, only require time and patience to bring to a successful issue. The 12 months have, in fact, been mostly spent in concluding contracts which will, we confidently anticipate, result in considerable profits to your company. At last year's meeting I told you that, as a direct result of the protracted negotiations that had taken place at that time, we were on the point of concluding final arrangements with the Admiralty and the General Post Office. As regards the Admiralty these arrangements have been finally and satisfactorily concluded, and our relations with the great department are now, I am glad to state, of a most cordial and encouraging character. The anticipations which were then expressed have been fully realised. There are now available for His Majesty's fleet the latest improvements of the system owned by your company, and considerable orders have been placed with us for the most up-to-date apparatus. That matter is concluded and finished. As regards the Post Office, however, the negotiations, involving several Government departments, have been of a most protracted and complicated character. The adoption, or recognition, by His Majesty's Government of the Marconi system as pre eminently one which should command their confidence and support, was hedged round and fraught with difficulties that could not be patent to an observer not cognisant, not only of the technicalities of the system itself, but of the ramifications of the great and far-reaching administration of the Post Office. Little by little, however, difficulties have been cleared away, obstacles have been removed, conflicting interests have been reconciled, and I am now in a position to inform you—as I do with the greatest satisfaction—that late yesterday afternoon the Post Office intimated to us their readiness to conclude an agreement of which the details had previously been the subject of discussion of a most exhaustive character; which agreement, in the opinion of your directors, will not only give the greatest satisfaction to the public generally, but will also duly safeguard the interests of the shareholders of the Marconi Company. The far-reaching importance of the subject demanded that no final conclusion should be arrived at unless every point had received the careful examination that it required. The issues of this agreement must necessarily be of a very widespread and, indeed, of a national importance, but your board believes that the decision that has now been arrived at is such as to justify the anticipations that have been entertained by us, both as to the commercial value of the invention and also as to its national utility. The details of the agreement cannot, of course, be made public at the present moment, as they have now to pass into the hands of our respective legal advisers, and to be duly embodied in contract form; but you may be sure that as soon as we are permitted to do so by His Majesty's Government, no time will be lost in giving you the fullest information as to what has been agreed upon. I am, however, in a position to say that not only do the general heads of the agreement clear away, as we hope, all possibilities for future divergence of opinion between the Post Office and ourselves, but they indicate not only the possibility but the probability that a far larger field will be opened for the operations of our system than we could possibly have anticipated some 12 months ago. Your board therefore consider, gentlemen, that the conclusion of this agreement affords solid grounds for congratulation. The progress that the Marconi Company has hitherto made has undoubtedly been due to the intrinsic merits of the system itself. Its development has necessarily met with many obstacles; with much prejudice, some of it from quarters where it could have been least expected to arise—prejudice mainly due, as we believe, to an inadequate comprehension of a very technical subject—and to some open hostility. In this regard it has certainly been placed at a signal disadvantage with its foreign competitors, of whom I desire to speak with all possible respect. For in foreign countries, and especially in Germany, the scientific men who have turned their attention to the development of wireless telegraphy have received the most gratifying material and moral support from their Governments and from the public. I need but to point to Germany, where His Imperial Majesty the Emperor has, by every means in his power, encouraged and fostered the development of the Slaby-Arco system. The policy of this country is apparently to withhold anything like Government support from any enterprise, however promising, until it has fully justified its existence. The recognition of these facts from such a quarter as the Post Office, and after such an inquiry, should certainly afford our shareholders confidence and encouragement. And while recognising to the full the way in which our representations have been met by the Post Office authorities, we are inexpressibly indebted to the efforts, the tact, the patience and the energy of our managing director, Mr. Cuthbert Hall. In addition to the intimate knowledge that he has of the whole working of our system, he has brought to the performance of this most onerous and important duty a devotion to the interests of the company which, combined with his striking ability and good faith, and his determination to spare no time or trouble in the prosecution of this object, have very largely contributed to the success that we have now attained, and I trust that the meeting of the shareholders here assembled will join with the board in according to him that vote of thanks which is so justly his due. In view of the new responsibilities with regard to construction of new works and the development of our system which will devolve upon the company in consequence of the conclusion at which we have arrived with the Post Office, the directors will probably shortly make a new issue of shares, the details regarding which, as to issue and price, will be communicated in due course. I now move the adoption of the report and balance-sheet.

Mr. H. J. DAVIS seconded the motion, and said that as an original shareholder and one of the first directors, he had great pleasure in stating that he highly approved of the decision arrived at with the Post Office, and he felt sure that the shareholders would be equally pleased when they knew the details. It was largely owing to Mr. Hall's untiring energy, devotedness, and long hours of works that the conclusion at which they arrived on the previous day was due.

No questions were asked, and the report and accounts were adopted unanimously.

A vote of thanks to Mr. Cuthbert Hall was then unanimously agreed to.

The retiring directors—Mr. Marconi, Mr. H. J. Davis, and Mr. W. W. Goodbody—were then re-elected, as were the auditors, Messrs. Cooper, Bros. & Co.

A vote of thanks to the chairman terminated the proceedings.

Bournemouth and Poole Electricity Supply Co. (Ltd.)

The seventh annual meeting was held on Thursday last, Mr. A. H. SANDERSON presiding.

The SECRETARY (Mr. H. B. Renwick) read the notice convening the meeting and the auditors' certificate.

The CHAIRMAN then said: We may congratulate ourselves on our prosperity during the past year. The progress of the company's business shows a substantial increase in revenue in lamps connected and applied for, and in units sold. The total capital expended on the company's undertaking to Dec. 31 last was £286,889. 11s. 3d., of which £55,433 2s. 7d. was expended during the past year. The largest item was in respect of mains, due largely to the fact that the accounts for the year include the cost of mains at Christchurch and at Pokesdown, as well as extensions under our Bournemouth order, 1890. This expenditure is one, however, which has proved in the past highly remunerative. With regard to the Richmond (Surrey) Electric Light and Power Co., our investments in that company stand at £110,186, against £105,436 at Dec. 31, 1902, the addition representing further advances to that company during the past year. Sundry debtors (£17,385) represent amounts

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due from consumers in respect of current supplied, interest and dividends, &c., and the greater portion of this sum has since been collected. On the liability side of the balance-sheet you will see the capital paid stands for £243,232, against £225,000 at the same period of 1902. The additional amount is represented by calls received on account of 4,500 new ordinary shares issued in July last. Debenture stock also shows an increase (£11,003), and here again there is a further sum falling due in the current year of £48,997. Sundry creditors and bills payable are somewhat in excess of 1902, due to our expenditure this year having been much greater than it was in the previous year. These liabilities, however, have now been largely cleared off. The item of loans against security now stands at rather a high figure (£59,850 compared with £28,500), but the amount has been considerably reduced since the close of the year, and will be still further reduced out of the moneys coming in from the issue of debentures and further calls from the last issue of ordinary shares. The reserve from premiums received has been increased from the premiums received on the ordinary share issue, and after writing off the expenses of that issue this reserve shows an increased balance of £6,634. The directors have, I think you will agree, acted wisely in keeping this reserve untouched in view of any future contingency that may arise. The revenue account shows marked improvement, the particular points of interest to you being:—Sales of current and meter rentals, increase £3,729, which, in view of the recent revision of our charges for current, is a most satisfactory feature. Gross receipts exceed those of 1902 by nearly £4,000, or practically 11 per cent. On the debit side there are increases in several items, and, on other hand, certain decreases. With increased business we must anticipate increased charges, but, taking the figures as a whole, I think they bear a reasonable relation to the increase in revenue and the increase of volume in the company's business. The net revenue account shows that the amount standing to our credit, after bringing forward the net balance from last year, is £22,607, an amount considerably in excess of last year's figures. On the debit side, interest charges have increased by nearly £600. This, in view of the large capital expenditure during the year, gives strong proof that the company's finances have been economically managed, as it represents only slightly over 1 per cent. on the capital expended during the year. On the vexed question of depreciation there are many opinions. We have this year placed £3,000 out of revenue to credit of depreciation, and this sum may not altogether meet the views of our critics, but it is an increase on our last year's provision of £500, and is a step in the right direction, particularly when I tell you that we have made a further reserve in the way of special redemption funds of over £1,100. I may, therefore, repeat that we have every reason to congratulate ourselves upon the all-round progress we have made during the past year. There is an increase of nearly 260,000 units sold, of 19,542 lamps applied for (compared with 13,343 last year), and this increase is a record in the company's history. We cannot, of course, promise that it will be maintained, but I am very hopeful. Since the close of the year there has been a very marked improvement even on these figures, the improvement in lamps applied for representing about 54 per cent. over the corresponding period last year, and the units sold an equally satisfactory rate of increase. The number of lamps for this period of 1903 was 2,883, and for 1904 4,441. During the past year additional generating plant has been erected at Bourne Valley, and I think we shall not have to increase the generating plant there to any extent during the next two years. Christchurch station has been completed, and supply was commenced in June last. The company has secured from Christchurch Council a contract for lighting the public streets. The Richmond Company, too, continues to make satisfactory progress, and we consider the future prospects of this company fully justify our anticipations. I now move the adoption of the report and accounts.

Dr. HOSKER seconded, and the resolution was carried unanimously.

Resolutions approving the dividend, re-electing the retiring directors (Dr. Hosker and Mr. F. E. Savory) and the auditors (Messrs. R. H. Marsh & Co.) were then agreed to, and a vote of thanks to the chairman terminated the proceedings.

ELECTRIC LIGHTING AND TRACTION CO. OF AUSTRALIA (LTD.)—At the meeting on Monday, Mr. J. B. Braithwaite said at Melbourne the Corporation had purchased the company's mains inside the city and had erected a power station with the view of supplying themselves, so that the final portion of the city load was transferred from the company's to the Corporation's station at the end of the previous financial year. The gross lighting revenue from Melbourne was £7,981, against £21,223 in previous year, so that the loss of the city load meant a decrease of £14,000 in their receipts. Owing to a saving in working expenses the actual profit on the station was only £5,400 less. It was hoped that this profit from the Melbourne station would show steady improvement. At Adelaide, where they had orders both for the city and suburbs, the revenue from lighting had risen from £3,275 to £6,398 and from £369 to £1,345 for power. The progress at Geelong did not show so well. The loss at Port Adelaide had been reduced from £413 to £71. If the proposal to connect Port Adelaide with Adelaide should be carried out, he had no doubt the former would prove a source of profit in the future. The increase in lamp connections at the three stations was proceeding at an accelerated pace, and the reduction in working expenses was also making satisfactory headway. The profit for the present year should be sufficient to pay the whole of the debenture interest, standing charges and bank loan, but there was as yet no prospect of any dividend on the preference shares.

GREENOCK AND PORT GLASGOW TRAMWAYS CO.—At the meeting on Friday, the chairman (Viscount Emlyn) regretted that differences still existed between the Corporation and the company. The former claimed under the lease on account of the working for 1902 £1,523. 15s. on account of profits. The directors were advised that the claim could not be substantiated, and, therefore, no allowance had been made for it in the accounts.

LIVERPOOL DISTRICT LIGHTING CO. (LTD.)—At the meeting on Wednesday it was reported that the number of units sold during 1903 was 187,197, an increase of 24,729 over 1902, and the receipts were £3,791, against £3,521. The reduction in price for electricity by 1d. per unit on July 1, 1902, had reduced the income for the first half of the year, but had been fully justified by increased consumption over the year, aggregating 3,344 additional lamps, making the total lamps connected at Jan. 1 14,000. Expenditure on mains during the year was only £2,150. It was, however, found necessary to put down additional plant to meet the demand and the anticipated increase, and the generating station in Waterloo has, therefore, been enlarged, and one set of plant capable of supplying 1,000 lights has just been put in position. The new portion of the building is capable of containing a further similar set, making the total capacity of the station when fully equipped equal to about 20,000 lights. A dividend at the rate of 3 per cent. per annum (less tax), making 4 per cent. for the year, has been declared.

WINCHESTER ELECTRIC LIGHT AND POWER CO. (LTD.)—The chairman (Mr. T. F. Kirby) presided at the meeting last week. The directors' report stated that the equivalent of 7,301 8 c.p. lamps had been added during the year, making the total connections 35,557 8 c.p. lamps. A dividend for the half-year at the rate of 7 per cent. per annum was passed, making 5½ per cent. for year. Additions have been made to the plant, and the accumulators have been replaced by a larger set.

CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 25½d. per oz. (March 30). Consols 86⅛—86¼ for money, 85⅞—86⅛ for account; 2½ per cent. annuities 85½—86 (March 30). **Consols Pay Day** April 7; **Stocks and Shares Continuation Days,** April 12 and 26; **Ticket Days,** April 13 and 27; **Pay Day,** April 14; **Mining Share Carry-over Days,** April 11 and 25.

CITY OF BUENOS AYYES TRAMWAYS CO. (LTD.)—A balance dividend of 4s. per share for the six months ended Dec. 31 has been declared.

DEWSBURY, BATLEY AND BIRSTAL TRAMWAYS CO. (LTD.)—The report presented at the meeting on Wednesday stated that the total revenue for the year amounted to £8,524 and expenditure to £5,316, leaving a profit of £3,207. A dividend of 6 per cent. on the ordinary shares was declared.

GATESHEAD AND DISTRICT TRAMWAYS CO.—A dividend of 3 per cent. has been declared on the ordinary shares.

METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—Subscriptions are invited to an issue of £350,000 4½ per cent. debenture stock at par, forming part of a total authorised amount ranking pari passu equal to one-half of the paid-up capital of the company for the time being. The authorised share capital of the company is £1,500,000 in 500,000 cumulative preference, 500,000 ordinary and 500,000 deferred shares, all of £1 each. Of these shares, 1,032,555 have been issued, which includes the whole of the preference shares, rather less than half the ordinary shares and about three-fifths of the deferred shares. On 40,750 of the ordinary shares only 6s. per share has been paid. The present issue is offered for subscription on behalf of the Metropolitan Electric Tramways (Ltd.) by the Electric and General Investment Co. (Ltd.) and is payable £5 per cent. on application, £25 per cent. on allotment, £35 per cent. on May 2 and £35 per cent. on June 1. Interest is payable half-yearly, in July and January; the first payment will be made on July 1 next. The stock will be transferable in multiples of £1. The original company was registered in 1894, and as the result of negotiations and engagements now owns the majority of the shares of the North Metropolitan Tramways Co. and of the Harrow Road and Paddington Tramways Co. In addition, the company owns 8½ miles of tramways in the north of London, 7¼ miles in the county of Middlesex, and 1¼ miles in the county of London, running from Finsbury Park and Stamford Hill, through Wood Green, Tottenham and Edmonton. Full information relating to the company's undertakings are set out in the prospectus, with which is issued an instructive sketch map of the lines and routes of the company's tramways. Copies of the prospectus can be obtained from the bankers, the brokers, and at the offices of the company, 101, Finsbury-pavement, E.C., and from the Electric and General Investment Co. (Ltd.), 1 and 2, Great Winchester-street, London, E.C.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—The directors' report states that the work of the Bridgend station already shows good results, and the business in that district is increasing. The stations at Pontypridd and Cwmbran are now ready to supply current. The buildings at the Neath station have been completed, plant is in course of erection, and it is anticipated that this station will be at work in about three months.

UNITED ALKALI CO. (LTD.)—At the meeting on Friday the chairman (Mr. J. Brock) said the gross profit was £385,185, or £48,843 less than last year, which was accounted for by the great fall in the selling price of bleaching powder and chlorine products.

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NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

ANDYER (LTD.)—Reg. March 16, capital £1,000 in 1s. shares, to acquire any patents, rights and inventions relating to the generation, production and distribution of electricity or electric impulses or to the detection, discovery, localisation and determination of the position of underground metallic lodes or bodies of ore, metals, &c., to adopt an agreement with E. J. Dyer and others, and to carry on the business of electricians, engineers, metallurgists, &c.

HEBERLEIN CO. (LTD.)—Reg. Feb. 29, capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in engineering and industrial material, machinery, stores and appliances for railway brakes and other purposes and for heating or electric lighting of railway and other carriages, vehicles, &c., also of electrical and mechanical engineers, &c. First directors are Hon. W. F. B. Massey Mainwaring, M.P., W. Binns and F. C. Fairholme. Reg. office, Suffolk House, Laurence Pountney-lane, London, E.C.

UNITED ELECTRIC TRAMWAYS, MONTE VIDEO (LTD.)—Reg. March 24, capital £500,000 in £10 shares (20,000 preference), to enter into agreements for acquisition of shares or debentures of La Sociedad Comercial de Monte Video, to acquire or construct, maintain and work tramways, light railways or other means of communication in any part of the world, to manufacture, maintain and use locomotives, cars, rolling stock and plant for same, and to carry on the business of tramway, railway, motor, cab and omnibus proprietors, carriers of passengers and goods, &c. Reg. offices, Basildon House, Moorgate-street, London, E.C.

STATUTORY RETURNS.

COSTA RICA ELECTRIC LIGHT AND TRACTION CO. (LTD.)—In the return to Jan. 13, the capital is given as £130,000 in £1 shares, all of which have been taken up. £1 per share has been called up on seven and £7 has been received. 129,993 shares are considered as fully paid. Mortgages and charges, £159,650.

CROWN ELECTRIC HEATING SYNDICATE (LTD.).—The return to Dec. 31 gives the capital as £5,000 in £1 shares, all of which have been taken up. £1 per share has been called up and paid on 1,150, and 3,850 shares are considered as fully paid. No mortgages or charges.

DIRECT UNITED STATES CABLE CO. (LTD.)—In the return to Feb. 9 the capital is given as £1,300,000, in 65,000 shares of £10 each, of which 60,710 have been taken up. £1,214,200 is considered as paid. No mortgages or charges.

EASTERN TELEGRAPH CO. (LTD.)—The return to Feb. 10 gives the capital as £6,000,000, in £4,000,000 ordinary and £2,000,000 preference stock, of which £3,999,890 ordinary and £2,000,000 preference stock has been taken up. £5,999,890 has been received. Mortgages and charges, £1,840,973.

ELECTRICAL CANAL HAULAGE CO. (LTD.)—According to return to Feb. 15, the capital is £3,000 in £1 shares, seven of which have been taken up. £1 per share has been called up and paid. No mortgages or charges.

HART ACCUMULATOR CO. (LTD.)—According to return to March 16, the capital is £40,000 in £1 shares, all of which have been taken up. £1 per share has been called up and paid on 17,500, and 22,500 shares are considered as fully-paid. Mortgages and charges, nil. *Note.*—The capital was increased to £60,000 by the creation of 20,000 new preference shares immediately after return was filed.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—In return to March 3, the capital is £350,000 in 50,000 ordinary, 10,000 first preference and 10,000 second preference shares of £5 each, of which 21,000 ordinary, 10,000 first preference and 10,000 second preference shares have been taken up. £5 per share has been called up on 15,968 ordinary, 10,000 first preference and 10,000 second preference shares, and £179,840 has been received. £25,160 is considered as paid on 5,032 ordinary shares. Mortgages and charges, £90,000. Debenture stock issued by company in conjunction with Notting Hill Electric Lighting Co., £135,000.

LONDON ELECTRIC WIRE CO. (LTD.)—The return up to Feb. 12 gives the capital as £150,000 in 20,000 ordinary and 10,000 preference shares of £5 each, of which 15,807 ordinary and 5,956 preference have been taken up. £5 per share has been called up on 8,087 ordinary and 5,956 preference and £70,215 has been paid. £38,600 is considered as paid on 7,720 ordinary shares. Mortgages and charges nil.

MUNICIPAL ELECTRIC LIGHT AND POWER CORP. (LTD.)—According to return to Jan. 7, the capital is £25,000 in 2,490 ordinary shares of £10 each and 100 founders' shares of £1 each, of which 37 ordinary and 30 founders' shares have been taken up. The full amount has been called up on each share and £400 has been received. No mortgages or charges.

NORTH WALES AND DISTRICT LIGHT RAILWAY AND ELECTRIC POWER SYND. (LTD.)—The return to Jan. 26 gives capital as £1,200 in 12 shares of £100 each, 11 of which have been taken up. £924 has been received, leaving £176 in arrears. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

CHISWICK ELECTRICITY SUPPLY CORP. (LTD.)—Issue on March 16 of £1,000 4½ debentures, part of series created by resolutions of Nov. 2, 1900, and March 8, 1901, to secure £50,000, charged on company's undertaking and property, present and future, including uncalled capital. Holders, Davey, Paxman & Co. No trustees. Previously issued of same series, £32,000.

COWPER-COLES GALVANISING SYND. (LTD.)—Issue on March 10 of debenture for £100, part of series created Jan. 15, 1902, to secure £1,200, charged on company's property, present or future, except uncalled capital. Holders, Sherard Cowper-Coles & Co. No trustees. Previously issued of same series, £1,000.

CORK ELECTRIC TRAMWAYS AND LIGHTING CO. (LTD.)—Lien reg. March 18 for £3,000 debentures, part of £110,000; amount previ issued £107,000; charged on companys' property situate in Cork.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Mar. 26	1,128	+ 288	43	51,706	+ 10,389
Airdrie	,, 18	185	...	6	1,085	...
Ayr Corporation	,, 19	163	+ 1	44	12,155	...
Barnsley	,, 18	157	- 4	11	1,653	- 80
Barrow	,, 18	121	+ 61	6	847	+ 506
Bexley District Council	,, 25	145	...	25	3,691	...
Birkenhead	,, 27	976	- 15	...	...	...
Birmingham Corporation	,, 26	273	...	12	3,472	...
*Birmingham Tramways Co.	,, 26	5,113	+ 6	12	60,820	+ 2,749
*Blackburn Corporation	,, 25	765	+ 29	§52	43,198	+ 2,234
Blackpool Corporation	,, 24	319	- 15	§51	41,933	- 406
Blackpool and Fleetwood	,, 26	210	- 9	14	2,334	- 186
Blackp'l, St. Anne's & Lytham	,, 24	177	+ 177	†21	3,122	+ 2,543
Bolton Corporation	,, 27	1,618	- 68	52	93,216	+ 8,798
Bournemouth Corporation	,, 23	907	...	51	51,431	...
*Bradford Corporation	...	...	...	...	...	...
Brighton Corporation	,, 27	730	- 65	51	45,598	+ 2,845
Brisbane Tramways	Feb. 10	2,852	+ 20	6	13,544	- 198
*Bristol Trams & Carriage	Mar. 25	4,467	- 44	18	80,578	+ 2,881
*Buenos Ayres & Belgrano	...	...	...	...	...	...
Burnley Corporation	,, 26	889	+ 173	52	50,438	+ 9,774
Burton Corporation	,, 27	284	..	84	11,405	...
Calcutta Tramways Co.	,, 26	R35,213	+ R4,113	13	R 454,903	+ R76,781
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	,, 26	7,279	+ 307	13	91,825	+ 985
Chatham & Dist. Lt. Rys.	,, 24	489	+ 20	12	5,923	+ 1,036
City & South London Rly.	,, 27	3,155	+ 86	13	41,406	- 558
Cork Electric Trams Co.	,, 21	377	- 13	12	4,611	- 111
Darwen Corporation	,, 25	205	- 19	52	11,561	- 312
Devonport & Dist. Trams	,, 18	455	+ 43	11	4,976	+ 750
Dover Corporation	,, 26	168	- 15	†52	1,145	- 56
Dublin & Lucan Railway	,, 27	101	+ 17	12	1,157	+ 77
Dublin Southern District	,, 25	747	- 9	¶12	52,077	+ 570
Dublin United	,, 25	3,562	- 40			
Dudley—Stourbridge	,, 18	741	+ 41	11	8,000	+ 410
Dundee Corporation	...	...	...	...	...	...
East Ham Council	,, 26	610	+ 1	†52	33,866	- 8,781
Gateshead & Dist. Trams	,, 18	836	+ 62	11	9,443	+ 590
Glasgow Corporation	,, 26	13,572	+ 928	43	583,236	+ 55,812
Gravesend—Northfleet	,, 18	215	+ 24	11	2,291	+ 847
Gt. Northern & City Rly.	,, 26	976	+ 11	6	5,584	...
Greenock & Port Glasgow	,, 18	462	- 24	11	5,112	+ 623
Halifax Corporation	,, 16	1,204	+ 186	51	63,849	+ 6,479
	,, 23	1,258	+ 187			
Hartlepool Tramways	,, 18	250	+ 16	11	2,631	+ 294
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 26	1,989	+ 228	†52	99,618	+ 8,265
Ilkeston Corporation	,, 23	183	...	19	2,295	...
Ipswich Corporation	,, 26	316	...	12	5,405	...
Isle of Thanet Co.	,, 26	275	- 63	...	...	...
Kidderminster & District	,, 18	97	- 5	11	1,026	- 68
Kirkcaldy Corporation	,, 23	193	...	4	760	...
Lanarkshire Trams Co.	,, 24	560	...	12	6,853	...
Leeds Corporation	,, 26	5,086	+ 89	52	279,330	+ 15,521
Liverpool Corporation	,, 19	9,583	+ 22	12	113,172	+ 3,078
*Liverpool Overhead Rly.	,, 27	1,6	- 8	13	19,790	+ 294
*London County Council	...	...	...	...	...	...
Lowestoft	,, 19	124	...	¶31	7,060	...
Manchester Corporation	,, 26	10,913	+ 2,197	40	467,455	+ 197,914
Mersey Railway	,, 26	1,452	+ 349	12	17,152	+ 4,252
Merthyr	,, 18	193	+ 18	11	2 0 9	+ 167
Middleton	,, 18	254	+ 25	11	2,695	+ 185
Newcastle-on-Tyne Corp.	,, 26	3,453	+ 33	12	41,478	+ 5,572
Newport (Mon.)	...	...	...	...	...	...
Oldham, Ashton & Hyde	,, 18	494	- 18	11	5,347	- 807
Perth (W. A.) Elec. Trams.	,, 25	1,345	+ 205	13	16,677	+ 2,214
Peterborough	,, 18	112	- 7	11	1,201	- 177
Poole and District	,, 18	286	+ 29	11	2,486	- 96
Portsmouth Corporation	,, 26	1,362	- 79	†52	87,526	+ 5,531
*Potteries	,, 18	1,662	+ 159	11	17,865	+ 1,428
Reading Corporation	,, 24	529	...	...	...	...
Rothesay	,, 18	46	+ 1	11	475	+ 40
Salford Corporation	...	...	...	...	...	...
Sheerness	,, 16	44	...	11	491	...
Sheffield Corporation	,, 28	4,866	+ 111	52	234,241	+ 20,406
*Southampton Corporat'n	,, 24	842	- 48	12	10,022	+ 72
Southend Corporation	,, 23	216	+ 1	51	15,432	+ 2,250
Southport Tramways	,, 18	228	+ 8	11	2,574	+ 242
S. Staffordshire Trams.	,, 18	788	+ 44	11	8,042	+ 414
Sunderland Corporation	...	...	...	...	...	...
*Swansea Trams	,, 18	425	+ 2	11	4,982	+ 168
Taunton Trams	,, 18	42	- 7	11	506	- 25
Tynemouth and District	,, 18	211	- 10	11	2,225	- 61
Tyneside Trams Co.	,, 23	300	+ 33	12	3,308	+ 564
Wallasey District Council	,, 26	599	+ 38	†52	31,714	+ 4,028
Warrington Corporation	,, 24	305	+ 19	..	...	...
West Ham Corporation	,, 24	358	...	4	1,043	...
Weston-super-Mare	,, 16	29	...	11	251	- 19
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 18	846	- 15	11	8,602	- 150
Worcester	,, 18	234	+ 92	6	1,478	+ 634
Wrexham	,, 18	94	...	11	1,066	...
Yorkshire Woollen District	,, 18	529	+ 855	11	5,471	+ 1,833

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name	Price Tues., Mar. 29	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business, 6 days to Mar. 29 Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4¼—5	5 0 0	April, Oct	4¼	4⅛
St.	6%	Do. Permanent 6% Deb. Stock	125 —130	4 12 4	..	..	..
St.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 —100	.. ..	..	..	..
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	.. ..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	97	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 10 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 18 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	93 —96	3 3 3	..	..	..
St.	5%	Do. Pref. Ord. Stock	98 —101	5 0 9	..	98⅛	98
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	4 13 0	..	..	..
5	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅞—105⅞	4 7 0	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	8½—9½	8 8 6	..	8⅞	8½
10	6/0	Do. 6 per Cent. Cum. Pref.	9½—10½	5 14 4	Feb, Aug	10⅛	9⅞
St.	5/0	† Do. 5 per Cent. Perpetual Debs	117 —120	4 3 4	..	121	120
5	..	Buenos Ayres and Belgrano Ord.	2⅞—3½	.. ..	..	3⅜	3
5	3/0	Do 6 per Cent. "A" Cum Pref.	5½—5¾	5 4 0	..	..	..
5	3/0	Do. "B"	4½—5¼	5 14 3	..	5⅛	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	..	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 —100	5 0 3	..	..	..
5	2/6	Calcutta Tramways	6¾—7¼	4 9 8	..	7⅛	6¾
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 0	..	107½	107
1	1/0	Cape Electric Tramways Shares	1⅞—2⅛	8 0 0	..	2 1/16	1 15/16
St.	4%	Central London Ordinary Stock	90 —93	4 6 6	June, Dec	93½	91
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	..	..
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	..	..
10	4%	Do. 4 per Cent. Debs.	110 —113	3 11 8	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾—5¼	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2%	City and South London Rly. Con. Ord.	49 —52	4 11 4	Feb, Aug	51½	49
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 8	Feb, Aug	122½	..
St.	5%	Do. (1896)	119 —122	4 2 0	..	..	..
St.	5%	Do. (1901)	118 —121	4 2 8	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101 —104	4 18 1	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	1½—2½	12 0 0	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..
10	..	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	4 12 2	..	6½	6½
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	.. ..	..	..	..
10	10%	‡ Imperial Tramways Ord	18½—19½	4 12 4	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	1½%	†Liverpool Overhead Railway Ord.	4 13/16—4 15/16	2 16 5	Feb, Aug	..	..
1	5%	† Do. 5 per Cent. Pref.	9¾—10½	4 17 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98½—100½	3 19 10	Jan, July	..	..
1	5/0	London United Trams. 5% Cum. Pref.	11¼—11¾	4 5 2	..	11⅜	11¼
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 —103	3 18 5	..	102½	101¾
St.	..	Mersey Con. Ord. Stock	6 —9	.. ..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	.. ..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	.. ..	.. ..	..	..	..
1	..	Metropolitan Electric Trams Def	⅜—½	.. ..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅜—1	5 0 0	..	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	101 —103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	104 —106	4 4 11	..	..	..
5	..	New General Traction Ord.	½	.. ..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1½—2½	.. ..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½—9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	.. ..	.. ..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	.. ..	.. ..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	.. ..	.. ..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	88 —91	3 8 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	.. ..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	.. ..	.. ..	..	..	..
St.	16/0	Anglo-American	48 —51	5 18 8	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	91 —93	6 9 0	F,My,Ag,N	92⅜	91
St.	2/0	Do. Deferred	6¾—7¼	1 7 6	F,My Ag,N	7	..
100	$2	Commercial Cable Capital Stock	180 —190	4 4 5	Jn,Ap,Jy,O	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	89 —91	4 8 0	Jn Ap,Jy,O	92	..
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 3	Feb Aug	..	..
5	2/0	†Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	† Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99⅝—102⅝	4 9 3	Jan, July	..	..
20	3/0	Direct United States Cable	9½—10½	6 16 7	Ja,Ap,Jy,O	10 5/16	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —101	4 9 1	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	117 —122	5 14 9	Ja,Ap,Jy,O	119	..
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 19 1	Ja Ap,Jy,O	87	86
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 15 8	May, Nov	105½	..
10	2/6	Eastern Extension	10¾—11½	6 4 5	Ja,Ap,Jy,O	11 1/16	11½
3	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 16 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 —102	3 19 0	Feb, Aug	100	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅞—103⅝	3 19 0	May, Nov	..	..
10	5/0	Great Northern of Copenhagen	25 —26	4 16 2	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	12/6	Indo-European	38 —41	6 1 11	May, Nov	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..
2½	..	West Coast of America	⅛—¼	.. ..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜—½	.. ..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	5¾—6¼	9 12 0	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	.. ..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..
10	3/0	†Western Telegraph	11½—12	5 16 8	Mr,Jn,O,D	12¼	12⅛
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100—103	4 18 2	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 3	..	100⅛	..
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8 —8½	4 14 2	Ja Ap Jy O	8⅜	8⅛
10	3/0	Do. 6 per Cent. Pref.	12½—12⅝	4 14 2	Ja Ap,Jy,O	12⅝	12½
8	4/0	Reuter's	6¼—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cert.)	115 —120	5 2 2	April, Oct	..	..

Share.	Last Dividend	Name	Price Tues., Mar. 29	Rate per Cent. Yielded. £ s. d.	Dividend Due	Business, 6 days to Mar. 29 Highest.	Lowest.
		TELEPHONES.					
5	3/0	Cuba Telephone (fully paid)	4¾—5¼	5 14 3	August	..	..
St.	6%	National Co. Pref. Stock	100 —102	5 18 3	..	..	..
St.	5%	Do. Def. Stock	80 —83	6 1 0	..	..	..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 9	Feb, Aug	13⅛	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —14	4 5 8	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 —5¼	4 15 8	Feb, Aug	5⅛	5 1/16
St.	3¾%	* Do. Deb. Stock 3¾ per Cent. (red.)	94 —96	3 18 1	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —100	4 1 0	..	100	97⅝
1	0/7½	Oriental	⅞—1	6 18 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1⅛	.. ..	..	..	..
5	3/0	United River Plate	5½—6	5 16 8	July	5⅝	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝—5¼	4 15 3	June, Dec	4⅝	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 - 105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
		Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅛—¼	.. ..	..	..	..
1	0/8½	Do. 7% Cum. Pref.	1⅛—1⅜	.. ..	..	..	..
St.	4½%	† Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	113 —116	3 17 7	..	..	..
10	16/0	†Bournemouth & Poole Elec. Sup. Ord.	12½—13½	5 18 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10¼	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¼—11½	5 4 4	..	..	..
St.	4¼%	Do. 4¼ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4¼%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	5 6	†Brompton & Kensington Elec. Sup. Ord.	10½—10¾	4 18 0	..	..	..
5	3/6	† Do. 7 per Cent. Pref.	9½—10½	3 8 4	Mar, Sept	..	..
5	3 0	Calcutta Electric Supply Ord.	6½—7	4 12 10	..	6⅝	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 - 109	3 18 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup	7 - 7½	5 6 8	Feb, Aug	7 1/16	7⅛
5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 5 9	Feb, Aug	5 1/16	5⅛
5	9/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	..	..
5	1 7	Do. Do. (19/3)	4½ 5	.. ..	..	4⅝	..
St	4%	Do. 4% Deb. Stock (red.)	101 —103	3 18 5	..	..	..
5	3 6	†Chelsea Electric Supply Ord.	5⅜—6½	4 8 0	March	..	..
St	4¼%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 3 1	Jn, Dec	107½	107⅛
10	5/0	City of London Electric Lighting Ord.	10¼—10¾	4 13 0	Feb, Aug	10⅜	10⅛
10	1/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	13⅛	13 1/16
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec	125⅛	122½
St.	4½%	Do. 4½ 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	4/0	†County of London & Brush Prov. Ord.	7 - 8	5 0 0	..	7⅞	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	11⅛	11
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	103 —109	4 2 11	..	..	..
St.	27,6½	Do. Second Deb. Stock Prov. Certs.	99 —102	.. ..	..	..	..
5	2 0	Folkestone Electricity Supply Co. Ord.	5½—6½	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 3	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	.. ..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
St.	..	I of W. Elec Lt. & Power 4½% Db St (red.)	100 —105	.. ..	..	..	..
1	..	Kalgoorlie Elec. Powe & Ltg. 6% Cm Prf.	⅛—⅜	.. ..	..	..	..
5	7 0	Kensington & Knghtsbdge Ord	11 —12	5 0 0	..	11⅜	..
f	6%	Do. 6 per Cent. 1st Pref.	6¾—7	4 5 9	Jan, July	..	..
St	4%	†Kensingtn. & Knghtsbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
5	..	London Electric Supply Ord.	¾ —1½	.. ..	..	..	..
5	5/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 —97	4 3 7	Mr,Jn,S,D	..	..
10	9 6	†Metropolitan Electric Sup. Ord.	18 —19	4 12 1	April, Oct	18⅛	18⅜
5	1/4½	† Do. 4½ per Cent. Cum. Pref.	5¼—5⅜	4 3 9	..	5⅜	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec	..	..
St.	3¾%	Do. 3¾ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 9	..	..	..
100	3%	Midland Elec. Corp. for P. D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
1	6 0	Notting Hill Electric Ord.	13 —14	4 5 9	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
5	4/0	Oxford Electric Ord.	5½ - 6	5 8 4	March	..	..
St.	4%	Do. 4% Deb. Stock	96 —99	4 0 9	..	..	..
1	..	Rand Electric	¾ - 1	.. ..	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mt. Deb.	99 —102	4 8 11	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅜	..
5	3 6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8⅝	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	3⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3 - 3½	4 5 8	..	3 1/16	3⅛
5	2/6	Urban Electric Supply Ord.	4⅜ 5	5 0 0	..	4⅜	..
5	2.6	Do. 5% Cum. Pref.	4½—5	5 0 0	..	5	..
5	7/0	Westminster Electric Supply Ord.	12½ 13½	5 0 0	Mar, Sept	12⅞	13⅜
5	4/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref...	½—¾	10 0 0	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	3/16—¼	.. ..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5¾—6¼	8 1 4	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3¾—4½	7 1 2	..	3 15/16	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 3 4	..	94	..
2	..	Brush Electrical Engineering	½—1	.. ..	March	¾	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1⅛	9 12 0	Mar, Sept	1 1/16	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	72 —77	5 18 4	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	5 1/16	5⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 8	Nov, May	..	..
1	7/4	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
1	0.7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	7 10 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7¾—8½	.. ..	..	..	..
5	3,0	† Do. 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
5	..	Edison & Swan United ("A" sh.) (£8 pd.)	½	.. ..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1½	.. ..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 8 11	June, Dec	..	..
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5¾—6¼	5 12 0	H'lf-yearly	6 1/16	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5¾—6¼	4 16 0	..	6	5 15/16
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 4 11	..	105	..
2	1/2½	Electric Construction Co.	1⅜—1⅝	6 7 1 2	Jan, July	1⅝	..
2	2/9⅜	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	⅜ ½	.. ..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	½—¾	.. ..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 6 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	9⅜	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9,0	†Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	12⅜	..
5	2/3	Do. 4½ per Cent. Pref.	5 - 5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 111	4 1 5	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	..	..
100	4%	† Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	Telegraph Construction & Mainten'ce.	33 —36	6 13 4	Mar, July	34⅜	33⅞
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	3/0	Willans and Robinson Ord.	2½—3⅛	9 5 8	Apr, Oct	3 1/16	3⅛
5	3/0	Do. 6 per Cent. Cum. Pref.	4½—5	6 0 0	Apr, Oct	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	93 —97	4 3 6	May, Nov	93	..

* In calculating the yield, allowance has been made for redemption.

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THE ELECTRICIAN:

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NOTES.

THE announcement made to the shareholders of the Mersey Railway Co., alluded to elsewhere in this issue, is of special interest, since it relates to the first half-year of electric traction on the first converted steam railway in this country. As might be expected, both the number of passengers conveyed and the receipts have considerably increased under the new *régime*, the percentage increase in passengers being, however, in excess of that of the receipts. This is easily explained by the greater readiness of the public to travel third-class on the electrified system. Unfortunately, however, the increase in traffic has not kept step with the increase of the train-mileage, but it appears that this is gradually rectifying itself. In any case it is satisfactory to note that electrification has conduced to great saving. The cost of energy for propelling a train one mile has decreased from 11·3d. to 5·2d., and even the cost of maintaining the permanent way has been reduced by more than half. The only really unsatisfactory feature pointed out by the Chairman of the Company was that the cost of maintenance of the cars had remained the same notwithstanding the fact that the carriages were new. It appears, however, that while the repairs and maintenance of the locomotives are not included under this head, those of the motor cars are. It would be interesting to learn what proportion of these charges have been due to the somewhat complicated system of multiple unit control which has been adopted. The total working expenses with steam traction between July and December, 1902, were 3s. 5d. per train-mile, as compared with 1s. 6d. for electric traction during the corresponding period in 1903—a satisfactory result even when account is taken of the fact that the frequency of the service has been increased so that the system is working with a better load curve than would have been the case if the time-table had remained unaltered. We do not doubt that, with the abolition of steam and smoke, and the institution of a more rapid and frequent service, the line will continue to attract more passengers and soon be converted to a profit-making concern.

THE Kjellin furnace described in this issue is interesting from two points of view. The abolition of electrodes and the generation of heat in a continuous ring of metal by making that ring a secondary turn and inducing in it a current from an appropriate primary coil are devices so ingenious that they are worthy of record, whether the furnace will work or not. The sound grasp of the principle, that the function of an electric furnace for heating iron does not lie in the reduction of ore but in the refining of pig, is almost equally notable. There was a time when inventors lavished their brains on the thankless task of displacing the blast furnace, an ungrateful undertaking likely to lead to disappointment; now, with the wisdom that comes from experience, they have realised that the blast furnace is their best friend, and its product is admirably fitted for electrical refining. The Kjellin mode of doing this is exceedingly fascinating and merits full enquiry.

IT has long been known that the driving of workshops by electrical means, and more especially by a combined system of electrical and mechanical means, possesses advantages over the time-honoured distribution of power by purely mechanical contrivances, and a number of articles dealing with the subject have appeared from time to time in *The Electrician*. Mr. B. LONGBOTTOM, in a Paper which appears elsewhere in this issue, discusses in considerable detail the saving to be effected by group-driving, and he substantiates his conclusions by some interesting experimental data. The nature of the problem is such that no solution applicable to all cases can be found, and the author's conclusions are necessarily based on a hypothetical foundation. In the choice of his artificial structure Mr. LONGBOTTOM has proceeded on reasonable lines, and his assumptions are likely to represent as nearly as can be expected an average case. In one or two instances—as, for example, the assumption

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of a frictional loss of only 3½ per cent. in the mechanical transmission of power from the motor to the machine tool—the author's figures are open to correction; but this does not affect his final conclusions which are in the main correct. He is quite right in pointing out that for works, the machinery of which is continuously running at full load (as, for example, a cotton mill), it is possible that a purely mechanical means of transmission may be the more economical; but in cases where the load is fluctuating, the balance weighs decidedly in favour of electrical transmission. The author's remarks regarding the economical limits of shaft lengths in group-driving are also deserving of careful consideration, as this point has not always received sufficient attention in the past.

THE Postmaster-General's draft regulations for the protection of the telegraphs under the Australian Post and Telegraph Act, 1901, were recently submitted to a Committee of representatives of municipalities and private commercial concerns at Melbourne. Exception was taken by electrical engineers to certain clauses in the regulations owing to the fact that they gave more power to the Commonwealth Government than was intended by the Act. One such clause stipulated that where alternating currents were used for transmission of energy from generator to transformer sub-stations such transmission should be by means of insulated lines, to be laid underground. This regulation is, of course, quite unnecessary in a country like Australia, where there can be few places in which overhead transmission lines should not be permissible. Even in thickly-populated England overhead lines may shortly be employed for this very purpose. A continuous record of the difference of potential on electric tram wires was also considered unnecessary by the Committee.

ANOTHER objectionable clause was one to the effect that if a leakage interfering with the Postmaster-General's telegraph lines existed at any part of an electric light or power system the supply authority should forthwith cut off the current and should not resume supply until the leakage was remedied. The Committee very rightly considered that this regulation, if enforced, would lead to very serious results. Although it is most important that nothing should interfere with the continuous and efficient working of the telegraphs, yet it would be obviously unfair to deprive the public of light, perhaps at a very inconvenient time, and when the difficulty could be overcome in another manner than by cutting off the current.

WE commence this week a summary of three interesting Papers on single-phase motors, recently read in America. All three are valuable contributions to our knowledge of single-phase commutating motors, which no doubt will play an important part in the near future, especially in connection with electric traction. In this respect we might refer to the recommendation of Mr. DAHLANDER, the expert to the State railways of Sweden, who suggests in his report (referred to on p. 866 of our issue of March 18th) that the preliminary trials with electric traction on this railway system should be carried out with single-phase currents pure and simple. Not so very long ago such a proposal would have seemed preposterous. Of the three Papers referred to, that of Mr. STEINMETZ is perhaps the most interesting. In its first part it contains a description of the early efforts of Mr. R. EICKEMEYER and Mr. STEINMETZ himself in the direction of designing a satisfactory single-phase series motor. To all intents and purposes, they appear to have succeeded remarkably well, and it is only surprising that they did not follow up their success. In the second part of his Paper the author gives a lucid explanation of the internal working of the repulsion motor, and although similar expositions have been repeatedly put forward by other investigators, few have been developed in a more masterly manner. Mr. STEINMETZ concludes his Paper with a rather formidable-looking array of mathematics, and it may be well to point out that these are, of course, not intended as definite formula from which the motor dimensions, &c., may directly be derived; they have been developed chiefly for the purpose of gaining a general insight into the dependency of the chief motor characteristics on varying conditions of speed, load, position of brushes, and so on. Reading between the lines, it would seem that Mr. STEINMETZ believes the repulsion motor to be superior to the series motor for traction purposes, and in this he echoes the opinion of many electrical engineers on this side of the Atlantic.

TUESDAY'S issue of the *London Gazette* contained the pleasing announcement that Lieut.-Col. R. E. B. CROMPTON, C.B., has been granted the honorary rank of Major in the Army on his relinquishing his temporary commission for service in South Africa. We need not remind our readers of the valuable work which Col. CROMPTON has performed for his country and his profession, both in England and abroad, but it would not be fitting to allow the new honour to be conferred without offering a word of congratulation to one who not only commands the respect of his engineering *confrères*, but who is also held in esteem by high officials in the State and Army.

Thunderstorm.—A thunderstorm which passed over Retford on Tuesday did considerable damage both to property and to persons. The lightning struck two houses, demolishing several chimney stacks and tearing off the roofs. Three persons were also struck, but were not seriously injured.

Personal.—At a general council of the Glasgow University held on Wednesday afternoon Lord Kelvin was nominated Chancellor of the University by Sir John Ure Primrose, Lord Provost of Glasgow. The nomination was seconded by the Lord Advocate, Mr. Scott Dickson, and in the absence of any other nomination, Lord Kelvin was unanimously elected Chancellor.

Erratum.—On p. 894 of *The Electrician* of March 25th it was stated that the 60-ton travelling cranes in the North-Eastern Marine Engineering Co.'s works were supplied by the British Westinghouse Co. The British Thomson-Houston Co. inform us that this statement was incorrect, the crane equipments having been supplied through various crane builders by the British Thomson-Houston Co. Altogether there are five 25-ton cranes, two 10-ton, three 60-ton and one 40-ton. The motors are three-phase and the total horse-power is 846.

McMillan Memorial Fund.—We are informed by the Institution of Electrical Engineers that the committee of the Electrical Engineers' Ball unanimously decided, with the concurrence of those interested, to ask the Committee of Management of the Benevolent Fund of the Institution to receive

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a cheque for £56. 12s. 11d., the balance remaining in their hands after paying all expenses connected with the ball, this amount to be applied by the Benevolent Fund Management to the McMillan Memorial Fund.

Fire in a New York "Tube."—A fire occurred on Wednesday in the new underground tube at the corner of Broadway and Fulton-street, New York. The railway has not yet been opened to the public, and the fire, it is said, was due to the carelessness of some workmen. No fewer than 6,000 telephone and telegraph wires were interrupted, and the exchange serving the business quarter of the city was rendered inoperative. Fifty men who were working in the tunnel had a narrow escape.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Dominica—Martinique	May 9, 1902 ..	—
St. Lucia—Martinique	May 9, 1902 ..	—
Cayenne—Pinheiros	Aug. 13, 1902 ..	—
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902 ..	—
New York—Hayti	Apr. 18, 1903 ..	—
Tourane—Amoy	Nov. 10, 1903 ..	—
Tarifa—Tangier	Jan. 18, 1904 ..	—
Cape St. Jacques—Haiphong	Mar. 7, 1904 ..	April 6, 1904
Dakar—Conakry.....	Mar. 24, 1904 ..	Mar. 24, 1904

Radium in Hospitals.—From the annual report of the Hospital for Diseases of the Skin, it is interesting and gratifying to learn that the latest discoveries in electrical science have been successfully applied to the treatment of skin diseases. The Light department of this hospital, besides being equipped with Finsen lamps, X-ray and high-frequency apparatus, &c., possesses also an efficient quantity of radium, presented by Mr. Cossor. From the report of Mr. T. J. P. Hartigan, F.R.C.S., who is in charge of this department, it appears that the results of the majority of the 144 cases subjected to the effects of radium exceeded expectations, and that two cases of rodent ulcer were practically cured.

Thorium in Ceylon.—According to *The Times*, specimens of a new thorium ore have been discovered in Ceylon and forwarded by the Government of that colony to the Imperial Institute. The specimens received were small black cubical crystals, and it was first thought that they were uraninite or pitch-blende. The specific gravity of the mineral, our contemporary continues, was found to be 9·32, and analysis showed that it was not pitchblende, since it contained only about 12 per cent. of uranium oxide and 75 per cent. of thoria. This percentage of thoria is said to be very much higher than that contained in any mineral hitherto examined. The mineral is, of course, clearly radio-active, since it contains this large percentage of thorium oxide. Prof. Dunstan has suggested the name "thorianite" for the new mineral. It is stated, also, that a second mineral, less rich in thorium, has been found, and explorations are being made as to the extent of the occurrence of both these materials in Ceylon.

"Story of the Atlantic Cable."—In the review, published in our last issue, of the shilling book "The Story of the Atlantic Cable" by Mr. Charles Bright, we quoted the following passage: "The retardation of the electric current through an insulated wire due to induction—a phenomena (*sic*) practically unknown with bare aerial wires suspended on posts—and of no consequence with quite short cables—was overcome by using a succession of opposite currents." We have received a letter from Mr. Bright explaining that this sentence was a historic record of Dr. Whitehouse's ideas at the time, although, owing partly to the exigencies of space, he had not made this fact as clear as it might have been. The terms "electric charge" and "current," Mr. Bright continues, were often used indiscriminately and wrongly in those days, where frequently "electricity" alone was the best word to employ. Mr. Bright also tells us that he sees from his proof that in substituting "phenomenon" for "phenomena" he unfortunately failed to erase the preceding "a."

Opening of the Dorking Electricity Works.—The electricity works which have been erected at Dorking by Messrs. Edmundsons' Electricity Corporation were opened on Saturday last. The provisional order was granted to the Dorking Urban District Council in 1897, but was transferred to Messrs. Edmundsons', who have formed a subsidiary company, the Dorking Electricity Supply Co., to run the works. The terms of the agreement between the company and the Council were that the latter advanced the whole of the necessary capital, the company making half-yearly payments which will eventually discharge the interest and sinking fund charges on the amount borrowed by the Council. The lease is for 25 years, but if at the end of seven, 10 or 14 years the Council desire to acquire the undertaking, they may do so upon payment to the company of certain agreed premiums upon the amount of capital advanced. Mr. W. H. Trentham acted as consulting engineer to the Urban District Council. The system is a three-wire continuous-current one at 2 × 250 volts. The plant consists of two Babcock and Wilcox boilers having a total evaporative capacity of 8,400lb. per hour, two Belliss engines with an aggregate capacity of 290 I.H.P. and two 90kw. Parker dynamos. There is also a 260-cell D.P. battery having a capacity of 400 ampere-hours and a maximum discharge rate of 100 amperes. The mains are Callender solid. The tariff is 7d. for the first hour and 4d. afterwards on the Wright system, or a flat rate of 6d. per unit. At present there are 1,500 lamps connected to the mains, but applications are coming in quickly, and a large number of new consumers are awaiting connection.

New Electricity Works for Birmingham.—A report has been prepared by the Electric Supply committee of the Birmingham Corporation relating to the present position of the undertaking, and will be presented to a special meeting of the Council on Tuesday next. In July, 1901, plans were submitted providing for a new 10,000kw. station at an estimated cost of £239,220, but it was decided that the station should only be equipped to the extent of 3,200kw. at a cost of £128,890. In June, 1902, the Local Government Board sanctioned the borrowing of £251,974 for a period of 28 years, but owing to uncertainty as to the tramway development and an impending change of engineer, the scheme was not proceeded with, and only £84,197 has been spent. Under the Corporation Act, 1903, the corporation obtained power to take over the tramways, the leases of which expire in 1906, and it was then decided that provision would have to be made for working them electrically. The length of tramways is 24½ miles and there are also 9 miles the leases of which expire in 1911. In addition to this new demand there is also an increasing demand for lighting and power, and the existing stations are already taxed to their utmost capacity. Since the appointment of Mr. Chattock as electrical engineer, the committee have gone into plans and estimates and have come to the conclusion that a very much larger scheme than that originally suggested is necessary. They have based their estimates on the probable demands for the next 10 years, and on this basis about 22,000kw. will be required, the total cost of building a station of this capacity being £510,000. For the present it is only proposed to instal 8,500kw. at a cost of £260,620. The site of the new station, already purchased for £23,174, has an area of 19,409 sq. yds., and there is canal wharfage at the rear. Two chimney stacks, having an internal diameter of 15ft. and a height of 230ft., will be required. The engine house will be 275ft. long by 100ft. wide by 66ft. high, and the boiler house 98ft. wide by 60ft. high. There will be coal bunkers for 2,000 tons of coal over the boilers. At the rear of the engine house, and situated between it and the private canal basin, will be built a small pumping station for the condenser circulating water. It is proposed to divide the engine house by a central gangway, the high-tension plant being on one side and the low tension on the other. High-speed sets will be adopted, each with its own surface condenser and air pumps. The switchboards will be at one end of the engine house upon a gallery, and will be kept distinct from each other and divided by the main entrance from the road. The boiler house will be equipped with underground flues, so arranged that any battery of boilers can be run on either of the chimneys. The boilers will be in four batteries, each containing six boilers of the water-tube type, equipped with mechanical stokers. High-speed steam-driven and motor-driven centrifugal pumps will draw the water from the canal basin through suitable strainers, pump it through the condensers, and discharge it through a 30in. pipe into the canal again. Coal will be delivered either by canal barge or by cart, and conveyed either to an overhead coal store in the boiler house or to an auxiliary coal store, capable of holding another 3,000 tons, on the bank of the canal

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basin. A duplicate system of conveyors will ultimately be put in. It will be necessary to employ high-tension transmission to the outlying districts both for tramway traction and lighting purposes, and six sub-stations will ultimately be necessary, the cost of which is estimated at £132,200. For the first equipment it is proposed to instal four such stations, at a cost of £55,186, having a total capacity of 3,900kw. Three high-tension cables will be run direct from the main generating station to each sub-station, one being for tramway supply, one for lighting and one as a spare to either. The estimated cost of the first equipment is as follows:—

Main Generating Station.—Buildings, £106,000; eight water-tube boilers, 24,000lb. per hour each, £16,559; other boiler house equipment, £11,188; four 2,500 H.P. and three 900 H.P. steam engines. £57,140; three 1,500kw. direct-current generators, £7,353; one 1,500kw. and three 500kw. alternating-current generators £4,141; two 200kw. steam-driven exciters, £4,477; one 500kw. direct-current turbo-generator, £3,850; one condenser and air pumps for same, £1,500; one 200kw. direct-current motor generator, £1,392; balancers, boosters, switchboards, &c., £33,765; circulating water plant, £9,130; workshop equipment, £1,925; total, first equipment. £260,620. *Four Sub-stations.*—Land and buildings, £13,000; 13 sets transforming apparatus, each having a capacity of 300kw., including rotary converters, static transformers, regulating appliances, switchboards and storage batteries, £42,186; total, £55,186. *Underground Cables.*—High and low-tension cables, switch pillars and trenching, £125,336. Total. £441,142.

The Engines at the New Dublin Generating Station.—Although the generating plant at the new electricity works at Pigeon House Fort, Dublin, described in our issues of September 25th and October 2nd and 9th, has been at work for several months, it was only delivered over to Mr. Robert Hammond, the consulting engineer, for the official tests at the end of February. The tests were then immediately made, and Mr. Hammond submitted his report to the Council. A considerable stir has been occasioned in Dublin by the fact that Mr. Hammond felt bound, as a result of his tests, to reject the engines. It will be remembered that the generating sets in question consisted of two 1,000kw. and two 500kw. Oerlikon three-phase machines, coupled to vertical cross-compound engines supplied by Messrs. Duncan Stewart & Co. It was decided by the Electricity committee that steam consumption tests should not be made; it was estimated that there would thus be a saving of £980. The tests for capacity, overload, parallel running, ability to run condensing or non-condensing and capability of working with superheated steam were all up to specification. With regard to cyclic variation, Mr. Hammond considered that for practical purposes the desired objects had been achieved, but with regard to momentary variations of speed, the limits set by the specification were in all cases exceeded. For small variations of load (60kw. up or down), instead of 1½ per cent., the variation was from 2 to 1·5 per cent. in the different engines; for variations of about one-third load, instead of 4 per cent., the variations were from 4·8 to 6·8 per cent.; and when full load was suddenly removed, instead of 7 per cent. variation, there was from 12 to 14 per cent. variation in speed. Then, again, the permanent variations in speed between no load and full load, instead of 5 per cent., were from 6 to 6·2 per cent. The range of adjustment of speed by hand was found to be sufficient, however, exceeding the 5 per cent. laid down in the specification. All the tests on the alternators themselves were deemed satisfactory by Mr. Hammond. After giving full particulars of the various tests in his report, Mr. Hammond states that he is unable to certify that the tests, on completion, have been satisfactory. The reasons for this are set forth by Mr. Hammond as follows:—

In points of detail, the engines leave much to be desired. The consumption of oil is very heavy indeed, and much of it is splashed on the floor and lost. The high-pressure guides run hot. The larger engines have a considerable rock, and the hammering of the dashpots is very marked. The "wypers" on the valve gear are unduly worn in the sleeves. The engines are not entirely free from "knock," and the wobbling of the exciter, due to undue wear in the end bearings, is objectionable. Oil creeps along the engine-shafts and on to the flywheels. There are leakages of steam past the valve spindles when running, and leakages of water when the engines are standing. The above are the most important points in which the engines are, in my opinion, deficient. There are other minor defects, but it would serve no useful purpose to set these out in detail here, especially as I feel that I have no other course open to me save to reject the engines, they having failed to pass the specified tests on completion.

The report concludes—

It is now for you (the Electricity committee) to decide as to the next step to be taken. Clause 41 of the General Conditions, which deals fully with the present situation, is as follows: "If any portion of the completed plant fails to pass the specified 'tests on completion,' *the engineer may totally reject* such portion of the plant, and in the latter event the Corporation shall have the option of: (*a*) Giving the contractor a further period in which to fulfil his contract, or (*b*) themselves replacing the defective portion by purchase from or contract with any party or parties; (*c*) returning the defective portion of the plant, and recovering the sum or sums paid on account of same." During the progress of the tests the representative of the engine builders admitted the defects, and offered to remedy them with the utmost possible speed, if permitted to do so. I, however, refused to discuss the matter with him, informing him that it would have to be dealt with by the committee.

The committee having duly considered Mr. Hammond's report on March 31, communicated with the General Electric Co., who were the contractors for the plant, Messrs. Duncan Stewart & Co. having been sub-contractors for the engines. The General Electric Co. have undertaken to have the defective parts of the engines repaired or reconstructed in the shortest possible time, and as soon as the work on the first engine is completed have it submitted once more to the official tests. If they find that it is impossible to make a good job of the engines they undertake to replace them. Should the unfortunate case arise that the engines have to be removed, or are not available during the progress of repairing to meet the demands of the approaching winter, the company are prepared to erect a new 1,000kw. or 1,500kw. set with any make of reciprocating engine the Council may desire as soon as possible, so that it may be working in the coming winter This is to be on the understanding that when the demand for electricity increases sufficiently to necessitate the purchase by the Corporation of additional plant, the new set shall be taken over under certain conditions as to payment. The Electricity committee have recommended the Council to accept the company's offer. It may be added that the matter has been greatly exaggerated in the Dublin newspapers, for although the engines are not up to specification in the respects pointed out by Mr. Hammond, they have been doing their work nightly since the station was started last autumn, and the alternators themselves have given satisfaction in every way.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, April 8th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER STUDENTS' SECTION.
7:30 p.m. Meeting in the School of Technology. Paper to be read: "Direct-current Controllers," by H. N. Dutton.

JUNIOR INSTITUTION OF ENGINEERS.
8 p.m. Meeting at Westminster Palace Hotel. Paper to be read: "The Heating and Ventilation of Factories," by K. Gray.

SATURDAY, April 9th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER STUDENTS' SECTION.
Visit to the works of Messrs. Glover & Co., Trafford Park, Manchester.

TUESDAY, April 12th.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER LOCAL SECTION.
7:30 p.m. Annual General Meeting at Owens College, for the election of officials for next session.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.
8 p.m. Meeting at 207, Bath-street, Glasgow. Paper to be read: "Corporation Telephones," by A. R. Bennett.

WEDNESDAY, April 13th.

INSTITUTION OF CIVIL ENGINEERS: STUDENTS' SECTION.
2:30 p.m. Visit to the works of the Great Northern, Piccadilly and Brompton Railway. Assemble at the Brompton-road site, adjoining the Oratory.

FARADAY SOCIETY.
8 p.m. Meeting at the Institution of Electrical Engineers, 92, Victoria-street, S.W. The following Papers will be read:—(1) "Alloys of Copper and Arsenic," by A. H. Hiorns. (2) "A New Primary Battery," by E. G. P. Bousfield. (3) "Note on Determining Accurately the Percentage of Ozone in Gases not Dissociated by Moderate Heat," by E. G. P. Bousfield.

THURSDAY, April 14th.

INSTITUTION OF ELECTRICAL ENGINEERS.
8 p.m. Ordinary General Meeting, when the discussion on Messrs. Edgcumbe and Punga's Paper, "Direct-reading Measuring Instruments for Switchboard Use," will be resumed. The following Paper will also be read: "Eddy Currents and Eddy Current losses in Cable Sheaths," by M. B. Field.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.
8 p.m. Meeting at the Royal College of Science. Agenda: (1) "Note on Rail Bonding," by P. S. Sheardown. (2) "Note on Harmonics in Three-phase Working," by W. Tatlow.

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LIVERPOOL CORPORATION TRAMWAYS.

The annual report which has just been issued by Mr. Bellamy, the general manager of the Liverpool Corporation Tramways, is extremely interesting. Attention may be called, first of all, to the statements with reference to the through running between St. Helens and Pierhead, Liverpool, which commenced on May 18, 1903, with a half-hourly service in both directions. There is a very substantial traffic on this route, especially during the summer months, and this is likely to be largely increased as the result of an arrangement now being completed under which a schedule of considerably reduced fares will come into force. Although the passenger traffic has progressed so favourably on this route, it seems that the carriage of merchandise between the Liverpool Docks and certain South Lancashire towns has not fared so well, and this is attributed to the South Lancashire Tramways Co. having failed to proceed with the doubling of their lines which they had in contemplation when the scheme was first discussed. However, it is now understood that the matter will receive immediate attention, and thus there are better hopes for the future.

In the beginning of 1903 the regulations governing the speed of cars were such that 10 miles per hour was allowed on 36 per cent. of the total equivalent miles of single track, 8 miles per hour on 55 per cent., and 6 miles per hour on the remaining 9 per cent. But it was found, as is usually the case, that these limits were being largely exceeded in practice, with no small advantages, one being that the number of accidents, instead of increasing, actually decreased. In order that this increased speed might be legalised, the Corporation requested the re-examination of the lines by the Board of Trade, with the result that after Col. P. G. von Donop had made an inspection, 14 miles an hour was permitted on 10 per cent. of the total equivalent miles of single track, 12 miles per hour on 54 per cent., 10 miles per hour on 26 per cent., and 8 miles per hour on the remaining 10 per cent. In his report to the Board of Trade, Col. von Donop says that he considered the increase of speed allowable owing to the drivers having become efficiently trained and the great freedom from accidents which the system had enjoyed of late. Statistics show that accidents of all classes are still on the decline. This is undoubtedly an important matter in connection with tramway undertakings, and, in view of recent prosecutions, it certainly behoves other tramway managers than Mr. Bellamy to follow in the steps of Liverpool. Higher speed means better service, increased efficiency, lower capital costs, and possibly lower maintenance costs, owing to fewer number of cars being required. In connection with the foregoing figures, it may be stated that the total route miles of the Liverpool tramways on December 31st last was 70 miles, an increase of 4 miles since the end of 1902. The net result of the increase in speed on all this route is that the average speed, including stops, has been raised from 5·8 to 7·5 miles per hour.

Dealing next with the experimental top-covered cars, illustrations of some of which have already appeared in *The Electrician* (Vol. LI., p. 35), the report states that they fulfilled all expectations and indicated that there was a general demand for such protection during inclement weather, but that it should assume a more permanent character than the curtained screens first provided. The newest car has sliding glass windows and a sliding roof in place of screens. The increase in the car-mile earnings with covered cars, including midwinter and midsummer months, was found last August to be about 1½d. per car-mile, or a total increase per car per annum of over £180; 50 of them were, therefore, put into service, and they are being added to at the rate of five or six per week, until a total of 150 is reached. It is maintained by the general manager that the adoption of this form of car would completely remedy the overcrowding evil; and, moreover, the cover may be almost entirely removed, this operation being performed both easily and rapidly. The sides of the cover are protected by balanced windows, which can be held in any desired position or dropped to the seat back level. The top is composed of a permanent centre running through the length of the car, carrying the trolley standard, &c., and covering a third of the total width of the roof, which affords a housing for the two sliding side panels when out of use. The top deck of the car can thus be used either open, entirely closed or with side screens and open roof.

An interesting section of the report is that which deals with the type of wheel employed. Steel-tyred wheels were used on the first electric cars in Liverpool, but they were discontinued owing to the very unsatisfactory results which were obtained. There is a possibility that they will be adopted again when more satisfactory experimental data are forthcoming, but for the present chilled wheels are in general use, the net cost of which is under 20s. each, and during 1903 they had an average life of 33,500 miles per wheel.

The "Plough" lifeguard, which has been fitted to all the cars, has behaved admirably. Out of 111 persons who were knocked down and succeeded in getting under the platform, 45 were pushed clear of the track by the lifeguard uninjured, 36 were pushed clear and slightly injured, 27 were pushed clear but required medical attendance, and three were killed. It is stated that in these three fatal accidents the guard pushed the body clear of the track after the fatal injury had been received. It is pleasing to observe that the fatalities recorded show a decrease of 50 per cent. as compared with those of the previous year, and that the ratio to passengers carried is only 1 in 28,264,308. 3,670 cars were sent into the works, showing that each car on the average ran 3,194 miles without requiring attention, and the average maximum number of cars in service during 1903 amounted to 407, as against 380 in 1902.

The following table shows the passengers carried, mileage and receipts for 1903, together with the figures for the six preceding years. There were 3·4 per cent. more passengers carried in 1903 than in 1902 and the receipts increased by 3·5 per cent.

The total number of emergency calls in connection with the overhead equipment during the year amounted to 400, as against 748 for the previous year, and the total cost entailed was £4,672. 17s. 1d., a decrease of 24·9 per cent. as compared with 1902. It is noteworthy that for seven days ending April 13, 1903, no emergency calls were received, and this

Passengers, Mileage and Receipts.

—		1897.	1898.	1899.	1900.	1901.	1902.	1903.
Passengers	Electrics	..	785,064	15,853,160	58,068,531	100,076,789	108,906,472	113,015,728
	Horse Cars	30,596,229	31,985,158	39,321,946	19,051,875	218,166	74,685	41,506
	Omnibuses	7,812,855	9,001,812	8,596,344	5,247,552	813,825	354,428	..
		38,409,084	41,772,034	63,771,450	82,367,958	101,108,780	109,335,585	113,057,234
Mileage ..	Electrics	..	53,197	1,473,750	5,584,357	10,771,461	11,705,425	11,724,097
	Horse cars	4,674,609	4,736,103	4,758,652	2,571,163	46,247	16,534	10,741
	Omnibuses	1,338,573	1,490,458	1,368,144	945,346	152,355	68,856	..
		6,013,182	6,279,758	7,600,546	9,100,866	10,970,063	11,790,815	11,734,838
Receipts ..	Electrics	..	£4,087	£77,145	£284,759	£463,164	£504,304	£524,321
	Horse cars	£239,399	£250,975	£234,756	£105,212	£717	£278	£147
	Omnibuses	£51,344	£59,145	£47,658	£27,603	£4,502	£2,146	..
		£290,743	£314,207	£359,929	£417,574	£468,383	£506,728	£524,468

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freedom from accident, with the exception of a slight failure of insulation brought about by heavy rain, was continued for a total period of 10 days, thus constituting a record since 1900.

The total car mileage was 11,724,097, as compared with 11,705,425 of the year before, while the passengers carried for the respective years were 113,057,234 and 108,906,472. The number of cars in use was 494, comprising 15 single-deck German motor cars with trailers, 12 single-deck American with side entrance, three American fitted with upper decks and reversed staircases, 114 double-deck single-truck with ordinary staircase, 300 double-deck single-truck with reversed staircase, and 50 double-deck single-truck fitted with improved canopy tops.

With regard to the financial position of the undertaking it appears that the total capital expended to the end of 1903 amounted to £1,863,485, as against £1,832,977, and the capital expended per route mile was therefore £26,621.

The following table gives a few of the most interesting figures in connection with the revenue and expenditure during 1902 and 1903 :—

	1902.		1903.	
	Total.	Per car-mile.	Total.	Per car-mile.
REVENUE.				
Total	£510,911	10·47d.	£531,483	10·86d.
From passenger traffic	504,304	10·34d.	524,468	10·733d.
Miscellaneous sources	6,607	0·135d.	7,015	0·13d.
EXPENDITURE.				
Total	336,004	6·890d.	341,463	6·983d.
Power	82,753	1·696d.	80,956	1·657d.
Maintenance and Repairs.	*63,175*	*1·295d.*	*67,358*	*1·38d.*
Maintenance of way	14,000	0·287d.	21,144	0·434d.
Repairs of structures and buildings	3,269	0·067d.	1,743	0·036d.
Overhead line and cables.	6,224	0·128d.	4,672	0·096d.
Cars*	37,179	0·763d.	37,882	0·775d.
Miscellaneous	2,503	0·051d.	1,917	0·039d.
Traffic expenses	*144,602*	*2·965d.*	*145,111*	*2·97d.*
Salaries and wages	119,089	2·44d.	121,651	2·485d.
Gravelling, cleaning cars, sheds, &c.	14,331	0·294d.	13,672	0·282d.
Tickets, punches, printing and stationery	3,527	0·072d.	3,149	0·0647d.
Uniform, clothing, &c.	7,655	0·157d.	6,647	0·048d.
Management and contribution to City fund	11,177	0·229d.	7,691	0·185d.
Rents, rates and taxes	21,091	0·432d.	23,284	0·476d.

		% to mean cap. expended		% to mean cap. expended
Working profit	£173,614	9·69	£190,020	10·09
Reserve, renewal and depreciation fund	50,332	2·81	64,161	3·43
Net interest on loans	46,193	2·77	45,328	2·43
Net profit	25,166	1·41	32,080	1·72

* Salaries and wages, £26,722. Materials, &c., £11,160.

The percentage of operating costs to total revenue was 65 per cent. in 1902 and 64·247 per cent. in 1903, and the revenue per mile of route was £7,620, as compared with £7,745 of the previous year. In 1902 the passengers carried per car-mile amounted to 9·3, but last year this figure was increased by 0·36, a very substantial increment. No fewer than 17,978,718 units were consumed, the corresponding figure for the previous year being 16,855,113, and the mean price per unit, therefore, works out at slightly under 1·08d., which is less by 0·1d. than the price paid in 1902.

Radium Research Fund.—The Court of the Goldsmiths Company, having recognised the great and immediate importance of investigation of the nature and properties of radium and radio-active bodies, recently signified their willingness to hand over a sum of £1,000 to the Royal Society to constitute a radium research fund. The Council of the Royal Society at once accepted the duty of administering this grant, and ordered the cordial thanks of the Society to be transmitted to the Goldsmiths' Company for their generous and timely subvention to scientific research. Proposals relating to the method of utilising the fund for the assistance of scientific investigation have at the same time been communicated to the company for their approval.

THE LIVERPOOL–SOUTHPORT ELECTRIC RAILWAY.

(Continued from page 942.)

The reversing switches, already mentioned, are fixed to the underframe of the motor cars near the motors themselves. They carry contacts which are normally held open by gravity, but can be closed by an electromagnet which, as has been

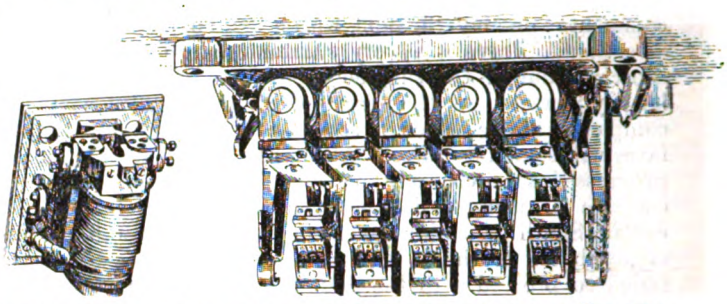

FIG. 16.—"SOLENOID SHUNT SWITCH" AND GROUP OF REVERSING SWITCHES

explained, is connected into circuit by the controller reversing barrel. There are eight reversers per train, one per motor, which are arranged in four parallels of two in series across the system. The reversers are all operated by shunt magnets, and in series with each reverser pair are the contacts of two magnetic overload releases, the coils of which are each in the main circuit of one of the motors, its reverser contacts and solenoids. Consequently, whether a pair of motors be in series or in parallel, the overload current (750 amperes) in either one will cause both releases to open and cut out the pair. These releases are enclosed in small neat cast-iron boxes mounted on the sides of the car near the truck facing outwards. When open, a flap falls down exhibiting "Open" in raised white letters on a scarlet ground, which catches the eye immediately. The releases may also be tripped by hand to cut out any pair

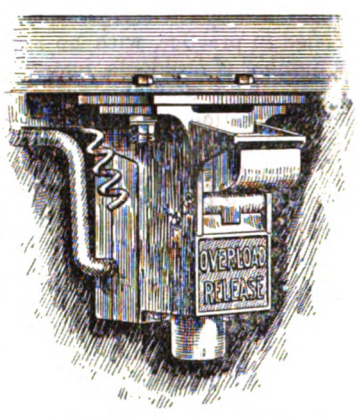

FIG. 17.—OVERLOAD RELEASE.

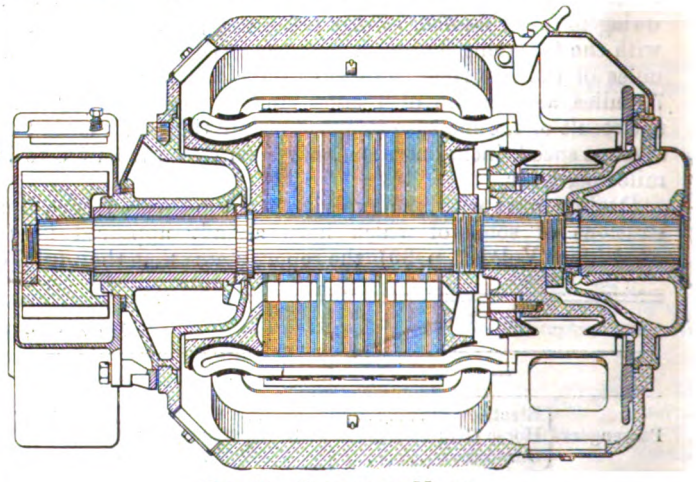

FIG. 18.—SECTION OF MOTOR.

of motors that may become disabled. Powerful and certain action of the reversers is secured by a compact magnetic circuit and a free and balanced suspension of a heavy clapper, while uniform and reliable contact is ensured by the use of several independent spring contacts, so hung as to render sticking impossible. Fig. 16 shows a group of reversing switches and one of the "solenoid shunt switches," and Fig. 17 one of the overload releases. The object of the solenoid shunt switch is to prevent excessive current flowing through

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the solenoid of the reversing switch when all the motors are in parallel. It will be remembered from Fig. 12 that, when the controller is in the parallel position, the two motors are each earthed through the coil of one of these switches. The coil thus energised will pull up the switch and connect S and S S (Fig. 12), thus paralleling a shunt across the blow-out magnet. The current will then find two paths through the solenoid and the shunt.

In circuit with each pair of reversers is a cartridge fuse and hand knock-out switch in the cab. The latter is for opening the relay circuits of the reversers in order to cut off the motors should the controller cylinders stick in any way or an accident be imminent. In accordance with the usual practice the power cylinder is locked when the reversing is in an "off" position, while the reversing handle is locked when the power handle is on one of the notches.

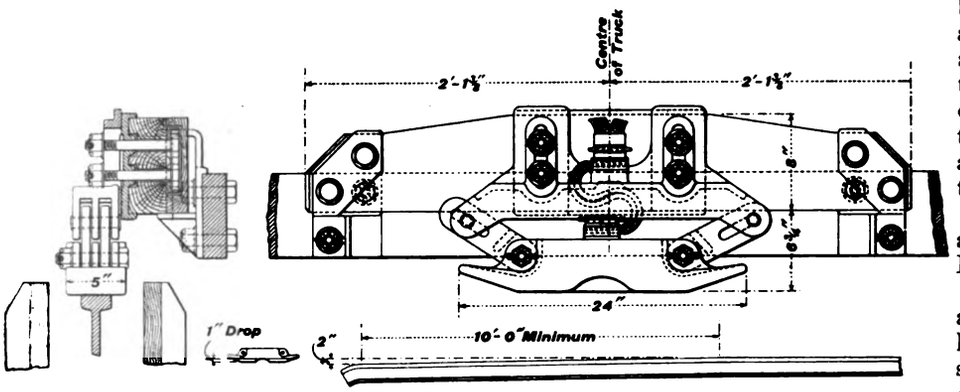

Fig. 19.—Contact Shoe and Third Rail Approach. Scale: ¾in. = 1ft.

As has already been seen there are eight motors on a complete train—four on each motor car. They drive on to the axles through single reduction gear. The motors (Fig. 18) are of the Dick-Kerr 4A railway type, rated to develop 150 B.H.P. at an armature speed of 470 revs. The weight of the complete motor is 6,050lb., the armature 1,920lb., and the gear wheels and housing 500lb. The conditions of performance which the motor has to fulfil, both as regards speed and high acceleration, have necessitated liberality in design, and in consequence they will give considerable overloads for short periods with a moderate rise in temperature.

The main features of the motor are similar to those of the standard traction type. In accordance with usual practice, the magnetic field is built up of steel shells, in which are four laminated steel poles, secured to the shells by bolts. The spools are built up of copper wire and asbestos ribbon, heavily taped over all, impregnated and baked. Steel is employed for the core discs of the armature, and the windings are former wound, insulated with a special combination of mica. The commutators are built up of drop forged copper bars insulated with pure mica, the whole being carried on a hard micanite ring. A special bracket carries the brushes, and this is designed to give considerable adjustment, and the general design is such that ready access is obtained to the brushes and the commutator.

The current is collected by cast-steel slippers on each side of the motor bogies (Fig. 19). These slippers weigh about 90lb. each, and have so far given the greatest satisfaction. On straight runs of third-rail there are thus four shoes collecting at one time. From these slippers, which are suspended by forged slotted links from a wooden beam carried on extensions on the bogie, a highly flexible lead of special construction is carried to a fixed terminal from which the main cables pass to the controller.

Both types of cars are 60ft. long and 10ft. wide, being the widest carriages in this country, and have 8ft. wheel base bogies fixed 40ft. 6in. centre to centre apart. They are arranged with straight sides, matchboarded below the side-lights. There is a "monitor" or clerestory roof 6ft. 2in. wide, the top being 12ft. 7⅞in. from the rail level. The motor cars are divided into two main compartments with a luggage and motor compartment, access being obtained through entrance vestibules which are recessed back at either end, the whole arrangement being so designed that the doors shall not project beyond the 10ft. width when extended. Immediately inside the compartments the seats are placed longitudinally against the side of the car, but the remainder of the cars are fitted with cross seats and reversible backs. The trailers serve as first-class cars, and accommodate two on each of the seats and a total of 66 passengers per car; the third class cars (motor cars) seat three on one side, and two on the other and a total of 69 passengers per car, the total accommodation in a normal train being in this way 270 passengers.

Between all cars vestibule gangways are provided (as will have been seen in Fig. 14).

At the driving end of the motor cars a luggage compartment is arranged for light luggage. Oak shutters on either side, which roll down in blind fashion and close or open the whole length of the compartment, have been arranged with the object of facilitating the work of the guard.

The underframes throughout are of steel, the sides and centre sills being of channel section, each sill being trussed with rods passing over the bolsters to the steel-plate headstocks. The bolsters are of steel channel, riveted to the underside of the sills and supported by straps. Central buffing and drawgear is arranged at each end of the trailer cars, and the trailing end of the motor cars, the couplers being fitted with side guide springs to damp oscillation and lateral motion when passing over crossings and round curves. At the motor compartment end, standard buffing gear is utilised to simplify the running or shunting of these trains if brought in contact with ordinary rolling stock.

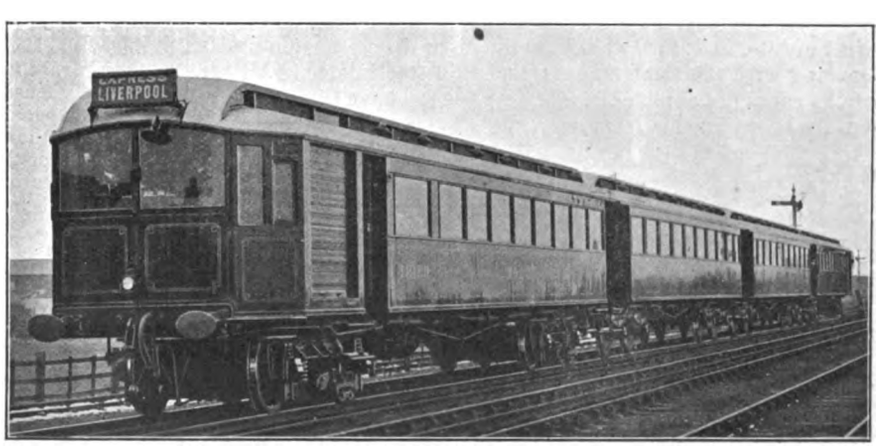

Fig. 20.—View of Four-coach Train.

All cars are electrically lighted and heated, the necessary switches being placed in the vestibule entrance of each coach, and so arranged as only to be accessible by means of a special key carried by the guard. There is a through bell communication which enables the guard by means of a special key to give the motorman the signal to start from any vestibule entrance on the train.

The total weight without passengers of each trailer car is 26 tons, and of each motor car 44 tons, making the total weight of each four-car train 140 tons, and a length overall of 248ft. 6in.

The bogies for the trailer cars are the L. and Y. Co.'s standard carriage bogie, the frame being composed of angle steel section, and channel steel bolsters. Special springs have been introduced to ensure easy riding.

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The motor bogie is entirely built of steel, and, as stated before, has 8ft. wheel base; the wheels are 3ft. 6in. diameter, an exceptional size in connection with electric traction. The weight of the coach is transmitted from the top bolster by means of elliptical springs to the swing beam, the weight being transmitted thence in the usual method by swing links to the bogie. Steel angles form the side frames; cast-steel stiffeners riveted to the outsides of these form nests for the tops of the heavy helical springs which intervene between the bogie frame and the straight equaliser bar. This equaliser bar is carried in stirrups below the axle boxes, the stirrups themselves bearing on the box tops by means of very stiff three-coil helical springs. A special feature in connection with the axle boxes is that the fillets on the journals are kept quite clear of the brasses, thus avoiding a fruitful source of hot bearings. The gears are not split but forced solid on to an enlargement on the axle, and keyed.

The vacuum brake is used on the trains, thus making them adaptable for service with the company's other rolling stock and locomotives at any time. The general arrangement of fittings and brake cylinders is similar to that already in use; the steam ejector is replaced by a twin-cylinder geared vacuum pump driven by a 3 H.P. 600-volt motor. An electrically-actuated valve is substituted for the usual ball valves on the brake cylinder; the movement of the motorman's valve, when the brake handle is placed in the brake off position, lifts these valves along the train, procuring, if desired, an almost instantaneous release of the brake. Automatic electro-pneumatic regulators in the pump motor circuits maintain a constant vacuum in the vacuum reservoir. A large motor-car horn, containing a reversed reed of special construction, is used in place of a whistle, a connection to the vacuum reservoirs enabling the air for blowing it to be supplied from the atmosphere.

The motorman's compartment, in addition to the controller, switches and ammeter for the main motors, contains the motorman's brake valve, a vacuum gauge, a single-pole switch for starting the brake motors and fuses for the pump motor and brake-control circuits.

With the exception of the roof, which is covered with sheet-steel plates, the motor compartments have been lined with the fireproof material "Uralite," the floor also being fireproof. In addition, the cable troughs, in which the cables are placed for conveying current to the motors and equipment, are lined with uralite, and the whole of the floor over the motors is covered with the same material and thin steel plates. All the trains carry fire appliances, and ample steps have been taken to ensure safety in this respect.

(To be concluded.)

THE ADAPTABILITY OF ELECTRICAL DRIVING.*

BY B. LONGBOTTOM.

The mechanical forms of power distribution can be split up into two sections: (1) Where a number of small engines drive individual machines or departments by means of shafting, gears, belts or ropes. (2) Where a single engine drives the whole of the works in a similar manner. With respect to the former method, as far as steam power is concerned, it has now long been recognised that the result is most unsatisfactory for various reasons. On the other hand, if gas engines are employed, a more satisfactory result is obtained. The gas engine, however, has yet to be designed that will lend itself as readily as the electric motor to being fixed in any desired position with the same economy of space and minimum amount of attention.

The alternative method of mechanical distribution is the more usual, and the one electrical driving has to contend with. Table I. has been compiled from tests I have taken in various well-known works. The figures were arrived at by taking the average of a number of indications of the engine when working on load, and again with the belts running on the loose pulleys. Owing to the fact that works have to be arranged to suit the specific nature of the manufactures, there is bound to be a difference in the variety and number of machines, necessitating a difference in the number of shafts, countershafts, bearings, &c., with the result that no two cases are alike.

* Abstract of a Paper read before the Manchester Association of Engineers on March 26th.

Table I.—*Tests of Mechanical Distribution.*

A.—DETAILS OF PLANT.

Test No.	Nature of work.	No. of machine tools.	Total length of line shafts. Ft.	Diameter of line shafts. In.	Av. R.P.M. of line shafts.	No. of line shafts bearings.	No. of belts.	Aver. width of belts. In.	No. of countershafts.
1	Gas engine makers	31	303	2·5 and 2·75	196	34	43	2·75	19
2	Do.	57	380	2·5 and 2·75	160	44	75	2·625	45
3	Do.	79	494	2·5 and 3	150	48	114	2·75	72
4	Textile mach. makers	154	546	5in. to 2in. by steps of ½in.	170	72	210	2·5	88
5	Do.	312	1,020	4in. to 2in. by steps of ¼in.	130	141	432	3·97	275
6	Do.	910	2,130	5in. to 2in. by steps of ¼in.	120	280	1,230	4·94	489
7	Cotton mill	50,000 spindles, spinning American cotton, average counts, 30s twists.							

B.—DETAILS OF TEST.

Test No.	Aver. I.H.P. on load.	Effective B.H.P. delivered to machines.	H.P. absorbed by engine shafting, &c.	Eff. power per cent.	Nature of load.	Prime mover.	Remarks.
1	29·6	15·1	14·5	51·0	Steady	Gas	Working at ¾ load.
2	18·5	9·3	9·2	50·0	Do.	Do.	Do. ½ do.
3	28·8	14·3	14·5	49·7	Do.	Do.	Do. ½ do.
4	104·0	54·0	50·0	52·0	Variable	Steam	Do. full do.
5	172·0	100·0	72·0	58·0	Do.	Do.	Do. do.
6	506·0	253·0	253·0	50·0	Do.	Do.	Do. over full load.
7	900·0	630·0	220·0	75·5	Steady	Do.	Do. about do.

In the above tests, it was assumed that the frictional losses are constant at all loads, and this is near enough for all practical purposes. In deciding as a basis for comparison, that an average of 55 per cent of the indicated horse-power is effectively delivered to the machines, it will be seen that I have taken a higher figure than the average results of the above tests, which, by the way, are more favourable than many that have been cited in the past.

Now, turning to electrical distribution, we will not take the ideal case of the plant working at full load, as this is rarely found in practice, but in taking a basis of three-quarter load throughout, it must be admitted that we are assuming a load that can always be obtained with ordinary care. We will take as our example a plant requiring 100 I.H.P. at three-quarter load, as this will render it easy to follow the losses through the different stages. This is equivalent to 133 I.H.P. at full load, and we will assume an efficiency of 82 per cent. at the engine room switchboard. The next step is to determine what percentage of loss must be allowed for the distribution by cables to the various motors, and if this is taken as 3⅓ per cent. at full load, or 2 per cent. at three-quarter load, as the losses vary as the square of the current, it is ample in a well-proportioned scheme. This brings the total efficiency down to, say, 80 per cent.—*i.e.*, 80 E.H.P.

We can reasonably assume the motor units in our example to be 5 B.H.P. and 10 B.H.P., and take 7½ B.H.P. as the average. Assuming again three-quarter load, which will imply an efficiency, say, of 83 per cent. as the mean efficiency of the motors, we have a total efficiency at the motor-pulleys of 83 per cent. × 80 per cent. = 66⅓ per cent., or 66⅓ B.H.P. In the case of the individual machine when driven direct, it is obvious that no further loss takes place, but when the machine is driven by gearing, chain or belt, there is a loss of 2½ to 5 per cent., and this must be deducted from the efficiency at the motor shaft. As far as engineering works are concerned, latter-day practice shows a decided tendency towards this method of driving, as the power required to drive small machine tools has been greatly increased by the advent of high-speed tool steels, and increased cutting speeds. However, in the majority of electrically-driven works, it can reasonably be assumed that from one-quarter to one-third of the power is taken up by group-driving. We will take the latter to be the case, so, continuing with our example, we have two-thirds of the available power—say, two-thirds of 66 B.H.P. (44 B.H.P.)—reduced a further 3½ per cent.—*i.e.*, 1·55 B.H.P.

The Table II., which has been compiled from tests I have had taken at hazard, shows that the frictional losses in well arranged group-driving should vary from 10 to 25 per cent.

For the remaining 22 B.H.P. we will then assume a liberal frictional loss of 20 per cent., which amounts to 4·4 B.H.P. This gives a total loss of, say 6 B.H.P., which must be further deducted from the 66 B.H.P. at the motor shaft, leaving us with an efficiency of 60 per cent. for electrical distribution as against 55 per cent., which was taken as the fair average for mechanical distribution.

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Table II.—*Efficiency Tests of Group Driving.*

Test No.	B.H.P. of motor.	Nature of work driven.	No. of machine tools.	Total length of line shafts. Feet.	Diam. of line shafts. Inches.	Av. R.P.M. of line shafts.	No. of line shaft bearings.	No. of belts.	Output in B.H.P. at motor shaft.	B.H.P. absorbed by shafting, belts, &c.	% to drive shafting, belts, &c.
1	3	Two 30in. Bullard boring mills, one No. 5 Herbert capstan lathe	3	16	2	230	3	7	2·3	0·46	20·0
2	4½	Two horizontal boring machines, one radial drill	3	20	2	180	5	7	3 1	0·4	13·0
3	*4½*	*Tool Room– Small lathe, shaping, slotting, milling and drilling machines. Three-tool grinding machines, metal saw and fan*	*11*	*36*	*2 (2)*	*230*	*7*	*15*	*3·4*	*1·7*	*50·0*
4	5	Four fine wire-drawing machines, a washing and mangling machine and pump	6	86	1½ (2)	210	17*	8	4·75	1 06	22·5
5	7½	Wire netting weaving frames	3	42	1½	180	7*	5	6·3	0·67	10·5
6	*7½*	*Two large lathes, planer, slotting machine and cylinder boring machine*	*5*	*150*	*2¼ (2)*	*95*	*15*	*11*	*3·85*	*2·3*	*60 0*
7	10	Five wire gauze weaving machines	5	70	1½	360	12*	6	5·16	1·31	25·0
8	*15*	*Lathes, shaping, planing, milling & grinding machines*	*18*	*128*	*2¼ to3 (3)*	*106*	*22*	*27*	*7·2*	*4·7*	*65·0*
9	*25*	*Vertical and horizontal milling machines*	*71*	*315*	*2½ & 1½(9)*	*169*	*42*	*95*	*25·25*	*11·35*	*45·0*
10	*30*	*Boring and turning machines, lathes, drills, &c.*	*102*	*673*	*2¾ & 2(10)*	*138*	*91*	*181*	*28·2*	*10·5*	*37·2*

* Roller bearings.

FULL COST OF ELECTRICAL ENERGY.

Table III.—*Slow-speed Horizontal and Vertical Condensing Engines. Direct-coupled.*

I.H.P. of engine.	Lbs. of steam per I.H.P. hour.			Total lbs. of steam per hour.			* Total lbs. of coal per hour.			† Cost of coal per hour, pence.			Output of generator, kilowatts.			Cost of current per B.T.U., pence.		
	Full.	¾	½	Full.	¾	½	Full.	¾	½	Full.	¾	½	Full.	¾	½	Full.	¾	½
25	15	17	19	375	320	238	54	46	34	2·9	2·5	1·8	14·7	10·6	6·4	0·197	0·236	0·282
50	14½	16½	18½	725	620	462	104	89	66	5·6	4·8	3·5	30·0	22·0	13·2	0·187	0·218	0·265
100	13½	15½	17½	1,350	1,160	875	193	166	125	10·3	8·9	6·7	60·5	43·5	26·0	0·17	0·204	0 258
250	13	15	17	3,250	2,820	2,120	465	405	303	25·0	21·7	16·3	155·0	110·0	68·0	0·162	0·197	0·24
500	12½	14½	16½	6,250	5,450	4,130	890	780	590	48·0	42·0	32·0	308·0	218·0	130·0	0·156	0·193	0·246
1,000	12	14	16	12,000	10,500	8,000	1,710	1,500	1,140	92·0	81·0	61·0	620·0	440·0	265·0	0·148	0·184	0·23

Table IV.—*High-speed Vertical Condensing Engines. Direct-coupled.*

25	21·0	21·5	22·5	525	403	282	75	58	40	4·0	3·1	2·2	15·0	10·7	6·4	0·266	0·29	0·344
50	20·0	20·5	21·5	1,000	770	538	143	110	77	7·5	5·9	4·1	31·0	22·4	13·6	0·242	0·263	0·3
100	19·0	19·5	20·5	1,900	1,460	1,025	272	210	147	14·5	11·2	7·9	62·5	45·5	28·0	0·232	0·246	0·282
250	17·25	17·75	18·7	4,320	3,330	2,340	618	477	335	33·0	25·5	18·0	161·0	107·0	72·0	0·205	0·238	0·25
500	16·5	17·0	18·0	8,250	6,380	4,500	1,180	910	644	63·0	48·5	34·5	326·0	236·0	149·0	0·193	0·214	0·232
1,000	16 0	16·5	17·5	16.000	12,370	8,750	2,290	1,770	1,250	133·0	95·0	67·0	655·0	475·0	298·0	0·203	0·2	0·225
1,000	13·5	14·0	15·0	13,500	10,500	7.500	1,930	1,500	1,070	103·5	80·5	57·5	645·0	467·0	290·0	0·161	0·172	0·198

Basis.—* 7lb. of steam per lb. of coal. † Coal at 10s. per ton. Steam pressure, 150lb. per square inch.

Table V.—*Gas Engines. Direct-coupled.*

I.H.P. of engine.	Town gas (heat valve, 700).							Producer gas.						Cost per B.T.U. in pence.								
	Cubic ft. per I.H.P. hour.	Total cubic feet per hour.			Cubic feet per kilowatt hour.			Lbs. of fuel per I.H.P. hr.	Total fuel per hour (lbs.).			Lbs. of fuel per kilowatt hour.			* Town gas.			† Dowson gas. Anthracite coal.			§ Mond gas. Bituminous coal.		
		Full.	¾	½	Full.	¾	½		Full.	¾	½	Full.	¾	½	Full.	¾	½	Full.	¾	½	Full.	¾	½
30	13·0	374	296	231	24·9	26·3	30·8	0·93	26·7	21·2	16·5	1·78	1·88	2·2	0·6	0·63	0·74	0·238	0·252	0·295	0·057	0·06	0·071
45	12·5	575	460	358	23·0	24·5	28·6	0·9	41·4	33·0	25·7	1·65	1·76	2·06	0·55	0·59	0·69	0·221	0·236	0·276	0·053	0·057	0·066
90	12·0	1,095	875	670	21 9	23·3	26 8	0·86	78·5	62·7	48·0	1·57	1·67	1·92	0·53	0·56	0·64	0·21	0·224	0·257	0·05	0·054	0·062
175	12·0	2,130	1,700	1,296	21·3	22·7	25·8	0·86	152·5	122·0	92·5	1·52	1·63	1·85	0·51	0·54	0·62	0·204	0·218	0·248	0·049	0·052	0·059
500	..	..	..	..	..	..	..	0·75	391·0	316·0	241·0	1·32	1·4	1·61	..	..	..	0·177	0·188	0·216	0·042	0·045	0·052
1,000	..	..	..	..	..	..	..	0·75	780·0	623·0	478·0	1·3	1·38	1·59	..	..	..	0·174	0·185	0·213	0·042	0·044	0·051

Basis.—* Gas at 2s. per 1,000. † Coal at 25s. per ton. § Coal at 6s. per ton.

Up to the present we have assumed the engine indicating three-quarter load, but to render our comparison more complete we will assume that the plant is extended until the engine is brought up to full load. Then, taking the mechanical case, the losses will increase in proportion, excepting that, roughly, 10 per cent. being the engine friction, remains constant. This means, with near enough accuracy, that the efficiency on full load will be about 57 per cent. instead of 55 per cent. But now we shall have greater proportionate losses on the lower loads, due to added shafting, &c.

To return to our case of 100 I.H.P. at three-quarter load—

	Full load.	¾ load.	½ load.
	133 ..	100 ..	67 I.H.P.
The losses are now 43% at full load	57 ..	57 ..	57 I.H.P.
Leaving	76 ..	43 ..	10 effec. B.H.P.

We now have an effective power of 43 B.H.P. at three-quarter load, as against 55 B.H.P. when the plant was only taking three-quarters of the load of the engine, and it will be seen that when it is necessary to drive only a small portion of the works requiring but a few horse-power, the engine must be working in the neighbourhood of half load, obviously, with most uneconomical results.

Turning again to the electrical side, when running the engine at full load, we shall have a slightly higher efficiency. The combined efficiencies of the engine and generator, together with the cables, will be :—

	Full load.	¾ load.	½ load.
Engine-generator	85	82	76
Cables	96½	98	99
Resulting in	82	80	75

From this we get the electrical power available at the motor terminals—namely :—

Full load.	¾ load.	½ load.
109	80	50 E.H.P.

The 10 H.P. motors are assumed to be working at three-quarter load (it must be remembered that the engine is at full load, because of extended plant, and not because the load on the motors has been increased), or 7½ H.P., and we find the input to be at this load

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9 E.H.P., which, into our available power of 109 E.H.P., gives 12 motors, with a total output of 90 B.H P. We thus get, with three-quarter and half-load respectively at the engine, an input to each motor of 6·7 E.H.P. and 4·15 E.H.P., and we may assume a corresponding output of 5·2 B.H.P. and 3 B.H.P., giving a total for the 12 motors of, say, 62 B.H.P. and 36 B.H.P. We must now deduct the friction on the working side of the motor, which will be constant at all loads. Taking this value as before, but this time proportionately to the greater output at full load—namely, 90 B.H.P., we get—

3½ per cent. of 60 B.H.P. = 2·1 B.H.P.
and 20 per cent. of 30 B.H.P. = 6 „

Giving a total of ..... 8·1 „

Tabulating the results we thus have :—

——	Full load.	¾ load.	½ load.
Indicated horse-power of engine	133	100	67
Electrical horse-power at motor terminals ..	109	80	50
Brake horse-power at motor shaft	90	62	36
*Effective horse-power applied to machines.	82	54	28
As compared with the result of mechanical transmission	76	43	10

* Arrived at by deducting the frictional losses of 8·1 B.H.P. from the brake horse-power at motor shaft.

This leaves us a margin in favour of electricity of 6 H.P. at full load, 11 H.P. at three-quarter load, and 18 H.P. at half-load.

There is yet another feature to be considered, and that is, whereas the frictional losses are usually constant in mechanical cases down to the lowest loads, through the inconvenience of throwing out sections of shafting, in electrical driving the idle section is at rest as the motor is stopped. This removes the motor and frictional losses in that section, but in our example we have taken it as though all the motors were running on the lower loads at a necessary lower efficiency. It is evident that our example will be improved if larger plants are considered, and the following example may be of interest.

It is assumed that from indications taken of the existing engine, it was found that 400 effective B.H.P. was required to drive the machinery. Then, taking the case where three-quarters and one-half of the whole plant is in operation, we get the following :—

Proportion of plant working	Full load.	¾ load.	½ load.	
Effective horse-power required by machines ..	400	300	200	B.H.P.
Frictional losses between machines and motor-shaft	40	40	40	„
Brake horse-power at motor-shaft.....	440	340	240	„
Electrical input, assuming 10 H.P. motors working at ¾ load	518	400	282	E.H.P.
Electrical horse-power at generator terminals, including losses in cables	537	410	285	„
Indicated horse-power of engine	615	485	356	I.H.P.
Against—				
By mechanical transmission, assuming frictional losses equal to 43% of the indicated horse-power of the engine at full load	700	600	500	I.H.P.
Or a decrease in steam by electrical distribution of	12%	19%	29%	

It is also worthy of notice that with electrical distribution the size of the prime mover is reduced from 700 I.H.P. to 615 I.H.P. if the plant is working at full load, and from 600 I.H.P. to 485 I.H.P. if the plant is working at three-quarter load, so it is apparent that in electrical driving a smaller prime mover can be employed, resulting in a saving that will go towards defraying the cost of the electrical plant.

In my opinion, the foregoing tables will afford a ready means of comparison if a change is contemplated from mechanical to electrical distribution, as it will only be necessary to compile a proposed electrical plant on similar lines to the examples submitted, and compare the efficiency with the result of the indications of the existng engine.

In the past there has been a great diversity of opinion as to whether each machine should be driven by a motor, or a number of smaller machines should be grouped together and driven from a short line shaft by one motor, but it is now generally recognised that where machines are in constant use, provided they are below a given horse-power—say 5 H.P.—grouping is the most desirable. This method most successfully overcomes the great variation of power that is experienced in the driving of small machines, due to the difference in the load, and the cycle of operations, and is naturally more efficient than if a number of smaller motors were employed on account of the necessarily lower efficiency, as well as more economical in first cost and upkeep. Moreover than this, the aggregate of the horse-power of the single motors would be much higher than the horse-power of the one motor driving the group of machines, as each of the smaller motors must be large enough to deal with the maximum load of its machine, whereas only a slight addition is required to the average working load in the case of the group motor, sufficient to be capable of dealing with the heaviest loads of a certain percentage of the machines in question.

The greatest care, however, must be taken that too many machines are not driven from one motor, or that they are not spread over too big an area, as this would only entail additional shafting, countershafts and belts, resulting in the distribution losses being greater than was the case with the system of engine and shafting. This is clearly demonstrated in Table II. In this table the bad examples of group-driving are printed in italics, and in test No. 5 it is seen that a 7½ B.H.P. motor, when driving three machine tools through 42ft. of line shafting, entails a loss of 10·5 per cent., whereas a similar sized motor, driving five machine tools through 150ft. of line shafting, shows a loss of 60 per cent. absorbed by friction. But if a proper system of motor units is employed, there would be no difficulty in obtaining a high efficiency, as it is only necessary to sub-divide the machines into the most efficient groups to suit the units. In the average engineering works, 5 B.H.P. can be taken as the smallest unit to be used, except in special cases of isolated machines, or machines used for intermittent working. This motor has an efficiency of 82 per cent. at three-quarter load, and can, therefore, be looked upon as an efficient power unit. In the majority of cases the other useful power units can be taken as 7½, 10 and 15 B.H.P., and only in works where very heavy materials are handled will it be found necessary to have larger units, except, of course, for individual machine driving.

In these days of specialisation, it is of the greatest importance that machinery and departments should be arranged with a view to economical and increased output, and it is now possible for the works organiser to achieve this result without taking into account how the power has to be delivered to the machines. It is no longer necessary to arrange the machinery in parallel lines down the works, so that it can be driven from line shafts supported from the main girders, as is the case with the best arranged mechanical distributions ; but under the same roof he can have as many sections or departments as he wishes, each entirely self-contained

It is quite probable that in attaining this result some sections will not be driven as efficiently as may have been possible, but provided the production is increased by the arrangement with the same outlay in labour, it justifies itself. The saving of power in such an instance is of secondary consideration. Now that there is no longer the weight and strain of heavy shafting on the girders to contend with, lighter structures can be used, resulting in a material reduction in the cost of the building, thus further defraying the cost of the electrical plant.

Then the advent of portable machine tools and other labour-saving devices has been rendered more possible by the electric motor, and the economies to be obtained by these methods of manufacture are daily becoming more apparent.

Again, in new works there is always a danger with mechanical distribution of the power plant becoming too small as the business increases, with disastrous results as far as further development is concerned ; but an electrical system is perfectly elastic, it being only necessary to put down another generating unit and an additional panel on the main switchboard, and this can be done without in any way affecting the efficiency of the existing plant.

It is now possible for the smallest user to obtain electricity for power purposes at a price varying from 1d. to 2d. per unit from our corporation and supply companies, and this must be of vital importance to young firms who require their available capital for other useful purposes, especially when they have the knowledge that their power costs them comparatively little more than would have been the case if they had had a plant of their own.

As a conclusion to this Paper, I thought that a set of tables giving the fuel cost of generating electricity by direct-coupled steam or gas-engine sets, would be of interest, if only to show the figures that our steam and gas engineers are prepared to guarantee.

The steam tables have been compiled from data kindly supplied to me by Mr. George Saxon and Mr. W. Stead, and the gas engine table from data received from Mr. H. N. Bickerton.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

" Manipulations et Études Électrotechniques." By L. Barbillion. (Paris : Vve. Ch. Dunod.) 12fr. 50c.

" Das Elektrotechnische Institut der K. K. Technischen Hochschule In Wien." By Prof. Karl Hochenegg. (Berlin : Julius Springer.) 10m.

" Essais Industriels des Machines Électriques et des Groupes Électrogènes." By F. Loppé. (Paris : Gauthier-Villars.) 8fr.

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DIRECT-READING MEASURING INSTRUMENTS FOR SWITCHBOARD USE.*

BY KENELM EDGCUMBE AND FRANKLIN PUNGA.

(Concluded from page 947.)

Methods of Connecting Wattmeters for the Measurement of Power.

Direct Current, or Single-phase Alternating Currents.—Figs. 15 and 16 show two methods, either of which can be employed. In Fig. 15 the watts spent in the current coil are included in the power measured, while in Fig. 16 the watts taken by the volt coil and its series resistance are included. The latter method is, as a rule, to be preferred, in that the voltage is usually fairly constant throughout a set of readings, and hence the necessary correction can be determined once for all. It is readily found by connecting up the volt coil only, the load circuit being open. The

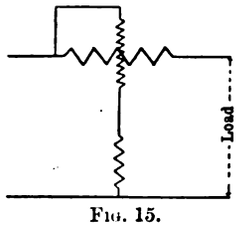

Fig. 15.

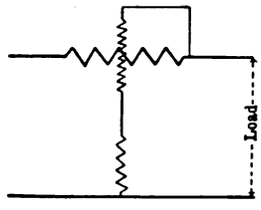

Fig. 16.

deflection (in watts) so produced has to be subtracted from all readings taken at that voltage. If the connections are as shown in Fig. 15, the correction is found by connecting the shunt coil across the terminals of the current coil when a given current is flowing through the latter, and noting the deflection.

The necessity for applying a correction can be obviated by the simple expedient of putting a second winding on the fixed coil and connecting it in series with the moving coil in such a way that the current flows through the auxiliary winding in the opposite direction to that in the main winding. If the number of turns of the two coils be made the same, and if the instrument be connected up as shown in Fig. 16, there will clearly be no deflection whatever when the volt coil alone is in circuit, and no correction is necessary.

Two-phase Systems.—If the load is unbalanced two readings must be taken, the wattmeter being connected first across one phase and then across the other. The sum of the two gives the total power. If the load is known to be balanced, as can be assumed to be more or less the case with motors, it is only necessary to take a reading on phase and to double it to obtain the total power.

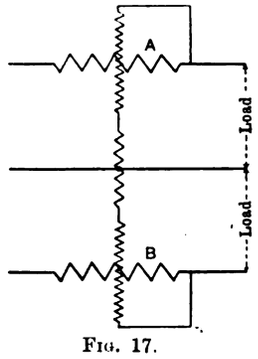

Fig. 17.

Three-phase Systems.—If the load is unbalanced two readings are necessary. The connections are shown in Fig. 17, where A and B are either two wattmeters, or the same instrument connected first to one circuit and then to the other. The sum of the two readings gives the total power supplied to the load. For convenience, the movings coils of the two instruments A and B could be fixed to the same spindle, so that the pointer indicates directly the total power. The question of insulation is, however, a difficult one in a double instrument of this kind, except in the case of low voltage. It is, moreover, necessary, if any degree of accuracy is aimed at, that the two instruments which are connected together should follow precisely the same law; that is to say, that the scales for both instruments should be the same.

With a balanced load three equal resistances are connected in star across the three phases, the moving coil of the instrument being included in one of these. The series coil is placed in the phase to which the moving coil is connected. The total power will in this case be three times the instrument reading.

* Abstract of a Paper read before the Institution of Electrical Engineers on March 24th.

[The next section of the Paper is on "Phase Meters and Power-factor Indicators," a subject which was well discussed in a correspondence in our columns last year in connection with an article on Messrs. Elliott Bros. power-factor indicator (see *The Electrician*, Vol., LI., pp. 168, 300, 339, 381, 422, 462)].

Current and Voltage Transformers.*

Allusion has already been several times made in this Paper to the use of transformers in connection with measuring instruments.

To design a satisfactory current transformer the following points must be attended to:—

1. Iron of the highest quality must be employed.
2. The magnetic circuit must be as short and as perfect as possible.
3. The ohmic resistance of the secondary circuit (including transformer winding, connecting leads and instrument) must be as low as possible.
4. High self-induction, far from being a disadvantage, is actually an advantage so far as independence of frequency is concerned.

A most interesting Paper read by Mr. Albert Campbell before the Physical Society† gives a number of figures which illustrate the correctness of these assertions.

The following is an abstract of the discussion which took place on March 24th in connection with the above Paper:—

Col. R. E. CROMPTON, in congratulating the authors upon the Paper, said that the only criticism that he had to pass was that it suffered from a fault which was really due to the Institution. The somewhat hard rule was imposed that an author was debarred from saying too much about his own work when he was in the position occupied by Mr. Edgcumbe. In consequence, the practical experience which the authors had gained in their business was denied to the members of the Institution for fear that the Paper be called an advertising one. The authors did not tellus how to make the instruments and how to solve some of the most disagreeable difficulties which the users of instruments met with continuously owing to difficulties in construction, difficulties in packing and carriage, and difficulties in connection with corrosion when the instruments were used in the moist or warm atmosphere so often found in engine rooms or elsewhere. The full description of the method which Messrs. Crompton & Co. had devised for getting over these difficulties would be sent in for publication in the Institution *Journal*, but, briefly, the object of it was to enable a station engineer to have a ready means of bringing all his instruments to as correct a reading as when they were first calibrated. The system made use of two portable instruments which he had termed gauges. The sub-committee of the Electrical Standards committee, which was dealing with electrical plant, had now almost reached the point of standardising switchboard work, and it seemed to him not to be a Utopian dream that there might be standard instruments that made a given deflection with a given number of milliamperes or millivolts, as the case might be. His device really consisted in standardising the manufacture to such an extent that, for instance, all the voltmeters turned out would be identical—*i.e.*, that with a certain number of milliamperes definite deflections would be obtained to one or more points on the scale. They had heard a good deal of Madame Curie and the work she had done, but the authors had not mentioned how much we were indebted to her for her series of Papers on the tempering point or plunging point of magnetic steel in order to get practical magnetic permanence. The users of the method, by following her specifications, had been able to get magnets of extreme permanence without any experiments or difficulties on their part. It was possible by suitably-devised tools to make the air-gap of moving-coil instruments accurate to within dimensions which mechanical engineers thought impossible. It was also possible to make instruments interchangeable at the contacts by which the current entered the moving coil and in the springs themselves. It would be found that a good many errors which were put down in the Paper to electrical causes disappeared from simple excellence of mechanical workmanship. Once a manufacturer set himself to produce such accurate workmanship, the cost of manufacture was very greatly reduced. It would then be found that the moving-coil instrument cost very little more, if any, than the moving-iron instrument. So long as the personal skill of the man who made the instruments was depended upon and attention was not paid to the perfection of the tools with which they were made, great progress could not be expected. In order to apply successfully the pair of "gauges," which he had mentioned, the instruments on the board should have their controlling spring easily accessible and removable without removing any other important part of the instrument. By their use it had been found that instruments could be taken out of stock, put on a switchboard and gauge-marked, and guaranteed to percentages which were mentioned in the Paper. This was done after the switchboard was erected. Another point of extreme difficulty was to provide against corrosion, and he hoped that something would be heard in the discussion about the springs and the pivots in this connection. Iridium and those kinds of metals acted satisfactorily as pivots, but such climates as were found in India and even in England were very hard upon the polished steel surfaces of the instruments.

Mr. J. RENNIE said that there should be some understanding as to what accuracy really was. Instruments had been sent to the Board of Trade Laboratory that induced remarks which he was afraid the chairman would not care to hear repeated. Some of the most extraordinary things

* See also an article by Mr. Punga in *The Electrician*, Vol. LI. p. 1,008, in which the design of these pieces of apparatus is fully dealt with.—Ed. *E.*

† *Phil. Mag.*, September, 1896, p. 271.

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were asked. Instruments costing 30s. were sent with a request that they should give readings of the highest possible accuracy, and he was afraid that with all his skill in writing plausible letters he did not always satisfy the senders that they were asking an impossibility. When this question of accuracy was settled they could attack the question of terminals and such trivial but very important things as the form of the scale. If he were to hazard an opinion, he would say that the scales should all be marked simply in divisions. He was glad to see the strong approval which the authors gave to moving-coil instruments, and he wished they had said a little more about them in respect to the shunts. Col. Crompton had spoken about standardising, and he wished they would standardise the shunts. Many years ago they had a shunt at the Board of Trade which was 5ft. long with 1,500 amperes, and worked with a drop of 1½ volts. Not many months ago they had one 8ft. long, and here again the current was very large—about 3,000 amperes—and the drop was also 1½ volts. It was quite an easy matter to get a moving coil instrument which gave indications with $\frac{1}{10}$th volt drop perfectly securely, and he thought that if the instrument makers were pressed a little harder they would give even less than this. The reason for having a small drop of volts was obvious when the cost of the shunt was taken into account. For the last 12 or 14 years the upper limit of measurement for direct current at the Board of Trade laboratory was 2,500 amperes. but an equipment had just been put in for 7,000, and it was hoped to increase it to 10,000 bye-and-bye. It was decided that a moving coil equipment would be the best, and when they began to discuss the matter with instrument makers they found they were faced with a cost of something like £60 for the 10,000-ampere shunt, and the metal was enormous. The size also was such that he hesitated having it brought into the establishment. On account of this experience, therefore, he asked that the question of shunts should be gone into, and if the Standardising committee would only get the opinion of the instrument makers and standardise the ammeter voltage, say, at $\frac{1}{50}$th, things would work very much smoother than they did now. At the opposite extreme he ought to have mentioned that some time ago they had a shunt sent to the Board of Trade as a part of an ordinary energy meter which had a resistance of 26½ millionths of an ohm. It carried a current of 4,000 amperes and they could see with what a very small drop that meter was working. He would have liked the section on hot-wire instruments to have been a little longer. They had been lately driven to thinking of these because of the need for measuring large alternating currents, and seeing that the moving-coil indicator was such a very handy thing they at once said they wanted a dynamometer which would deal with voltages something near to $\frac{1}{10}$th. There was surely room for something of the hot-wire kind to answer the same purpose. Mr. Trotter had made some experiments which showed that it would be quite possible to get a hot-wire arrangement to work with very much less than 1 or 2 volts.

Mr. ALBERT CAMPBELL said that the question of the average number of ampere-turns used in moving-coil instruments was interesting, and also what kind of effects one might expect from changes of temperature, frequency and wave-form. The deflecting forces used in instruments were also interesting, and the amount of power taken. Mr. Rennie had talked about reducing the size of shunts or the drop of volts on shunts of moving-coil instruments. The difficulty was that if the shunts were reduced, the drop of volts was reduced, and the temperature errors became very important. If a reduction were made to, say, $\frac{1}{100}$th volt, copper must be used entirely in the measuring instrument, and copper shunts could not be employed because the heating would be so objectionable. The point he would like to mention about the arrangement which he had designed, and which was in use in many instruments now, was that it practically allowed the use of the minimum drop of volts and yet have perfect compensation. With one of these compensators it was possible to have complete temperature compensation and still work with a drop of volts of $\frac{1}{13}$th. A small point that the authors might perhaps give a little more information upon was in connection with set-up instruments. These were very useful in that they widened out the top of the scale and gave a large deflection for a small difference in the quantity to be measured, but it would be very useful if a little more data could be given as to how setting up instruments affected the readings. With regard to the use of transformers for measuring extremely large currents, this question had been gone into very thoroughly at the Central Laboratory in Paris. The results of experiments upon some rings only 6in. across, both theoretically and practically, were an entire corroboration of what he himself had stated on a former occasion. He recommended air transformers for extremely accurate measurements, because there was no trouble with hysteresis and such things.

Mr. SYDNEY EVERSHED cordially agreed with many of the expressions of opinion in the Paper, but of course there were many others in which he differed from the authors, and he would therefore run through the Paper and note the various points which might be commented upon. The first was the question of scales. In the early days everybody used engraved scales, which were practically everlasting but expensive and difficult to produce, and not necessarily very accurate. If they were inaccurate they remained inaccurate for ever. Another kind of scale was enamelled paint, but with this it was practically impossible to get an accurate scale, because no mechanical process had been devised for putting the marks on the enamel. The enamel also chipped off after a time, in a hot engine room, for instance, and as a result of experience with engraved and enamelled scales most people were going round to paper, against which there was a great deal of prejudice, chiefly on account of the name. It ought to have been called dessicated cellulose. It lasted well under all conditions and could be varnished, printed or marked by mechanical processes, Several firms employed it, and an ingenious process had been introduced by Messrs. Hartmann and Braun. Paper was the scale of the future. Referring to Mr. Campbell's remarks he said there was no difficulty from the fatigue of a spring in a set-up instrument. It was a remarkable fact that a set-up spring had less fatigue than one which was allowed occasionally to go back to zero. The principal disadvantage in setting up the spring was that the errors in the instrument were magnified quite as much as the readings were. There was rather a curious figure in the Paper—viz., the value of the field in the air-gap in moving coil instruments, and he wanted to correct the impression that it gave before it got stereotyped. The figure mentioned was 700. It was just possible, of course, that in the instrument manufactured by Messrs. Everett, Edgcumbe & Co. the field might have this value, but it did not follow that it was the same in all other instruments of that type. He could only give the fields employed in the instruments made by his firm. Instruments having indexes of from 3in. to 5in. in length had fields varying from 1,500 to 1,700, whereas with a 10in. scale the field would be a little over 2,000, and in instruments having an index of 18in. the largest size of the field would be 4,500. He believed the latter to be the largest field ever employed in a commercial switchboard instrument. The moment of inertia increased as the square of the length. It was important to increase the forces if the movement was to be kept rapid, and this could only be done by increasing the field. As far as possible he had always attempted to increase the force at the same rate as the moment of the inertia increased. With regard to permanent magnets used in moving-coil instruments, in spite of the very valuable work done by Madame Curie, all permanent magnets must be treated in some way to protect them from the various diseases which might attack them in after life. The processes which had been used had been called artificial ageing, but this seemed to him to be a complete misnomer, because it gave a totally wrong impression of what had to be done to the magnet. It might as well be said that in vaccinating a baby it was being artificially aged. One of the diseases of the magnet was temperature, and, therefore, it must be put through a process which made it immune to variations of temperature. The next disease which might attack a magnet was natural decay, but no vaccination had ever been discovered to correct that in the baby. In the case of the magnet, however, it was possible to leave it in such a state that natural decay was practically impossible. At all events it had never been observed by him during his investigations, which had been many and elaborate. A third disease was one which rather resembled sudden death—viz , demagnetisation. Nothing would ever protect a magnet against demagnetisation. If a magnet was put in a field of anything like 100 it would be demagnetised, no matter of what it was made or how it had been treated. The magnets of moving-coil instruments did not get into fields of that sort, but they had to be protected against more moderate fields. When these three processes had been carried out, the permanent magnet was really permanent. It was quite true that something depended upon the shape, and that a bar magnet could be more easily tested than a ring magnet, but with moving-coil instruments the magnets were nearly all practically closed circuits. One of the advantages of moving-coil instruments from the instrument makers' point of view was that everything could be determined beforehand. But when it came to making large instruments, with indexes something like 12in. or 14in. in length, this was not quite true. It was not possible to predetermine the amount of damping due to the air friction against the index. To give an idea of how important this might be in an indicator of 12in. in length and 1mm. diameter, the damping torque due to the eddy currents in the copper bobbin on which the coil was wound was something of the order of 233, whilst the damping torque due to the index itself was no less than 90 to 130, depending upon the extent of the swing. The next point he wished to touch upon related to springs particularly in moving-coil instruments. The ordinary spring which nearly everyone used was made of phosphor bronze. The temperature coefficient was 0·061 per degree centigrade, whilst the springs used by the Allgemeine Elektricitats-Gesellschaft had a temperature coefficient of 0·24, approaching that of copper. At first sight it would appear that everyone should use phosphor bronze because of the 0·061. Unfortunately, however, the specific resistance of this was 15 to 16 microhms, whilst that of the other was only about 2·9 microhms, so that it was about as broad as it was long. The authors did not like the use of soft iron, but perhaps that was because a rival maker had introduced this. It seemed to him essential that the iron in an instrument should be soft. The air damper which he devised some years ago had given him a good deal of trouble at one time, but he believed it to be the best form of air damping ever introduced, for it was extremely difficult to devise an air damper which did not add to the moment of inertia of the instrument. On p. 18 there was a drawing of a most ingenious air damper, a piston moving in a circular cylinder. That damper introduced a very large addition to the moment of inertia of the instrument. Some time ago he had the curiosity to measure the difference in the damping of the cylinder form made by Messrs. Everett, Edgcumbe & Co. and that of the type manufactured by his own firm, and he found that whereas with his own damper the damping was no less than 8·8, the damping due to the piston in the circular cylinder was only 2·8, about one-fourth or one-third as much. This had a very important bearing on switchboard instruments because it affected the time taken by the instrument to come to rest. This in his own instrument was 1·2 seconds, whilst in the Everett-Edgcumbe instrument it was no less than 4·5 seconds. But there was another important difference in these two dampers. The authors stated that the clearance between the piston and the cylinder was only 0·015in. The damper which he introduced had a clearance of 31 mils—*i.e.*, more than double. This was very important because, naturally, the damper which had a big clearance was a more practical thing and more likely to last. As a matter of fact, if he were to make the damper clear the box by 15 mils the instrument would be absolutely aperiodic. He quite agreed with the authors as to hot-wire instruments, and he thought the time not very far distant when they would totally disappear. He had come to the conclusion that the defects in

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them were inherent and not due to the design at all. He believed that in future we should have moving-coil instruments for direct-current work and moving-iron instruments for alternating-current work, and that both would be absolutely dead beat. Dealing with induction ammeters, voltmeters and wattmeters, he said he regarded these as the most curious type of instrument mentioned in the Paper. Some years ago a man came to him with a frequency meter—at least, he said it measured frequency. He (Mr. Evershed) had asked if it was effected by the volts at the terminals, and the answer was that this was so to a small extent, but that on the whole it measured the frequency fairly well. He did not take up the instrument because it did not appear to have been developed into a very practical thing, but that same instrument was now being used as an ammeter! It was quite true that its readings varied with the frequency and that when the frequency varied 50 per cent. the readings varied 25 per cent. But still it was a very much better ammeter than it was when it had been brought to him as a frequency meter. These remarks did not apply to the voltmeter because it was possible to make that an accurate instrument, although he did not think it had yet been done. But as regards ammeters he thought there were almost insuperable difficulties in the way; inherent in the principle. The authors stated that the temperature coefficient of such instruments was small. It was just possible that lately some device had been introduced to reduce the temperature coefficient, but so far as he was aware the ammeters had a larger temperature coefficient than any ammeter in the world. All these induction instruments had a rotor which was usually composed of aluminium or copper. These both had a temperature coefficient of 0·38 per cent. and that entered directly into the readings of the instrument, so that such an instrument could not have a temperature coefficient of less than 0·38 per cent. whilst it could have a great deal more quite easily. Fig. 12 showed the instrument made by the Allgemeine Elektricitäts-Gesellschaft. In this instrument the induction due to a single coil not only produced an E.M.F. in the rotor but it also induced an E.M.F. in a disc and therefore induced currents both in the rotor and the disc in the same place; and as both the rotor and the disc were made of copper or a metal having an equal temperature coefficient, one had the temperature coefficient of the disc in addition to that of the fixed inductor and that instrument, unless corrected, had a temperature coefficient of something like 0·76 per cent. Of course, that error could be got rid of by making the rotor of some metal having a negligible temperature coefficient, but when this was done the resistance of the rotor was increased enormously, and therefore there was very much less torque. There was still the same weight, but nothing to move it, and it was much better to use soft iron instruments. He would be very glad to hear that these difficulties had been overcome. At present he did not know what these instruments measured. He had an idea that they measured the frequency of the credulity of the engineers who used them.

Prof. W. E. AYRTON referred to the mention of stray fields and the errors due to them. Some little time ago he had a magnetic survey made of the switchboards of one of the well-known London central stations, which was very easy to do with a portable magnetic field tester, and the result was that fields far greater than those mentioned by the authors existed. With 1,000 amperes flowing along an endless circle a metre away from a given point there was a field of 2 C.G.S. units, but in some cases the magnetic field was as high as 71 units at the switchboard, 36 times that referred to in the Paper. Thirty-five and 20 units were quite common at different parts of the switchboard. It was clear, therefore, that what had to be dealt with were errors much larger than 2 C.G.S. units, and it could easily be seen how this arose. An ordinary switchboard was more than 2 metres high, and if there were 1,000 amperes at the omnibus bars top and bottom, that would give twice as much as the quantity referred to by the authors, but, as a matter of fact, in many central stations there were 4,000 amperes, and as the instruments could not all be in the centre of the switchboard, fields many times greater than those he had just referred to were encountered. Last year, when he had to advise about the disturbance of the compasses in ships where dynamos were used, he had a similar survey made of the generating station, which was not near the switchboard, and with modern multipolar dynamos and hundreds of kilowatts the field was very small indeed, of the order of 0·27 and 0·219, &c., not very much larger than the horizontal forces due to the earth's field. Therefore, the disturbance in a modern central station was not at all due to the dynamos, but to the currents in the conductors, and, as he had just explained, that field might be 20, 30 or 40 times as great as that referred to in the Paper. One other point which the authors quite rightly referred to was in connection with the thermo-electric effect in shunts when using large currents. He had had to make experiments with cables of some thousands of amperes, and the same difficulty had occurred, but it had been overcome by an arrangement due to Messrs. Hartmann and Braun, in which constantan connecting pieces for the instrument wires were interposed between the constantan shunt and its copper terminals. Referring to electrostatic instruments, and to the arrangement of condensers attributed by the authors to Peukert in 1894, he quoted the claims of a patent specification five years earlier: "Such combination of a condenser with an electrostatic voltmeter for the purpose of measuring very high pressures without the necessity of having two surfaces, working parts. . . . ." Another claim was "and the combination of a condenser with an electrostatic voltmeter for the purpose of altering the law of the instrument." One of the difficulties of an electrostatic instrument was that the readings were very much crowded at the beginning and open at the ends. With the device mentioned in the patent specification referred to it was possible to make the scale more or less uniform. With regard to wattmeters, the author gave a formula on p. 946 which, it was stated, was approximate, but he was not altogether in favour of this formula, for this reason. This formula apparently showed that the true power was always greater than the wattmeter reading, provided tangent ϕ had a positive value. That was to say, that in any ordinary self-inductive circuit W must always be less than W'. But this was not the fact. W might be greater or less or equal to W', depending entirely on the ratio of the time constant of the pressure circuit of the wattmeter to the time-constant of the circuit, the power given to which it was desired to measure. It might be greater, equal, or less, and also, which did not appear from the authors' formula, it was a very important thing to remember that when tangent ϕ was negative then W and W' might differ in sign, and they got that the wattmeter would be reading negatively whilst the true power was positive.

The PRESIDENT said it would be necessary to adjourn the discussion until April 14th, when, in addition, a Paper by Mr. M. B. Field on "Eddy Currents and Eddy Current Losses in Cable Sheaths" would be read.

THE ELECTRIC STEEL FURNACE AT GYSINGE, SWEDEN.*

BY F. A. KJELLIN.†

The problem of smelting steel by electricity attracted years ago the attention of inventors, and as early as 1879 C. W. Siemens constructed his first furnace for the smelting of metals, especially steel. His furnace was of the arc type, in which the voltaic arc was formed between a carbon electrode and the metallic content of a crucible, the length of the arc being regulated by an electromagnetic device. This electric furnace, as well as others of similar construction, has the inconvenience that the source of the heat—the voltaic arc—possesses a temperature of 3,700°C., which is much more than that required by steel smelting. The result of the use of this intense heat is that the steel is overheated in the vicinity of the arc, while in other parts of the furnace it has not yet reached the temperature suitable for teeming. Another inconvenience is that the steel very easily takes up impurities from the electrodes consumed. The cost of the electrodes also is an item that sensibly increases the cost of production, and the carbon monoxide resulting from the oxidation of the electrodes exerts a bad influence, as it prevents the steel from giving off the carbon monoxide dissolved in it. A more uniform heating of the steel can be obtained by passing electric currents of great intensity through the steel, and using the heat evolved by the resistance of the steel for the smelting. But as the resistance of metals, even when molten, is comparatively low, the currents used must be so great as to necessitate copper cables of a section at least as great as that of the steel in the furnace.

Mr. de Laval, the Swedish inventor, has tried to diminish this inconvenience by using molten slag instead of steel as resistance in his furnace; but the results cannot have been satisfactory as the patent has been allowed to expire. The greatest difficulty in electric furnaces of this kind comes from the electrodes, for the reason that carbon electrodes, having high resistance, cause great losses of energy, and are soon consumed with molten steel. Water-cooled iron electrodes could possibly be used, but then the magnetic properties of the iron create new difficulties. In order to get sufficient intensity of current, alternating currents must be used, and then the magnetism causes the concentration of the current at the surface of the electrodes (skin effect), and the result is great current density in the electrodes withgreat losses of power, and, owing to self-induction, a diminished capacity of the electric generator. In order to eliminate these difficulties, I proposed in May, 1899, to build an electric furnace at Gysinge without electrodes, and I went to Gysinge to carry it out.

The illustration shows a cross section of the furnace. An annular groove, AA, forms the furnace room, the sides and bottoms of which consist of refractory bricks. The covers BB close the furnace. In the centre of the circle formed by the furnace room is a quadrangular core, C, formed of iron laminations. The coil DD is connected to an alternating current generator. When passing through the coil the current excites a varying magnetic flux in the core, and the intensity of current in the steel is then almost the same as the primary current multiplied by the turns of wire in the primary coil. In this way it is possible to use an alternating-current generator of high tension and yet—without using transformers with copper cables of large sections and costly electrodes—obtain a current of low voltage and great intensity in the furnace. In February, 1900, the first furnace at Gysinge was ready for use, and by March 18th the first steel ingot was cast, which was of an excellent quality. The problem was then solved technically, but not economically, for, with an electric generator of 78kw., only 270kg. of steel were produced in 24 hours.

The next furnace built was ready in November, 1900, and produced with 58kw. from 600kg. to 700kg. of steel ingots in 24 hours. The charges were composed of 100kg., and the time between the teemings from three to four hours. The output was not fully satisfactory, because the cooling surface of the walls was too great com-

* A Paper read before the American Institute of Mining Engineers.
† Gysinge, Sweden.

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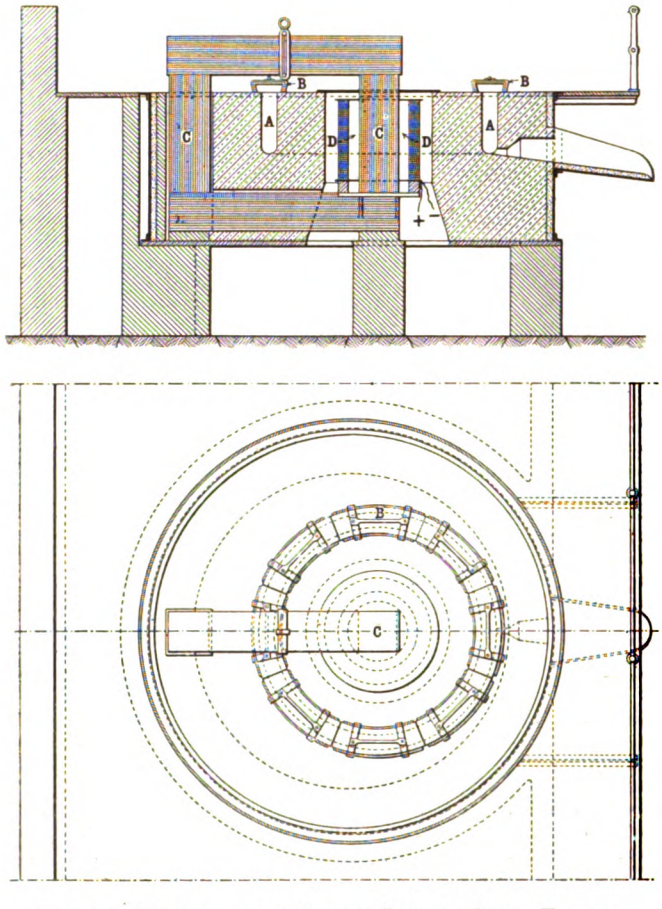
pared with the contents of the furnace, and the cost of repairs was also rather high. On August 11, 1901, the sulphite pulp mill of Gysinge was completely destroyed by fire, and it was then resolved not to rebuild it, but to use for steel smelting the water power formerly absorbed by the pulp mill.

The new plant was ready to start in May, 1902, and has since that time worked satisfactorily. It consits of a furnace containing 1,800kg. of steel, from which from 1,000kg. to 1,100kg. are taken out by each teeming, and the rest left to keep the current passing. The furnace produces with 165kw. 4,100kg, of steel ingots in 24 hours when charged with cold materials. The electric generator produces alternating single-phase current of 3,000 volts, which is transformed by means of the primary coil and iron core of the furnace into a current of about 30,000 amperes in the steel forming the secondary circuit. The smelting process, as carried on at Gysinge, produces only first-class steel, from the excellent Dannemora pig iron and weld iron. After teeming, about 800kg. of metal is left in the furnace to keep the current passing, and to this is added the proper quantities of pig iron, bar ends and steel scrap, such as experience has proved will give the percentage of carbon desired in the resultant steel. In teeming there is always less carbon in the steel than that contained in the materials charged, because the pig iron is rusty, and



PLAN AND SECTION OF THE KJELLIN ELECTRIC STEEL FURNACE.

the steel also takes up a little silicon by reduction of the silicic acid of the lining. When the charge is molten and over-heated to a suitable degree, the teeming is done in the same way as in the open-hearth furnace, by making a hole in the wall. The upper part of the furnace, as shown in the illustration, is on the same level as the working floor, and the charging is done simply by taking off the covers and putting in the materials. As the heat is produced in the steel itself, the slag is not so hot as in other steel furnaces, and consequently the workmen do not suffer much from the heat. The steel produced is, as mentioned above, of an excellent quality, unusually homogeneous, dense and tough, easy to work, cold when annealed, and less disposed to crack and warp in hardening than other kinds of steel. I think that the cause of these excellent qualities, apart from the good raw material used, must be due to the fact that the product contains less dissolved gaseous matter than other kinds of steel.

Even small quantities of gases, especially hydrogen, injure the quality of steel, and the principal cause of the high quality obtained by smelting in crucibles is, in my opinion, that the steel is not in contact with the fuel gases, though it may absorb a little through the porous walls of the crucible. In the electric furnace described above, the steel has no opportunity to take up such gases or other impurities, and the quality is even better than that of the crucible steel. To make special steels with nickel, tungsten or chromium offers no difficulties, and the alloys themselves are quite homogeneous. The cost of production depends principally on the efficiency of the furnace and the price of the power. In the furnace now in use at Gysinge the losses have been proved experimentally to be 87·5kw., so that the effective power absorbed by the steel is 165 – 87·5 = 77·5kw., and, as this produces 4,100kg. of steel in 24 hours, one effective kilowatt produces about 53kg. of steel ingots in the same time. Every additional kilowatt in the furnace, when the size is not altered, increases the output by 53kg., and it is calculated that within a few months, when a stronger water wheel is obtainable, it will be possible to produce about 6,000kg. of steel ingots with 200kw. As the absolute cost of labour and repair will be the same, the cost for 1 ton of steel ingots will be about two-thirds of the present cost, and the price of power per ton also will be sensibly diminished. At Gysinge the cost of repair (renewing the lining of the furnace when it is worn out) was £15. From experience with this furnace it is calculated that a furnace of 736kw. will produce 30,000kg. of steel ingots in 24 hours, when charged with cold materials. With hot materials the output is much greater. For instance, if 250kg. of molten pig iron are charged for each ton of steel ingots produced, the output is increased from 30,000kg. to 36,000kg. in 24 hours with 736kw. In my opinion, the costs of labour and repairs for a furnace of this type will be less than those of an open-hearth furnace of the same size; so that, where power is cheap, there is a possibility of producing a steel competing with the expensive crucible steel at a smelting cost not exceeding that of the open-hearth furnace.

THE USE OF AUTOMATIC MEANS FOR DISCONNECTING DISABLED APPARATUS.*

BY H. G. STOTT.

This subject may preferably be divided into three sections as follows:—(*a*) Generating apparatus. (*b*) Transmission apparatus. (*c*) Receiving apparatus.

(*a*) *Generating Apparatus.*—That no overload device should be used in the generating plant to disconnect disabled apparatus, may be stated as a general proposition Experience has probably been responsible for the evolution of the art to a point where it has become not only possible, but necessary, to eliminate all overload devices. Only a brief statement of the reasons for abandoning the use of overload apparatus will be necessary. In case of an accident to one generating unit, the other units in multiple with it will immediately begin to force current into the disabled one, and the increased load on the good units, due to their normal load plus the short-circuit current supplied to the crippled unit will, in all probability, trip all the circuit-breakers simultaneously, thus interrupting the service. Without automatic circuit-breakers the overload on the good units would cause the potential of the system to fall so low that the service would, in all probability, be as completely interrupted as in the former case, unless the attendant succeeds in locating and disconnecting the crippled unit immediately. Should he fail to do so, the service will inevitably be interrupted, and a great deal of damage done to the crippled unit by the current from the good machines. It is, then, evidently necessary to have some means of discriminating between a current coming out of the machine and one going into it. Modern apparatus can safely carry 200 per cent. or more load for a few minutes, but if a unit has become crippled it will immediately cease to be a generator and become a receiver. All that is necessary to do then is to instal on each generator a suitable circuit-breaker which will operate *only* when the direction of flow or energy through it is reversed. This type of safety device has been developed for both continuous-current and alternating-current apparatus so that it operates quite satisfactorily. As an additional precaution in large plants, a second reverse-current relay should be installed which will merely light up a letter or number in front of the operator so that in the event of the failure of the first automatic device the faulty machine may be quickly disconnected by hand. These reverse-current relays should have a time-element and current-limit attachment, which should be set for not less than three seconds, so that a slight reverse current, or one of momentary duration, such as is liable to occur at the moment of multiplying, will not operate the circuit-breaker.

(*b*) *Transmission.*—When transmitting power through overhead and underground cables, it is essential to successful operation to be able automatically to disconnect the feeders from (1) the generating station, and (2) if there are duplicate transmission lines, from the receiving station.

* Paper read before the American Institute of Electrical Engineers.

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1. At the generating station this should obviously be done by an overload circuit-breaker, whose operation is delayed by a time element which may be set at from 1 to 10 seconds, according to the local conditions. This is all the protection necessary or desirable where only one transmission line exists.

2. With two or more transmission lines in muliple, an entirely different set of conditions exist, as in case trouble develops in one, current will be fed back from the receiver end into the fault through the good feeders; the result will be that all the feeder overload breakers at the generating station will trip, thus shutting down the entire line and, in all probability, shutting down all synchronous receivers on the system, due to the resultant fall in potential. Reverse-current relays at the receiver end of the feeders operate satisfactorily, provided the fault is not severe enough to drop the potential. If, however, the fault amounts to a short-circuit the potential at the receiver end will fall so low that the potential coil of the differentially-wound relay will not receive enough current to enable the relay to operate. Reverse-current relays on the receiving end of feeders are not as yet to be depended upon, but recent improvements gives promise that we may soon expect to find a satisfactory solution of this important problem. When only two feeders are in use, a method devised by Mr. L. Andrews, of England, seems to be very satisfactory. At the receiver end the two feeders are connected together through a choking-coil wound entirely in one direction. The current is drawn from a tap in the centre of this winding. Under normal conditions the feeders supply equal current through each half of the winding to the tap, but as the currents pass in reverse direction through the winding the resultant flux is nil, and, therefore, the resultant inductance is nil, the only loss being that due to the ohmic resistance of the coils. Should a short-circuit occur in one of the lines, the current from the other line will flow through both halves of the reactive coil in the same direction, thus producing a strong choking effect and limiting the current to an inconsiderable amount. As the overload circuit-breaker on the faulty feeder at the generating station will trip immediately, it is then only necessary for the attendant at the receiving station to open-circuit the section of the reactive coil connected to the faulty cable and short-circuit the other half connected to the good cable. This device, I am informed, has given excellent results in England, but for obvious reasons would not be suitable for more than two feeders.

Where possible, the safest plan at present is, in the writer's opinion, to run the feeders entirely separate at the receiving end, only putting the continuous-current end of the rotaries in multiple; or in cases where low-tension alternating current (2,000 volts or less) is supplied, putting the secondaries in multiple. If, under these conditions, reverse-current relays are installed at the receiving end of the feeders they will operate very satisfactorily, as the reactance of the rotaries and transformers will be sufficient to limit the reverse-current in the faulty cable, thus allowing the reverse-current relays to operate, as there has been no serious fall of potential. The greater the number of feeders used between the generating station and the sub-station the better this method becomes, as, for instance, with two cables a fault in one will only reduce the capacity 50 per cent. until the operator can synchronise all the apparatus, which was running on the faulty cable, and as the apparatus and converters will continue to run at full speed, only a few minutes will be necessary to synchronise on the good feeder, which will in the meantime carry the whole load, so that no interruption to service will occur. With three cables this would mean a loss of capacity of 33·3 per cent., and with four cables 25 per cent., &c.

(*c*) *Receiving Apparatus.*—This should be treated in exactly the same way as the generating apparatus—namely, use reverse-current relays *only* to operate the circuit-breakers on the rotaries, &c., and use time-element overload relays only on the low-tension feeders leaving the sub-station. The above remarks apply generally to both continuous and alternating-current apparatus, with the exception of the part devoted to transmission apparatus, which, of course, only applies to alternating-current transmission.

The following discussion took place:—

Mr. W. F. WELLS: Recent experience with 6,600-volt revolving field apparatus in central power station practice has proved that automatic disconnective devices are not necessary in order to insure reliable operation of the system to which current is supplied, and that capable operators with good judgment can handle any cases that may arise better than automatic devices could be expected to operate. The instruments and controlling devices on each generator should be placed close together, and their positions so related that there could be no possible chance of the operator, when noting the indication on the instrument of one generator, becoming confused and by mistake opening the switch of another machine. In the station referred to each generator is equipped with an overload relay whose secondary is connected to a red lamp only, and the following indicating instruments: wattmeter, power-factor indicator, field ammeter, voltmeter and two ammeters. The first indication of any trouble is generally a drop in 'bus pressure, unusual noise from the generators, or lighting up of the overload lamps. A quick survey of the instruments enables the operator to determine if the trouble is on the generators or feeders. If on the generators, the wattmeter or power-factor indicator shows if current is reversed in any one of them, and the field ammeter shows if the reversal is due to open field circuit or loss of motive power. The character of the swing or vibration of the needles will show whether the trouble is due to some accident affecting the angular velocity, such as break in valve motion, or if it is due to faulty governor, cut off of steam supply or broken vacuum. After a short experience in any such station equipped similarly to the one mentioned, the operator is able almost immediately to locate the cause of the trouble, and, if he thinks advisable, open the circuit-breakers before any automatice device would operate, if properly protected by a time-limit element. During the past 18 months eight generators have been operated a total of 25,000 hours, and a careful analysis of every accident or mishap that has occurred has failed to show any necessity or even desirability of automatic disconnective devices. It is almost needless to add that the station was free from accidents that might have been caused by faulty operation of unreliable devices, and there was no expense incurred for maintenance and repairs of such devices. In the transmission apparatus it has been found best to set the time-limit overload relays on the feeders in the generating station for two seconds and at about 2½ times normal load. During the entire time that the station has been in operation, a period of nearly two years, it has always been the practice to run the high-tension feeders on what Mr. Stott refers to in his Paper as the safest plan—*i.e.*, entirely separate at the receiving end, only putting continuous-current ends of the rotaries in multiple. But as practically all the sub-stations are equipped with large storage batteries, which are also in multiple with the rotaries, it has been found best to operate without reversed-current relays, but depend on the operator in the sub-station opening the circuit-breakers when necessary. Here, as well as in the generating station, the operators very quickly learn to read from their instruments the nature of the trouble, and the disturbance to the system caused by any accident is always less than it might have been had automatic devices been depended on. In the sub-stations, the receiving apparatus converts the alternating current to 260-volt direct current, and here the only automatic device is an overload-relay on the high-tension feeders, and a centrifugal device which opens both alternating-current and direct-current switches of the rotary if its speed approaches too close to the danger limit. On the direct-current feeders there are no automatic devices. In general, on the entire system there are in use no automatic disconnective devices except those operated by the time overload relays on both ends of the high-tension feeders, and by the centrifugal speed limit device on the rotaries in the sub-stations.

Mr. CARL SCHWARTZ: As to the reverse-current relay for the generator circuit, I think that this relay should operate a lamp, and then, maybe in addition, a bell signal in order to call the attention of the operator, so that he could take as quickly as possible suitable steps to bring the load back to the generator, or disconnect this unit if it is unable to work. A reverse-current relay, opening the generator oil switch, is in that case not very essential and could be left out entirely; but if it is applied it should be provided with a time and current-limit relay. The exciter generator circuit must contain a reverse-current circuit-breaker acting as soon as the generator begins to run as a motor, the supply of the generator field being maintained by a storage battery. Referring to the transmission lines, I would say that at the generator end overload relays with a time-limit device will be generally sufficient. It is important that the overload as well as the reverse-current devices for the feeder lines are connected to each phase, as burn-outs between one conductor and the lead cover, not affecting the other phases of a three-conductor cable line, may occur. I refer here especially to the star-connected system.

Mr. R. S. KELSCH (communicated): A plant operated by the writer for five years was equipped with expulsion type fuse blocks using aluminum fuses, on the eight 750kw. generators, and the same type of fuse on the eight 5,000-volt transmission lines at both the receiving and the generating ends, and gave excellent results. On one occasion the collector rings for the field leads of one of the generators short-circuited when the eight machines were operating in multiple. The disabled generator was disconnected from the system without the trouble being recorded on the recording voltmeter in the city sub-station. On several occasions one or more of the lines were short-circuited by wire thrown on the transmission line, and on each occasion the disabled line was disconnected without interrupting the service. During the past year, relays have been employed and the fuses removed, and we have not had as good results. Recently a dead short-circuit on one of the secondary circuits protected by a time-limit overload relay set for three seconds caused the potential of the system to fall so low that all power service was interrupted. Reverse-current relays should be set to operate at 5 per cent. reverse current. Reversecurrent should not occur except under abnormal conditions, and under these conditions the apparatus protected by reverse-current relay should be disconnected instantaneously, and should not have a time-element attachment. A reverse-current relay so constructed would operate before the potential lowered sufficiently to make the relay inoperative. The only objection to setting a reverse-current relay to operate at 5 per cent. is the difficulty in synchronising. This, however, can be obviated by synchronising with the incoming generator pressure slightly above the 'bus pressure and the synchroniser indicating that the speed of the incoming generator is a trifle higher than the general system, which will ensure the incoming machine acting as a generator the instant the switch is closed.

Dr. F. A. C. PERRINE (communicated): One question which has been touched on by a number of Papers in this discussion, but which has not been specifically treated, is that of the proper sub-division of the lines for their protection from interference. The apparatus for line switching and line insulation has been treated for protection against lightning and the sub-division of the circuits has been considered, but it seems

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necessary to call attention to the fact that we have not, as yet, treated the question of dividing the line up into sections so that in case of accident the interference with the proper maintenance of supply by reason of the use of multiple lines shall not become excessive. The importance of this was recently called to my attention by some calculations I have been making on a line 350 miles long, for which figures have been requested. If two lines were installed for this transmission, using such a size of copper as the question of economy would best warrant, the regulation, when only one of the two lines was in service, would be too bad for the proper supply of energy to the service. In consequence, it was necessary to consider whether the size of line wire be increased or the line divided up in sections, which would permit cutting out only a short section in case of accident anywhere along the line. In lines approaching 100 miles in length, the capital invested in each pole line is very considerable, and in addition to the loss of energy which must be excessive if but one of the lines is in operation, there is a heavy capital charge during such times which must be carefully considered. On most long-distance lines there are points of distribution along the line which naturally cut such a line up into sections, and if switching stations are installed at these distribution points, permitting the transposition of the circuits, the effect desired can be accomplished, but it is not always possible to rely on the fortuitous arrangement of switching stations. With increased length of line, there may be a great distance between these switching stations, and, furthermore, the change-over switches operate under much more serious conditions when the sections they are controlling are long than when they are short. It is true that up to the present time there has been a general tendency to avoid multiplying switching stations on account of the imperfection of high-potential switching apparatus, and the increased danger induced will be somewhat above the necessary imperfection of insulation in the switching apparatus itself. Such imperfection, however, is not a necessity, and is one of the questions which must be solved in order to obtain satisfactory long-distance transmission. This problem solved, the multiplication of switching points is feasible, and this implies that with long lines, where two or three duplicate transmission circuits are established, it will become necessary to establish switching sub-stations for no other purpose than the cutting out of sections in the line when repairs become necessary, thus obtaining satisfactory regulation, the efficient employment of the large amount of chemical which is necessarily employed in the transmission for great distances. Such switching stations have been proposed as frequently as 10 miles apart. The ordinary practice is not to instal them more frequently than 50 miles apart. It is the writer's opinion that they should not be more distant than 25 miles, and their location at 15 or 20-mile points would be more practical. Handling circuits at this short distance will be easier on the switching apparatus itself. Where switching stations are installed 50 or 75 miles apart the high capacity of the line between switching stations increases the difficulty of switching; but even at the highest voltages transposition switches can be installed with comparative ease, provided only, as I have already said, their insulation be sufficient to prevent concern for the safety of the circuit from this cause. In connection with this question comes in the important problem of the use of automatic switching apparatus for such switching, and while the writer believes that the use of automatic switching apparatus be very advisable, at the same time we must recognise that at the present time the main problem of switching has not been so satisfactorily solved as to permit our consideration of automatic apparatus, however desirable it may be.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Sensitising Tissues for the Light Cure.—The physiological and bactericidal action of light increases from the red end to the blue end of the visible spectrum. The penetration of light, on the other hand, increases from the blue end to the red end. This means that the most active rays are the least able to penetrate any but the most superficial tissues, and the failure of the light cure in deep-seated affections is attributable to this fact. S. Leduc has worked out an ingenious plan which promises to get rid of this difficulty. He bases it upon the well-known effect of certain organic colouring matters in sensitising photographic films for the less refrangible rays of light, and on Dreyer's work on sensitised cultures of bacteria and infusoria. The cultures are sensitised by means of a $\frac{1}{10}$th per cent. solution of erythrosine, which by itself has no action upon them. The cultures are then exposed to light filtered through various media, such as quartz, glass, nickel sulphate, potassium chromate and potassium bichromate, and the effect noted in each case. The bacteria show no increase of mortality due to the sensitiser when exposed to the whole of the spectrum. But whereas the non-sensitised bacteria would live for nine hours under the action of the red and orange light, they are killed off in 25 minutes in the sensitised culture. The infusoria show an even more pronounced effect, death occurring after 10 seconds, instead of two hours. The penetrating rays thus acquire the same bactericidal efficiency as the violet and ultra-violet rays. The action is due to a real sensitisation, and not to an absorption of certain wave-lengths of light. For there are substances which absorb exactly the same waves and produce no corresponding effect. Neither do the results depend upon the production of a toxic substance by the illumination. For, if the illumination takes place independently and the bacteria are then introduced, they do not die off.

[S. LEDUC, *Arch. d'Électr, Méd.*, March, 1904.]

Propagation of N-Rays along Nerves.—A. Charpentier has found that it is possible, by means of the N-rays, to map out the nervous system of the living subject. If a small fluorescent screen is held in the hand, or placed on the tips of the fingers, its luminosity is increased if any other part of the skin is touched with a portable source of N-rays or with the end of a wire conducting N-rays. The increase of luminosity varies according to the more or less close nerve connection existing between the fingers and the point touched. Thus it is great when the trunk nerve of the arm is touched. The nerve may thus be followed right up to the brain, and it is found that in the brain itself the sides are changed, and the centres on the side opposite the fingers must be touched in order to produce a sensible effect. This is quite in accordance with the general laws of innervation. The author points out that a similar mapping out of the nervous system may be carried out by means of faradisation, but that the procedure is painful, whereas the N-rays are not felt. A screen placed over the heart shines out when the N-rays are applied to the neck where the pneumogastric nerve crosses, or better still, to the inferior cervical and superior dorsal regions of the medulla. Another effect recorded is the transmission of N-ray effects from one side to the symmetrical point on the opposite side.

[A. CHARPENTIER, *Comptes Rendus*, March 14, 1904.]

New Carbide Process.—Carbon only reduces the oxide of calcium at a temperature at which the latter becomes liquid. The manufacture of calcium carbide, therefore, requires an enormously high temperature and an electric furnace to produce it. It is pointed out, however, by H. Moissan, that metallic calcium combines with lampblack to produce calcium carbide at any temperature above red heat. In any electrolytic process, therefore, where calcium is produced in contact with carbon at a red heat, calcium carbide is formed. The author bases a new carbide process on these considerations, which, however appears not to have any commercial value, since the carbide obtained is firmly embedded in a fused mass of calcium chloride and fluoride. A graphite crucible, which serves as the positive pole, is filled with calcium chloride fused by means of a small electric arc. A vertical rod of graphite serves as a negative electrode. The chloride is put in gradually, and after the first fusion electrolysis is carried out by means of a current of 10 to 15 amperes at 120 volts. Chlorine is given off freely, and after an hour the process is stopped and the crucible broken. Under the crust is found a mass with a crystalline fracture. The central portion dissolves in water, and evolves a mixture of gases containing some 14 per cent. of acetylene, the rest being hydrogen. The process is greatly improved by mixing the chloride with a quarter of its weight of fluoride, which makes the fused mass more fluid and the conduction of the current more regular. The amount of carbide obtained is small, but it may be increased by adding to the liquid a coarsely-powdered mass of petroleum coke.

[H. MOISSAN, *Comptes Rendus*, March 14, 1904.]

Velocity of Light in a Magnetic Field.—Several investigations have been undertaken to determine the nature of the Faraday effect. The kinematical explanation of the rotation of the plane of polarisation in natural rotatory substances by the assumption of two oppositely polarised circular components which travel with different velocities has led many investigators to a similar explanation in the case of the magnetic

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rotation of the plane of polarisation. Such investigations have been made by Righi, Brace and Morley and Miller. In every case the method has been to note the shifting of the interference bands formed by the divided portions of the same beam, one portion of which has traversed a medium in a magnetic field. The observations have hitherto been unsuccessful, but J. Mills has now obtained a definite effect by a modification of the apparatns made by Morley and Miller, in which a tube of carbon bisulphide, surrounded by a magnetising coil, is placed in the path of each ray of a Michelson interferometer. In the new arrangement, the light was passed through a quarter-wave plate after leaving the Nicol, and the chance of a shifting of the bands due to any mechanical cause was entirely eliminated by substituting for the single quarter-wave plate a Bravais double plate giving right-handed circularly polarised light in one-half of the field and left-handed in the other. Thus, with the same current as before, an effect of four times the magnitude was to be expected. A distinct shifting of the fringes was noticed, and this shifting increased with the current. By interposing a rheostat in the system the current could be gradually increased until the shifting amounted to a full band—that is, until the fringes again coincided. The current was then about 13 amperes, and the corresponding difference of phase of the two circular components was 368deg. A shifting of four bands was noticed for a current of some 52 amperes, but the heating effects of such a large current made it impossible to obtain a set of readings for that displacement with the same degree of accuracy as was possible in the preceding sets. The author was unable to detect any asymmetry in the amount of acceleration of one component as compared to the corresponding retardation in the other.

[J. Mills, *Phys. Review*, February, 1904.]

Variable Motion of Electrons.—In a Paper on "The Internal Field of the Electrons," E. Kohl investigates mathematically the problem of the non-uniform motion as against the uniform motion of an electron, which has hitherto almost exclusively been dealt with. To do this he has to make very general assumptions, and he goes so far as to attribute a structure to the electron, supposing it to consist of smaller particles rigidly connected. He obtains three integrals for the complete motion of an electron, two of the integrals disappearing when the internal connections are rigid. He finds that in an electron in purely translational motion no couples occur owing to internal forces, and that, therefore, such an electron can only acquire a rotation owing to the action of external forces. Such forces might be brought into play in a highly non-uniform field, and then the electromagnetic energy would no longer be measured by the work of the convection current. The author discusses the question of the apparent mass of the electron, and inclines to the conclusion that it is only partly electromagnetic, on the ground of certain phenomena of emanation. That in all known forms of motion of electrons the motion is purely translational may be ascribed to the very small size of the electron, which makes every electric field comparatively uniform.

[E. Kohl, *Ann. der Physik.*, No. 4, 1904.]

Electric Resistance at Low Temperatures.—J. Dewar has investigated the resistance of a number of metals down to the boiling point of hydrogen, which he has shown by means of the hydrogen and helium gas thermometer to lie at −252·5deg. He arrives at the remarkable conclusion that the connection between resistance and absolute temperature in metals is not represented by a parabola having its vertex at the origin of co-ordinates, but by a curve resembling the sign *f*, and having asymptotes at certain values of the resistance, so that the resistivity of a metal can never exceed or fall short of a certain amount. The magnetic metals present the most striking curves, being at first sight quite unlike any of the others. But on closer inspection it is found that this is not so, and, in fact, they give the clue to the general connection between resistance and temperature in metals. The magnetic metals and gold are found to have negative values of Callendar's coefficient δ. Now, on examining the curves for the other metals, they are all found to be concave towards the axis of temperature for the arcs extending from the boiling point of water, through the freezing point, down to the boiling point of oxygen, while below the boiling point of oxygen these curves are convex to the axis. On the other hand, gold and the magnetic metals are already convex to this axis from the boiling point of water to the lowest temperature reached. It is clear that in no case can anything parabolic connect resistances and temperatures ranging from the boiling point of water to that of hydrogen. Just as we seek for a circle of curvature at any point of a curve, so in the present case we may, at a point or over a short range of the curve, seek for an approximate parabola, but any such parabola will be of little or no use for extrapolation. The alloys show a very slight slope in comparison with the pure metals. Of the latter, gold and silver are the most suitable for thermometry, since their temperature curves are nearly straight lines.

[J. Dewar, *Proc. Roy. Soc.*, March 10, 1904.]

Optical Ammeter.—E. Orlich describes a method of measuring currents which is employed at the Reichsanstalt for testing alternate-current ammeters. It consists in heating to incandescence a sheet of platinum foil by a continuous current and an alternate current in succession. If the effective value of the alternate current equals that of the continuous current, the amount of heat developed in the platinum foil is the same in both cases, and if the emission is also the same, the sheet must attain the same temperature in both cases. The equality of temperature may very conveniently be tested by Holborn and Kurlbaum's optical pyrometer. An image of the glowing platinum is projected by means of a lens upon the filament of a small incandescent lamp, which is observed through a second lens. The current feeding the lamp is so regulated that the filament apparently disappears in the bright background. Special provision has to be made for constancy of temperature. As regards radiation, it is kept constant by allowing the platinum to radiate into the open air, and the conduction of heat is kept constant by perforating the electrodes and supplying them with a stream of cold water. The temperature imparted to the platinum sheets varied from 400 to 1,400deg. At higher temperatures the method loses in sensitiveness, and the platinum begins to evaporate. The author quotes a number of tests of commercial ammeters. A Kelvin hecto-ampere balance with sub-divided copper leads gave correct readings, but a kilo-ampere balance containing massive leads required an alternate current 5 per cent. stronger than the corresponding direct current to produce the same temperature.

[E. Orlich, *Zeitschr. für Instrumentenk.*, March, 1904.]

Rubber Cultivation.—Amongst the many subjects treated in a 1903 *Bulletin* of the Imperial Institute, issued under the authority of the Board of Trade, that relating to the cultivation of rubber is of special interest to the electrical community. A report, dealing with the experimental cultivation of Castillon and Funtumia rubbers in Trinidad, states that Funtumia trees yield a marketable product at the age of 4½ years, while the other plant requires twice that time before it can be utilised to advantage. The Egyptian Sudan, especially the Bahr-el-Ghazal, forms a vast field for the cultivation of rubber, and the rubber forests there were placed last summer under official management in order to prevent a reckless and short-sighted system of cultivation. Experiments have been made at the Institute with the seeds of the Para rubber tree (*Hevea Braziliensis*), now acclimatised and extensively cultivated in the Malay Straits Settlements. These seeds were formerly regarded as a waste product, but it is now found that they may be used for the production of a light yellow oil capable of employment as a substitute for linseed oil, and said to be worth £20 per ton. The husk and kernel ground together yield, it is stated, one-fifth of their gross weight in oil.

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The Electrician.

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DANGER OF ELECTROSTATIC SHOCKS.

The unfortunate fatality which occurred on March 28th at the Charing Cross and Strand Electricity Supply Corporation's generating station at Bow was surrounded by very peculiar circumstances, and was of such a nature as to admit of only one probable explanation. It appears that the victim, a switchboard attendant named GEORGE CRATES, aged 22, went on duty as usual at 6:30 a.m., and at 1 o'clock was assisting in shutting down the generating plant in order that some repairs might be carried out. While so engaged he received a severe shock, and, in spite of efforts to restore respiration, he died before the arrival of the medical man who had been summoned. It will be remembered that the Bow station is employed for the generation of three-phase current at 10,000 volts, energy being transmitted to the company's sub-stations situated in various parts of London, where it is transformed to continuous current by means of motor-generators, and distributed in the ordinary way. Six cables are used for the transmission of energy at high voltage to the City and West End, and their total length is about 36 miles. Each has three cores, and the sectional areas of the cores are about 0·1 sq. in. After all the sub-stations had disconnected their motor-generators, the engineer-in-charge at Bow proceeded to reduce the generator fields and bring the engines to a dead-slow speed. This accomplished, he then broke the generator fields, and finally opened the main switches. The voltmeter at the generating station was observed to be standing at zero, and, signals being given that all was clear, CRATES commenced to remove the cable fuses. These fuses are mounted in heavy glass tubes, with about 8in. between the metal fittings at each end. All went well until the sixth fuse had been removed, but when the seventh—apparently the first fuse of the third cable—was being taken out there was a report and a flash, and CRATES fell backward with the fuse in his hand. Evidence given by the medical attendant was to the effect that the deceased had died from an electric shock, and that his face was scorched and his hair singed.

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Naturally, such an occurrence appears extraordinary, not to say mysterious, at first sight. According to the particulars at our disposal the generators were disconnected entirely, and, as they are star-wound with the centre of the star earthed, when they had been switched off the earth connection on the cable conductors was, of course, removed. Even if all the motor-generators in the sub stations had not been switched off as was stated, they could not have been sending current back, for we are informed that the voltmeter indicated zero pressure and no sparks were observed when the first six fuses were removed. Hence it was fair to presume the cables to be absolutely dead. Moreover, if they had been alive, CRATES must have suffered very severe burns, but, as a matter of fact, we have it on the authority of those who saw the poor fellow after the occurrence that they did not notice any singed hair as described by the doctor; what they did see, however, were slight red marks on the hands and arm and a round red mark between the eyes. These marks could be compared to nettle-rash better than anything else. Assuming, therefore, that the cables were not connected to any source of electrical energy, the only remaining hypothesis is that the fatality was due to a "residual" electrostatic charge, and, however improbable this may appear, it must be accepted as the explanation. To render such an explanation feasible, the switchboard connections would have to possess a high insulation resistance to earth to prevent any charge leaking away with great rapidity. There were special insulated tongs provided for removing the fuses, and there were regulations in force which made their use compulsory, but on this occasion they were not used, and we are not surprised; it would be the most natural thing in the world for an attendant, knowing that all machines were disconnected, to presume everything safe and dispense with the use of the tongs.

Since the generator fields were switched off before the main circuit was broken, there will have been direct connection between each core of the cables and earth through the dynamo armature for a few instants, and this should have sufficed to discharge the cables. Hence, it can only be assumed that, during the time that elapsed between the switching-off and the fatal shock, a "residual charge" must have accumulated in the cables. This phenomenon is familiar to those who perform experiments with condensers, and is even not unknown in the testing room of a cable factory. It must be remembered that the combined capacity of the cables was considerable.

Whether the shock was very severe or not there is nothing to show, and as there was no *post mortem* examination it is not apparent whether the deceased suffered from any affection of the heart, but assuming this to be the case, then, of course, a comparatively slight shock might have proved fatal. Indeed, there is every reason to believe that many fatalities alleged to be due to electric shock are actually attributable to ordinary heart failure or heart disease, so that although it may be the shock which has actually produced death, any shock—whether electrical, mechanical or mental—would have caused a similar result. Although the sad event is greatly to be deplored, yet it is pleasing to know that no blame can be attached to any of the company's employés; at the same time the incident serves as a warning to generating station engineers. No matter how safe everything may seem, a high-tension cable—and especially an extra high-tension cable—should always be treated as a source of potential danger; before any work is done on such a cable the conductors should be connected to earth, and the stringent regulations in force at the electricity works should not be relaxed in the slightest degree.

OBITUARY.

JAMES STAATS FORBES.

The death of Mr. James Staats Forbes at the advanced age of 81 years, occurring at a moment when the Government are contemplating the acquisition of the National Telephone Co.'s undertaking, recalls the prominent part he played in connection with the famous telephone inquiries of 1895 and 1898, prior to the passing of the Telegraph Act of 1899 which authorised competition by the Government and local authorities with the National Company. It was also largely due to Mr. Forbes' endeavours that the agreement for the acquisition of the trunk lines by the Post Office was arrived at in 1892. From 1898 Mr. Forbes retained the presidency of the National Telephone Co., throughout the negotiations with the Post Office which culminated in 1901 in the agreement as to intercommunication between the Post Office and the company's systems in the London area, and having seen these negotiations satisfactorily completed, he resigned in November, 1901.

To the general public, however, Mr. Forbes was chiefly known by reason of his work in connection with railways, which was not, naturally, of an electrical character until late in his career, when the scheme for the conversion of the Inner Circle to electrical working was first set afoot. Of the Metropolitan District Railway Co. he was chairman for many years prior to the advent of Mr. Yerkes, Mr. Perks then being elected to the chairmanship in succession to Mr. Forbes. Mr. Forbes was at the head of the affairs of the District Company throughout the electrical experiments which were made in 1899 by Sir John Wolfe Barry and Sir William Preece upon the line between Earl's Court and High-street, Kensington. These experiments determined the future policy of the District Company with regard to its lines, but before definite proposals could be laid down the opinions of the Metropolitan Railway Co. as to the system to be adopted upon the Inner Circle had to be consulted. How the latter company favoured the Ganz high-tension alternating-current system, with the result that protracted arbitration proceedings followed in 1901, is still, no doubt, fresh in the minds of most engineers, and it was only a short time before the appointment of the Hon. Alfred Lyttelton by the Board of Trade as arbitrator that Mr. Forbes resigned the chairmanship of the District Company. Mr. Forbes has also been on the boards of several other railway companies, and was chairman of the Whitechapel and Bow Railway Co. at the time of its formation.

Since 1901 Mr. Forbes lived practically in retirement, maintaining active relations with only two railway campanies—viz., the Hull and Barnsley and the London, Chatham and Dover. At various times anterior to 1901, however, he was chairman of the Edison and Swan United Electric Light Co., the London Electric Supply Co., and several other undertakings not of electrical interest. He was one of the first railway chairmen to advocate the electrical block system of signalling.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electric Lighting and Power Distribution: An Elementary Manual of Electrical Engineering. Vol. II. By W. PERREN MAYCOCK. (London: Whittaker & Co.) 7s. 6d.

This book will be useful to those desirous of obtaining a superficial knowledge of the subject. It contains a little of everything and not much of anything, with a good many catalogue illustrations thrown in; these latter, together with the line diagrams are well printed, however, and although some of them are upside down, yet they really contribute largely to the value of the book. The title-page informs us that the treatise is suitable for students preparing for the preliminary and ordinary grade examinations of the City and Guilds of London Institute, and we can recommend the book for this purpose when studied under the guidance of a competent teacher.

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Wireless Telegraphy. By C. H. Sewall. (London: Crosby Lockwood & Son.) 10s. 6d.

As a popular treatise on wireless telegraphy, written in typical American style, this work contains a great deal of matter that might well have been left out, especially that relating to some of the extraordinary ideas which have originated from Mr. Tesla. One of this gentleman's ideas seems to be that "if one captive balloon were put at 7 miles' elevation over Niagara Falls, and another balloon at the same height in France, energy from a dynamo at the former station might, without undue loss in transmission, be made to set in motion upon French territory electric motors, or to supply the power to illumine electric lamps." Criticism of a book which contains such "information" as this is hardly necessary, but it is only fair to say that a more or less correct view has been taken of the present commercial position of wireless telegraphy. The chief American patents of Dolbear, Lodge, Marconi and others are reprinted at the end of the book.

A Manual on the Care and Handling of Electric Plants. By Norman H. Schneider. (London: E. and F. N. Spon.) 3s. 6d. net.

Several items that would prove useful to persons in charge of small electric lighting plants, such as those in use at country houses and hotels are contained in this volume. But there is also a good deal of space occupied by matter which is found in every elementary text book, and might, therefore, have been omitted without seriously interfering with the value of the book. The language is not quite so explicit as it ought to be, and some of the phrases employed lead one to think that the author is not an Englishman.

Geometry for Technical Students. By E. H. Sprague. (London Crosby Lockwood & Son.) 1s.

This is a useful little work in which those propositions of Euclid possessing direct practical value are collected and arranged in convenient order. The language employed is simpler and the methods of proof are shorter than those of Euclid, and many practical illustrations are given. As a whole, the work would probably be of more use to a schoolboy than a technical student.

X-Rays Simply Explained. By R. P. Howgrave-Graham. (London: Percival Marshall & Co.) 6d.

The author explains in a very clear and concise manner, and with the aid of numerous illustrations, the origin and applications of X-rays. A considerable portion of the booklet is devoted to the practical side of X-ray photography, and many hints as to the choice, testing and maintenance of the tubes and accessory apparatus are given. Some good X-ray photographs conclude the treatise, which may be recommended to beginners in the art.

Calculating Scale: A Substitute for the Slide Rule. By W. Knowles, B.A., B.Sc. (London: E. and F. N. Spon.)

This is an attempt to provide in volume form the equivalent of an ordinary slide rule. There are two parallel columns of scales, one simple and the other logarithmic, so that the volume forms, as it were, a graphical logarithm book or a slide rule in which an addition sum replaces the sliding operation. We do not anticipate, however, that constant users of the slide rule will abandon such a convenient and simple instrument for the substitute under review.

Five-Figure Tables of Mathematical Functions. By John Borthwick Dale, M.A. (London: Edward Arnold.) 1903. 3s. 6d.

This compilation of mathematical tables and of numbers and figures often used in calculations will appeal directly to workers in physical science and applied mathematics, but it may also prove useful to engineers and others requiring only one or two of the tables given. Amongst the chief contents are tables of logarithms, powers of numbers, trigonometric, elliptic and other transcendental functions. Tables used exclusively in navigation, however, have been excluded. The logarithms and anti-logarithms of three-figure numbers are given to five figures, and there are tables of "proportional parts" ranging with each line. The volume is of octavo size and thin, the paper is good and the print clear.

Die für Technik und Praxis Wichtigsten Grössen in übersichtlicher und leichtverständlicher Darstellung. By Olaf Linders. (Leipzig: Jäh and Schunke.) 1904. 10m.

In the several hundred pages of this book the absolute and derived physical units, as used in scientific research and practical work, are very fully explained and discussed. Especially is this the case with the electric and magnetic units; the part of the book devoted to them forms, in fact, quite a treatise on electricity and magnetism, and electro-chemical actions are discussed at some length. A great amount of trouble has been bestowed by the author on the question of symbols and how best to represent each unit by one letter or a simple combination of letters chosen from the Latin, Greek, German and Russian (!) alphabets.

SINGLE-PHASE MOTORS.

Since the publication of our leading article on January 15th, summarising the progress which had been made in the design and construction of alternating-current single-phase motors, several Papers have been published in the United States containing further contributions to this subject. The Papers represent to a large extent the present state of development in America, besides explaining in a concise manner the fundamental working of the two types of motors—series and repulsion—and we do not doubt that a short account of them will be of considerable interest to our readers.

The first Paper which we shall deal with is one on the single phase series motor read by Mr. F. D. Newbury before the Electric Club, Pittsburg. Although it brings forward no new points in the design of single-phase motors, it places the principles upon which the series motor is dependent in an exceedingly clear light. According to this author, the phenomena characteristic of the alternating-current series motor are:

1. *Mechanically and Electrically-generated E.M.F.s.*—The former is produced by the movement of the coil through the

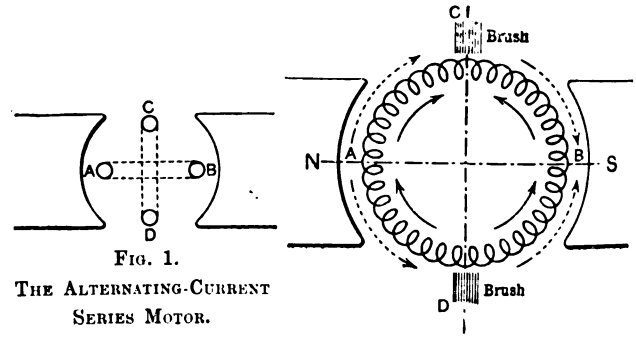

Fig. 1.

The Alternating-Current Series Motor.

Fig. 2.—Electromotive Force Characteristics.

field, and is a maximum when the coil is in the position AB (Fig. 1.), and zero when in the position CD. The second E.M.F. is generated by the alternating magnetism, with the maximum value occurring when the coil is in the position CD and a zero value in the position AB. As seen from Fig. 2, it is only the mechanically-generated E.M.F. which appears at the terminals of the motor, the electrically-generated E.M.F.'s (dotted arrows) compensating each other. When the brushes are shifted, however, a component of the latter E.M.F. will also appear at the brushes.

2. *The Local Armature Current.*—When the armature coil is short-circuited by the brush, it is in the position of maximum value of the electrically-generated E.M.F. corresponding to position CD (Fig. 1). The loss occasioned by the local current appears as a part of the energy component of the field voltages, the short-circuited coil acting precisely as the secondary of a transformer.

3. *Iron Losses.*—They are made up of the losses occurring in the armature and pole-faces, due to the rotation of the armature, and of those occurring in the entire magnetic circuit,

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due to the alternating magnetic field. The former correspond to the iron losses in continuous-current machines and appear in mechanical form, their effect being to increase the frictional torque of the motor. The latter, which may be called the alternating-current iron losses, are supplied electrically by an increase in the energy component of the voltage of both armature and field.

4. *The Counter E.M.F. of the Field Coils.*—This affects the operation of the motor in two ways: (*a*) It increases the total voltage required to run the motor, particularly at starting. This counter E.M.F. is very nearly at right angles with the armature voltage, the total voltage being obtained by the geometrical addition of the two. (*b*) It increases the seriousness of a short-circuit in the field coil. This danger is met by additional insulation. Figs. 3 and 4 are similarly lettered. Starting at one terminal, A, and with the direction of current as shown, the field voltage may be represented by the line AB. It is made up of two components, the E.M.F. used in overcoming the counter E.M.F. of self-induction (AX) and the

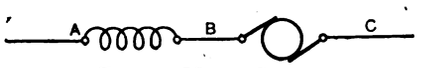

FIG. 3.—MOTOR CIRCUIT.

E.M.F. representing the losses (XB). The energy component (XB) is small compared with the inductive component, and the field voltage is, therefore, nearly 90deg. ahead of the current. BC, the resultant of the energy and induction components YC and BY, represents the armature voltage, AC representing the total voltage required. AZ is the total inductive component, and ZC the total energy component.

Since the motor is a series machine, the total inductive component is always the same for the same current, and it does not depend on the impressed voltage or power developed. At starting, the total energy component approximates ZD. It is evident that the field counter E.M.F. has a much greater effect on the total motor voltage on starting than at full speed. With alternating current, the starting voltage is about half the full rated voltage. At starting, the power-factor is low (see Fig. 4), but improves as load is put on the motor.

Mr. Steinmetz read a Paper on "Single-phase Railway Motors" before the American Institute of Electrical Engineers on January 29th. In 1891, Mr. Steinmetz, it appears, tested a

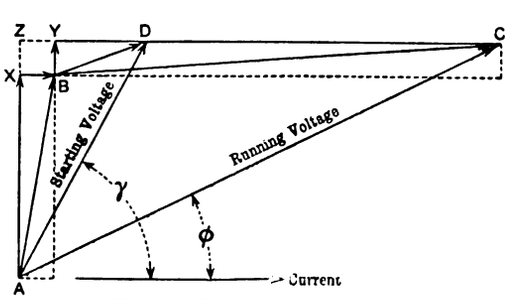

FIG. 4.—VOLTAGE DIAGRAM.

bipolar motor of Mr. Eickemeyer's design. The field consisted of two coils of 14 turns of No. 10 B. & S. wire connected in parallel, and the armature of 24 coils of four turns each of No. 12 B. & S. wire. A secondary circuit (made up of two coils of 18 turns each of No. 10 B. & S. wire connected in parallel) was employed with a view to neutralise the armature self-induction and reaction. It was stationary and placed at right-angles electrically to the field circuit, being either short-circuited upon itself or energised by the main current in the opposite direction to the current in the armature. At a frequency of 100 cycles per sec., an impressed voltage of 150 volts, and at a speed corresponding to three-fourths synchronous speed, the following figures were observed:—

Current, 45 amperes; I^2R, 400 watts; hysteresis and eddy currents, 900 watts. Total output, including friction, 4,000 watts. Therefore, efficiency, 75·5 per cent., and power-factor, 79 per cent. At 150 volts the starting current of this motor was 70 amperes.

The speed of this motor (4,500 revs. per min.) being undesirably high, the investigators proceeded to build an eight-pole motor. In this construction, solid copper rings were used as secondary circuits, surrounding the armature and neutralising the latter's self-induction. Their effective copper section was more than four times that of the armature conductors. Fig. 5 contains the results of tests carried out with this motor in 1892. For comparison, the continuous-current voltage required to drive the same motor at the same speed and current is also given. The commutation was fair at 85 cycles per sec. and perfect at 33 cycles per sec. As seen, the alternating-current series motor is made practical by introducing the transformer principle. Instead of closing the stationary circuit upon itself as secondary circuit and feeding

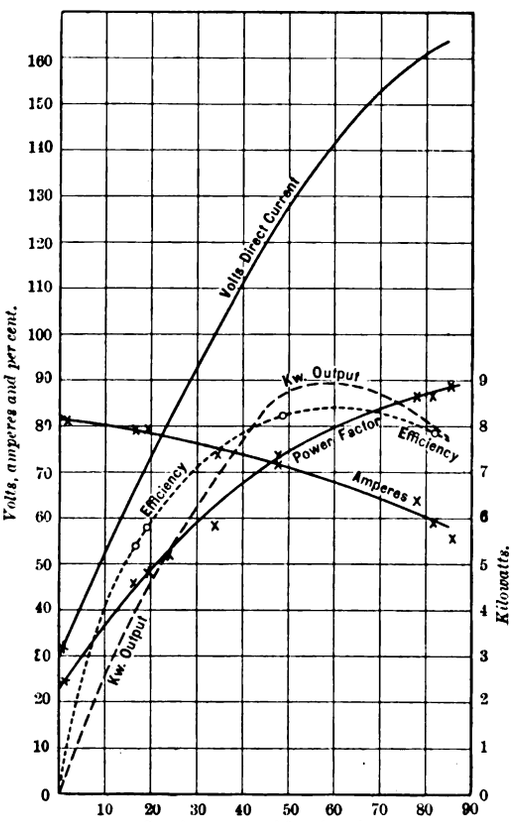

FIG. 5.—EIGHT-POLE SINGLE-PHASE ALTERNATING-CURRENT SERIES MOTOR. 200 VOLTS, 85 CYCLES.

the main current into the rotating armature as primary circuit, mechanically the same results would obviously be obtained by using the stationary circuit as primary, energised by the main current, and closing the armature upon itself as secondary by short-circuiting the brushes, as shown diagrammatically in Fig. 6. This introduces the great advantage of reversing the sign of the uncompensated part of the armature self-induction, so that it is subtractive, this resulting in an essential improvement of the power-factor, especially at low speeds.

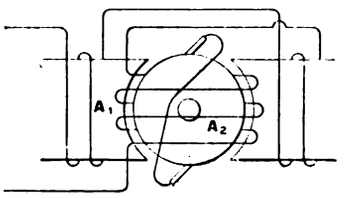

FIG. 6.—DIAGRAM OF REPULSION MOTOR.

Such motors are known as repulsion motors. The great improvement in power-factor is shown in Fig. 7, where the power-factors of the Eickemeyer compensated series motor of Fig. 5 (with a ratio of armature-A.T.: field-A.T. = 4) are compared with those of a repulsion motor with a ratio = 3·5. The compensation of the armature self-induction in Fig. 6 is based on the feature of the transformer that primary and secondary current are in opposition to each other. The secondary current of the transformer, however, lags slightly less than 180deg. behind the primary current. Considering

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it in the reverse direction, it is a leading current with regard to the primary current. In the motor of Fig. 6, therefore, the armature current is leading with respect to the line current, and so not only does it not cause an additional lag, but it reduces the lag caused by the self-induction of the field exciting coil. Obviously, the two coils at right angles may be replaced by one coil at an angle with the position of the brushes (Fig 8), and the co-tangent of the angle made by the axis of this coil with the position of the brushes is the ratio of effective armature series turns to field turns. The motor of Fig. 8 is Prof. Elihu Thomson's repulsion motor.

An E.M.F. is induced in the armature by the alternating magnetic field M_2 of coil A_2, proportional to M_2 and

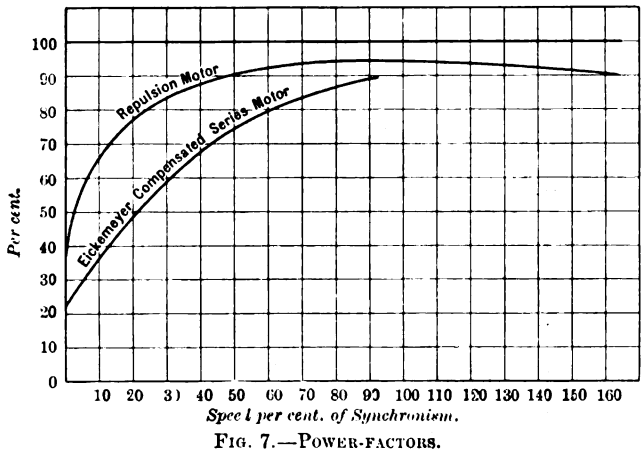

FIG. 7.—POWER-FACTORS.

to the impressed frequency, and in quadrature with M_2. By the rotation of the armature in the magnetic field M_1, another E.M.F. is generated in the armature, proportional to M_1 and to the frequency of rotation and in phase with M_1. These two E.M.F.s must be equal and opposite, since the armature is short-circuited (neglecting the resistance and self-inductive reactance of the armature) and at synchronism M_1 and M_2 are, therefore, equal and in quadrature with each other. At synchronism a rotating field exists, the hysteresis loss in the armature core being then zero, and at other speeds proportional to the difference between speed and synchronism—*i.e.*, the slip. The hysteresis loss of the repulsion motor is, therefore, lower than that of the same motor as a compensated series motor.

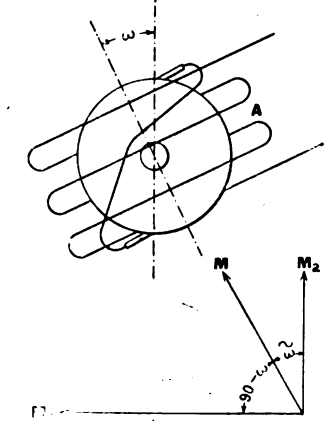

FIG. 8.—DIAGRAM OF FLUX DISTRIBUTION IN THE REPULSION MOTOR.

The two E.M.F.s in the armature are $E_1 = 2\pi N_0 M_1 n$ and $E_2 = -j2\pi N M_2 n$, in which n = number of armature turns, N = impressed frequency, N_0 = frequency of rotation, and $j = \sqrt{-1}$ (used as a symbol for denoting that E_2 is in quadrature with E_1).

Since, approximately (as explained above), $E_2 = E_1$, we have

$$jN_0M_1 = NM_2 \quad \text{or} \quad jM_1 : M_2 = N : N_0. \quad . \quad . \quad (1)$$

That is, M_1 and M_2 are in quadrature in phase, and their strength is inversely proportional to the ratio of the armature speed to the speed of synchronism; or, in other words, an elliptically rotating field exists in the repulsion motor, which becomes a uniformly rotating field at synchronism. Below the speed of synchronism the component M_1, which induces an E.M.F. in the armature by the rotation of the latter, is greater than M_2. The flux M interlinked with the primary coil A is, however, nearer to M_2 (since a good power-factor requires a small angle ω). Below synchronism, therefore, especially at low speeds, the magnetic flux which induces an E.M.F. by rotation of the armature, and so corresponds to the useful work, is greater than the magnetic flux which interlinks with the primary coil producing the lag of the primary current. This accounts for the high power-factor of the repulsion motor at low speeds. Neglecting resistance and self-inductive reactance, we have M = constant corresponding to the impressed voltage. From equation (1)

$$M_2 = jM_1(N_0/N),$$

hence

$$\begin{aligned} M &= M_2 \cos\omega + M_1 \sin\omega, \\ &= M_1[\sin\omega + j(N_0/N)\cos\omega], \end{aligned}$$

$$\left.\begin{aligned} M_1 &= \frac{M}{\sin\omega + j(N_0/N)\cos\omega} = \frac{M}{\sqrt{\sin^2\omega + (N_0/N)^2\cos^2\omega}} \\ M_2 &= \frac{M}{\cos\omega - j(N/N_0)\sin\omega} = \frac{M}{\sqrt{\cos^2\omega + (N_0/N)^2\sin^2\omega}} \end{aligned}\right\} \quad (2)$$

At synchronism $N_0 = N$ and $M_1 = M_2 = M$. At standstill $N_0 = 0$ and $M_1 = M/\sin\omega$ and $M_2 = 0$. Fig. 9 shows the two components M_1 and M_2 of the magnetic field of the repulsion motor for $\omega = 16°$ and $M = 1$.

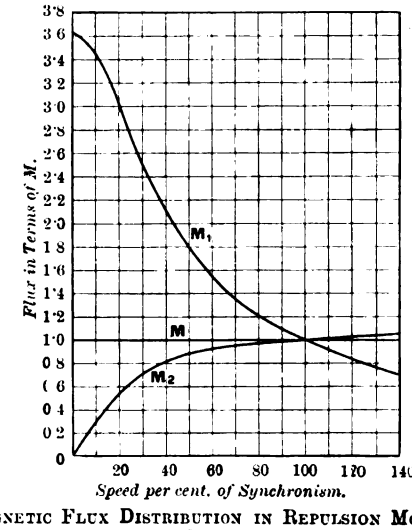

FIG. 9.—MAGNETIC FLUX DISTRIBUTION IN REPULSION MOTOR AT VARIOUS SPEEDS.

If E_0 = impressed E.M.F., used as zero vector e_0, I = primary current, I_1 = secondary current reduced to the primary by the ratio of turns (as is also customary in the treatment of induction motors), Z = primary exciting impedance (*i.e.*, induced primary E.M.F. divided by primary current at open secondary circuit), Z_0 = primary self-inductive impedance, Z_1 = secondary self-inductive impedance reduced to the primary circuit, ω = angle between primary and secondary circuit (*i.e.*, angle of shift of brushes from the position of complete transformer action) and $a = N_0/N$ = ratio of speed to frequency, then the total magneto-motive force acting upon the primary coil is given by the primary current I, plus the component of secondary current acting in the direction of the primary—*i.e.*, $I + I_1 \cos\omega$.

This, then, is the primary *exciting* current, and the primary induced E.M.F. is therefore $(I + I_1 \cos\omega)Z$. Since the primary impedance voltage $= IZ_0$,

$$e_0 = Z(I + I_1 \cos\omega) + IZ_0. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The magnetic flux M_1 is due solely to the component of primary current ($I \sin\omega$) acting in the direction of M_1, since the secondary current exerts no magneto-motive force in this direction. The E.M.F. generated thereby is in phase with I and

$$= E_1 = axI \sin\omega. \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

In the secondary, an E.M.F. is induced also by the alternation of the magnetic flux M_2 in the axis of the secondary coil. This flux is produced by the secondary current I_1 and the component of primary current ($I \cos\omega$) acting in this direction,

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hence $E_2 = -Z(I_1 + I\cos\omega)$. The impedance E.M.F. of the secondary circuit is $Z_1 I_1$ and, since the secondary is short-circuited,

$$Z(I_1 + I\cos\omega) + Z_1 I_1 - ax I\sin\omega = 0. \quad . \quad . \quad . \quad (5)$$

Equation (3) for the primary circuit and equation (5) for the secondary circuit are the two fundamental equations of the repulsion motor. From equation (5)

$$I_1 = \frac{-IZ\cos\omega - ax I\sin\omega}{Z + Z_1}.$$

Substituting this in (3), we get for the primary current

$$\left.\begin{aligned} I = \frac{e_0}{Z}\,\frac{Z + Z_1}{ax\sin\omega\cos\omega + Z\sin^2\omega + Z_0 + Z_1 + \dfrac{Z_0 Z_1}{Z}} = e_0(a_1 + ja_2) \\ \text{and for the secondary current} \\ I_1 = \frac{e_0}{Z}\,\frac{Z\cos\omega - ax\sin\omega}{ax\sin\omega\cos\omega + Z\sin^2\omega + Z_0 + Z_1 + \dfrac{Z_0 Z_1}{Z}} = e_0(b_1 + jb_2). \end{aligned}\right\} \quad (6)$$

Hence, power-factor $= \cos\phi = \dfrac{a_1}{\sqrt{a_1^2 + a_2^2}}$,

Volt-ampere input $Q_0 = e_0 I = e_0^2\sqrt{a_1^2 + a_2^2}$.

Power input $P_0 = e_0^2 a_1$.

Power output $P = ax e_0^2 \sin\omega(a_1 b_1 + a_2 b_2)$.

Torque $T = x e_0^2 \sin\omega(a_1 b_1 + a_2 b_2)$.

Efficiency $\gamma = \dfrac{P}{P_0} = \dfrac{ax\sin\omega(a_1 b_1 + a_2 b_2)}{a_1}$.

Total internal self-inductive impedance $= Z_0 + Z_1 = Z' = r' - jx'$.

Neglecting minor terms it is, approximately,

Primary current

$$I = \frac{e_0}{(ax\sin\omega\cos\omega + r') - j(x\sin^2\omega + x')}, \quad . \quad . \quad . \quad (7)$$

and secondary current

$$I_1 = -\frac{e_0(\cos\omega - ja\sin\omega)}{(ax\sin\omega\cos\omega + r') - j(x\sin^2\omega + x')}. \quad . \quad . \quad . \quad (8)$$

Angle of lag

$$\tan\phi = \frac{x\sin^2\omega + x'}{ax\sin\omega\cos\omega + r'}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Torque $T = \dfrac{e_0^2 x\sin\omega\cos\omega}{(ax\sin\omega\cos\omega + r')^2 + (x\sin^2\omega + x')^2}$. . . (10)

The secondary current leads the primary current by the angle $\tan x_1 = a\tan\omega$. The secondary current comes into phase with the primary impressed E.M.F. e_0 if

$$\frac{a\sin\omega}{\cos\omega} = \frac{x\sin^2\omega + x'}{ax\sin\omega\cos\omega + r'}$$

$$\therefore \quad a = \frac{-r'}{2x\sin\omega\cos\omega} + \sqrt{\frac{x'}{x\sin^2\omega} + \frac{(r')^2}{4x^2\sin^2\omega\cos^2\omega}}.$$

Above the speed which fulfils this equation the secondary current leads the primary impressed E.M.F. e_0, and hence has a magnetising effect. At $a = 1$—*i.e.*, at synchronism—$I_1 = I$, but the secondary current leads by the angle of brush-shift (ω). At infinite speed $a = \infty$. $I = 0$—*i.e.*, the primary current decreases with increasing speed down to zero at infinite speed. (In the ordinary induction motor the current can never fall below a certain minimum value, the exciting current.) In this case $I_1 = j(e_0 x\cos\omega)$—*i.e.*, lags 90deg. behind the primary impressed E.M.F.—hence it is 90deg. ahead of the phase of a transformer secondary current, and supplies the magnetising current of the magnetic circuit just as a condenser in the secondary circuit of a transformer would do. At standstill $a = 0$.

$$I = \frac{e_0}{r' - j(x\sin^2\omega + x')}, \qquad I_1 = \frac{e_0\cos\omega}{r' - j(x\sin^2\omega + x')},$$

$$\tan\phi = \frac{x\sin^2\omega + x'}{r'}, \qquad T = \frac{e_0^2 x\sin\omega\cos\omega}{(r')^2 + (x\sin^2\omega + x')^2}.$$

Current and torque are a maximum, and the power-factor a minimum at standstill.

For backward rotation, the torque T is still positive, therefore opposed to the rotation, and the repulsion motor with reversed brush angle ω acts as brake.

$$I = \frac{e_0}{(ax\sin\omega\cos\omega + r') - j(x\sin^2\omega + x')}.$$

The watt-input falls to zero, when $ax\sin\omega\cos\omega + r' = 0$. From this equation we get the critical value of a, $a = -r'/x\sin\omega\cos\omega$.

For higher negative values of a, or if at a speed greater than corresponds to $a = (r'/x\sin\omega\cos\omega)$, (a very slow speed), the brush angle ω is reversed, the energy component of the primary current becomes negative—*i.e.*, the motor returns power into the line. Experiment verifies this feature.

(To be concluded).

PHYSICAL SOCIETY.

At a meeting of the Physical Society, held on March 25th, Dr. R. T. Glazebrook, F.R.S., president, in the chair, a Paper, entitled

"Note on the Measurement of Small Inductances and Capacities and on a Standard of Small Inductance,"

was read by Prof. FLEMING. The author referred to a Paper read before the Society last year by himself and Mr. W. C. Clinton, in which a motor-driven commutator was employed to measure small inductances. It had since been found that very good results could be obtained in the measuremont of small inductances by Prof. Anderson's method by using a telephone in place of a galvanometer and a buzzer in the battery circuit. The author had found that for long solenoids, at least 50 diameters long, the inductance could be calculated with an accuracy of about 1 per cent. by the rule:—Inductance in centimetres = (Length of wire in 1 unit length of solenoid) × (Total length of wire in the whole solenoid in centimetres). Numerous measurements were given showing the agreement between the measured and predicted inductance of various solenoids and the limits of the dimension ratio within which the rule was valid. It was also shown that by means of such a predetermined inductance small capacities, such as those of Leyden jars, could easily be measured. A standard of inductance graduated in microhenrys suitable for electric resonance experiments and Hertzian wave telegraphy was exhibited. The standard consisted of a spiral of copper wire with special means for producing gradual variation or definite variation in the inductance thrown into a circuit.

Mr. A. CAMPBELL said that they had lately measured some self-inductances of the order of 100 microhenrys (100,000cm.) at the National Physical Laboratory. The method used was practically that of Max Wien as modified by Dolezalek. In the original method two continuous arms of a Wheatstone bridge consist of (1) the inductive coil (under test) shunted by a known non-inductive resistance, and (2) an unknown (preferably variable) inductance with an adjustable resistance in series. The other two arms are non-inductive resistances, with a slide wire between them. The indicating instrument (either an optical telephone or a vibration galvanometer) is tuned to respond only to a particular frequency, and the source of current is worked at this frequency. Thus, although the source may give a quite irregular wave-form, the instrument practically ignores all but one sine-curve component, and the formula can therefore be easily obtained. The product and the quotient of the inductances in the network are given in terms of non-inductive resistances and p, where $p = 2\pi n$, n being the frequency of the current source. From these equations the inductances can be separately determined. The modification described by Dolezalek consists in using a current-source giving a nearly pure sinoidal wave and an ordinary telephone as an indicating instrument. The current-generator is a "microphone hummer." In this a telephone plate, P, carries a microphone, M. A current from two accumulators is passed through M and the primary of an induction coil, the secondary being connected with a polarised magnet acting on P. Dolezalek states that, by the use of a "hummer" and a variable inductance standard, inductances of about 0·1 microhenry (100cm.) can be readily measured to within 1 or 2 per cent. For obtaining frequencies above 1,000 ~ per second, Mr. Campbell has found it desirable to replace the telephone plate by a steel bar 2·5cm. in diameter. In order to make the note in the detecting telephone pure, the latter is tuned by means of a small screw pressing against the ferrotype plate.

Mr. W. DUDDELL expressed his interest in the Paper, and asked what precautions were taken to ensure that the resistances and connections used were free from self-induction and capacity. He thought that some of the variations in the figures given in Table I. of the Paper might be due to these effects.

Dr. FLEMING, in reply, said that in connection with all measurements of small inductances it was essential to continually check the measurements by the aid of a small known inductance made as he described. We were all apt to forget that the ideal "bridges" drawn on paper were not identical with real "bridges," in that the latter had small inductance and capacity in all the arms and connections, and hence formulæ obtained

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on the assumption that certain branches were absolutely inductionless and without capacity were not strictly correct. In some experiments he had found that great errors were introduced merely by using ordinary flexible twin wires for connections, as these had quite a sensible capacity per metre. In all methods employing the telephone as a detector we were testing the observer quite as much as the method, and not only a perfectly quiet room, but a very acute ear, were necessary if good results were to be obtained. It was becoming important to possess methods of measuring accurately inductances of less than 1 microhenry. The author sketched a plan which he said he had not yet put into practice, but which seemed promising. It involved the use of a Hertz rectangle, and the measurements were made to depend upon the identity in time-period between two conducting paths connecting the same points.

A Hot-wire Ammeter for Measuring very small Alternating Currents

was exhibited and described by Prof. FLEMING. The author said that in alternating-current work, particularly in taking the power-factor of small transformers and of short lengths of cables, the need had been felt for an ammeter not involving the use of iron capable of measuring currents as small as 0·01 or less of an ampere. He exhibited an ammeter capable of being made to read currents as small as 0·002 with fair accuracy. The arrangement was as follows:—Two very fine platinoid or constantin wires, about 1 metre long and 0·05mm. or even 0·02mm. diameter, are supported on a wooden rod with arrangements for adjusting their tensions. These wires are 5mm. apart, and are held down at the centre by delicate spiral springs. The two wires are embraced at the middle by a small loop of paper carrying a very small plane mirror. These wires are enclosed in a box, the lid of which carries a lens. By this means the light of a straight carbon filament of a glow-lamp, or of a slit illuminated by an arc lamp reflected by this small mirror can be focussed on a screen of ground glass. If a current is passed through one of these wires it sags down slightly, and the square root of the displacement of the image on the screen is almost exactly proportional to the current passing. The instrument can be quickly calibrated by applying a known voltage to the ends of the wire, the resistance having previously been measured corresponding to the range of current used. Examples were given of the use of such an instrument. Suitable very fine wires of pure metals and alloys are now prepared by Messrs. Hartmann and Braun of Frankfurt. These fine wires require "ageing" before use by intermitting a current through them for 12 hours or more.

Mr. W. DUDDELL expressed his interest in the Paper and said it was difficult to make a satisfactory instrument. The author had said that with a fine constantin wire it was possible to measure currents as small as 2 milliamperes. He asked if this was calculated or observed. There should be a standard method of comparing these instruments, and he suggested using the current necessary to give a deflection equal to one-quarter of the scale distance. Mr. Duddell pointed out that many dynamometers were more sensitive than the instrument shown, and asked the author the order of magnitude of the currents which it was necessary to measure in aerial conductors.

Dr. W. WATSON exhibited and described a form of ammeter for small alternating currents. The current to be measured flows through a piece of iron wire bent into the form of a right angle. This is linked with a similarly shaped piece of nickel wire forming part of a galvanometer circuit. The thermo-E.M.F. at the junction, produced by the heating effect of the current, sends a current through the galvanometer which can be measured in the usual way. The current to be measured is practically proportional to the deflection of the galvanometer.

Mr. A. CAMPBELL described a form of ammeter by Rubens; and Mr. W. A. PRICE referred to an instrument similar to that shown by the author, in which the sag of the wire is measured by the movement of an aluminium pointer.

Dr. FLEMING said he was quite aware that electrodynamometers had been designed for measuring very small alternating currents, but they were more difficult to make and calibrate than the simple form of hot-wire instrument he now exhibited. He had no doubt that the use of a constantin wire of 0·02mm. diameter would greatly increase the sensitiveness of the instrument, though he had not actually tried it for want of time. As regards Mr. Duddell's question about the magnitude of the currents flowing into a wireless telegraph aerial, that, of course, depended upon the size of the aerial. In the case of an ordinary 180ft. single aerial the average value was about 0·05 to 1 ampere, but that depended, of course, on the frequency of the groups of oscillations. The author said that although in the ammeter he exhibited the sag of the working wire was indicated by a mirror, yet he had also used an index needle, and he had no doubt a good commercial instrument might be made on this plan.

A Paper on

"Energy of Secondary Röntgen Radiation"

was read by Mr. C. G. BARKLA. To measure the intensity of radiation electroscopes were placed in a primary beam of Röntgen rays and in a secondary beam proceeding from air in a direction perpendicular to that of propagation of the primary rays. By comparison of the two rates of leak when no absorbing plates were used and when similar aluminium plates were placed before each electroscope, it was found that the absorbability of the secondary rays differed from that of the primary by less than 5 per cent. of its value. It was, however, found that a secondary beam of the same intensity as the primary would produce a slightly different number of ions in a given volume of air, consequently the radiations differ slightly in character. The difference in what may be called the "ionising powers" was evidently greater when the primary beam consisted of more penetrating rays. The fraction of energy lost in secondary radiation was very nearly, if not entirely, independent of the character of the primary radiation. The law which the author had previously found to govern the intensity of radiation from gases, was found to be equally applicable to those light solids which are the source of a radiation differing little in character from the primary—*i.e.*, the energy of secondary radiation from these substances situated in a beam of definite intensity is proportional to the quantity of matter through which the primary beam passes. In the passage of X-radiation through air under normal atmospheric conditions, the diminution of intensity due to secondary radiation is of the order of magnitude 0·02 per cent. per centimetre. This is a large fraction of the total loss of energy for penetrating rays passing through air. Applying experimental results to J. J. Thomson's calculation of the loss of energy per centimetre due to the passage through a medium containing ions, and considering the electrons as the source of radiation, the number of these per cubic centimetre of air under normal conditions is of the order of 10^{22}. By using the secondary radiation from copper as the primary, approximately the same fraction of the energy was lost in secondary radiation; hence we have quantitative results showing that this radiation from copper, thought differing in character from the primary radiation producing it, is of the same nature. Evidence was also found pointing to the conclusion that even from metals which are the source of a secondary radiation differing greatly from the primary, the energy of secondary radiation is of the order of magnitude given by gases and light solids of the same mass.

ALTERNATORS IN PARALLEL.*

BY H. BOHLE.

(*Continued from page 859*).

Of great interest is the graphical representation of the free and forced oscillations as given by E. Rosenberg (*E.T.Z.*, 1902). Let OA (Fig. 30) be the vector, representing p_m, the maximum value of the variable pressure of the crank effort diagram. (The vector makes one revolution in the time T = time of one cycle, its projection upon the horizontal line being the instantaneous value p.) The vector giving the velocity is represented by OB equal to v_m and lagging by 90deg. in regard to OA. The lead vector will lag by 180deg. in regard to OA, and it is equal to $OC = S_m$. Each vector must, of course, be shown in its proper scale, so that we have actually three scales, but each bearing a definite ratio to the scale of the preceding vector. The scale for OC should, further, be such that OC in the scale of the pressure represents the synchronising force of the lead. OB/OA is also determined by the moment of inertia of the machine.

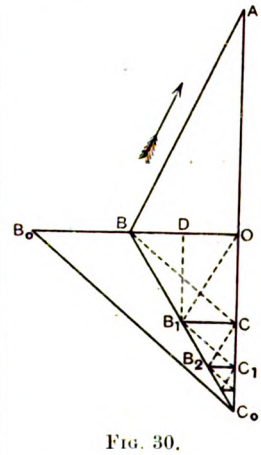

FIG. 30.

With an original lead OC, the actual vector of the variable tangential pressure is not OA but OA + CO, on account of the reaction of the alternator upon its prime mover. The increased variable pressure produces, of course, an increased lead, as we saw above, and this rectifying may go on indefinitely. The final lead is found as follows:—

Draw OB_1 parallel to AB; CB_1 parallel to OB; B_1C_1 parallel to BC; CC_1 will then be the additional lead. Repeating this construction, we find that the points B, B_1, B_2, &c., lie on a straight line, so that the final lead OC_0 may be found by executing the construction once and drawing the line BB_1 until it cuts the vertical in C_0. A line parallel to CB from C_0 will then cut off from the horizontal the final variable velocity OB_0.

Proof:—Triangles CB_1O and OBA are similar, hence

$$\frac{CB_1}{OB} = \frac{CO}{OA} = \frac{\text{synchronising force}}{\text{variable pressure}} = Z;$$

hence,

$$CB_1 = Z \times OB$$

and

$$\frac{OC_0}{OC} = \frac{OB}{OB - OD} = \frac{OB}{OB - CB_1} = \frac{OB}{OB - (Z \times OB)} = \frac{OB}{OB(1 - Z)}$$

or

$$\frac{OC_0}{OC} = \frac{1}{1 - Z} \quad \ldots\ldots\ldots\ldots (22)$$

and

$$OC_0 = \frac{OC}{1 - Z} \quad \ldots\ldots\ldots\ldots (23)$$

* Paper presented at the Leeds Local Section of the Institution of Electrical Engineers, Jan. 21st. (See *The Electrician* of Jan. 22nd, p. 511.)

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OC_0 gives now in the pressure scale by its synchronising effect a secondary variable pressure, so that the final variable pressure is $OA + C_0O = C_0A$.

The quotient $1/1-Z$ is, as we see, a characteristic quantity, as it shows at a glance the total reaction of the oscillations. Thus, if we have a synchronising force equal to $\frac{1}{10}$, $\frac{1}{5}$, $\frac{1}{3}$ or $\frac{1}{2}$ of the initial variable pressure, the final lead is $\frac{1}{9}$, $\frac{1}{4}$, $\frac{1}{2}$ or $\frac{2}{1}$ times the initial lead, and, according to equation (18), the actual coefficient of speed variation is $\frac{1}{9}$, $\frac{1}{4}$, $\frac{1}{2}$ or $\frac{2}{1}$ times larger than the original one. We see in this way that the initial lead is of very little importance as long as the final lead is not too large.

The question will now arise: Are there no means which will enable us to run alternators in parallel, even if forced and free oscillations are of the same or nearly the same duration? What must be done is to see that the free oscillations have already died out before they obtain fresh aid from the knocks upon the piston. In other words, the oscillations must be quickly and effectively damped, which may be done mechanically or magnetically. Mechanical damping is obtained by means of friction couplings arranged between the inductor shaft and engine shaft, or by driving the alternators by belts. In fact, belt-driven alternators have been found very suitable for parallel running, as the slip and the tensions of the belt neutralise the variations in the speed. Direct-driven steam plants possess, however, many advantages over belt-driven sets, and being chiefly used, magnetic damping is thus practically the only remedy.

When a metal disc is rotated in a magnetic field eddy currents are produced in the disc which tend to stop the movement. In alternators the magnetic field is already there, and if the poles of the field magnets are solid the eddy currents produced will usually be of sufficient strength to damp the oscillations effectively. It is a fact that alternators with solid poles are better adapted for parallel running than machines with laminated pole-pieces, as in the former type the eddy currents are allowed to spread out freely, while in sets with laminated pole-shoes eddy currents are prevented from being produced. Special arrangements must then be made. A well-known damping apparatus is that by Hutin and Leblanc, which is shown in Fig. 31. The field magnets M produce current in the turns T of the stator, setting up stator fields which rotate at the same speed as the fields M. As long as the inductor is running synchronously its fields will be in step with the stator fields, and the copper rods, fixed near the circumference of the pole-shoes, will not cut across any lines of force. When, however, the inductor is oscillating we have a field set up by the current in the circuit 1, 2,

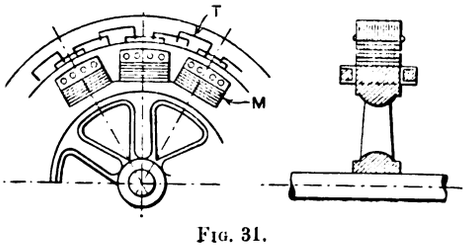

Fig. 31.

8, 7, 5, 6 (Fig. 2), which will always be in synchronism, and the copper rods cut across the lines of this field, producing strong damping currents. The best damping effect would evidently be obtained by using solid rings. This would, however, reduce the iron too much.

Now, consider the action of the damper graphically, as given by E. Rosenberg (*E.T.Z.*, 1903). The force of the damper is always proportional to the variable velocity v, and, of course, in opposition. We have here similarity with asynchronous motors. The short-circuited rotor is replaced by the inductor with amortisseur. The rotating field produced in the stator drags the rotor along when it is lagging and pulls the rotor back when it is leading. The turning moment is proportional to the slip, in our case to the variable velocity v. The vector of damping must, therefore, be drawn in opposition to the vector of the variable velocity. The ratio damping vector : variable velocity vector may be found by experiment. Disconnect the crank from the shaft and run the machine as an asynchronous motor, and make a brake test. Find the slip. The ratio brake moment : slip will then also hold for damping moment : variable velocity.

The final variable velocity will obviously stand perpendicular to the resultant variable pressure, hence the vector of the damping must stand perpendicular to the vector of the resultant pressure. The latter will, therefore, be the side of a right-angled triangle with hypotenuse OA equal to the primary variable pressure and OD equal to the damping vector, as the other side (see Fig. 32).

The final lead is OC_m. We see that, on account of the damping, the variable velocity does not lag now by 90deg., but less in regard to the pressure, and the lead lags less than 180deg. The greater the damping force the greater will be the ratio OD/OB_0 and the more will the diagram of the velocity be like the original diagram. The geometrical construction is as follows:—

Take any pressure vector, OE_1, and find by means of the formula given above the corresponding velocity vector OB_{01}, which bears a definite ratio to OE_1. Similarly, find the corresponding lead OC_{01} and the damping vector OD_1. From E_1 draw now a line parallel and equal to $OD_1 = E_1A_1$. OA_1 will then be that primary variable pressure which in this case would produce all the assumed vectors. On the direction of OA_1 cut off the actual primary variable pressure, equal to OA. By means of parallel lines we find then the actual velocity, lead and damping vectors.

A machine with an amortisseur may be considered as an asynchronous and synchronous machine at the same time. The amortisseur corresponds to the cage rotor. The slip is, however, not always positive, but alternately positive and negative. The turning moment produced by an asynchronous motor is taken from the network, but energy is supplied to the network when the motor runs past synchronism or when the slip is negative. The energy of a synchronous machine is proportional to its lead in regard to the network, or its fluctuation of energy is proportional to the lead.

This fluctuation we will consider now, also the damping energy due to the variable velocity. Both must be added geometrically, as they have different phases.

We saw above that

$$S_m = v_m \frac{T}{2\pi}; \text{ but } v_m = \sigma_m \frac{T}{2\pi} \text{ and } \sigma_m = \frac{p_m R}{I},$$

so that

$$S_m = \frac{p_m R}{I} \times \frac{T^2}{4\pi^2} \quad \ldots\ldots\ldots \quad (24)$$

S_m produces a synchronising force which must be added to the variable pressure p_m. Let $S_e = S_m p_1$ be the lead in electrical radians, the synchronising power will approximately be given by (assuming an infinitely large network of constant pressure velocity)

$$^{*}\ P_s = EC_c S_e = EC_c \frac{p_m R}{I} \times \frac{T^2}{4\pi^2} \times p_1. \quad \ldots\ldots \quad (25)$$

where E is the terminal pressure, C_c the short-circuiting current. Let T_1 be the time of a revolution, the work in metre-kilogrammes is $W_s = g M_s \frac{2\pi}{T_1}$, where M_s is the synchronising moment, g the acceleration of gravity of a freely falling body.

From this it follows

$$M_s = \frac{T_1}{2\pi} \times \frac{W_s}{g} = \frac{EC_c}{g} \times \frac{p_m R}{I} \times \frac{T_1 T^2}{8\pi^3} \times p_1. \quad \ldots\ldots \quad (26)$$

The scale for the lead should be such that OC represents also the synchronising force in the pressure scale and the synchronising moment

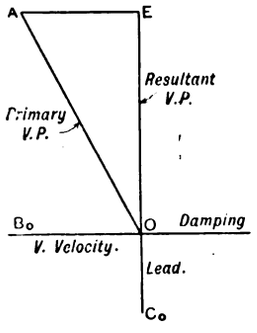

Fig. 32.

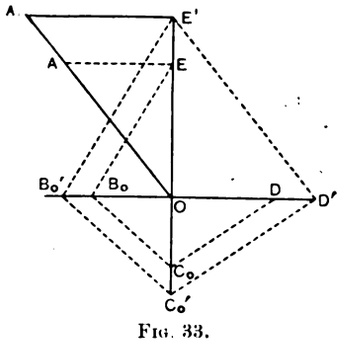

Fig. 33.

in the moment scale. The ratio synchronising moment : variable pressure moment gives the reaction upon the prime mover, and is equal to Z, or

$$Z = \frac{CO}{OA} \frac{M_s}{p_m R} = \frac{EC_c}{g} \times \frac{1}{I} \times \frac{T_1 T^2}{8\pi^3} \times p_1. \quad \ldots\ldots \quad (27)$$

The synchronising moment, which is to be added to the variable pressure moment $M_s = Z(p_m R)$ produces an increase in the synchronising moment, or $ZM_s = Z^2(p_m R)$, and so on. But when Z is smaller than unity the total synchronising moment approaches a value,

$$M_{st} = \frac{M}{1-Z} = \frac{Z}{1-Z} \times p_m R, \quad \ldots \quad (28)$$

the final lead

$$S_{mt} = \frac{S_m}{1-Z}, \quad \ldots\ldots\ldots \quad (29)$$

the final velocity

$$v_{mt} \frac{v_m}{1-Z}, \quad \ldots\ldots\ldots \quad (30)$$

and the total variable pressure

$$p_{mt} = \frac{p_m}{1-Z}. \quad \ldots\ldots\ldots \quad (31)$$

These final values would, of course, be obtained after an infinite number of cycles. When Z is, however, small, the values are soon approached. With Z equal to unity the synchronising force is equal to the variable pressure, and the oscillations grow indefinitely. We have, in this case,

$$M_s = p_m R = \frac{EC_c}{g} \cdot \frac{p_m R}{I} \times \frac{T_1 T^2 r_1}{8\pi^3},$$

from which the time, which we will call the critical time, follows:

$$T_{\text{critical}} = \sqrt{\frac{g \times I \times 8\pi^3}{E \times C_c \times T_1 \times p_1}}.$$

* P_s is here twice as large as in equation (20), where two similar machines (one of uniform speed) are joined in parallel. For these P_s is the synchronising power for the most unfavourable crank positions at which the alternators could be joined in parallel.

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Now, $I = \frac{1}{4g} WD^2$, where W is the weight of the rotating masses, D the diameter; hence,

$$T_{critical} = \sqrt{\frac{WD^2}{E \times C_c} \times \frac{2\pi^3}{T_1} \times \frac{1}{p_1}} \quad . \quad . \quad . \quad . \quad . \quad (32)$$

Equation (5) gave the time of a free oscillation—viz.,

$$t_a = 2\pi \sqrt{\frac{I}{S_1}},$$

where S_1 is the synchronising moment, which acts when the lead is 90deg. Substituting $\frac{1}{4g} WD^2$ for I, we get

$$t_a = \sqrt{\frac{W}{g} \times \frac{D^2}{4S_1} \times 4\pi^2}.$$

But $$S_1 = \frac{M_s}{S_m}, \text{ where } M_s = \frac{EC_c p_m R T_1 T^2 p_1}{g \times I \times 8\pi^3},$$

and $$S_m = \frac{p_m R T^2}{I \times 4\pi^2},$$

hence $$S_1 = \frac{EC_c T_1 p_1}{2g \times \pi} \quad ; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

from this it follows that the time of a free oscillation

$$t_a = \sqrt{\frac{WD^2 2\pi^3}{EC_c T_1 p_1}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (34)$$

We see that $t_a = T_{critical}$—that is to say, there is perfect resonance. The diagrams hold, of course, only for machines with moments of inertia, which make perfect resonance impossible.

The action of the amortisseur may be beautifully seen by comparing the diagrams of non-damped and damped machines. In Fig. 34 we have a damped machine. Let OC_{01} be the resultant

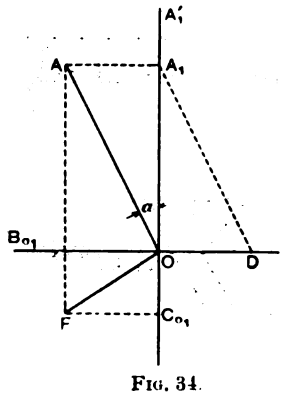

FIG. 34.

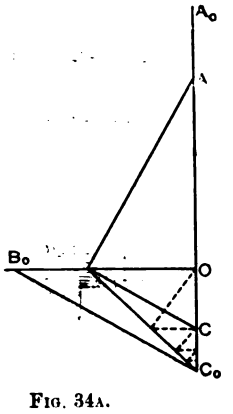

FIG. 34A.

lead, OB_{01} the resultant velocity; OA'_1 will then be the resultant variable pressure, $A_1A'_1$ being equal to $C_{01}O$. This pressure is determined by the initial pressure, the synchronising force of the resultant lead and the damping force, the latter being opposed to the velocity. The relationship between the damping force and the velocity is given by the resistance of the amortisseur, the E.M.F. of the network and the construction of the machine. OA is the initial pressure, from which we must subtract geometrically the damping force OD, producing the resultant OA. To the latter we must add $C_{01}O$, the final value being OA'_1. The fluctuation of energy which results from the synchronising and damping forces is superposed upon the mean machine energy which goes into the network. As now energy is given off and not taken (as assumed before), the two vectors have the same direction as the lead and the velocity, their resultant being OF. We must now see whether the fluctuation of energy with damping can be larger than without damping. Assuming similar machines with the same number of cycles and moments of inertia, the ratio synchronising variable force : total variable pressure will be the same in both cases. Or we have (see Figs. 34 and 34A) $OC_0/OA_0 = OC_{01}/OA'_1$, and also $OC_0/OA = OC_{01}/OA_1$.

Let A be the angle between the initial and the variable pressure, then

$$OA_1 = OA \cos A \; ; \; OC_{01} = OC_0 \cos A \; ;$$

$$OA'_1 = OA_1 + C_{01}O = OA \cos A + C_0 O \cos A = OA_0 \cos A.$$

From this it follows that lead, synchronising force and variable pressure are decreased proportionately with the cosine of the angle of damping. The damping force $OD = AA_1 = OA \times \sin A$, and the resulting net fluctuation

$$OF = \sqrt{OC_{01}^2 + OD^2} = \sqrt{OC_0^2 \cos^2 A + OA^2 \sin^2 A}.$$

$OF = OC_0$ when $OC_0 = OA$, but

OF is greater or smaller than OC_0 when OA is greater or smaller than OC_0.

From Fig. 34A, where $C_0O = AA_0$, it follows that, when $OF = OC_0$, $1/(1 - Z) = 2$; but, when OF is greater or smaller than OC_0, $1/(1 - Z)$ is smaller or greater than 2. The damping decreases, therefore, in all cases the mechanical oscillations and reaction upon the prime mover. It decreases, however, the fluctuations of energy only when $1/(1 - Z)$ is greater than 2; it increases the fluctuations when $1/(1 - Z)$ is smaller than 2; and damping has no effect upon the fluctuations of energy when $1/(1 - Z) = 2$. Now, damping is always a loss, but the decrease of mechanical fluctuations by increasing the moment of inertia is a net gain. We saw that $1/(1 - Z) = 2$ when $C_0O = OA$, or when the synchronising fluctuation of energy is equal to the primary variable pressure.

In a machine without an amortisseur the former is the same as the fluctuation of energy sent into the network. If, therefore, on account of sufficient flywheel masses, the fluctuations of energy supplied to the network are smaller than the fluctuations of energy of the crank effort diagram, damping is useless. But if there are small flywheel masses, so that the fluctuations into the network are larger than the fluctuations of energy of the crank effort diagram, damping will give good results. In other words, use damping with multi-crank sets, but not with single-crank sets.

(To be continued.)

A FEW NOTES ON THE STEAM TURBINE.*

BY THE HON. G. L. PARSONS.

The early turbines were governed by a lantern type of throttle valve worked by the movement of a leather diaphragm, which the suction of a fan on the shaft tended to close against a spring. The admission of air to the diaphragm was controlled by an electrical governor. On the top of the magnet yoke there was a small iron bar pivoted on a vertical spindle and carefully balanced. This was moved round by the alteration of the magnet yoke against a spiral spring. A double finger or arm was keyed on the same vertical spindle; the end of each finger was flat, and, when opposite to the inlet of the air-pipe, closed it. The spiral spring was so adjusted by a movable head that the greater the voltage the more was the air inlet closed by one of the fingers. When the inlet was open the air rushed along the pipe and partially neutralised the suction of the fan, allowed the diaphragm to extend, and thus opened the throttle valve. If the dynamo got demagnetised the needle turned the other way, and the safety finger closed the air inlet and thus cut off steam. This type of governor was very sensitive, and kept the voltage steady within 1 per cent. The steam consumption of a 32kw. plant of this type running non condensing was about 48lb. per electrical horse-power-hour with a boiler pressure of 61lb., and about 42lb. per electrical horse-power-hour with a boiler pressure of 92lb.

In 1889, owing to temporary loss of patents, the radial-flow type of turbine had to be adopted. This consisted of a series of fixed annular discs with rings of blades, between which another series of discs keyed to a shaft rotated. The guide blades were secured to the faces of the stationary discs, and nearly touched the rotating discs, while the moving blades nearly touched the fixed discs. The steam passed outwards through the successive rings of blades, then inwards along the back of the first moving disc, and again outwards through the next ring of blades until it finally reached the exhaust. In 1892 this type of turbine was first tried condensing with a vacuum of 27in. With slightly superheated steam at a pressure of 100lb. the consumption at the normal full load of 100kw. was 27lb. per kilowatt-hour.

In 1894, however, the parallel-flow type was again adopted with considerable improvements. The turbine was made single-ended, with the steam passing in one direction only, the second series of rings being replaced by three rotating pistons, or dummies, by which the end pressure of the steam along the shaft was balanced. Each of the pistons corresponded in size to the part of the turbine it balanced, and to which it was connected by a pipe. Grooves were turned in these pistons, between which the corresponding fixed collars of the cylinder projected, and, being almost in contact, reduced the leakage of steam to less than 2 per cent.; the amount of clearance could also be regulated by the thrust bearing at the end of the turbine shaft.

The governor can be either of the mechanical type, which keeps the speed constant, or of the electrical solenoid type, which maintains a constant pressure at the terminals of the dynamo by raising the speed of the turbine to meet the fall in voltage due to the increase of the load. The electrical governor is now seldom fitted except on the smaller continuous-current plants. A small pump supplies oil under pressure to all the bearings, the oil being then returned to the tank to be used over and over again, resulting in a great saving as compared with reciprocating engines. Inside the cylinder itself no lubrication is required, since no parts are touching; the two end packing glands being of similar construction to the balancing pistons, also run clear, hence no oil can possibly find its way into the exhaust. Turbines are running in breweries and chemical

* Abstract of a Paper read before the Newcastle Local Section of the Institution of Electrical Engineers on March 21st.

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works, where the exhaust is led straight into the vats or liquids which require to be heated, and at Heaton part of the turbine exhaust steam is specially condensed to be used as distilled water for delicate chemical processes. The cost of oil for a large turbine works out at about 0·002d. per kilowatt-hour. The single-cylinder type of turbine has again been adopted for the larger as well as for the smaller sizes, being found cheaper as well as more efficient, besides requiring a shorter engine room. Plants up to 10,000 I.H.P. are now being constructed with a single cylinder. As a high vacuum is most important for obtaining the best results in steam economy, ample space is allowed at the end of the turbine for the exhaust steam, and the condenser is generally placed in a pit straight under the turbine, so that the drop in vacuum may be as small as possible between the machine and the condenser, while the length of piping required is greatly reduced. The following table shows the effect of variation of vacuum on the consumption of steam in the case of a 1,500kw. set. For the smaller sizes the variation is not so marked:—

Vacuum bar = 30in. Inches.	Difference in steam consumption per 1in. of vacuum. Per cent.
29	6
28	5
27	4
26	3½
24	3
22	2½
16	2

As regards the cost of obtaining these high vacua, a little investigation will show that the extra power required to maintain a higher vacuum in a given condenser (and the cooling surface need not be larger than usual) is very small in comparison with the saving of steam in the main turbine with a good vacuum. Three sets of 300kw. each have just been completed for the Corporation of Derby. They run at 3,000 revs. per min., and are intended to supply current for traction and lighting. Curves were taken on a Horn tachograph showing the variation of speed when the main circuit was made and broken on a load of 350kw. The temporary variation did not exceed 4½ per cent., and the permanent 2½ per cent. The dynamo was tested by throwing 350kw. off and on when running both as a shunt machine and as a compound, no movement being found necesary for the brushes, which were of brass wire. The following table shows the variation of voltage under different conditions:—

	Kilowatts.	Voltage.	Speed.
Compounding in use	0	505	3,075
„ „	336	565	3,000
Shunt only	300	500	3,000
	0	543	3,075
	0	520	3,000
(Constant excitation)	0	518	3,000

The following is an abstract of the discussion which followed the reading of the Paper.

Mr. BARKER mentioned that the steam consumption of a Curtis turbine when exhausting to atmosphere was 40lb. of steam per kilowatt-hour, this figure being obtained by carrying the curve backwards and not from actual test. Station engineers had a great dislike to tandem generators. He congratulated Messrs. Parsons on the use of a bedplate, this being an improvement on the foot at each end of the cylinder previously used.

Mr. RISELEY said that in nearly all cases it was necessary to pass at least twice as much water through the condensers as was needed with a reciprocating set. Of course, all this meant extra power consumed by the pumps. It was also necessary to have high-class air pumps, and although these did not require a great deal of power to drive them, they were, as a rule, so very complicated that the maintenance bill was out of all proportion to their worth, and he very much questioned whether it was not more advisable to put in simple pumps, say, of the Edwards type, where the wear and tear was nil, and where it was possible to replace the valves even when the machine was running. It took five hours or more to get at the bottom valves of one of these high-vacuum pumps. It was not much use saving steam consumption in the main sets if the saving were counterbalanced by increased steam consumption and maintenance charges of the auxiliary plant.

Mr. C. PROCTOR asked what power was absorbed by circulating and air pumps to obtain high vacuum.

Dr. THORNTON asked if the mechanical efficiency of a turbine had been ascertained.

Hon. G. L. PARSONS, in reply, remarked that the heavy cost of air-pump maintenance was very often due to their being worked too hard and subjected to rough usage. The power consumed by air pumps was, roughly, about 3·33 per cent. The mechanical efficiency of a turbine, ascertained by electrically driving it in a vacuum, was about 97½ per cent.

Iron and Steel Institute.—The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, May 5th and 6th next, at 10:30 a.m.

NOTES ON IMPEDANCE COILS *

BY C. FARADAY PROCTOR.

It is now some years since I was asked to devise a method of regulating a current between the limits of 0·3 to 1·5 of an ampere and 0 to 300 volts, or as near these limits as possible. An alternating current at 375 volts was employed, and a regulating choking coil, which consisted of about 3,000 turns of 0·03in. double cotton-covered wire wound into a coil 6in. long and 4in. diameter, and regulated (between 0·2 to 1·0 ampere and 0 to 350 volts), by having a core composed of a bunch of iron wires about 1·5in. diameter and 14in. long drawn in or out of the hollow fibre tube on which the coil had been wound (see Figs. 1, 2, 3 and 4). Some years later some other coils were made, but the results in this case were so unsatisfactory that the coils were sent to me to report on and advise how to correct them. My experience has led me to believe that the coils should have been somewhat longer than originally constructed, since the ampere-turns per pound of wire increased more rapidly by adding to the length rather than the diameter. Coils B_1 and B_2 have exactly the same weight of wire on them, but B_1 has 2,550 turns against 2,300 of B_2, but any further increase in the length seems to again decrease the efficiency. The weight of wire on these two coils, as may be seen from Table I., is just two-thirds of that used in the first coil, P small, and the choking effect is quite as good (in the list it is not shown as being quite as good at

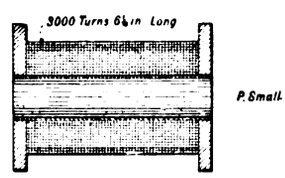

Fig. 1.

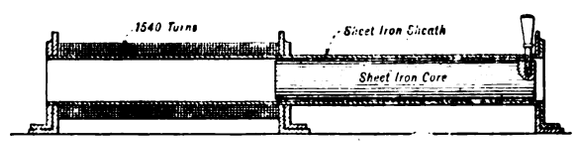

Fig. 2.

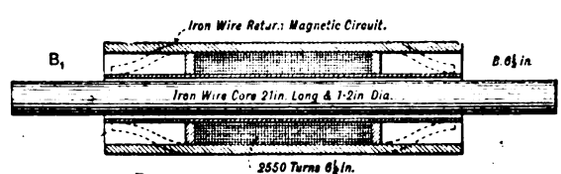

Fig. 3.

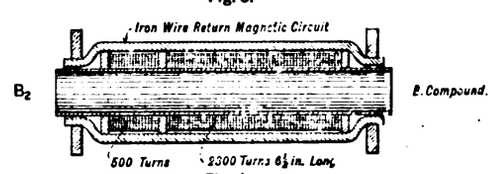

Fig. 4.

minimum current, but the ends of the return magnetic circuit are not closed together, which, as you will notice, more than accounts for the difference of 0·01) at maximum volts, the coil being, of course, the better the shorter the length of wire. The core used in the experiments with the coils P small and P large, also the coils B 6½, B 5 and B compound, consists of a bunch of iron wires 21in. long, 1·20in. in diameter and weigh 4lb. 10oz. The exterior iron wire return magnetic circuit consists of a number of small bunches of the same sized wires, held together with string, making a band 13in. wide and 10in. long, and weighed 3½lb.

Coil J, which is one of the second batch of coils made, is of very different construction. It is 8in. long, somewhat rectangular in section, is wound on a split sheet-iron sheath, insulated by a mica sleeve, and has only 1,540 turns of wire, and the core is made up of strips of sheet iron; its short-circuiting current is more than 5 amperes, and its maximum regulation as at first constructed, and with a current of 1·5 amperes passing and an E.M.F. of 400 volts, is 383 volts, the difference between the 400 volts and the 383 being loss by effective resistance. At 0·3 ampere its regulation is only 400 to 386 volts. Reference to Table II. will show what a very great improvement can be made in this coil by removing the iron

* Abstract of a Paper "Regulating Impedance Coils: Experiments Illustrating the Importance of some Details in Construction," read before the Newcastle Local Section of the Institution of Electrical Engineers on February 29.

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Table I.—*Table of Dimensions and Ranges.*

Coils.	Length of coil.	Diam. of coil.	Weight of wire.	Diam. of core in coil.	Diam. of iron core.	Resistance in ohms.	Total turns.	Amperes passing on short-circuiting across 400 volts.		On a 400-volt circuit the volts available for regulation at the following amperes are:—			
								Core in.	Core out.	1 A.	0·75 A.	0·50 A.	0·30 A.
P small ..	6·25	4·00	8lb. 5oz.	1 625	1·20	37	3,000	0·21 A.	2·90	354 V. to 0 V. at ·21 A.	360 V. to 0 V. at ·21 A	381 V. to 0 V. at ·21 A.	385 V. to 0 V. at ·21 A.
P large ..	6·25	5·50	12lb.	2·00	1·20	70	5,000	0·10	1·30	225 V. to 0 V. at 0·1 A.	310 to 0 V. at 0·1 A.	360 to 0 V. at 0·1 A.	..
J	8·0	2·25 sq. in.	2lb. 4oz.	1·25 sq. in.	1·20	10	1,540	*	*	376 to 326	380 to 345	..	382 to 375
B 6½ in. ..	6·5	3·25	5lb. 7oz.	1·625	1·20	25	2,550	0·22	5·0 A.	373 to 0 V. at 0·22 A.	379 to 0 V. at 0·22 A.	..	391 to 0 V. at 0·22 A.
B 5	5·0	3·50	5lb. 7oz.	1 625	1·20	25	2,300	0·23	5·0 A.	373 to 0 V. at 0 23 A.	379 to 0 V. at 0·23 A.	..	391 to 0 V. at 0·23 A.
B compound	6·50 + 1·75 = 8·25	2·8	..	1·75	1·20	17 plus 5 = 22 total	2,300 + 500 = 2,800	0·3	*	..	..	..	..
								0·22	*				
B 100 volts	5·0	1·5	1lb.	0·85	0·75	5 terminals 0·9 ohm each 4·5 ohms.	1,000	..	..	..	..	..	..

* Too high for size of wire above 5 A.

Table II.—*Coil J as Constructed, and as Altered, compared with Coil P and B on a 400-volt Circuit.*

Coil J as at first constructed.	Loss in volts by effective resistance at				Range in volts at various amperes.			
	0·3 A.	0·75 A.	1·00 A.	1·50 A.	0·3 A.	0·75 A.	1·00 A.	1·50 A.
With iron sheath and without iron wire return magnetic circuit	18	20	24	33	7	35	50	90
J without sheath and with return magnetic circuit	3	9	10	18	25	85	110	150
Coil P small	15	46	40	..	385	360	350	344
Coil B 6½	9	21	27	36	391	379	371	370

sheath and adding an exterior magnetic circuit; at 0·3 ampere the regulation is more than three times what it was, and at the 1·5 amperes more than twice what it was.

In the course of the discussion which followed the reading of the Paper, Dr. Thornton said that he was interested in the indirect results obtained from the figures, as it was impossible to calculate the actual air reluctance of an impedance coil. Mr. Stoney said that he had often tried to calculate the outside reluctance of impedance coils, but had so far not succeeded. In the case of large coils, the result obtained in practice could not be accounted for, and the heat generated in the core was so enormous at the present time that the large cost of ventilating a large coil made it commercially impossible.

CORRESPONDENCE.

"MODERN ELECTRIC PRACTICE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your review of "Modern Electrical Practice" last week, there is one statement which, I think, requires some comment. Your reviewer says that a "description of the Duddell oscillograph followed by a chapter on the sine wave and its representation" is an arrangement which "obviously admits of considerable improvement." This particular arrangement has been adopted by me after experience extending over several years in teaching evening students, most of whom do not possess much mathematical knowledge. With such students I have found it far better to spend some time in showing exactly what an alternating current is and how it may be observed before mentioning the sine wave. The results I have found from starting with the sine wave are two: The student is apt to think, firstly, that there is one, and one only, wave shape, and, secondly, that the laws governing the flow of alternating currents are entirely dependent on the properties of sines and cosines. These errors may, of course, be corrected subsequently, but surely in this, as in every other case, prevention is better than cure. If, at the outset, the student understands that the sine wave is assumed simply because it is simple, and because the results obtained approximate, in most cases, fairly closely to the observed phenomena, it is not difficult for him to comprehend the variations which he may meet with in actual work, variations from "sine law" calculations which by the other method would be inexplicable.—Yours, &c.,

The University, Liverpool, April 5. E. W. MARCHANT.

LEGAL INTELLIGENCE.

Rating of Machinery.

At the Leeds Sessions on Thursday last week the Recorder (Mr. Tindal Atkinson, K.C.), delivered judgment in the appeal of an engineer (Mr. Thos. Kirby) against an assessment made on behalf of the Hunslet Guardians by their Assessment committee. The Hunslet Board recently had a re-valuation made of all properties in the township. Formerly engineering and other works were assessed according to the amount of horse-power employed, but latterly the value of the machinery on the premises was taken into consideration, and this led to the present appeal.

In the course of his judgment, the RECORDER said that machinery by itself was not the subject of rating. If fixed to the freehold either as a landlord's or tenant's fixtures, it was, for the purpose of being rated, a part of the freehold, and no difficulty arose. Where plant and machinery were not affixed to the freehold, but had been placed on the premises to be rated for the purpose of making, and did make, the premises fit for the particular purpose for which they were used, they then were capable of being taken into account in ascertaining the rateable value of such premises. In that case the machinery belonging to the tenant, and which was at present on the premises in question, was admitted to come within the above category. It was common ground between the parties that that machinery had in some way to be taken into account in arriving at the rateable value. Appellant urged that the value of the user of the machinery in connection with the occupation of the premises ought not to be considered, but that the extent of the benefit must be limited to the advantage derived from the fact that the machinery afforded proof of the convenience of the building for the business, and a possible value of his being able to take it *in situ*. Respondents, on the contrary, urged that the only way in which one could properly take the machinery into account was by taking the hereditament as one found it, furnished and equipped with the necessary machinery, and ascertain what was the rent which a tenant from year to year would give for such premises as they stood, including the right to use what he found there. It was extraordinary (continued the Recorder) how little decisive authority there was on the point. The earlier authorities quoted were of little or no assistance, although exceedingly valuable on the point as to what sort of machinery might be treated as adding to the rateable value, and in the leading authority on the point, the Court of Appeal, in "The Tyne Boiler Works Co.," carefully and deliberately refrained from expressing any opinion on the method by which the value was to be ascertained. The Recorder also cited the cases of "The Queen *v.* Haslam" and "Gifford *v.* Chard Union." In the latter case two questions were submitted to the Court: (1) Whether the machinery was to be taken into account at all; and (2) whether, assuming it was, it was taken into account on the proper principle. In delivering his judgment Lord Esher said "that machines whether fixed to the freehold or not, if necessary to the use of the premises and going to make up the value for which the rent is paid, ought to be taken into account," and that showed to his (the Recorder's) mind, that Lord Esher was referring to the user of both the premises and the machinery as the factor in the production of rent. The two main grounds which had been urged by the respondents were: (1) That in adopting it you would be rating machinery, and (2) that the tenant buys the machinery and yet has to

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pay the landlord rent for it. As to the first objection, he thought the answer was that to take the value which machinery might add to the letting value of the premises was not to take the value of the machinery. The added rent had no fixed relation to the value of the machinery. If new machinery were put into old and inconvenient buildings, where the full benefit of the machinery could not be obtained, no tenant would give as an addition a 5 per cent. rental on the value of the machinery, or calculate the rent he offered on any such basis. The premises in the present case afforded an illustration of what he meant. Evidence had been given that, owing to the lowness of the rooms, full power could not be obtained to drive the machinery, which had the effect of detracting from the value of the machinery as applied to the building. The second point urged was that the tenant bought the machinery and yet had to pay the landlord rent for it. He thought that involved a consideration of the facts of the particular tenancy in question, which was fallacious. The question was not what that tenant had done in the purchase, or whose property the machinery in that case was. For rating purposes they must take the premises as they found them, permanently equipped as engineering works with all the necessary appliances and machines. As it stood, what was the rent? The answer to the question showed what was the rateable value. He was of opinion, therefore, that the principle by which the rateable value was to be ascertained in that case was that contended for by the respondents—viz., that in ascertaining the rent you must take into account the value of the user of the machinery as contributing to the rental value of the freehold. But in saying that he was far from saying that such value was to be arrived at by taking the cost or value of the machinery, putting a percentage on such value and adding it to the rest. The increase of value due to the machinery might and would vary in each case, owing to a number of causes. Applying those principles to the case, the Recorder found the net rental value of the land, buildings and landlord's fixtures, without the rent of the machinery, to be £21. To that he added what he thought a tenant would give by way of additional rent for those premises, equipped, as they were, with the machinery, including the right of user. That he estimated roughly at £10 a year, making the net rateable value £31. For the purposes of appeal, the Recorder said that if appellants' contentions should be found to be correct, the rateable value should stand at £26. As the case had been fought on principle, respondents were entitled to costs.

On behalf of the appellant, it was urged that the Recorder had no power to give such costs. Appellant had succeeded in reducing the assessment 30 per cent. of the sum appealed against.

The RECORDER replied that that was the case, but the issue had been chiefly one of principle, not of figures. After further consideration, however, he decided that each party should pay their own costs.

Upon application the RECORDER said he would state a case for the High Court.

Assessment of Tramways.

At the Middlesex Quarter Sessions, presided over by Sir Ralph Littler, K.C., last week, the hearing of the appeal of the London United Tramways (1901), Ltd., against the assessment of their property in Brentford and Chiswick was concluded.

Mr. BALFOUR BROWNE, K.C., opened the company's case and dealt with the method of assessment of the company's lines and property. Particulars of the working expenses were given and the total assessable value arrived at had been £13,659, the poor rate being 7s. in the £. As there were no stations it was very very difficult even when the lines were working to ascertain the amount earned between two points other than the terminii. As an instance of the difficulty of assessing a line which had not been working a full year he said the Shepherd's Bush route to Hounslow was only open during the last 141 days of 1902 and the company had estimated that the takings during the remainder of that year, if the line had been in operation, would have been of the same daily average and would have amounted to £20,036, instead of which they only received £7,740 in the corresponding period of 1903. Moreover, there were certain expenses connected with tramways which had no relation to the number of miles run. The gross receipts on the whole of the company's system were £235,679 and the net revenue £92,688. Taking from this the "tenant's" share (£35,529), statutable charges (£43,504) and the rateable value of the company's buildings and land in the Brentford Union district, the rateable value of the whole of the lines was £3,700 or 0·0006037 of a £ per car-mile. On this basis the rateable value of the lines in Acton would be £318 and of those in Ealing £181.

Mr. J. CLIFTON ROBINSON, managing director of the company, gave evidence as to the value of the undertaking and its assessment.

Mr. F. C. RYDE (Messrs. E. Ryde & Son), said he had made a valuation of the whole line, and took the expenses, against the receipts, at 4·16d. per car-mile. The working expenses were £142,991 and the receipts £235,679, which left £92,688. The occupiers' share of that was £35,525. The assessable value should be £11,058 for land and £110,686 for buildings. The cost of the rolling stock was given him by the company as £185,600.

Sir EDWARD CLARKE, K.C. (for the Assessment committee): We say that £138,000 is the proper figure, which makes a great difference.

Replying to further questions by Sir Edward, Mr. Ryde said that no bank would take an account such as that of a tramway company unless there was a permanent balance of £10,000. As a matter of fact, the London United had a balance of £16,000 at the bank.

At this point, Mr. VESEY KNOX, for the Chiswick District Council, said his clients could not accept the figures put forward by the company, and even if they had to pay their own costs, he had been instructed to appear, as the Council's interests were hostile to those of the Brentford Union.

Sir RALPH LITTLER held that Chiswick Council had no locus, and, therefore, the Court could not hear Mr. Vesey Knox.

Mr. ROBERT HAMMOND said the figures given by the company had been carefully compiled, and were perfectly fair to the local authorities; if anything, they were unequable to the company. The money expended by the company on repairs of the permanent way in 1903 was more than double the sum expended in 1902; the figures were £4,613 and £9,371 respectively. The price of the cars, which were particularly fine, was £816 each, whereas the average price in other places was £600. It was somewhat difficult to arrive at the average cost of repairs, &c., of this undertaking, as there was no undertaking in the kingdom with which it could be compared.

Mr. A. DICKINSON said the figures given with regard to the overhead equipment, &c., were the actual cost, and not capital value. To ascertain the value of the equipment at any given time, the actual cost would have to be depreciated.

The Secretary of the company (Mr. W. G. VERDON SMITH) said that at the beginning of 1902 the company had 150 cars, whilst at the end of that year they had 255. The first lot of cars cost £850 each, and the last set £750 each. There was an obligation on the company to keep a balance of £5,000 at the bank. He could not say how often the balance was over that sum, but in the summer it was high and in the winter low. During the year they had carried out large works and their balance had fluctuated.

The witnesses for the Brentford Assessment committee included Mr. W. G. Cook (rating surveyor), Major P. Cardew and Mr. Joseph Kincaid, C.E.

After addresses by counsel, the CHAIRMAN announced that the Court was unanimously of opinion that the appeal should be allowed with costs, and the assessment reduced to £11,245 for the whole undertaking.

It was stated that very heavy costs in the appeal will fall upon the Brentford Union Assessment committee.

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Governors of Woolwich Polytechnic require a head of the department of mechanical and electrical engineering, also first and second assistant; acting head of department of mathematics and experimental physics, also senior and junior lecturers and demonstrators; head of department of chemistry and metallurgy and assistant lecturer and demonstrator. Further information is given in an advertisement. Particulars of duties and conditions of appointment from the principal, Mr. Wm. Gannon, M.A. Applications to the principal by April 26.

The Municipal Commissioners of Singapore (Straits Settlements) require an electrical engineer, with experience in the management of three-wire continuous-current supply station, and qualified to superintend the laying and maintenance of underground cables on the solid system and to take entire charge of their electrical department. The appointment will be made for three years, at £360 for first, £390 for second and £420 for third year, with transport allowance. Applications to Mr. C. C. Lindsay, M.Inst.C.E., 217, West George-street, Glasgow, by April 19. See also advertisement.

A lecturer and demonstrator in electrical engineering is required at the School of Engineering, Electricity and Technical Science, Canterbury College, University of New Zealand. The appointment will be for three years; salary, £300. Particulars, &c., from the Agent-General for New Zealand, 13, Victoria-street, London, S.W. Applications by 28th inst. See also advertisement.

Preston Tramways committee require a chief assistant to act under the engineer and manager of their tramways department at a salary of £200 per annum. Applications to the engineer and manager (Mr. Walter H. Tittensor), 25, Burrow-road, Preston, by April 16. See also advertisement.

There is a vacancy for a pupil at the Cromer electricity supply station. Applications to the manager. See advertisement.

A jointer, used to triple concentric cables, is required for the electricity department of the Borough of Hornsey. Applications to borough electrical engineer (Mr. Norman Staniland) electricity works, Tottenham-lane, Hornsey, London, N. See advertisement.

Yorkshire Electric Power Co. require an engineer to supervise the laying of high and low-tension mains and take charge of distribution. Applications by 16th inst. to resident engineer (Mr. W. B. Woodhouse), Central Bank-chambers, Leeds. See advertisement.

A competent designer of alternate-current generators, motors and transformers is wanted by Messrs. Vickers, Son and Maxim, River Don Works, Sheffield. Applications to electrical department. See advertisement.

A mechanical draughtsman, with first-class knowledge of machine design, is required by Messrs. Harland and Woolff, Belfast. See also advertisement.

An assistant lecturer and demonstrator in engineering is required at Merchant Venturers' Technical College, Bristol. Particulars from Registrar, to whom applications by April 30.

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Argentina.—The "Review of the River Plate" states that Señor G. Abello has obtained a concession for electricity supply at Saladillo.

Pablo Bessana y Hermano are to supply an electric light and power installation at Buenos Ayres Congress Hall at $60,000 gold.

Mr. J. E. Stewart (representative of Messrs. Kincaid, Waller, Manville and Dawson) has removed to 651, Avenida Mayo, Buenos Ayres.

The Cia Alemana Transatlantica at Paseo Julio, Buenos Ayres, is substituting three-phase for single-phase plant, and when this is completed the Paseo Colon station will be closed.

The Chief of Customs advises the Finance Minister that all overhead and permanent way materials, electric lamps and lubricating oil required for tramways in the country should be admitted duty free.

Electricity works are to be established at Rioja.

Buenos Ayres Corporation are recommended to cancel the concession (of September, 1900) to Gaston Roux & Co. for electric tramways, as it is stated the concessionaires have not complied with its conditions.

During recent storms many of the overhead telephone wires in Buenos Ayres were, it is stated, broken, and fell upon the tramway trolley wires, stopping the traffic for about 24 hours. The director of public lighting recommends that the telephone wires be placed underground.

There is said to be about £250,000,000 of British capital invested in Argentina. Buenos Ayres municipality proposes to expend £1,500,000 in new electricity supply works to compete with the German company which now holds a concession for this supply.

Aston.—The City of Birmingham Tramways Co. have agreed to the appointment of the borough engineer (Mr. Green) as sole arbitrator on the question of the purchase of the whole of the company's tramways in the borough. Warwick County Council have consented to the construction of a double track over Salford Bridge.

Birkenhead.—During the past year 11,327,932 passengers were carried on the municipal electric tramways. The receipts were £54,660; the cost per car-mile was 9·58d. For 1902-3 the figures were:—Passengers 10,390,985, receipts £51,067, cost per car-mile 9·71d.

Bradford.—The total receipts of the Corporation Tramways department for the year ended March amounted to £194,310 (including £1,044 for parcels), an increase of £21,382 on the year. More than 46,000,000 passengers were carried.

Burnley.—The salary of the tramways manager, Mr. Mosley, has been increased from £350 to £400 per annum.

Crewe.—The Council had intended to promote a municipal electric tramway scheme, but it has now been decided to postpone the matter for a time on account of trade depression in the borough.

Customs Regulations.—Materials for the construction and maintenance of tramways and railways are now admitted free of duty into the British East Africa and Uganda Protectorates.

Accumulator "grids," whether made wholly or in part of lead, imported into the United States of America are, under a recent decision, dutiable at the rate of 45 per cent. ad val. under para. 193 of the Tariff. Formerly these goods were admitted under para. 182.

Derby.—The estimated capital expenditure of the electricity department for the year ending March 31, 1905, is £6,500, including mains, £3,000, supplying electric motors on hire £1,800, meters £500, telephones to sub-stations £40, extensions of lighting switchboard £60, sundries and contingencies £600. Application has been made for permission to borrow this amount.

Dover.—The Council have applied for sanction to a loan of £11,260 for providing additional generating plant, including a 400kw. Parsons turbo-alternator, at the electricity works.

Ealing.—There is the equivalent of 74,040 8 c.p. lamps connected to the electric lighting mains.

Electric Power and Supply Station Equipment.—Messrs. Johnson and Phillips are issuing a series of illustrations of supply and power station equipments which have been erected by the firm. The latest example to hand is that of the Blackheath station.

Glasgow.—The Corporation have come to terms with the Caledonian Railway Co. in regard to the supply of water for condensing purposes.

The Tramways committee recommend the acceptance of the offer of the General Assurance, Limited, to undertake for one year the third-party risks for a premium of £14,000, payable in four quarterly instalments, and, in addition to the security offered by them to have their policy covered at Lloyd's, the limit for any one accident to be £2,500, and the indemnity for the year to be £25,000.

Gloucester.—Electric energy will be supplied by the Council for the new electric tramways at ¾d. per unit and at 2d. for lighting depots, &c.

Hartlepool.—On Wednesday the Council decided to seal the agreement with the General Electric Tramways Co. by which they waive their right for 21 years to purchase the tramway undertaking.

The company undertakes to relay such portions of the track as now consist of single line, to put the overhead equipment into thorough working order, to double the line within the borough should the West Hartlepool portion be doubled, to relay the line in Northgate from the terminus to Cleveland-street with wood blocks, to use bogie cars and to run them at intervals of not more than nine minutes, to charge ½d. fares on certain routes as an experiment for six months on condition that if, after that time, it is found not to produce 7 per cent. on capital expenditure 1d. fares be reverted to, to pay £250 deposit for due performance of agreement and £500 to Corporation in consideration of the renewal of lease, together with one-third of all profits realised by working the trams in the borough over and above a sum equal to 7 per cent. on the capital expenditure.

Hastings.—The receipts of the Electricity department during 1903 from the sale of current by meter were £7,729. 12s. 11d., lamp charge from private consumers £3,324. 19s. 2d., sales under contract £47, public lighting £4,028. 19s. 10d. (including lamp charge, interest and sinking fund, repairs, carbons, &c.), meter rental, &c., £653. 5s. 7d., rents, £152, and miscellaneous receipts £76. 7s. 6d.—total £17,977. 14s. 6d. Expenditure was: Generating expenses £6,990. 6s. 8d., distribution £359. 12s. 4d., repairs, renewals and attendance of public lamps £825. 12s. 11d., and rents, rates and taxes £204. 16s. 6d. Management expenses, including salaries, were £1,505. 7s. 3d., and special charges (insurance, &c.) £218. 2s., leaving gross profit £7,873. 6s. 10d. After providing for redeemable stock dividends, interest, bad debts and amounts transferred to loans and sinking fund, there was a deficiency on the year's working of £951. 989,562 units of electrical energy were generated, of which 228,432 were supplied to public lamps and 623,662 to private consumers. The maximum supply demanded was 610·4kw. Capital expenditure to date is £131,831. 19s. 3d.

Heston and Isleworth.—The Council will give a supply of electric current for light and power in May, and consumers are promised a supply for the first month free of charge. The charge for energy for lighting has been fixed at 5d. per unit, less discounts, and for power at 3d. per unit for consumption up to 750 units per quarter, and 2d. per unit for all excess. Consumers' premises will be wired free of initial cost, the charge for current in these cases being 5¾d. per unit.

Inquest.—Mr. G. E. Hilleary held an inquiry at Stratford, London, E., last week, into the death of George Crates, aged 22, a switchboard attendant in the employ of the Charing Cross and City Electric Light Co. at Pudding Mill-lane generating station, Stratford.

Deceased had been in the employ of the company for about six months, and had previously been working at Bristol and Chelmsford electricity stations. On March 28 he went to work at about 5:30 a.m., and about 1 p.m. arrangements were made to shut down the station to effect some repairs. Signal was given that all was clear, and Crates proceeded to remove the fuses from the switchboard. He had removed six out of the nine safely, and was in the act of removing the seventh when there was a report and a flash, and he fell back. The fuse was not damaged. Deceased had apparently received a shock, and efforts were at once made to restore respiration, but he died before medical assistance could be secured.

Dr. S. Alexander said deceased was scorched on the face and his hair was singed. He had died from electric shock.

Mr. W. H. Kingston, engineer-in-charge at the station, in reply to Mr. G. Scott Ram (representing the Home Office), said current was shut down in order that a cable might be cut off. After this had been done he (witness) would have had no hesitation himself in touching the fuses with his bare hands, and deceased, with his experience, probably had similar confidence. Special tongs, with insulated handles, were provided to remove the fuses, whether they were alive or dead. Of course, no one would think of touching the fuses when they were alive; the tongs were provided as an extra precaution; but when the switchboards were cleaned before the works started each morning the fuses were removed by hand. The occurrence was inexplicable; he could only suggest that it arose from a static or capacity charge. In that case, had the man used the special tongs provided he would not have received a shock. Possibly Crates caught hold of the first six fuses by their glass centre, but had touched the metal part of the seventh fuse. A verdict of accidental death was returned.

Khartoum.—The Egyptian Government have declined an offer by a company to establish electricity and water supply undertakings in this town, deciding to carry out the work themselves.

Lancaster.—The Electricity committee have set apart £750 out of the profits of the department for the past year in relief of rates.

Leeds.—The receipts of the Tramways department for the year ended March were £277,655, compared with £262,433 in 1903. The car-miles run were 6,091,437, compared with 5,773,651. The receipts per car-mile were 10·94d., against 10·90d.

Lincoln.—The City Council have been authorised to borrow £11,700 for the purchase of the local tramways.

The City Council decided on Tuesday to increase the salary of the city electrical engineer (Mr. Stanley Clegg) by annual increments of £50 up to a maximum of £500.

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Liverpool.—In the annual report of the city lighting engineer (Mr. C. R. Bellamy) it is stated that up to date 185 10-ampere electric arc lamps have been erected in 4½ miles of streets. During 1903 electric lighting had been extended, 15 new arc lamps having been erected. During the year 2,770 electric meters were tested, the total testing fees amounting to £138. 15s.

Liverpool Corporation Tramways.—We have received from Mr. C. R. Bellamy, general manager of these tramways, a copy of the "Official Handbook and Illustrated Map of the Electric Tramway Routes, Stages and Fares," which has been compiled for the use of passengers and is obtainable at the popular price of 1d. The contents of the publication are varied and afford the stranger in the town especially an interesting guide to the city. The arrangement of the text enables him to trace his way through the city, and to inform himself of the landmarks en route. A section of the pamphlet is entitled "Pleasant Rides," and agreeably describes four special trips. The first is a journey of 23½ miles, occupying about 2½ hours, which can be accomplished for the sum of 11d.; trip No. 2 covers a distance of 9 miles 434 yds., occupying about 1¼ hours, fare 4d.; No. 3 is a double route of nearly 18 miles, costing 1s.; and No. 4 an hour's ride of 8¼ miles, costing 4d. A number of maps are given, one of which is on a large scale and coloured. An exhaustive index completes probably the most comprehensive tramway handbook ever published.

Malton.—Plans of the electricity generating station proposed to be erected in this town by the Northern Counties Electricity Supply Co. were approved by the Council last week.

Manchester.—The electricity committee recommend sanction being obtained to a loan of £135,000 for extensions and alterations at Dickinson-street generating station, for lighting and traction feeders and distributors, &c.

Morecambe.—The Council have entered into an agreement with the General Electric Co. for the supply of electric motors, &c., for letting out on hire.

Municipal Tramways in the United States.—A plebiscite at Chicago has resulted in a majority of three to one in favour of the acquisition of the tramways by the municipality, who will have to apply for an extension of their borrowing powers before the proposal can be carried into effect.

New York-Ottawa Railroad.—The U.S. Commercial Agent at Cornwall, Canada, states that the receiver of the New York and Ottawa Railroad has been authorised and directed by the Court to change the motive power used on the railroad between Ottawa and Tupper Lake, New York, to electric working, on the ground that a great reduction in running expenses and a more rapid and prompt service would be effected by this means. The line is about 123 miles in length.

Newcastle-on-Tyne.—It was reported to a special meeting of the City Council last week that the Lords Committee had refused sanction to certain proposed Corporation tramways outside the city, and also the purchase of Scotswood Bridge.

The town clerk said the Tyneside Tramway Co.'s bill had been before the House of Lords Committee and the clauses relating to compulsory running powers over the Corporation system had been passed without amendment.

The Council unanimously declared its objection to these compulsory running powers, and appointed a committee to use every legitimate means to defeat the application.

Nice.—It is stated that a group of financiers have acquired a concession for the building of an electric power plant in the upper Roya Valley. There is already a company operating in the district whose concession does not expire until 1913.

Nuneaton.—At the meeting of the Council last week, the electrical engineer (Mr. S. Cameron Gibson) reported upon the recent explosion which had occurred in Bridge-street. His report states that

No doubt the explosion was due to the ignition of coal gas, which had found its way into the conduits and pits connected with the electric cables, but there was no evidence to show how the explosion was caused. It was impossible that the explosion should have been caused by electricity. He had constantly reported to the Electric Light committee on the presence of gas in the conduits, and had communicated with the gas company.

Panama.—Recent developments in Panama have called attention to the demand for improved public works, and amongst the enterprises which will shortly have to undergo extensions is the electric lighting of the city, which is old and unequal to the demand. It is also in contemplation to start an electric tramway system to be operated by the company owning the electric lighting concession. Considerable extensions also of the telegraphic system of the country are in contemplation.

Preston.—Notwithstanding a ratepayers' petition for extension of the electric tramways along Ribbleton-lane to the borough boundary at an estimated cost of £16,000, the matter has been deferred by the Council until the routes under construction have been working 12 months.

Private Bill Legislation.—Tottenham District Council give notice of intention to apply for leave to introduce into the Tottenham Improvement Bill an additional provision that if the powers granted by the act are not exercised by the Council within six months after passing, or such other period as may be prescribed, such powers shall cease to be exercisable by the Council, and shall be transferred to the Metropolitan Electric Tramways (Ltd.), and that if such powers are so transferred the company shall be bound to exercise them within two years.

Riga-Cherson Canal.—There has recently been presented to the Czar of Russia a project for the construction of a canal to connect the Baltic with the Black Sea, starting from Riga and ending at Cherson. It is stated that for the purposes of working the canal when constructed, extensive water power will be available. The proposal is to light the route of the canal throughout by electricity, and, by means of electric working, to ensure a day and night service being maintained. The length of the canal is 1,468 miles.

Scottish Provisonal Orders.—Among the applications for provisional orders which will be made this month are Ayr Corporation Tramways, Loch Leven Water Power (Extension of Time) and Perth Corporation orders.

Shanklin (Isle of Wight).—The Council on Tuesday decided to consider the question of Sandown and Shanklin Councils exercising their right to acquire the electricity works at Lake.

South Africa.—The "British and South African Export Gazette" states that

The exports from the United States to British and Portuguese Africa in December last included electrical machinery valued at £789, a decrease of £741 compared with December, 1902. Amongst recent shipments from New York to South Africa were 33 cases of electrical machinery and material. The total exports from the United States to British and Portuguese Africa during 1903 included electrical material and scientific instruments (including telephone and telegraph apparatus) to the value of £78,664, against £42,161 in 1902.

Port Elizabeth Municipality will probably be inviting tenders shortly for plant for their projected electricity supply undertaking.

Messrs. Harris, Lee & Co., of Johannesburg, have secured the concession for the supply of electricity in Heilbron, Orange River Colony, and expect to have the plant in working order in four months.

A project is being prepared for erecting electricity supply works and constructing electric tramways in Paarl (Cape Colony).

The Maritzburg electric tramway system is approaching completion. Among the contractors are the Brush Company, who are supplying six eight-wheeled bogie cars; R. W. Blackwell & Co., the overhead equipment; and Hadfield's Steel Foundry Co., the points and crossings.

An electric power station is being equipped at Zomba, British Central Africa.

Aliwal North Municipality are applying for Parliamentary powers to erect electricity works and to utilise water power available on the Orange River in generating current.

Electric light is in general use at Nairobi, British East Africa.

Durban Corporation seek parliamentary sanction to raise a loan of £900,000 for public works, including £150,000 for electricity supply and £50,000 for tramway extensions.

Stourbridge.—Shropshire and Worcestershire Electric Light Co. have withdrawn their application for a provisional electric lighting order, and at the last meeting of the Council tenders were accepted for the supply and erection of electric lighting plant.

Strike of Telegraph Operators.—Reuter announces that 100 operators of the Great North-Western Telegraph Co. at Toronto and Ottawa have struck work owing to the refusal of the company to reinstate six unionist telegraphists recently discharged. It is stated that the strike is likely to extend.

Sunderland.—The chairman of the Electricity and Lighting committee (Ald. Bruce) last week, in submitting to the Council particulars relating to the working of the electricity undertaking, said these would show a profit of 6½ per cent. on the large capital expenditure apart from interest and sinking fund. He considered the Corporation's tramways and electricity undertakings could, if it were desired, be realised for a sum representing the whole amount spent and a surplus which would considerably reduce the municipal debt.

Telephone Call-Office Instruments.—The Postmaster-General has issued a notice that the mouthpieces and earpieces to Post Office telephones at call-offices should be wiped out with a clean cloth every morning, but that the apparatus should not be taken to pieces for the purpose, nor unscrewed in any way.

Tramways and Trade Unions.—Application has been made to Glasgow Tramways committee on behalf of employés in the tramway department that they shall be paid at time and a half for Sunday work. Time and a quarter, in addition to the other six days of the week, has been offered to men working on Sundays. At a meeting of the National Amalgamated Union of Labour

Mr. Brough, organanising secretary of the men's union, urges that no trade union would admit the right of employers to work their men on any six days of the week they chose, and that the Corporation itself, when giving out work to contractors, insists upon trade union rates being paid. Trade union rates for Sunday meant practically double time. The offer of the Corporation has, therefore, been declined. It has also been

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decided to ask that no employé of the tramways department be dismissed from the service by any subordinate official, but that all charges against men should be dealt with by the general manager.

Tramway Workers' Association.—The report of the Executive Council to the members of the Amalgamated Association of Tramway and Vehicle Workers for 1903 states that an attempt is being made to get the class of labour which the Association represents included in the Workmen's Compensation Act, and the Home Office committee have signified their willingness to hear evidence on the subject. The report submits a proposed programme for consideration aiming at a minimum wage of 7d. per hour and a maximum working week of six days aggregating 54 hours, the abolition of split turns and the institution of double shifts.

Transvaal Imports.—For the 12 months ended December, 1903, the value of the imports into the Transvaal of electric cables, wires and fittings was £65,000, compared with £45,000 in the previous year, in both cases without including goods imported as "public stores."

Tunbridge Wells.—A long discussion took place at the meeting of the Council on Wednesday upon an offer made by Mr. A. E. Tylor, on behalf of a London syndicate, for the purchase of the Corporation's electricity undertaking for £80,000, or £10,000 in excess of the capital expenditure to date.

Ald. G. Finch advised the Council to retain the property as a valuable asset of the borough. He did not see the wisdom of parting with municipal electric lighting just because there had been a temporary loss of a few hundred pounds.

In reply to questions the Mayor (Ald. Elvy Robb) explained that only Councillor Hicks voted against the Electric Light committee's report favouring the retention of the system.

Ald. Delves thought the electric light was not such a financial failure as was supposed.

Councillor Hicks opposed trading in any competitive way by the Corporation, on principle.

Councillor T. Edwards was strongly against any kind of municipal trading.

Councillor Strange opposed the transfer.

Ald. Stone dissected the report, and proposed "free" wiring. If current was being sold under cost price, then the Council should know it.

Several other members having expressed their views, the Council decided not to take a vote on the question at present, but to base their final decision upon fuller information as to profits and loss, a report to be brought up in June.

Wandsworth (London)—The Council have again asked the County of London and Brush Provincial Co. to reduce their charge for electric current for private lighting to a flat rate of 4½d. per unit.

Watford.—Messrs. Pritchard, Green & Co. have been appointed consulting engineers for the Watford and District light railway scheme, and plans are being prepared for the approval of Watford Council and the Board of Trade.

West Ham.—Major J. W. Pringle, R.E., officially inspected the following new routes of the Corporation tramways system on the 30th ult :—Canning Town railway station via Barking-road to Green-street (East Ham boundary) (1m. 5f. 1·55ch.), and Portway and Upton Park route (1m. 1f. 1·50ch.) The report of the inspector being satisfactory, the Board of Trade certificate was issued on March 31. The Barking-road route was opened for traffic on Good Friday, and the Upton Park route on Easter Monday. There are now 4·66 route miles of the system open for traffic. The receipts for the four days amounted to over £500.

Wilmslow—The scheme of electricity supply prepared by Alderley and Wilmslow Electric Supply (Ltd.) has received the sanction of the Board of Trade.

Wireless Telegraphy.—Under sec. 1 (1) of the ordinance issued last year by the Governor of the Seychelles it is provided that :—"No telegraphic or electrical station, apparatus, machinery or implements whatsoever, whether for the purpose of electrical communications by what is generally known as 'wireless telegraphy,' or for any other purpose connected with the transmission, emission or reception of messages between the Seychelles Islands and any place within or outside the Seychelles Islands, shall be erected or used in any place, including any ship or floating conveyance within or without the Seychelles waters, except vessels of H M. Navy, in the Seychelles Islands, whether on private property or not, without the sanction of the administrator previously obtained." Any person contravening the provisions of the ordinance is liable to a fine up to Rs.5,000, and to have apparatus, &c., forfeited and destroyed.

A similar ordinance was issued by the Governor of Hong Kong in July last in order to authorise and regulate the establishment and use of installations of wireless telegraphy in the colony. This ordinance provides that no person shall establish or use within the colony any installation for the purpose of wireless telegraphy unless authorised to do so by licence, which may be issued under such conditions and stipulations as the Governor may, from time to time, find desirable in the public interest.

Wolverhampton.—An additional section of the Lorain surface-contact tramways from Horseley Fields to the borough boundary at Moseley Village was opened for traffic on Saturday.

Worthing.—Application has been made for sanction to borrow £1,500 for mains extensions and for the purchase of meters, house service materials, &c., during the next nine months.

Marriage.—At St. Mary Abbot's Church, Kensington, London, W., yesterday (Thursday), Mr. Claud Crompton, son of Col. R. E. B. Crompton, C.B., of Tanfield House, Bedale, Yorks., and Thriplands, Kensington Court, London, was married to Miss Jeanetta Gordon, daughter of General Sir Thomas E. Gordon, K.C.B.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1904 Edition of the Big Blue Book is now ready, price 15s., or post free in the United Kingdom, 15s. 9d. The new volume brings a great mass of statistical and technical data thoroughly up to date. All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates over 2,000 pages. If possible, the Directory Division is more complete and accurate than in previous issues. All mere lists of members of societies and institutions are excluded, as quite unreliable for Traders' purposes. A number of large sheet Tables, Maps, &c., are included in the issue. Digest of Contents will be sent post free.

TENDERS INVITED.

The Urban District Councils of *Royton* and *Crompton* invite tenders for permanent way construction. Specifications, &c. (after 16th inst.), of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. Tenders (addressed chairman of Tramways committee, Town Hall, Royton) by noon 30th inst. See also advertisement.

Lichfield Council invite tenders for a lease of their provisional electric lighting order. Plans of the district can be inspected and further information obtained at the offices of the solicitor to the Electric Lighting committee (Mr. George Ashmall), 20, Bore-street, Lichfield, to whom applications by April 16. See also advertisement.

The directors of the *Great Western Railway Co.* require tenders for the supply and erection of four 200kw. and 10 400kw. motor-generators (three-phase h.-t. to continuous-current l.-t.); four natural-draught cooling towers, each capable of dealing with 180,000 gallons of condensing water per hour; electrically and hand-driven overhead travelling cranes and runways; and coal and ash conveyors, coal hoists and ash hoppers. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London, W., by April 26.

St. Pancras (London) Borough Council require tenders for two 1,000kw. steam turbines connected to two continuous-current dynamos, switchboards, condenser, &c., for the King's-road power station. Tenders to town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-road, London, N.W., by noon April 12.

The Scottish office of the *May-Oatway Fire Appliances (Ltd.)* invite tenders for wiring installations (set out in an advertisement) for direct connection with the fire brigades at Sheffield, Dundee and Partick. Tenders close 13th inst. Particulars from managing director, 49, Queen-street, Glasgow.

Partick Town Council invite tenders for one 500kw. steam dynamo, one 75kw. steam balancer (dynamo only) and extensions to main switchboard. Tenders to town clerk (Mr. James Donaldson) by noon April 12.

Westminster Electric Supply Corp. invite tenders for the supply and erection at their Duke-street sub-station of a high-tension and a low-tension switchboard. Tenders to secretary (Mr. Frank Iago), Eccleston-place, London, S.W., by 10 a.m. April 18.

Manchester Electricity committee invite tenders for two 750kw. turbo-generators and alterations and additions to high-pressure steam piping and valves at the Dickinson-street generating station. Tenders to chairman by noon 13th inst.

Manchester Tramways committee require tenders by 5 p.m. April 18 for special (permanent way) track work and permanent way points, tongues, &c.

Rhyl Urban District Council invite tenders for 12 months' supply of carbons, meters, lubricating oils, &c. Tenders to Mr. Arthur Rowlands, Council offices, Rhyl, by April 18.

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Barnes Urban District Council invite tenders for storage batteries, balancer-boosters and switch gear. Tenders to clerk, Mr. J. E. Anderson, Council Offices, Mortlake, by noon April 12.

Stepney (London) Council require tenders for the erection of the second half of their electricity generating station. Tenders by noon April 14.

Grimsby Education committee invite tenders for wiring and fitting up the Ald. Dobson schools for about 538 lights. Tenders to the clerk, Leonard-street, Grimsby, by April 18.

Lancaster Tramways committee invite tenders by 14th inst. for permanent way, cable conduit and overhead trolley wire construction for a short length of tramway.

Tenders are required by noon, April 15, by *Belfast* Gas and Electric committee for exhaust steam grease separators and auxiliary feed-water heater.

Belfast Corporation also invite tenders by 11th inst. for wiring and plain fittings for the city hall.

Glasgow Corporation invite tenders by April 20 for alterations at Dennistoun tramways depot.

Glasgow Parish Council and District Lunacy Board invite tenders for six months' supply of electric lamps and fittings.

Buenos Ayres Corporation invite tenders by May 30 for the construction and working of an electric tramway from Plaza Mayo to Villas Ortuzar, Devoto and General Urquiza.

TENDERS RECEIVED AND ACCEPTED.

Poplar (London) Council have received the following tenders for motor generators, two 250kw. sets, &c. :—

Bruce Peebles & Co. (Arnold, Bragstad and La Cour's motor-generators) (*recommended*)	£7,815 10
Electric Construction Co.	10,075 0
Siemens Brothers & Co.	9,661 0
Johnson and Phillips	9,205 0
Bruce Peebles & Co.	9,060 10
General Electric Co.	9,060 0
Mather and Platt	8,740 0
Dick, Kerr & Co.	8,532 0
British Westinghouse Co.	8,345 0
British Thomson-Houston Co.	8,323 0
Electrical Co.	7,392 0

The Electrical committee rejected the tender of the Electrical Co. on the ground that the plant would be made in Germany.

For switchboards and switch gear the following tenders were received :—

Cowans Limited (*recommended*)	£3,078 10 0
British Thomson-Houston Co,	4,930 0 0
Electric Construction Co.	4,537 0 0
Siemens Brothers & Co.	3,670 0 0
Ferranti Limited	3,600 0 0
Kelvin and Jas. White	3,297 12 6
Johnson and Phillips	2,970 0 0

In addition to the tenders of the General Electric Co. for carbons, W. T. Henley's Telegraph Works Co. for house service and meter boxes and the British Thomson-Houston Co. for meters, as mentioned in our issue of 25th ult., Hammersmith (London) Council have accepted the tenders of the Anchor Cable Co. for insulated wires at £269. 7s. 10d., Johnson and Phillips for arc lamp globes and shades at £42. 2s. 1d., General Electric Co. for electrical accessories at £20. 11s. 3d., insulating material at £22. 12s. 8d. and incandescent lamps at £179. 12s., A. A. James for commutator brushes at £8. 17s. 3d., W. H. Willcox & Co. for packing and jointing materials at £92. 11s. 10d., G. Angus & Co. for rubber goods at £20. 7s. 10d., J. House for tools at £100. 9s. 1d. and files at £26. 2s. 1d., Pimblett & Co. for gauge glasses at £6. 10s. 2d. and J. Gibb & Co. for screws at £28. 18s. 10d.

The Birmingham, Tame and Rea District Drainage Board and Birmingham Corporation have accepted the tender of Lee & Sons for the erection of electric power transmission scheme buildings and furnace chimney at £15,615. There were 21 tenders varying in amount from that of the accepted to £21,290. 17s. 1d. In the accepted tender the amount included for furnace chimney was £1,149 and the sums quoted for this portion of the work varied in the other cases from £1,247 to £1,747. The Alphons Custodis Co. and the Universal Engineering Co. tendered for the chimney only at £1,297 and £1,057 respectively.

Gloucester Corporation have received the following tenders :—

British Electric Equipment Co. (arc lamp pillars)	£8 19 6	each
Gilbert Arc Lamp Co. (123 arc lamps)	1,395 12 6	
Electrical Power Storage Co. (maintenance of new battery for 10 years)	90 0 0	per year
J. G. Statter & Co. (electrical equipment of Cross sub-station)	72 0 0	

East London (South Africa) Harbour Board have placed orders with the Allgemeine Elektricitäts Gesellschaft for the electrical generating plant for lighting and for driving the machinery and cranes in the workshops and on the wharves. The plant includes two direct-current generators, two continuous-current transformers, switchboards, motors, &c. Orders have been given to the Temperley Transporter Co. for a tower transporter, and to Dick, Kerr & Co. for a steam alternator and direct-current generator.

Stourbridge District Council have accepted the following tenders for the supply and erection of electricity generating plant :—

Bruce Peebles & Co. (steam dynamos—Belliss engines)	£1,487
Babcock and Wilcox (water-tube boiler)	550
Electrical Power Storage Co. (storage battery)	1,100
Rodgers and Kaye (crane)	85

Bruce Peebles & Co. have secured from the War Office the contract for the entire electrical equipment of the Enfield Lock small arms factory. The contract will comprise close upon 1,000 H.P. in electrical machinery. The entire plant will be manufactured at the company's works in Edinburgh.

Two 750kw. three-phase alternators coupled to Willans engines and about 60 motors are being supplied to Pumpherston Oil Works, Glasgow, by Bruce Peebles & Co.

The United States Navy department have placed with Messrs. Babcock and Wilcox an order for 50 water-tube boilers of a total of 88,000 H.P.

The Brush Company and Musgrave Bros. are supplying a 300kw. generating set at Durban Harbour works.

Leek Urban District Council have accepted the tender of the Reason Mfg. Co. for electricity meters up to and including 10 amperes, and that of Chamberlain and Hookham for meters above 10 amperes.

BUSINESS NOTICES.

Mr. Haydn T. Harrison has severed his connection with the Improved Electric Glow Lamp Co. and has been appointed manager of the street lighting department of the Reason Mfg. Co., of Brighton, whose London offices will now be at 11, Victoria-street, Westminster, S.W.

Consequent upon steady increase of business the Electrical and Ordnance Accessories Co. (Ltd.), of Stellite Works, Cheston-road, Aston, Birmingham, are about to open a new sales office at 1, Temple-street, Birmingham, which will prove serviceable to local contractors and others. A representative display of the firm's manufactures will be made, and Mr. V. J. Delebecque, who will be in charge, will be glad to show these to callers.

We are informed that Messrs. Philips & Co, of Eindhoven, Holland, have acquired from the Constantia Electric Works, Venloo, the right to supply a certain number of incandescent electric lamps in virtue of their being a member of the Verkaufsstelle Vereinigter Gluhlampen Fabriken Gesellschaft (m.b.H), of Berlin. In consequence of this agreement, the Constantia works were closed on the 1st inst.

Messrs. Christy Bros. and Middleton, electrical engineers, Chelmsford, announce that in order to deal with the large increase of their business, they have secured the services of Mr. E. S. Saunders, recently of the British Westinghouse Co., who will represent them in the South and West of England.

LIQUIDATIONS, BANKRUPTCIES, &c.

Meetings of the creditors and contributories of the McGuire Mfg. Co. (Ltd), will be held on 13th inst. at 3 p.m. at Bankruptcy-buildings, London, W.C.

The British Electric Separating Co. (Ltd.) is to be wound up voluntarily for reconstruction, and Mr. R. P. Pike, Swansea, has been appointed liquidator.

A meeting of the Electric and General Contract Corp. (Ltd.) will be held on May 6 at 111, Little Park-street, Coventry, to receive an account of the winding-up.

A meeting of the Electric Lighting and Fittings Corp. (Ltd.) will be held on May 9 at 10, Cook-street, Liverpool, to receive an account of the winding-up.

April 15 has been appointed for the public examination, at Preston, of Gavin Knox Gilchrist, electrical contractor, St. Anne's-on-the Sea.

The trustee in the failure of J. H. Redgrave, electrical engineer (formerly Regent-street, London, and New Barnet), has been released.

Sale by Auction.—Mr. Henry Sherley-Price (of Wheatley Kirk, Price & Co,) has been appointed by the Court to sell by public auction in one lot as a going concern, at the Mart, Tokenhouse-yard, London, E.C., early in May, the extensive freehold and well-equipped car-building works known as the Castle Car Works, Hadley, near Wellington, Salop, together with the fixed plant and machinery and trade connection. The works have been erected within the last five years, and were specially designed for turning out at lowest cost between 600 and 700 tramcars per annum. The plant is by eminent makers, and was laid down with every regard to efficiency and economy. An electric power station supplied the whole of the electric drive throughout the works, and elaborate heating, ventilating and lighting services are installed. There is a railway siding into the works, and a canal adjoins. The loose plant, with stock, stores, &c., must be purchased at a valuation. Further information from the receiver and liquidator (Mr. H. D.

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Eshelby, F.C.A., of Messrs Harmood, Banner & Son), 24, North John-street, Liverpool; of Messrs. Gribble, Oddie, Sinclair and Johnson, solicitors, 38, Bedford-row, London, W.C., or of the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester. An advertisement contains further particulars.

Plant for Sale.—A Newton dynamo, a Stockport gas engine, switchboard, &c., are advertised for sale by tender in another column. Tenders by 18th inst. to Mr. Asquith, Theatre Royal, Dewsbury.

Sale of Old Post Office Stores.—Tenders are invited for the purchase of about 50 tons of gutta-percha and about 140 tons of copper, 50 tons of lead, a quantity of other metals, indiarubber-covered copper wire, electric glow lamp tops, &c. Forms of tender from the Controller of Stores, G.P.O., 17–19, Bedford-street, London, W.C. Tenders by 10 a.m. April 20. See also advertisement.

Wire for Sale.—Messrs. Robert Lyon & Co., 27, Cornhill, London, E.C., will sell on Thursday next, at noon, at the Commercial Sale Rooms, Mincing-lane, London, E.C., 4,000lb. of copper and German silver electrical wire (cotton and silk covered). See advertisement.

Offices to Let.—Exceptionally well-lighted drawing offices on ground floor in Westminster, also five rooms on second and third floors, are advertised to be let. Applications to Messrs. Fox and Preece, solicitors, 15, Dean's-yard, Westminster, S.W.

"Robertson" Lamps.—Mr. Harry Golding has contributed to the "Windsor Magazine" for April an interesting illustrated article entitled "Light on Lamps: How the Glow Lamp is Made." Readers of the article are informed that "hitherto, for some mysterious reason, the manufacture of electric lamps has always been conducted with impenetrable secrecy." In this we are unable to agree with Mr. Golding, for a book by Mr. G. S. Ram on "The Incandescent Lamp and its Manufacture" was published by "The Electrician" Printing and Publishing Co. as long ago as 1893. In any case, Mr. Golding has been admitted to an intimate acquaintance with the works at Brook Green of the Robertson Electric Lamps (Ltd.), which, by the way, he designates "the General Electric Co. (Ltd.)." The article is a particularly readable one, and the illustrations serve to adequately elucidate the text.

Catalogues.—The Chloride Electrical Storage Co. have issued in handy form detailed particulars of the "Exide Accumulator" for vehicle work. The types described include ignition cells. A serviceable set of instructions for the care of the "Exide" motor car battery is given, and a series of diagrams showing the dimensions of crates for the various types of these cells will be of service.

An excellent catalogue of motor engineers' specialities and requirements is being issued by Messrs. W. H Willcox & Co. of 23, Southwark-street, London, S.E. Many of the items described and illustrated in the catalogue have been prominently exhibited at recent automobile exhibitions. The assortment is very wide and varied, including lubricating oils, semi-rotary water-circulating pumps, patent automobile injectors, wire-bound-hose, water raisers, lifting jack, tool kits and tools, &c.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) on March 30 and 31, with the ports of destination:—

Africa—Alexandria, £33; Cape Town, £1,967; Delagoa Bay, £350; Durban, £46; East London, £481; Port Elizabeth, £41. *Argentina*—Buenos Ayres, £43. *Australasia*—Otago, £1,582; Perth, £102; Sydney, £1,473 (including £720 telegraph material); Wellington, £64. *Belgium*—Ghent, £20. *France*—Paris, £681. *Greece*—Piræus, £536 (telegraph instruments). *Holland*—Amsterdam, £31. *India*—Calcutta, £172; Madras, £297 and 144 cwt. copper cable. *Straits Settlements*—Penang, £23. Total (for two days) £7,942, against £13,773 for one week last year (April 1 to 7).

PATENT RECORD.

The following List of Applications for Patents and Specifications published has been compiled for this Journal by MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, 70, Chancery-lane, London, W.C.*

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after acceptance of Complete Specification. The names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

Unless otherwise stated, the application is made in London.

January 7, 1904.

402 F. C. FISHER. Bristol. Electric apparatus for therapeutic use.
429 C. V. USBORNE. Electro-gyroscopic compass.
455 F. RITCHIE. Telautograph apparatus.*
456 S. LEETHAM and E. G. P. BOUSFIELD. Manufacture of chlorine by electrolysis.
460 S. LIFSCHITZ. Wireless telephony and apparatus therefor.
461 F. BENEDIKT, jun., and J. MACEK. Securing wires on insulators.
472 C. A. CARUS-WILSON. Method of testing for earths and short-circuits in electric cars and trains.
474 M. SUTHERLAND and E. MARCUSON. Twickenham. Batteries.

January 8, 1904.

498 C. T. A. HENSHAW and T. MACINTYRE. Edinburgh. Jointing tall body for electric light fittings.
501 R. S. BAXTER and D. WILSON. Broughty Ferry. Trolleys.
511 A. E. RUBERY and G. LAXTON. Storage batteries.
534 E. F. MOY, P. H. BASTIE and E. F. MOY (LTD.). Fuses and fuse-boxes.
547 B. GÁTI. Liverpool. Systems of electrical conductors.
550 F. RITCHIE. Telautograph apparatus.*
552 L. T. BASSOMPIERRE and J. M. DARDEAU. Microphones for telephonic apparatus. (Date applied for, Jan. 15, 1903, date of application in France.)*

January 9, 1904.

571 E. S. G. REES. Wolverhampton. Means of connection between brush-holders and pillars of dynamo-electric machines and electric motors.
574 E. S. G. REES. Wolverhampton. Construction of the armatures of dynamo-electric machines and electric motors, to facilitate mounting of same upon their shafts.
582 W. SILLERY and MELDRUM BROS. Liverpool. Accumulators.
583 A. JULIAN. Portsmouth. Burglar and fire alarm.
628 J. SCHWAB and L. VOGEL. Electric incandescent lamps.*

January 11, 1904.

644 K. R. STUART, S. BROUGHTON-HALCOMB and P. MACGREGOR. Sheffield. Rail bonds.
653 SAARBRÜCKER A.G. and J. EMMERICH. Germany. Dynamo casings.*
656 A. BRUNTON and W. M. BRUNTON. Queensferry, Fife. Plug switch.
658 W. FAIRWEATHER (Cutler-Hammer Mfg. Co., U.S.). Rheostats.*
660 M. PLATO. Electric alarms.
661 J. B. DE ALZUGARAY. Obtaining metals by electricity.
674 F. W. LE TALL (Cooper-Hewitt Electric Co., U.S.). Gas and vapour electric apparatus.
692 R. VON HORVATH. High-tension microphone.
699 J. A. BAUER. Electric stoves and heating and cooking apparatus.
707 L. C. WERNER. Electric block signalling systems.*
711 E.A.G. (vorm W. Lahmeyer & Co.). Controlling devices for electrically driven vehicles. (Date applied for, June 22, 1903, date of application in Germany.)*
716 J. S. RAWORTH. Control and propulsion of electric vehicles.

January 12, 1904.

758 W. G. HEYS (Walter Emil Ammon, U.S.). Manchester. Insulating conductors.
768 LE R. W. STEVENS and B. TIMMERMAN. Apparatus for making carbides.*
786 J. H. SUTTON and L. GREGSON. Forming joints in conduits for cables.
789 L. W. PULLEN. Electric railways.*
810 J. S. RAWORTH. Electric automobiles.
818 B.T.-H. Co., H. N. SPORBORG, F. W. CARTER and A. S. CUBITT. Electric railway systems.
819 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control.
820 B.T.-H. Co. (G.E. Co., U.S.). Switches and the like.
821 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control and controlling apparatus.
822 PHŒNIX DYNAMO MFG. CO. and H. A. JONES. Brush holders.
833 H. REDMON R. L. HALLS, R. H. CONWAY and N. F. SMITH. Telephone systems.*
839 J. A. COREY. Electric typing.

January 13, 1904.

848 G. D. A. PARR. Leeds. Electro-mechanical mechanism for controlling, from moving car or train, movable "shunting points" in tram or railway lines and in bare conductor from which current is collected.
850 A. W. CLAYDEN. Exeter. X-ray tube for alternating currents.
869 W. E. G. JOHNSTON. Liverpool. Relays for recording re-transmitting and controlling currents of electricity and apparatus therefor.
880 T. THOMAS, H. BRECKNELL, E. M. MUNRO and H. I. ROGERS. Bristol. Automatic electric signalling for railways and tramways.
885 W. T. MUNRO. Glasgow. Automatic temperature or fire alarm.
904 A. ABERCROMBIE. Telephone apparatus.

January 14, 1904.

952 D. BURNS and J. M. FLEMING. Glasgow. For obtaining power for driving electric vehicles.
954 H. M. HOBART. Variable speed electric motors.
959 G. C. GEISLER. Electric testing apparatuses.
962 V. W. DELVES-BROUGHTON and J. A. COLE. Induction coils.
968 R. THRELFALL. Electrodes for electrochemical processes.
984 C. B. STURGESS. Electrical alarums for clocks and watches.
1,006 A. D'ARSONVAL. Spark extinguishing apparatus for high frequency circuits.
1,011 H. LAING. Electric winches.

January 15, 1904.

1,020 F. E. SPITTLE. Birmingham. Electric and other suspension lamps.
1,027 G. W. BELDAM. Liverpool. Switches, bell pushes and the like.
1,036 T. PESCATORE. Manchester. Accumulators or secondary batteries.
1,044 A. ALLTREE. Manchester. Electrical contact maker for internal combustion engines.
1,050 P. R. J. WILLIS. (Albert Eli Caughey, U.S.) Kingston-on-Thames. Electric signalling mechanism.
1,064 J. BROOKE. Mounting and construction of overhead conductors employed in electric traction.

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1,078 C. H. Offord and T. H. Marsh. Automatic switches.
1,081 C. Nathan and J. J. L. Newland. Telephone for partially deaf persons.

January 16, 1904.

1,126 G. B. Batten. High frequency electric machines.
1,128 Veritys Limited and P. G. Ebbutt. Birmingham. Electric light fittings.
1,143 H. Hirst and A. E. Angold. Manchester. Electric arc lamps for currents of low periodicity.
1,145 B. L. Myer. Liverpool. Adapters for affixing incandescent lamps to oil lamps.
1,176 C. Simmons. Electric stopping cars and indicating speed thereof.
1,187 C. P. Elieson. Electric accumulator plate.*
1,197 G. H. Padgham. Resistances.
1,203 M. A. Masson. Electric transmission by three-phase currents for motor vehicles.
1,205 K. Höflinger and K. Wolffhardt. Telephonic apparatus.*

January, 18, 1904.

1,209 H. Webber. Hastings. Recording gear for electricity meters.
1,222 E. H. Micklewood and S. Currin. Plymouth. Automatically timing the electrical firing of internal combustion engines.
1,225 E. Apted. Terminal for electric wires and cables.
1,242 W. W. Dean. Party line telephone systems. (Date applied for, June 15, 1903, date of application in U.S.)*
1,258 G. S. Tiffany and J. V. Inwagen. Electric clocks.*
1,296 A. J. Postans. Electric ignition for internal combustion engines.*
1,307 I. Moscicki. Electric condensers.*
1,308 I. Moscicki. High-tension electric condensers.
1,314 C. Ropiquet and A. Daveluy. Electric igniters for explosion motors. (Date applied for, May 30, 1903, date of application in France.)*

January 19, 1904.

1,326 V. Hope, V. H. Sugden and W. Gardner. Manchester. Switches.
1,337 G. Sample. Manchester. Burglar alarm.
1,349 W. Fairweather. (Arnold Magnetic Clutch Co., U.S.) Magnetic clutch.*
1,363 E. Liddle and G. E. Druiff. Stockton-on-Tees. Electric bells and pushes so that a light may be obtained or a bell rung from the same batteries over the ordinary bell wiring.
1,364 F. W. Le Tall. (Cooper Hewitt Electric Co., U.S.) Gas or vapour electric apparatus.
1,366 Otis Elevator Co. (Otis Elevator Co., U.S.) Magnetic brakes.
1,374 J. G. V. Lang. Method and means of regulating electric motors.*
1,414 B. Gáti. Telephone relay.*

January 20, 1904.

1,473 H. H. Kenshole. Apparatus for indicating leakage in electric circuits.
1,481, 1,482 and 1,483 B.T.-H. Co. (G.E. Co., U.S.). Alternating-current motors.
1,484 B.T.-H. Co. (G.E. Co., U.S.). Controlling electric motors.
1,494 M. Latour. Alternating-current dynamos. (Date applied for, Jan. 21, 1903, date of application in France.)*

January 21, 1904.

1,513 P. Escaré. Shade carrier holder.
1,539 H. W. Clothier. Manchester. Limiting the destructive effect of an electric arc accidentally formed in a generating station, and method for automatic supply of light during and after a breakdown.
1,542 R. Cohen. Middlesbrough. Street junction distribution box.
1,549 Seacombe Pressed Brick and Tile Works and F. P. Jones. Liverpool. Cable troughs or conduits.
1,588 V. F. Feeny (Fabrik Elektrischer Zünden Gesellschaft mit beschränkter Haftung, Germany). Dry cells.
1,599 J. H. Ryffel. Galvanic batteries.*

January, 22, 1904.

1,624 A. B. Mudie. Birmingham. Preventing accidents from broken trolley wires.
1,625 O. Gross. Manchester. Arc lamps.
1,626 W. T. Chapman. Endon. Securing doors of vehicles by electric current.
1,641 A. V. Hunt. Apparatus for arranging and displaying telephonic addresses.
1,642 B.T.-H. Co., E. B. Wedmore and J. Whitcher. Switchboards.
1,676 A. Blondel. Manufacturing electrodes for arc lamps. (Date applied for, Feb. 5, 1903, date of application in France.)*
1,704 O. Rennert. Thermostatic indicators and in thermostatic systems.
1,711 E. C. Ekstomer and the Ekstromer Accumulator Co. Secondary batteries.
1,714 A. Pieper. Electrical signalling apparatus.*

SPECIFICATIONS PUBLISHED.

Note.—All specifications can be obtained at the uniform price of 8d. each.

1903.

3,170 James (Algonquin Electric Brake Co.) Electric brakes for cars.
3,438 Brown. Relay translation for submarine cables.
3,657 Raworth. Regulating devices for electric vehicles.
3,658 Raworth. Motors and regulating devices for electric vehicles.
3,888 Griffiths and Bedell. Contact stud and fixing for surface-contact systems.
4,393 Maclean. Electric appliance for prevention of racing of marine engines.
4,442 Bauer (Helios E.A.G.) Rail bonds for electric railways.
4,548 Rosenberg. Ozonising, purifying and otherwise treating air.
4,698 Ferguson and Kelvin and James White (Ltd.) Electric measuring instruments.
5,989 Bradley and Edmunds. Electric sparking devices for internal combustion engines.
6,484 & 6,488 Carolan (G.E. Co., U.S.). Alternate-current transformers.
6,487 Carolan (G.E. Co., U.S.). Alternate-current induction motors.
6,497 Carolan (G.E. Co., U.S.). Electric railways.
6,499 Carolan (G.E. Co., U.S.). Machines for coating fabrics.
6,500 Carolan (G.E. Co., U.S.). Dynamo-electric machines.
6,892 Zealander and Cummins. Rail bond.
7,140 Carolan (G.E. Co., U.S.). Electric railway apparatus.
7,455 Carolan (G.E. Co., U.S.). Boxes for electric conductors.
7,639 Hindley. Standards and trolley boom controlling apparatus.
7,960 Ellis (Automatic Electric Pump Co.) Electric pumps.
7,983 Davy. Insulation of metal pieces.
8,810 Claremont and Beaver. Cables.
8,883 Dixon. Circuit-breaking fuse.
12,193 Otto. Ozoniser of high frequency to be directly connected to dynamo.
18,181 Franke. Apparatus for determining the length of waves and observing oscillations in electric oscillation systems.
23,750 Danneels. Electric signalling apparatus for railways.
23,876 Korn. Autographic and other telegraph systems.
25,255 Carius. Limiting or preventing upward movement of trolley booms.
25,389 Bloxam (Schceller). Magneto-electric machines.
26,058 Johnson E. A. (vorm. W. Lahmeyer & Co.). High-voltage spark arresters.
26,255 Childress and Sauls. Attachments to desk telephone instruments.
26,259 Johnson (E.A.G. vorm. W. Lahmeyer & Co.). Regulating speed of engines driving generators.
26.783 Breedlove and Grant. Electrically-operated points and switches.
27,734 Hearson (Adolf Bleichert & Co.) Safety device for switches of suspended electric railways.
27,900 Hardegen. Telephone systems.
27,924 Gibbs. Safety devices for electric railway systems.
28,115 Hoffmann. Pocket-induction coils.
28,545 Heys (Ammon). Machine for covering wire with insulation.

1904.

288 Gibbons. Galvanic devices applicable to footwear and bracelets.
291 Regnart. Incandescent lamp.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

BRITANNIA ELECTRIC CARRIAGE SYND. (LTD.)—Reg. March 29, capital £12,000 in £1 shares, to adopt an agreement for the acquisition of patent No. 23,426 (1902), to manufacture and deal in carriages, carriage appliances and devices, and to carry on the business of electricians, mechanical engineers, machinists, carriers of passengers and goods, omnibus and carriage proprietors, &c.

BRITISH TEXTILE DESIGN AND ELECTRIC CARD-CUTTING CO. (LTD.)—Reg. March 29, capital £10,000 in £1 shares (7,700 7 per cent. preference) to acquire the rights for the patent automatic electric jacquard card-cutting machine (jointly owned by O. Zerkowitz and Zerkowitz Inventions, Ltd.), and to carry on the business of designers and card cutters, manufacturers of or dealers in the said card-cutting machine, &c. First directors, G. Clay, E. Wood, H. Walbank and P. Parkin. Reg. office, 23, Cheapside-chambers, Bradford.

PNEUMATOPHONE (LTD.)—Reg. March 29, capital £3,000 in £1 shares, to acquire patent rights relating to an invention by H. L. Short for improvements in methods of and apparatus for increasing the volume of sound from telephonic and photographic instruments and transmitting such sounds to distances, and to develop same. First directors, M. Luite, F. Newman, S. Spurling, E. A. Boddington, C. L. Demson, Miss L. M. Daniell and W. L. Bingley. Reg. office, Palmerston House, Old Broad-street, London, E.C.

STATUTORY RETURN.

MAZARRON ELECTRIC LIGHT CO. (LTD.)—The return to Jan. 4, gives the capital as £15,000 in 500 preference shares of £10 each and 10,000 ordinary shares of £1 each, of which 151 preference and 10,000 ordinary have been taken up. £10 per share has been called up on 151 preference and £1 per share on seven ordinary and £1,517 has been received. 9,993 ordinary shares are considered as fully paid. Debentures, £820.

MORTGAGES AND CHARGES.

FINCHLEY ELECTRIC LIGHT CO. (LTD.)—Issue on March 8 of £400 debentures, part of series created Dec. 7, 1903, to secure £2,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £100.

F. A. GLOVER & CO. (LTD.)—Issue on March 21 of a £500 debenture, part of a series created April 11, 1902, to secure £6,000 and 6 per cent. interest, charged on company's undertaking and property, including uncalled capital. No trustees. Holder, R. F. Wahl. Total amount previously issued of same series, £5,500.

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CITY NOTES.

MEMORANDA.—Bank rate 4 per cent. (since Sept. 3, 1903). Price of silver 25 1/16d. per oz. (April 7). Consols 86 7/8—86 5/8 for money, 86 13/16—87 1/16 for account; 2½ per cent. annuities 86½—86 7/16 (April 7). Consols Pay Day May 5; Stocks and Shares Continuation Days, April 12 and 26; Ticket Days, April 13 and 27; Pay Days, April 14 and 28; Mining Share Carry-over Days, April 11 and 25.

ANGUS ELECTRIC LIGHT AND POWER CO. (LTD.)—The annual report states that during 1903 the lamp connections increased in Montrose from 6,422 to 11,670 8 c.p., and in Brechin from 5,725 to 7,359, and up to the present time 1,500 additional lamps have been applied for in Montrose and 2,000 in Brechin, making the total of 22,529. A dividend of 2½ per cent. per annum is recommended.

BABCOCK AND WILCOX (LTD.)—The directors' report for 1903 states that the net profit, after deducting depreciation on plant, &c., was £180,042. 13s. 5d., and with £17,878. 3s. 5d. from previous year, the balance is £197,920. 16s. 10d. Interim dividends to June on the 6 per cent. preference and of 7 per cent. on the ordinary shares absorbed £40,100, and out of the balance (£157,820. 16s. 10d.) the following dividends for the December half-year are recommended:—Balance preference, less tax (£3,000), 8 per cent. on ordinary shares, tax free (£42,400), and bonus of 2 per cent. on ordinary shares, tax free (£10,600). £50,000 is put to reserve, £25,000 to dividend equalisation fund, leaving £26,820. 16s. 10d. to be carried forward.

CALCUTTA TRAMWAYS CO.—The gross traffic receipts for 1903 were £113,756, working expenditure £55,670, leaving a balance (after crediting sundry receipts) of £58,812. A dividend is recommended at the rate of 7 per cent. per annum for the half-year, making 6 per cent. for the year, tax free. Last year was the first complete year of working by electric traction. Although the mileage is greater, the working expenses are rather lower, whilst the receipts show an expansion corresponding more or less with the increased mileage. Negotiations are in progress for the extension of the lines to various suburbs.

DEUTSCH-ATLANTISCHE TELEGRAPHEN GESELLSCHAFT.—The report for 1903 states that the traffic receipts were nearly equal to those of 1902. The effects of trade depression, which were intensified by the failure of some American trusts, was especially noticeable in the first half of the year; but in the last four months there was an increased traffic. An interruption in March gave the opportunity of carrying out the intention to alter the position of the cable in a dangerous part of the North Sea. This alteration was quickly effected by the c.s. "Von Podbielski." The manufacture of the duplicate cable for the Emden-Fayal section, which was commenced in 1902, was finished in April, 1903. The coast end was landed at Borkum at the beginning of May, and 13 miles of the shore end were laid. On May 16 the c.s. "Stephan" commenced to lay the cable in the English Channel to the Land's End, and the work was completed in a few days. The laying of the deep-sea section (about 1,200 knots) was commenced in the beginning of September and throughout the work was hindered by bad weather. The section between Borkum-Horta of the new cable has been open for traffic since October and the cable works more rapidly than the 1900 one. The company received under their agreement with the German Imperial Post Office 750,000m. for 1904 on account of the Borkum-Azores section. On Dec. 31, 1903, the Norddeutsche Seekabelwerke had finished 1,432·37 knots of the second portion of the cable (Fayal-New York) and the whole was to have been finished by the end of March. The c.s. "Stephan" is expected to commence the laying of the cable by the middle of April. The company will complete the purchase of the Emden-Vigo cable on Dec. 31, 1904, and then take over the shares of the Deutsche See Telegraphen Gesellschaft. The work of providing housing accommodation for the company's officials at Horta, Azores, is being proceeded with. After paying working expenses (197,536·49m.), cable repairs (17,308·25m.), interest (78,675·78m.), cable amortisation and renewal fund (247,667 15m.), the balance is 1,617,381·81m.; 52,030·74m. were written off cable apparatus, &c., the 5 per cent. statutory reserve required 61,077·72m., and out of the balance a dividend at the rate of 5½ per cent. on the paid-up capital is recommended, being ½ per cent. more than in 1902.

DOVER ELECTRICITY SUPPLY CO. (LTD.)—At the meeting last week the chairman (Sir W. H. Crundall) said for 1903 they had practically earned 8½ per cent., but they could only pay 6, which was the equivalent of the 4 per cent. the Corporation were paying on the purchase price, so that the other 2½ per cent. went to the Corporation. If they had remained a private company they would have earned a dividend this year of 10 or 11 per cent. on the ordinary shares. The concern, whether run by a company or by the Corporation, had a great future before it. It was anticipated that formal transfer of the concern to the Corporation would take place about May 6. Amongst their last year's works they had arranged with the Harbour Board to supply power to the new bridge and capstans and cranes, now being constructed for the accommodation of ocean liners, and they also had a large number of applications for private lighting, several of them important contracts.

DUDLEY, STOURBRIDGE AND DISTRICT ELECTRIC TRACTION CO. (LTD.)—For 1903 the gross profit was £45,294, and the expenditure £34,216, including £2,000 placed to depreciation and renewals account. The net profit was £11,078. After deducting preference dividend, the directors recommend that £2,100 be placed to reserve (sinking fund) and a dividend declared at the rate of 4 per cent. per annum on the ordinary shares. The Birmingham and Midland Tramways (Ltd.) has acquired the controlling interest formerly held by the British Electric Traction Co. in the Dudley Company, and negotiations are proceeding between the Birmingham and Midland Tramways (Ltd.) and the other companies owning or leasing lines in the district for working arrangements as one system under one management. This company will then form part of a system consisting of over 90 miles of uniform gauge.

W. T. GLOVER & CO. (LTD.)—At the meeting last week the directors' report for 1903 was presented, and stated that the manufacturing profit was £32,025. 9s. 3d., and after adding dividends on investments, rents and miscellaneous receipts (£1,739. 13. 6d.) the total was £33,765. 2s. 9d. Management and administration expenses came to £20,954. 17s. 11d, interest, bankers' charges, &c., to £3,760. 14s. 8d. The balance from last account was £4,280. 10s. 6d. After deducting directors' fees and interest on 4½ per cent. first mortgage debenture stock and loans for year, the balance was £7,309. 4s. 9d. The surrender of ordinary shares to the nominal value of £35,150 by the original vendors has been duly completed, and the reduction of capital by this amount has been approved by the Court. There has been a considerable decrease in output due to trade depression experienced through the entire industry, but material economies and improvements have been effected, resulting in a substantial reduction in standing charges. In addition to general trade depression, many of the electrical projects so long contemplated have not as yet been put into operation, with the result that the demand for the manufactures of the company still remains low. There are indications of the prospects showing an improvement during the remainder of the current year. The directors regret that the result of the working during the past year does not permit them to recommend the payment of a dividend to the preference shareholders, although the general position is now more satisfactory. The anticipated demand for non-lead-covered cable, referred to in the last report, is being realised. To meet requirements common to the trade, the directors have from time to time found it necessary to give their personal undertakings for the fulfilment of contracts entered into by the company, some of which obligations are still existing. They recommend the formation of a fund to cover such undertakings, and a resolution was submitted to the shareholders authorising this arrangement to be carried into effect. During the past year Messrs. W. P. J. Fawcus and A. H. Howard resigned their positions as directors of the company. Mr. Ll. B. Atkinson joined the board in July last, and manages in particular the London office, also co-operating with Mr. E. A. Claremont in the general conduct of the business. Mr. E. A. Claremont's appointment as managing director has been confirmed, and his services retained by agreement.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—The gross receipts for 1903 were £3,897. 7s. 7d., as against £3,312. 15s. for 1902. It is proposed to pay a dividend of 3 per cent. on the ordinary shares. During the year the company has put in a new Diesel oil engine.

KIODERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LTD.)—The gross receipts (including amount receivable from Kidderminster and Stourport Electric Tramway Co. for dividend on shares held by the company) amounted for the past year to £6,258. After payment of preference dividend the directors propose an ordinary dividend of 4 per cent.

MELTON MOWBRAY ELECTRIC LIGHT CO. (LTD.)—The equivalent of of 8 c.p. lamps connected increased from 8,520 to 11,028 during the past year. A dividend of 2½ per cent. has been declared.

MERSEY RAILWAY CO.—At the meeting last week, the chairman (Mr. James Falconer) said that the report (abstracted in our issue of 25th ult.) contained the results of the first half-year of the working of the line by electric traction. The figures could not be taken as a complete indication of what the results of the innovation would be. The receipts showed an increase of practically £8,000 for the half-year, but it was in the latter months that the increase began to tell appreciably, and there was evidence that as the public gained experience of the system and confidence in it the traffics would develop. The number of passengers had improved from 2,844,000 to 4,153,000 in the corresponding six months. The number of first class passengers had not increased in the same ratio as the third class, and it had been decided to reduce the difference between the first and third class fares. The increase was mainly on the local lines, and the directors thought the remedy lay in reduction of the through fares. The working expenses bore too large a proportion to the revenue in spite of the reduced expenses per train mile on the adoption of electric traction. This was accounted for by the much increased service of trains. The train mileage for the half-year ended December, 1902, was 155,039, against 401,046 for the same period in 1903. The cost of maintenance of permanent way was 3·9d. per train-mile by steam, and by electricity 1·6d. The cost of locomotive and generating power under steam was 11·3d. per train-mile, against 5·2d. under electricity. Traffic expenses under steam were 13·5d. per train-mile, against 7·3d. under electricity; the cost of ventilation 3·4d. under steam and 0·2d. under electricity; the cost of pumping 4·85d. compared with 1·5d. The total cost of repairs and renewals of carriages showed considerable increase (having been £1,394 during the half-year just closed and £611 during the corresponding half-year in 1902). This was disappointing in view of the fact that the cars were new. However, the total working expenses per train-mile under steam was 41·2d., compared with 18·2d. under electricity.

MERTHYR ELECTRIC TRACTION AND LIGHTING CO. (LTD.)—The gross receipts on the light railways for 1903 amounted to £10,580, and the gross receipts of the electric supply department were £3,469. After paying preference dividend, placing £250 to reserve and depreciation, the directors recommend a dividend on the ordinary shares of 2½ per cent. per annum. Notwithstanding inclement weather the receipts of the light railways slightly increased, whilst the expenses were considerably reduced. There is a reduction in working expenses on the combined traction and electric supply undertakings of £992. The number of private consumers now connected to the mains represents a demand equivalent to 5,090 8 c.p. lamps.

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METROPOLITAN ELECTRIC TRAMWAYS (LTD.)—Allotment letters have been posted for the whole of the recent issue of £350,000 4½ per cent. debenture stock.

PERTH (W. AUSTRALIA) ELECTRIC TRAMWAYS (LTD.)—The gross receipts for 1903 were £62,523. 14s. 9d., yielding a profit of £22,971. 10s. 4d., compared with £56,157. 9s. 5d. and £20,591. 19s. 9d. for the previous year. The returns for the current year continue to expand, the gross receipts for 12 weeks to March 25 showing an increase of £2,214 over the corresponding period last year. The credit balance was £22,971. 10s. 4d. for 1903, and after providing for interest and sinking fund and adding £9,908. 9s. from previous year, the balance is £18,232. 1s. 1d. £6,000 has been placed to reserve for repairs and renewals, and the preference dividends have been paid to end of 1903. A little over 18 miles of tramways is in operation, and a further 2½ miles of track will be constructed during the present year, which will complete the whole of the works which have to be constructed. The company is also working under contract 2¾ miles of tramway belonging to the Town Properties of West Australia (Ltd.). To provide for the necessary additions to plant and take over the cars which had been obtained on hire, and generally to provide for the increasing traffic, an issue of £35,000 second debentures has been made and the whole was subscribed. An important Act of Parliament has been recently passed which will enable the company to duplicate single tracks at any future time without applying for a special act.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—The report to be presented at to-day's meeting states that the gross receipts for 1903 were £97,701. The directors recommend a dividend on the ordinary shares of 5 per cent. An issue of £25,000 debenture stock will be made at an early date.

PRIMITIVA GAS AND ELECTRIC LIGHTING CO. OF BUENOS AYRES (LTD.)—In June last the directors were approached by the Deutsch Ueberseeische Electricitats Gesellschaft (Berlin) with an offer to take over the electrical section of the company's operations, and an agreement was entered into in August whereby the entire property of the electrical department had been handed over to the Deutsch Company in consideration of their making to the company regular semi-annual payments of £15,000 in November and May each year up to November, 1943. The company pays a dividend of 5 per cent. on the ordinary shares for 1903.

RAND CENTRAL ELECTRIC WORKS (LTD.)—During March 883,520 kw-hours were generated, yielding a gross revenue of £7,750, compared with 687,195 kw-hours, and £5,438 for the corresponding period last year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered the further issue of 7,495 5 per cent. cumulative £10 preference shares (fully paid) of *Mather and Platt (Ltd.)*, and the further issue of 2,500 £5 ordinary shares (fully paid) of the *Oxford Electric Co. (Ltd.)* to be quoted in the official list. The committee have also been asked to appoint a special settling day in and grant a quotation to 109,251 £1 ordinary shares (fully and partly paid) of the *Consolidated Electrical Co. (Ltd.)*

SUBMARINE CABLES TRUST.—The coupon due on 15th inst. will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, London, E.C. Coupons should be left four clear days before payment.

THAMES IRONWORKS, SHIPBUILDING AND ENGINEERING CO. (LTD.)—The report for 1903 states that the profits amounted to £34,015. Deducting interest, &c., the balance (with £4,934 from last year) is £22,434. Deducting interim preference dividend, £14,934 is available for distribution, and the directors recommend payment of the balance dividend on the preference shares, and the placing of a further £5,000 to reserve, carrying forward £2,778.

WILLANS AND ROBINSON (LTD.)—The twentieth half-yearly report of the directors announces, with deep regret, that the operations of the company in the past half-year have resulted in a loss, and that no dividend can be paid either upon the preference or ordinary shares. Owing to depression in trade and to increased competition, there has been a falling off in orders for engines, as well as in the price obtained, the result being that the profit for the half-year upon the engine-building and other business carried on at Rugby (after making special reserve against depreciation on certain shares receivable in part payment for engines) is only £11,772. 5s. 10d., increased to £14,108. 13s. 8d. by £2,336. 7s 10d. brought forward. Against this there is a loss of £22,040. 18s. 5d. at Queen's Ferry, including £7,249. 3s. 5d. for depreciation. The net debit balance is therefore £7,932. 4s. 9d. The company is in need of the balance of the new capital (£83,340), and as, under present conditions, a new issue of capital is not likely to be successful, it is necessary to borrow upon the security of the reserve fund investments. It was the directors' intention to issue the new capital a year ago, but they were advised to postpone the issue for a year, and in consequence made temporary arrangements for an overdraft on the bankers. This arrangement expires in July, and it is important that a new understanding be arrived at with the bank. The directors will therefore ask authority to borrow up to the maximum amount permitted by the articles of association—viz., 50 per cent. of the paid up capital, less the sum already authorised to be borrowed upon debenture stock. The sum which can be so borrowed is £83,330. The steel works at Queen's Ferry, including the steel foundry, will be closed as soon as existing orders can be completed; work in the boiler shop and tube works will be pushed on with energy. Extensive reductions are in course of being carried out in the Queen's Ferry staff and organisation and every effort will be made to effect similar economies at Rugby.

WYCOMBE (BOROUGH) ELECTRIC LIGHT AND POWER CO. (LTD.)—The directors' report for 1903 states that the connections have risen from 28,081 to 31,930, an increase of 3,849 equivalent 8 c.p. lamps. Though disappointed with the rate of increase, the directors are satisfied that this is attributable to the depressed state of the staple trade of Wycombe during the year. After paying interest the surplus is £1,793. 5s. 8d. A dividend of 4 per cent. for the year will absorb £1,200, £500 is placed to reserve for renewal of plant and £93. 5s. 8d. is carried forward. Edmundson's Electricity Corp. have waived their claim for interest on overdue accounts, amounting to over £500. It is proposed to issue a further £20,000 of debentures.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 2	1,167	+ 295	44	52,872	+ 10,635
Airdrie	Mar. 25	186	...	7	1,271	...
Ayr Corporation	,, 26	172	+ 6	45	12,327	+ 163
Barnsley	,, 25	168	− 26	12	1,811	− 106
Barrow	,, 25	132	+ 72	7	979	+ 573
Bexley District Council	...	...	...	...	...	...
Birkenhead	April 3	988	− 80	...	...	...
Birmingham Corporation	,, 2	291	...	13	3,763	...
*Birmingham Tramways Co.	,, 2	5,805	+ 159	13	65,025	+ 2,907
*Blackburn Corporation	,, 1	1,007	+ 270	1	1,007	+ 270
Blackpool Corporation	Mar. 31	344	− 42	§52	41,727	− 425
Blackpool and Fleetwood	April 2	439	+ 171	15	2,773	+ 85
Blackp'l, St. Anne's & Lytham	Mar. 31	165	+ 165	122	3,286	+ 2,707
Bolton Corporation	...	...	...	...	...	...
Bournemouth Corporation	,, 30	829	+ 101	52	52,961	...
*Bradford Corporation	,, 31	1,938	+ 141	53	194,310	+ 25,267
Brighton Corporation	,, 31	411	+ 225	†52	46,039	+ 2,570
Brisbane Tramways	Feb. 17	2,338	+ 92	7	15,882	− 106
*Bristol Trams & Carriage	April 1	4,607	+ 167	19	85,185	+ 3,048
*Buenos Ayres & Belgrano	Feb. 28	3,168	− 11	20	63,371	+ 3,2 3
	Mar. 6	8,417	+ 267			
Burnley Corporation	April 2	1,233	+ 427	1	1,233	+ 427
Burton Corporation	,, 3	339	...	85	11,737	...
Calcutta Tramways Co.	,, 2	R32,902	r R1,106	14	R497,805	+ R77,837
Camborne-Redruth	Mar. 28	91	...	22	2,895	...
	April 4	117				
Cardiff Corporation	Mar. 26	1,815	+ 127	1	1,815	+ 127
Carlisle Tramways Co.	...	...	...	...	...	...
Central London Railway	April 2	6,297	− 825	14	98,122	+ 159
Chatham & Dist. Lt. Rys.	Mar. 31	503	+ 50	13	6,420	+ 1,045
City & South London Rly.	April 3	2,712	− 862	14	44,118	− 920
Cork Electric Trams Co.	Mar. 31	398	− 19	13	5 009	− 139
Darwen Corporation	April 1	273	+ 48	52	11,778	− 289
Devonport & Dist. Trams.	Mar. 25	437	+ 26	12	5,413	+ 776
Dover Corporation	...	...	...	...	...	...
Dublin & Lucan Railway	April 3	101	+ 7	14	1,258	+ 84
Dublin Southern District	,, 1	677	− 54	¶13	56,258	+ 456
Dublin United	,, 1	3,595	− 140			
Dudley—Stourbridge	Mar. 25	757	− 15	12	8,758	+ 895
Dundee Corporation	,, 30	767	− 12	...	...	...
East Ham Council	April 2	718	+ 162	52	34,312	+ 8,971
Gateshead & Dist. Trams	Mar. 25	858	+ 20	12	10,201	+ 539
Glasgow Corporation	April 2	13,412	+ 237	44	596,648	+ 56,949
Gravesend—Northfleet	Mar. 25	217	+ 17	12	2,508	+ 354
Gt. Northern & City Rly.	April 2	983	+ 7	7	6,565	...
Greenock & Port Glasgow	Mar. 25	431	− 7	12	5,543	+ 616
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 25	243	+ 14	12	2,924	+ 303
Huddersfield	...	...	...	...	...	...
Hull Corporation	April 2	2,144	+ 360	§52	101,652	+ 8,991
Ilkeston Corporation	Mar. 30	133	...	21	2,428	...
Ipswich Corporation	April 2	434	...	13	5,830	...
Isle of Thanet Co.	,, 2	432	+ 115	...	...	...
Kidderminster & District	Mar. 25	98	− 7	12	1,126	− 70
Kirkcaldy Corporation	,, 30	195	...	5	955	...
Lanarkshire Trams Co.	,, 31	570	...	13	7,424	...
Leeds Corporation	April 2	5,317	+ 339	1	5,317	+ 339
Liverpool Corporation	Mar. 26	10,016	− 98	13	123,188	+ 2,975
*Liverpool Overhead Rly.	April 3	1,547	− 36	14	21,337	+ 258
*London County Council	Mar. 26	10,453	+ 1,474	§51	568,815	+ 88,091
Lowestoft	...	...	...	...	...	...
Manchester Corporation	April 2	11,563	+ 1,463	52	601,911	...
Mersey Railway	,, 2	1,502	+ 373	13	18,654	+ 4,625
Merthyr	Mar. 25	190	+ 6	12	2,258	+ 173
Middleton	,, 25	255	− 7	12	2,909	+ 178
Nelson Corporation	April 2	136	+ 91	1	136	+ 91
Newcastle-on-Tyne Corp.	,, 2	3,611	+ 489	13	45,071	+ 6,061
Newport (Mon.)	,, 2	188	+ 331	1	488	+ 331
Oldham, Ashton & Hyde	Mar. 25	488	− 67	12	5,895	− 374
Oldham Corporation	,, 13	1,063	...	2	2,105	...
	,, 20	1,042				
Perth (W. A.) Elec. Trams.	April 1	1,336	+ 214	13	18, 13	+ 2,424
Peterborough	Mar. 26	114	− 5	13	1,315	− 182
Poole and District	,, 25	2 4	− 46	12	2,710	− 82
Portsmouth Corporation	April 2	1,706	+ 282	1	1,705	+ 282
*Potteries	Mar. 25	1,697	− 7	13	19,562	+ 1,420
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	April 4	148	+ 29	...	...	...
Rothesay	Mar. 25	50	+ 7	12	525	+ 47
Salford Corporation	,, 28	3,687	+ 646	52	196,893	+ 52,761
	April 4	4,377	+ 1,236	1	2,763	+ 59
Sheerness	Mar. 23	45	...	12	533	...
Sheffield Corporation	April 3	4,374	+ 83	1	4,374	+ 83
*Southampton Corporat'n	...	...	...	...	...	...
Southend Corporation	Mar. 30	211	− 3	52	15,843	+ 2,247
Southport Tramways	,, 25	247	− 17	12	2,811	+ 225
S. Staffordshire Trams.	,, 25	745	− 82	12	8,736	+ 332
Sunderland Corporation	,, 27	1,101	+ 39	52	61,840	+ 3,014
*Swansea Trams	,, 25	450	− 17	12	5,431	+ 146
Taunton Trams	,, 25	42	− 10	12	548	− 35
Tynemouth and District	,, 25	206	− 25	12	2,431	− 84
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council	April 2	653	+ 76	52	35,367	+ 4,105
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 31	263	...	5	1,306	...
Weston-super-Mare	,, 23	23	− 4	12	270	− 23
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District	,, 25	357	− 27	12	3,959	− 177
Worcester	,, 25	229	+ 69	7	1,703	+ 703
Wrexham	,, 25	97	...	12	1,161	...
Yorkshire Woollen District	,, 25	564	+ 337	12	6,035	+ 2,170

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., April 6.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business, 8 Days to April 8 Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4½—5½	4 17 7	April, Oct	5	4½
St.	6%	Do. Permanent 6% Deb. Stock	127 —132	4 11 11	..	..	..
St.	3½	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	..	..
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 10 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 18 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	87½	87⅛
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	97 —100	5 0 0	..	..	..
St.	5%	Do. Pref. Ord. Stock	98 —101	5 0 9	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10⅛—10¾	4 13 0	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅞	4 7 0	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	8½—9½	8 8 6	..	9⅛	8⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—11½	5 6 8	Feb, Aug	11	10⅝
St.	5/0	† Do. 5 per Cent. Perpetual Debs	116 —119	4 4 0	..	117½	117
5	..	Buenos Ayres and Belgrano Ord.	2⅝—3	..	..	2⅛	2⅛
5	3/0	Do 6 per Cent. "A" Cum. Pref.	5⅛—5⅜	5 4 0	..	5⅛	5⅛
5	3/0	Do. "B"	4⅞—5⅛	5 14 3	..	5⅛	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	100	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 —100	5 0 3	..	..	..
5	2/6	Calcutta Tramways	6¾—7½	4 9 8	..	7⅛	7
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 0	..	..	..
1	1/0	Cape Electric Tramways Shares	1⅞—2⅛	8 0 0	..	..	..
St.	4%	Central London Ordinary Stock	90 —93	4 6 6	June, Dec	92	..
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	..	..
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 —113	3 11 8	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅜—5½	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..
St.	2%	City and South London Rly. Con. Ord.	49 —52	4 11 4	Feb, Aug	51	50½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 8	Feb, Aug	..	..
St.	5%	Do. (1896)	120 —123	4 2 2	..	..	..
St.	5%	Do. (1901)	119 —122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams&Ltg.5% 1st Mt.Db.(rd.)	101 —104	4 18 1	..	..	..
10	6 0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	12⅛	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf	1½—2½	12 0 0	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..
10	..	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	4 12 2	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..
10	10%	‡ Imperial Tramways Ord	18½—19½	4 12 4	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..
10	11%	†Liverpool Overhead Railway Ord.	413—415	2 16 5	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	9¾—10½	4 17 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98½—100½	3 19 10	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11½—11¾	4 5 2	..	11½	11½
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 —103	3 18 5	..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅞—1	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	..	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	101 —103	4 17 3	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	104 —106	4 4 11	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1 —2	..	May	1	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	..	..
10	10/0	Potteries Electric Traction Ord.	8½—9½	5 5 3	..	..	..
5	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	..	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	83 —91	3 8 8	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec ..	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	16/0	Anglo-American	48 —51	5 18 8	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	91 —93	6 9 0	F,My,Ag,N	92½	91½
St.	2/0	Do. Deferred	6⅞—7½	1 7 6	F,My Ag,N	7⅛	7
100	$2	Commercial Cable Capital Stock	180 —190	4 4 5	Ju,Ap,Jy,O	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	89 —91	4 8 0	Jn Ap,Jy,O	91	90
10	7/0	Cuba Submarine Ord.	7 —8	10 0 0	Feb, Aug	7⅛	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 3	Feb Aug	..	..
5	2/0	†Direct Spanish Ord.	2½—3½	5 14 4	April, Oct	..	..
5	5/0	† Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99⅞—102⅞	4 9 3	Jan, July	..	..
20	3/0	†Direct United States Cable	9⅜—10¼	6 16 7	Ja,Ap,Jy,O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —101	4 9 1	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	117 —122	5 14 9	Ja,Ap,Jy,O	121	118½
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 19 1	Ja Ap,Jy,O	87½	87¼
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 15 8	May, Nov	105½	..
10	2/6	Eastern Extension	11 —11½	6 1 9	Ja,Ap,Jy,O	11½	11½
8	4%	Do. 4 per Cent. Deb. Stock	103 —106	3 16 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	90 —102	3 19 0	Feb, Aug	100	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—103%	3 19 0	May, Nov	..	..
10	5/0	Great Northern of Copenhagen	25 —26	4 16 2	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..
25	12/6	Indo-European	38 —41	6 1 11	May, Nov	..	..
100	4%	Pacific&Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	97½	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..
2½	..	West Coast of America	1⅛—⅜	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	95 —98	4 1 8	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	5⅞—6½	9 12 0	May, Nov	6⅛	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..
10	3/0	†Western Telegraph	11½—12½	5 14 3	Mr,Jn,O,D	12½	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	100—103	4 18 2	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	98 —101	3 19 3	..	99½	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	8 —8½	4 14 2	Ja Ap Jy O	8⅜	8¼
10	3/0	Do. 6 per Cent. Pref.	11½—12½	4 14 2	Ja Ap,Jy,O	12⅝	12½
5	4/0	Reuter's	6½—7½	5 6 8	April, Oct	..	..
100	6%	Submarine Cables Trust (Cmn.)	115 —120	5 2 2	April, Oct	119½	..

Share.	Last Dividend	Name.	Price Wed., April 6.	Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business 8 Days to April 8 Highest.	Lowest.
		TELEPHONES.					
5	3/0	Chili Telephone (fully paid)	4½—5½	5 14 8	August ..	..	..
St.	6%	National Co. Pref. Stock	103 —105	5 14 10	..	104	101
St.	5%	Do. Def. Stock	85 —87	5 18 5	..	86½	84½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 9	Feb, Aug	12½	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12 —14	4 5 8	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	4½—5½	4 17 7	Feb, Aug	5⅛	5
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	95 —97	3 12 11	June, Dec	96½	96
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	99 —101	4 0 0	..	100	99½
1	0/0	Oriental	¾—1	6 13 4	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 —1½	..	..	..	..
5	3/0	United River Plate	5½—6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 —105	4 15 3	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅛—¼	..	..	..	..
1	0/8	Do. 7% Cum. Pref.	1—1⅛	..	..	..	..
St.	4½%	† Do. 4½ 1st Db. Stk. Prv. Cts. (rd. &con.)	113 —116	3 17 7	..	..	..
10	16/0	†Bournemouth & Poole Elec. Sup. Ord.	12 —13	6 3 2	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	100 —103	4 7 5	..	..	..
5	5/6	†Brompton & Kensington Elec. Sup. Ord	10½—10¾	4 18 0	..	10¾	10½
5	3/6	† Do. 7 per Cent. Pref.	9¾—10½	3 8 4	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	6½—7	4 12 10	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7 —7½	5 6 8	Feb, Aug	7⅜	..
5	2/3	Do. 4½ per Cent. Pref.	5½—6½	4 5 9	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	..	..
5	1/7	Do. Do. (19.3)	4½—5	..	..	4¾	..
St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 10	..	103	102
5	3/6	†Chelsea Electric Supply Ord.	6 —6½	4 4 7	March	6⅜	6⅛
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 3 1	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord	10½—10¾	4 18 0	Feb, Aug	10⅝	10½
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	4/0	†County of London & Brush Prov. Ord	7 —8	5 0 0	..	..	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.	103 —109	4 2 11	..	..	..
St.	27/6½	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord	5½—6½	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 3	..	..	..
10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
5	3 6	Hove Electric Lighting Ord.	7⅞—8½	5 0 0	..	8⅜	..
St.	..	I of W. Elec Lt. & Power 4½% Db St. (red.	102 —105	..	..	..	..
1	..	Kalgoorlie Elec. Power&Ltg.6% Cm Prf	⅛—⅝	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	11 —12	5 0 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
St	4%	†Kensingtn. & Knghtbg. Co. & Notting Hil. Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	..	..
8	..	London Electric Supply Ord.	1 —1½	..	..	..	..
5	3/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	4⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 —97	4 3 7	Mr,Jn,S,D	..	..
10	9 6	†Metropolitan Electric Sup. Ord.	18 —19	4 12 1	April, Oct	18⅛	..
5	1/4½	† Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	4 8 0	..	5⅛	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort	109 —113	3 19 6	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.	95 —98	3 11 9	..	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	6/0	Notting Hill Electric Ord.	13 —14	4 5 9	March	..	..
100	4%	† Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 5	..	..	..
5	4/0	Oxford Electric Ord.	5½—6	5 8 4	March	5⅜	..
St.	4%	Do. 4% Deb. Stock	96 —99	4 0 9	..	..	..
1	..	Rand Electric	¾—1	..	..	..	..
100	4½%	*†Royal Elec., Montreal 4½% 1st Mt. Deb	98 —101	4 9 1	April, Oct	..	..
5	9 6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	8⅛	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
5	3/0	South London Electric Supply Ord.	3 —3½	4 5 8	..	3⅜	3⅛
5	2/6	†Urban Electric Supply Ord.	4½ 5	5 0 0	..	..	..
5	2/6	† Do. 5% Cum. Pref.	4½—5	5 0 0	..	..	..
5	7/0	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	12⅝	12⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	6⅛	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½—⅝	10 0 0	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅝—¾	..	Mar, Sept	..	..
5	4/0	†British Insulated & Helsby Cables Ord	5⅞—6⅛	6 8 0	July, Feb	..	..
5	3.0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 7 5	..	..	..
5	3/0	British Westinghouse 6% Pref.	3¾—4¼	7 1 2	..	3⅞	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	93 —96	4 3 4	..	..	..
½	..	Brush Electrical Engineering	½—¾	..	March	⅝	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	¾—1½	9 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	72 —77	5 18 4	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	11	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	5½	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.	104 —108	4 3 3	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 —93	4 14 9	..	88	..
1	0/7½	Chadburn's Ship Telegraph Ord	¾—1	8 0 0	March	..	..
1	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½—2	7 10 0	Jan, July	1⅝	1½
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	98	..
5	..	Dick, Kerr & Co. Ord.	7⅞—8½	..	..	..	..
5	3.0	† Do. 6% Cum. Pref.	5 —5⅛	5 9 1	..	..	..
St.	4½%	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	¼	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	..	..
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5½—6½	5 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅝—6½	4 16 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 4 11	..	..	..
2	1/2½	Electric Construction Co.	1½—1⅝	6 71 2	Jan, July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
1	..	Electrolytic Alkali Ord.	½—¾	..	..	..	..
1	7%	Do. 7 per Cent. Cum. Pref.	¾—1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 3	..	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	93 —98	4 1 8	..	..	..
5	9/0	†Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5⅛	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	18 —19	5 5 3	Feb, Aug	18⅞	18½
100	4%	† Do. 4 per Cent. 1st Mort. Deb (red.)	99 —102	3 18 5	Mar, Sept	101	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10½—11	4 10 11	Mar, Sept	..	..
12	36/0	Telegraph Construction & Mainten'ce.	33 —36	6 13 4	Mar, July	34⅜	33½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
5	..	Willans and Robinson Ord.	2 —3	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3½—4½	..	Apr, Oct	3½	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —97	4 3 6	May, Nov	..	..

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NOTES.

MR. GEORGE C. LLOYD is to be congratulated on his appointment, out of a large number of applicants, to the secretaryship of the Institution of Electrical Engineers, and the Institution is also to be congratulated on having made such a judicious selection. Born in Lincolnshire in 1862, his father being the Rev. C. A. LLOYD, Rector of Rand, near Lincoln, Mr. LLOYD was educated partly in Germany, and on returning to England at the age of 17, he entered the works of Robert Stephenson & Co., locomotive and marine engine builders, Newcastle-upon-Tyne, as an apprentice. In 1884 he joined the firm of Messrs. Lamport and Holt, of Liverpool, in the capacity of marine engineer, and subsequently entered the service of the Spanish Royal Mail Steamship Co. (Compañia Transatlantica de Barcelona). He holds an extra first class Board of Trade certificate. In the course of his voyages he visited the Philippine Islands five times, making a stay of one month on each occasion, and has also been in India, Brazil, the Argentine Republic and the West Indies, spending some three months in Cuba before the outbreak of the rebellion. He returned to England in 1891, and for the next nine years was engaged in engineering work in Glasgow and London. Since 1900, Mr. LLOYD has acted as chief assistant to the secretary of the Iron and Steel Institute, and we believe that, in addition to his other numerous qualifications, Mr. LLOYD is an excellent linguist. He enters on his duties on May 12th. Mr. PERCY F. ROWELL, chief assistant to the late Mr. MCMILLAN, has been appointed assistant secretary. We cordially wish both Mr. LLOYD and Mr. ROWELL every success in their new appointments.

OUR correspondence columns this week show that there is considerable scepticism with regard to the official explanation of the recent fatal accident at the Bow-road electricity works of the Charing Cross and Strand Company, reference to which was made in our leading article last week. The "residual charge" explanation is, as we have said, the only possible one if the facts are precisely as were stated; but the suggestion that there may be some mistake must not be set aside too summarily. We do not wish to suggest that there has been any desire to misrepresent the facts, but it is certainly possible that, in the excitement of the moment, the observations made and the conclusions arrived at were not so accurate as they might have been in a time of less mental stress. The most likely explanation appears to us to be that the synchronous motor at one of the sub-stations was still revolving at the time of the accident, and that it was connected to the main from which the shock was received either directly or through the transformer of a voltmeter or synchroniser. There is, in fact, a temptation in the case of synchronous motors to leave them on the mains when the generating plant is shut down, and to let them run up with the alternators again afterwards. This is bad for the cables, on account of the possibility of causing high potential resonance effects, but it is a practice not unknown to supply station engineers.

WHEN examining the residual charge hypothesis, one is naturally inclined to put it to the test of previous experience. Now, as we pointed out last week, this hypothesis must include the supposition that the cables were well earthed and discharged through the dynamo as it came to rest with its field circuit broken, and that the fatal shock was brought about by a residual charge subsequently creeping up in the cable. Ten-thousand volt cables of large capacity are not new things, however; they have been in constant use between Deptford and London for about 15 years. These mains and their 'bus bars, we happen to know, are switched off daily, and are then discharged by connecting them to earth. Slight dis-

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charges and shocks have, of course, been experienced before this earthing, but, so far as we have been able to ascertain, no flash or report (as was observed at Bow-road) has ever been noticed on connecting the earthed plug to them. Mr. NISBETT'S letter is also clear on this point. For the satisfaction of other station engineers, we hope that there will be a Board of Trade inquiry into the circumstances of the accident, and also that an endeavour will be made to reproduce the conditions under which the cable became charged so as to give a fatal shock.

THE reports, collective and individual, of the members of the Mosely Educational Commission, abstracts of which appear on another page, are rather disappointing, although they contain a very large amount of valuable information. Naturally, the same thing is said many times over by different Commissioners, owing to the fact that several of them covered some of the same ground, but the cause for disappointment is that no actual scheme is suggested for the improvement of English educational systems. The key to the whole situation seems to lie in the one word "initiative"; Americans possess the faculty of seeing ahead, as it were, and acting so as to be ready to meet the position. This seems to be no less true of education than of industry and trade. Moreover, children are taught quite early in life to look upon schooling as part of their business training, and the result is that by the time they enter college they are fully alive to their responsibilities and recognise how much depends upon close application to work. Manufacturers in America appreciate well-educated engineers, and encourage the getting and giving of education to the greatest possible extent. For the past few years innumerable pessimists have said that the engineering industry of Great Britain is crumbling away because of the false system of technical education in vogue, and there is doubtless some truth in the assertion. But we are still waiting for some great authority to take the lead and actually initiate the reform which so many have merely advocated in speeches, articles and reports. In Prof. ARMSTRONG'S words: "The message awaits delivery, and we need more than anything else the man to make it heard."

PROF. F. NIETHAMMER'S method of pre-determining the characteristics of alternating-current machinery by graphical means, described on another page of this issue, merits careful attention. It has been found, the author points out, to give accurate results in practice—particularly with regard to the pre-determination of the regulation of alternators—and it possesses over experimental methods, such as those proposed by BEHN-ESCHENBURG, ROTHERT and others, the distinct advantage of being applicable as soon as the details of the machine have been settled. Experimental methods come in useful for verifying the theoretical conclusions and for guiding would-be customers in their choice. It will be remembered that Mr. B. A. BEHREND criticised somewhat severely (see *The Electrician* of January 1st, p. 410) the existing methods of determining the voltage regulation experimentally, and we hope to publish shortly an experimental method developed by Dr. T. HEYMANN, which would appear to give nearer approximations to truth than the older ones.

PROF. BRAUN, in a letter appearing in our Correspondence columns, raises anew the question of priority in the use of a closed oscillator at the transmitting end of a wireless telegraph system. It will be remembered that Mr. MARCONI claims to be, so far as he knows, the first to emphasise the necessity of having the closed condenser circuit in perfect tune with the open radiating circuit or air-wire at the sending station. Prof. BRAUN'S letter shows us two things: First, that the necessity for the separate tuning of the two parts of the transmitter to their common natural frequency may not be so absolute as Mr. MARCONI believes; and, secondly, that Prof. BRAUN had this wider view of the problem in mind when he refrained from binding himself to the particular case Mr. MARCONI seems committed to. We might mention here that in this matter some confusion seems to exist regarding what Mr. MARCONI claims: whether it is the use of a compound transmitter of the Braun type with its two parts tuned to each other, or whether of a system with its receiver tuned to the transmitter. Surely not the latter, which has been among the dreams of inventors for many years.

THE arguments adduced in the discussion on "Power Schemes—Projected and in Operation," which took place at a recent meeting of the Leeds Local Section of the Institution of Electrical Engineers, were hardly what might be called "forcible." Little fresh information was elicited, and Mr. WOODHOUSE, who started the discussion in favour of power schemes, certainly carried the day. It is all very well to argue that municipal generating stations are in as favourable positions as power companies' stations, both as regards fuel and distribution of energy, and that they would be glad to supply consumers at the same rate as the power companies; but the fact remains, nevertheless, that in the majority of cases they cannot compete with the prices offered by power companies. Mr. EMMOTT, who led for the opposition, argued that, in spite of existing municipal stations being equipped with small and comparatively inefficient engines, if only the load were forthcoming they would soon put in large engines and bring the price down. The answer to this is obvious. In order to obtain the increase of load and the improvement in load factor it is necessary to increase the area of supply; and it is not expedient that a Local Authority should be allowed to enter into trading operations too far outside its own district.

Old Lamp Ends.—A correspondent asks us what is the quickest and most economical method of extracting platinum from a large quantity of electric lamp ends. Perhaps some of our readers can assist him.

Erratum.—The heading to Tables III., IV. and V., on p. 979, of Mr. Longbottom's Paper on "The Adaptability of Electrical Driving," published in last week's *Electrician*, should read, "Fuel Cost of Electrical Energy," instead of "Full Cost of Electrical Energy."

Cable Interruptions.	Date of Interruption.
Dominica—Martinique	May 9, 1902
St. Lucia—Martinique	May 9, 1902
Cayenne—Pinheiros	Aug. 13, 1902
Reissi-Issa (Yemen)—Camaran	Oct. 22, 1902
New York—Hayti	Apr. 18, 1903
Tourane—Amoy	Nov. 10, 1903
Tarifa—Tangier	Jan. 18, 1904
Dakar—Conakry	April 11, 1904

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Crystal Palace Company's School of Engineering.—The annual award of certificates to the students of the Crystal Palace Company's School of Engineering was made yesterday by Sir W. H. White, F.R.S. Afterwards the several departments of the school were visited.

Compulsory Tramway Running Powers.—As a result of the decision of the Committee of the House of Lords in passing the preamble of the bill promoted by the Tyneside Tramways and Tramroads Co., referred to in our issue for April 1, p. 931, a meeting has been convened by the local authorities for Tuesday next, in London, to protest against compulsory running powers over municipal tramway systems being granted in this manner. By municipal tramway managers the decision in question is regarded as of the gravest importance, and the object of the meeting is to organise united opposition to the Tyneside Tramway Company's Bill when it comes before a Committee of the House of Commons.

The Anglo-French Telephone.—On Monday, the public telephone service was opened between the provincial towns in England and France enumerated, on p. 891 of *The Electrician* of March 25th, and the following messages were transmitted :—

Sous-Secrétaire d'État Postes et Télégraphes à Postmaster-General, Londres.

À l'occasion de la mise en vigueur de la nouvelle convention téléphonique Franco-Anglaise, le Sous-Secrétaire d'État et l'Administration Française des Postes des Télégraphes et des Téléphones envoient à Monsieur le Postmaster-General et à l'Administration Anglaise leurs cordiales salutations.

Sous Secrétaire d'État, Postes, Télégraphes et Téléphones, Paris.

Lord Stanley, on his own behalf, and on behalf of the British Post Office, warmly thanks M. Berard and the French Administration for their kind message and cordially reciprocates their friendly sentiments.

Opening of the Chepstow Electric Supply Works.—On Saturday last the small electricity works at Chepstow were put into operation. A provisional order was obtained by the Chepstow Electric Lighting and Power Co. in 1902, and work was very quickly put in hand. It is a two-wire 230-volt system. Two locomotive boilers have been installed which supply steam to two Peache-Silvertown four-pole 50kw. sets. There is also a 132-cell Hart battery with a capacity of 500 ampere-hours, and a maximum discharge rate of 96 amperes. The charge for lighting is 7d. per unit and for power 3d. per unit. Mr. A. Langston Yockney has acted as consulting engineer to the scheme, and Mr. A. E. Wilkins is the resident engineer.

Opening of the Berwick Electricity Works.—The electricity works which the Urban Electric Supply Co. has erected at Berwick-on-Tweed were officially opened last week. The company obtained a provisional order in 1900, and a three-wire continuous-current 240-volt system has been adopted. Steel-armoured lead-covered mains are employed, laid direct in the ground. The generating plant consists of two Sugden water-tube boilers having a total evaporative capacity of 6,500lb. per hour, and two Bellis-Crompton 90kw. sets. The station also contains a 260-cell 21-plate D.P. battery, with a capacity of 350 ampere-hours and a maximum discharge rate of 90 amperes. The tariff is 7d. for the first hour of maximum demand, 4d. for all surplus current for lighting and 4d. and 1½d. for power. Free wiring is undertaken at 4½d. per lamp per quarter, or 7d. per unit through prepayment meters. The resident engineer is Mr. J. H. Howe.

A New Phase-meter.—Prof. A. Grau, in a recent article in the *Elektrotechnische Zeitschrift*, suggests a phase-meter on the following principle:—A wattmeter follows the law $E_1 J_1 \cos\phi = CW\alpha$, where E_1 is the potential difference between the terminals, J_1=main current through wattmeter, $\cos\phi$=power-factor, C=a constant depending on the dimensions of the wattmeter, W=total resistance of the wattmeter shunt coil, and α=angle of torsion. If i=current in the shunt coil of the wattmeter, then $E_1 = iW$, and, if this value be substituted in the equation given above, we get $J_1 i \cos\phi = C\alpha$, or, the power-factor $(\cos\phi) = C\alpha / J_1 i = K\alpha$. If, therefore, the currents J_1 and i, flowing through the two coils of the wattmeter, be kept constant for all loads, then the wattmeter will indicate the power-factor of the system and not the watts consumed. The current J_1 is kept constant by means of an adjustable liquid resistance connected in shunt to the stationary coil of the wattmeter, and the current i is regulated to a constant value by varying the resistance of the shunt coil of the instrument

City Lamps and Signs.—The following is a digest of a series of regulations issued by the Streets Committee of the Public Health Department at the Guildhall and relating to lamps, cranes, clocks and projecting boards within the City :—Applications for such fixtures must be accompanied by drawings showing the mode of fixing, dimensions and total projection from the frontage line. Lamps not used for shop-window lighting must be 12ft. or more from the footway, and their external dimensions, including frame and ornaments, must not exceed 5ft. in height and 3ft. in any other direction. They must not project more than 4ft. 6in. from the frontage, or be less than 2ft. from the carriage way. Advertisements may be placed on the sides but not on the bottoms of such lamps, which must be kept lighted from sunset until the premises upon which they are fixed are closed. The underside portion of shop-window lamps must be at least 8ft. from the pavement, while the extreme projection over the public way must not exceed 3ft. when the width of the pavement permits, and it must also be 2ft. or more from the carriage way. The external dimensions of such lamps must not exceed 2ft. 3in. in any direction. No advertisement lettering will be permitted on the dials of clocks, which must be synchronised with Greenwich time at the expense of the owners. Trade advertisement boards may be erected provided they do not exceed 3ft. in width by 2ft. in height and 3ft. in thickness, with a projection of not more than 3ft. 6in. from the front of the building to the extreme edge of the board or tablet, but in no instance beyond 2ft. inside the line of kerb. In future there must not be less than 9ft. from the pavement to the underside of the board.

Manchester Local Section of the Institution of Electrical Engineers.—The annual general meeting of the Manchester Local Section was held at Owens College on Tuesday. It was shown by the report of the committee that the membership had increased from 472 to 549 during the year, and that the newly-formed Students' section had a membership of 250. The report was adopted, and the thanks of the meeting were given to Mr. E. W. Cowan, retiring chairman, the hon. sec., Mr. P. A. Ramage, and to the Owens College authorities. A number of electric lamps, brakes, controllers, circuit-breakers and other apparatus were exhibited and explained. Dr. Rhodes showed his pneumatic rail brake ; the British Westinghouse Co. a specimen of the Newell rail brake and the Cooper-Hewitt mercury vapour lamp ; Mr. L. Andrews, automatic discriminating switch gear for single-phase alternating currents and a new magnetically-balanced and almost friction-less wattmeter ; Mr. E. W. Cowan, a Cowan-Carbone high-voltage arc lamp ; and Messrs. W. T. Glover & Co., cable samples and photographs. At the close of the meeting the chairman announced the election of the following officers for the coming session :—

Chairman, Mr. C. D. Taite (borough electrical engineer, Salford). *Vice-Chairman*, Mr. A. F. Giles. *Hon. Sec.*, Mr. P. A. Ramage. *Committee :* Drs. Bowman, Rhodes and Schuster, Messrs. L. Andrews, A. A. Day, A. H. Gibbings, Bromley Holmes, Cortez Leigh, M. B. Mountain, G. F. Metzger, T. L. Miller and S. L. Pearce.

Interior Wiring in Metal Pipes.—A new code of "Installation Work Rules" has been published by the Edinburgh electricity department. The rules as to the wiring itself are stricter than is customary. All wires concealed behind walls are to be laid in iron or other hard metal pipes. Wires under floors in wood casing must be at least 4in. below the boards, otherwise the wires are to be placed in metal pipes. When iron pipes are employed, the lengths must be joined by suitable screwed unions, so that metallic connection is obtained throughout, and the whole system of tubing must be connected to earth at a main water pipe. When it is necessary to leave a gap in the run of piping this must be bonded by a copper wire of sufficient size. Other rules specify that no switches shall be placed on the middle wire of the three-wire supply system except the main switches, which are to be supplied on each pole by the consumer. The consumer is not bound to fix a main fuse, except in the case of flats or in similar circumstances, when a double-pole fuse

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capable of being sealed by the Corporation is to be supplied by the consumer. Branch fuses are to be placed on both poles. The minimum insulation resistances specified vary from 5 megohms for 12 lamps to 0·2 megohm for 300 lamps, and from 2½ megohms for motors up to 2 H.P. to 0·5 megohm for motors above 10 H.P. From wire to wire the insulation resistance must not be less than 75,000 ohms. The remaining rules are of a similar nature to those issued by other corporation electricity departments.

The Government Telephone Proposals.—On Monday a conference was held at the Westminster Palace Hotel of representatives of municipal authorities owning and working telephones to consider what action should be taken with regard to the proposal of the Government to take over the National Telephone Co. Sir John Primrose, Lord Provost of Glasgow, presided, and representatives from Glasgow, Hull, Guernsey, Brighton and Swansea were also present. The chairman said that corporations should make a representation to the Postmaster-General at once in order that, before negotiations with the National Telephone Co. had proceeded too far, the corporations should be afforded an opportunity of being heard on the subject in so far as their interests might be affected. The conference was strongly of opinion that local authorities should have the opportunity of working local telephones, and that the Government should be left to work and perfect the trunk system. The meeting subsequently adjourned so that the representatives might report to their respective councils. Meantime, an executive committee was appointed to watch over the interests of the municipalities in the light of the full discussion which took place. Delegates representing the various municipalities were received on Tuesday by the secretary to the Post Office, who gave his assurance that an opportunity would be given them of placing their views before the Postmaster-General. The municipal corporations advocate that in the event of a committee being appointed by Parliament to consider the negotiations between the Postmaster-General and the National Telephone Co., they should be enabled to bring evidence before that committee.——At the Court of Common Council to day it was decided that the Streets committee should arrange a conference of representatives of local authorities in the London telephone area, with reference to the proposed purchase by the Government of the National Telephone Company's system. The conference will take place at the Guildhall.

Wireless Telegraph Notes.—We have received from the de Forest Wireless Telegraph Co. the following additional particulars with regard to the plant supplied to *The Times* newspaper for use by their war correspondent in the Far East. The contract provided for two complete sets of wireless telegraph apparatus, manned by two expert operators. Within 10 days after arrangements had been concluded, the full outfits, including two kerosene oil engines and weighing in all over 4 tons, were shipped express to Vancouver, where they were put on board the steamship "Empress of Japan." From Yokohoma the expedition sailed at once for Shanghai. There, Capt. James, *The Times* war correspondent, had chartered the Chinese steamer "Haimun," a two-master on which topmasts had been rigged to the height of 75ft. To this boat the apparatus was transferred, and during the voyage north to Wei-hai-wei the two de Forest experts, Messrs. Athearn and Brown, worked unceasingly until the ship's set was completely installed and in operation. Capt. James' lieutenant, Mr. Froser, had preceded him to Wei-hai-wei, and erected a bamboo mast, 180ft. high, rigged in the best possible fashion, considering the unsatisfactory wood which alone could be obtained for that purpose, and the great dearth of necessary supplies. A pair of rough bungalows were constructed by coolie labour, and the task begun of moving the engine and heavy machinery from the dock to the promontory where stands the station. This point is some 10 miles east of the town of Wei-hai-wei, accessible only by pony messenger, over a narrow and rocky trail. The utmost energy and ingenuity were required on the part of the English and Americans to get the Wei-hai-wei apparatus quickly installed, and just three weeks from the date of landing at Wei-hai-wei *The Times* printed a lengthy dispatch headed "via de Forest Wireless Telegraphy." Each station is of 1kw. capacity and comprises a 2½ H.P. Secor oil engine, a 60-cycle 500-volt generator with separate exciter, oil transformer (delivering 20,000 volts), oil transmitter key, regular Shoemaker–De Forest oscillator and syntoniser, electrolytic receiver, with relay and bell attachment and highly sensitive telephone receivers. It was the original intention to instal one station upon one of the Sir James Islands on the Chemulpo peninsula and transmit thence to Wei-hai-wei, a distance of 175 miles; but Capt. James decided that an installation upon a boat would give him greater mobility and save long delays in getting dispatches to the transmitting station. The de Forest apparatus in the Yellow Sea has not been exempt from serious competition by the Japanese wireless stations on board their war vessels. There has been a continuous stream of wireless signals, but we are informed that the methods of syntonisation employed in the de Forest apparatus, the speed with which the Press dispatches are rushed through with the alternating-current transmitter (25 to 30 words per minute, which greatly exceeds the speed of the Japanese system), together with the telephonic methods of sound reading, have overcome all difficulties.——In *The Times* of yesterday, the correspondent on board the "Haimun" states that on April 10th the receiving station heard them at a distance of 170 sea miles, and acknowledged messages as received at a distance of 150 sea miles. At the time of writing he was sending from a distance of 125 sea miles. *The Times* had, however, not yet received the previous message referred to by their correspondent.

The American De Forest Telegraph Co. inform us that Judge La Combe handed down his decision on March 29th, refusing the application for preliminary injunction in the suit brought against the American De Forest Wireless Telegraph Co. by the National Signalling Co. (owners of the Fessenden patents). This case concerned the alleged infringement by the De Forest Company in using a type of electrolytic receiver which the plaintiffs claimed to be a "liquid barreter," for which Mr. Reginald Fessenden was granted a patent last June.

A system of wireless telegraphy has been successfully inaugurated between Port Limon, Costa Rica, and Bocas del Toro, Panama.

Under "Dockyard Notes" the *Engineer* of April 8th makes the following announcement: "For 'economy,' Marconi apparatus has been removed from most of the ships in the Mediterranean Fleet." We do not know on what authority this statement is made, but we presume it is correct as our contemporary is usually well-informed on naval matters.

A Dalziel telegram from New York states that the Lighthouse Board has requested the Marconi Wireless Telegraph Co. to remove its apparatus from the Nantucket Lightship, on account of the company's refusal to receive messages sent by the German system.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, April 19th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "Aerial Suspension Cableways," by J. M. Henderson.

WEDNESDAY, April 20th.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, Westminster. Paper to be read: "Armature Reactions in Alternators with Some Notes on the Running of Synchronous Motors," by H. W. Taylor.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

7:30 p.m. Meeting at the University. Paper to be read: "Some Properties of Alternators Under Various Conditions of Load," by A. F. T. Atchison.

SOCIETY OF ARTS.

8 p.m. Ordinary meeting. Paper to be read: "Motor Cars for Popular Use," by Mervyn O'Gorman.

THURSDAY, April 21st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Special Meeting when Mr. Dugald Clerk will deliver the twelfth "James Forrest" lecture on "Internal Combustion Engines."

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THE LIVERPOOL–SOUTHPORT ELECTRIC RAILWAY.

(Concluded from page 978.)

The high-tension cables leading from the power house are arranged in each case in triplicate. Under ordinary working conditions, all three cables are used, but, in case of breakdown of one of the cables, the remaining two can do the work without the voltage drop or the current density exceeding the permissible limit. All the cables were manufactured and laid by Messrs. W. T. Glover & Co. as sub-contractors to Messrs. Dick, Kerr & Co. The extra high-tension cables are of the triple triangular type, diatrine paper-insulated, lead-covered and armoured, and they are laid on the solid system. Four different sizes of cables were employed—37/15, 37/16, 19/15 and 19/16, the length of each being respectively 13 miles, 6½ miles, 6½ miles and 18 miles, a total of 44 miles. The insulation consists of manilla paper impregnated with diatrine by a process in which the surplus compound is removed from the surface of the paper after the latter is thoroughly impregnated. The thickness of insulation is 0·36in. between conductors and 0·26in. between conductors and the lead sheath. As the system is earthed at the centre point of the star winding of the alternators, and the working pressure between conductors is 10,000 volts, the pressure between each conductor and earth is 5,780 volts. Each of the insulated cores is finished off with a different coloured layer of paper strip to serve as a distinguishing mark. The lead sheathing varies from 0·125in. to 0·15in. thick, according to the size of cable. The armouring is of galvanised steel wires 0·08in. to 0·1in. diameter. The joints are of the plumbed lead sleeve type, the lead sleeve being filled up with diatrine compound.

The third rail is supported at intervals of about 10ft. on insulators of reconstructed granite, held in position by two clips, the centre of the rail being exactly 3ft. 11½in. from the centre line of the track, and the top of the rail 3in. above the surface of the track rails. These dimensions were agreed upon by all the main line railway companies at a meeting held at Clearing House on March 3, 1903, in order to obtain uniformity in case of extensions of third-rail system.

Generally, the third rail is placed in the six-foot way between the tracks, but occasionally it is brought outside the track, to suit special conditions. At all level crossings gaps in this rail have been provided of such a length that there can be no risk whatever to the public; where these gaps occur the third rails are bonded with cable underground. Of course, the length of these gaps is always less than the distance between the two motor cars of the train. When the rail is interrupted the height of the top of the rail is gradually reduced by 2in. over the last 10ft. of the rail, thus affording a gradual approach for the collector shoe. This was shown in Fig. 19 in our last issue. Timber guarding has been provided at all the busy places on the line, to prevent the possibility of any person coming into contact with the third rail, though even if they did so the consequences, while unpleasant, would not be serious.

The fourth rail is supported on wooden blocks, and is placed in the middle of the four-foot way between the two running rails.

At most stations the third rail is interrupted and the ends are connected by cables to section switches. This apparatus consists of four knife switches, one for each end of the up and down line, which, in the ordinary way of working, are connected in parallel. By cutting out one of these switches in two adjacent boxes any part of the up and down line may be shut off.

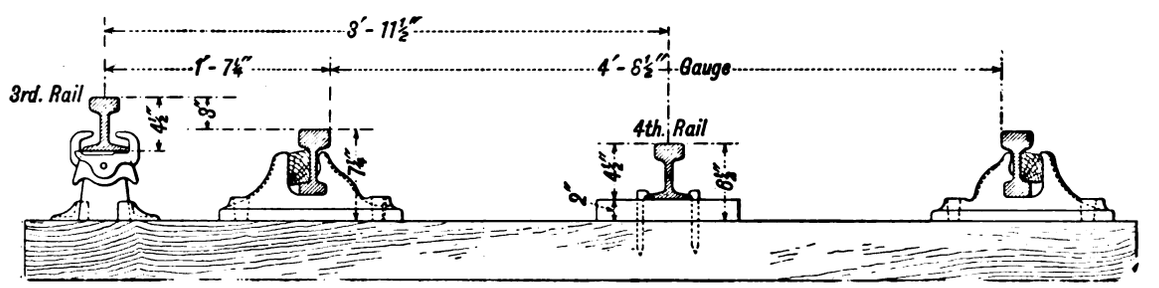

FIG. 21.—CROSS SECTION OF TRACK SHOWING POSITIONS OF THIRD AND FOURTH RAILS.

Stout tarred and creosoted wooden troughs are employed covered over with tiles. Impregnated wood bridges support the cables at 18in. intervals, and three cables are laid solid in each trough. The cables are placed for the most part in the six-foot way, and where they pass over bridges or in exposed situations are laid in stout steel troughs. All cables were tested with 30,000 volts between cores, and to earth, for one hour before leaving the works.

As shown in Fig. 21, the permanent way has been equipped with two additional rails. One of these is brought alongside each track on insulators, whilst the other rail is placed between the running rails, uninsulated, on the sleepers, this forming the principal part of the return circuit. The joints of both the third and the fourth rail are bonded as usual, and, in addition, the fourth rail is also cross-bonded to the running rails, which are not bonded in the ordinary manner. No collector shoe is provided on the train for the fourth rail, the current being delivered through the wheels to the running rails, and thence, through the cross-bonds, to the fourth rail. One advantage of this system is that it is a comparatively simple matter to renew the running rails without unduly interfering with the continuity of the return circuit.

The third and fourth rails are both of equal section, and consist of mild steel of special high conductivity, the resistance being proved by test to be not greater than 7¼ times that of pure copper. As a matter of fact, the average resistance is somewhat lower. The rails have been supplied by the North Eastern Steel Co. of Middlesbrough, are of Vignoles section, weigh 70lb. per yard, and are in lengths of 60ft.

To provide for expansion and contraction due to change of temperatures in the rails, they are divided into sections of 300ft., and the joints between the lengths of rail making up each section are closely butted. The 300ft. sections are connected by "expansion joints." The fishplates at the fixed joints are made as rigid as possible, and the bonds are four in number, two bonds being fixed in the web of the rail and two bonds in the flange of the rail. It was deemed advisable to use bonds of semi-flexible type, which have a conductor built up of parallel strands of copper ribbon or "flat wire" with solid copper terminals. They are thus sufficiently flexible to provide for any movement which may take place at the joints, and are more easily adjusted in case of any variation in distance between the bond holes at the time of construction. The bonds at the expansion joints are four in number, of the same cross-section as those at the fixed joints, but all four are fixed in the flange of the rail. These bonds are also made of "flat wire."

The fishplates at the expansion joints are of special design, and properly slotted to provide for any change of length which may take place in the 300ft. section. This system of bonding is carried out on both the third and fourth rails. The terminals of all the bonds are of solid copper, and are expanded in the bond holes by means of screw or hydraulic compressors.

The formal inauguration of the electrically-equipped line took place on March 22nd, and on April 5, a start was made with a portion of the regular passenger traffic. After running for a week with a few trains experimentally sandwiched in between

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steam trains, it was decided to postpone the opening of the whole electrically-operated service for a few days to allow of final adjustments being made to machinery in the power station. The reports in the daily papers as to a subsidence having occurred at the power house are entirely without foundation. The institution of a complete service of electric passenger trains between Liverpool, Southport and Crossens will be commenced in a few days, and we may confidently prophesy complete success for the pioneer piece of main-line "conversion" work in this country.

SINGLE-PHASE MOTORS.

(Concluded from page 993.)

Mr. Steinmetz concludes his article with the following discussion of the above theory:—

In the preceding outline of the theory of the repulsion motor, the impedances Z Z_0 Z_1 have been assumed as constant. While this is approximately the case in the ordinary induction motor, it is not the case with the repulsion motor which works over a wide range of magnetic flux densities. With increasing load, and thereby increasing current and decreasing speed, magnetic saturation is approached and causes a decrease of the impedances Z Z_0 Z_1, which has to be taken into consideration in predetermining the characteristic curves of such a motor. Furthermore, the different component magnetic fluxes are affected differently by saturation. The flux M interlinked with the primary coil is approximately constant and, therefore, affected by saturation only indirectly, while the flux M_1 at

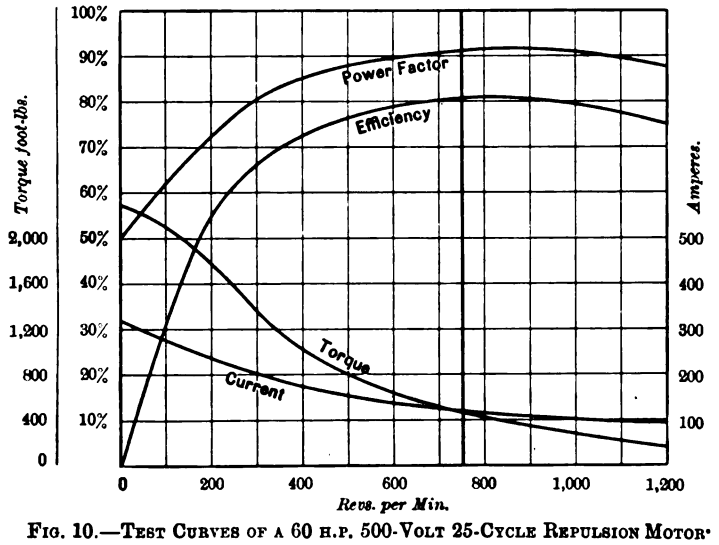

FIG. 10.—TEST CURVES OF A 60 H.P. 500-VOLT 25-CYCLE REPULSION MOTOR.

right angles to the line of polarisation of the secondary coil is approximately proportional to the load, and so reaches saturation at high loads, and the impedances become thereby different in the different directions of the magnetic structure.

The magneto-motive forces in the preceding have been treated as vector quantities, independent of their distribution around the periphery of the armature. This distribution, however, is different with the different magneto-motive forces. The magneto-motive force causing the effective flux M_1 is due to a zone of the primary winding within the angle $\pm \omega$ from the axis of the secondary coil, hence nearly a concentrated winding, which gives a flat-topped flux distribution, while the flux M_2 in the direction of the axis of the secondary coil is that of a distributed winding or peaked. For the same magneto-motive force the effective flux M_1 is, therefore, greater than the effective M_2. Taking this into consideration gives the motor somewhat better characteristics than calculated above. Due to the different wave-shapes of the fluxes M_1 and M_2, they are affected differently by saturation. The flat-topped flux M_1 reaches saturation at a much higher value, but then over the whole range, while the peaked flux M_2 shows the effect of saturation at a lower value but then gradually, by a rounding off of the peak. In the repulsion motor it is, therefore, not sufficient merely to consider the resultant magneto-motive forces as vectors but their distribution in the air-gap, and the effect of saturation must be taken into consideration in the calculation and design of the motor.

The secondary circuit of the motor has been considered as the seat of two E.M.F.s induced respectively by the rotation through flux M_1 and by the alternation of flux M_2. These E.M.F.s, however, have no separate existence. At synchronism, for instance, the magnetic field is an approximately uniformly rotating field, and, therefore, no E.M.F. is induced in the armature conductors except that required to overcome the resistance. The secondary frequency varies with the load, and thereby the secondary self-inductive reactance which we assumed as constant in the preceding discussion.

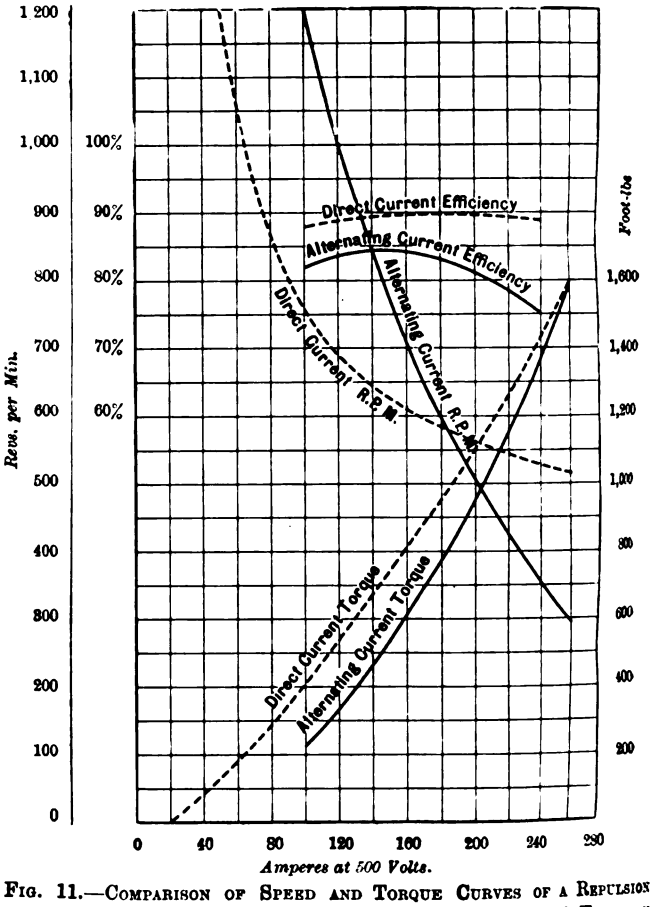

FIG. 11.—COMPARISON OF SPEED AND TORQUE CURVES OF A REPULSION MOTOR AND A CONTINUOUS-CURRENT SERIES MOTOR, 500 VOLTS ON EACH. THE EFFICIENCIES INCLUDE GEAR LOSSES.

The complete investigation of the repulsion motor must also take into consideration the current flowing in the armature coil during the moment when the coil is short-circuited by the brushes. The magneto-motive force of this short-circuit current of commutation is at right angles to the axis of secondary polarisation of current I_1, hence has the angle of brush-shift $-(90-\omega)$. A corrective term must, therefore, be applied, taking this phenomenon into consideration, essentially of the character of a repulsion machine with negative or generator brush-angle of $(90-\omega)$ and very high effective secondary resistance. This term is very small or negligible at speeds up to a point somewhat beyond synchronism, but becomes noticeable at speeds considerably above synchronism, due to the decrease of the main current at these speeds.

Mr. W. I. Slichter read a Paper on repulsion motors at the same meeting as that at which Mr. Steinmetz's Paper was presented. He gave curves, partly from test and partly from calculation, of motors with air-gaps of $\frac{1}{8}$in. or more. As the speed decreases the current increases rapidly, producing a tendency to spark, but with the reduced voltage at starting the rush of current is limited to values within the range of good commutation. At higher speeds, above $1\frac{1}{2}$ times synchronism,

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the frequency of commutation becomes high and sparking appears. The motor of Fig. 10 will start with 75 per cent. of full voltage and twice full-load current with no trouble from sparking. The ability of the repulsion motor to commutate successfully on over-loads is better than that of the continuous-current series motor; this is due to the short-circuited commutator which makes flashing over impossible. Fig. 11 refers to a later type of repulsion motor with steep

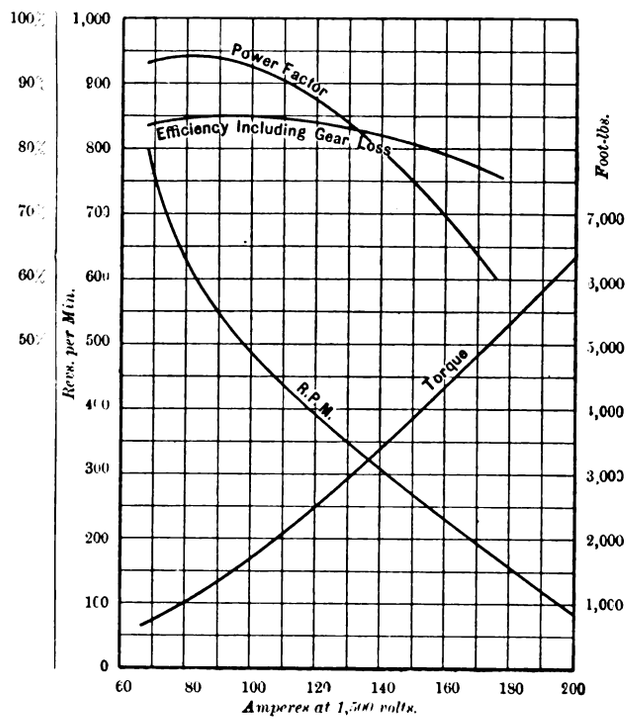

FIG. 12.—CALCULATED CURVES OF A 175 H.P. REPULSION MOTOR AT 1,500 VOLTS. AIR-GAP 0·15IN. 25 ∿ PER SECOND.

speed characteristics for acceleration work, while the motor of Fig. 12 is designed for constant speed running and has not such steep curves, but better constants at light loads. The dotted lines in Fig. 11 refer to a standard continuous-current series railway motor. Fig. 13 represents the acceleration curves from the test of a 25-ton car equipped with two 60 H.P. repulsion motors, the full lines indicating the repulsion motor characteristics, and the broken lines those calculated for a

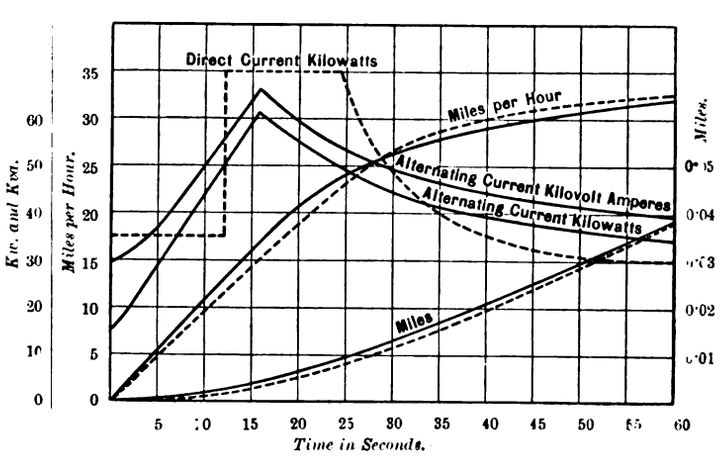

FIG. 13.—COMPARATIVE SPEED-TIME CURVES OF A 25-TON CAR, WITH REPULSION MOTORS AND DIRECT-CURRENT MOTORS.

continuous-current equipment. For the continuous-current motor the curves of kilowatt input, miles per hour and miles travelled are given as calculated, and for the alternating-current motor the kilovolt-ampere input, kilowatt input, miles per hour and miles travelled are taken from tests. The repulsion motor remains on the controller 16 seconds and the continuous-current motor 25 seconds. At the end of 25 seconds the total kilowatt-hour input of the two cases is 0·375 for the continuous-current and 0·30 for the alternating-current equipment. At the end of 60 seconds both cars have travelled a distance of 0·039 miles and have reached practically the same speed of 32·5 miles, the kilowatt-hour input being 0·72 for the continuous-current and 0·685 for the alternating current motors. The curves also show a smaller volt-ampere input at starting for the alternating-current equipment.

REPORTS OF MOSELY EDUCATIONAL COMMISSION.

The joint and individval reports of the Mosely Educational Commission which proceeded to America in October, 1903, have just been issued, and occupy a bulky volume of 400 pages. Particulars of the Commission were given in *The Electrician*, Vol. LI., p. 727. It will be remembered that Mr. A. Mosely, C.M.G., organised the inquiry and bore the entire expense. In his preface to the report Mr. Mosely says that, looking into the future of our own country, he feels bound to record his belief that the *regime* of the past, however successful it may have been, is obsolete.

Honesty, doggedness, pluck and many other good qualities possessed by Britons, though valuable in themselves, are useless to-day unless accompanied by practical, up-to-date scientific knowledge, and such knowledge only becomes possible with an enlarged and enlightened system of education, such as the United States possesses. I feel that if we are to hold our position as the dominant nation—or one of the dominant nations—of the world, we cannot afford to lag behind in educational matters as we are now doing.

Referring, then, to the scholars in American schools, he remarks that they are taught to be self-reliant, and, as a consequence of their individuality and reasoning powers being fully developed, they make up their minds at a comparatively early age to "carve out a career for themselves." But Mr. Mosely does not claim to be an educational expert, and he therefore occupies but a very few pages of the report himself.

In the joint report, signed by the members of the Commission, it is held that in America a very close connection is being established between theory and practice, and that experts in various branches of knowledge are held in high esteem and are in constant demand. Attention is also called to the liberality which is displayed by both public and private donors on behalf of education.

Of all the reports made by individual members of the Commission perhaps none is so eloquent and explicit as that of Prof. Henry E. Armstrong, F.R.S., who visited New York, Baltimore, Washington, Cleveland (Ohio), Buffalo, Ithaca (Cornell University), Boston, Yale and Middletown (Conn.), in addition to which, six years ago, he visited America and saw much of the scientific work carried on there. He finds it difficult to evaluate the part which school education plays in the United States and thinks that American "cuteness" would seem to be governed rather by environment than by education. ". . . the conditions have always been such as to develop enterprise and to stimulate individuality and inventiveness. . . . Moreover, success has given them belief in themselves and leads them to trust themselves." Turning next to the question of universities, Prof. Armstrong says that what has recently counted as university education here is almost unknown in America, but that provincial universities, such as are now being established at Manchester, Liverpool, Birmingham and other places, are already developed to a considerable extent in America and are advancing with great rapidity. On the other hand, the erection of technical schools is only just beginning and evening classes are practically unknown. After dealing with the common schools and elementary education at some length he then states that, in connection with public high schools the teaching of mathematics and science is far behind that administered in the best English schools. No proper foundation for such work is laid in the elementary schools, and the academic, instead of the practical, methods of teaching science still prevail. With reference to school management, Prof. Armstrong thinks that the Americans do not seem to have settled any more than we have what are the

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elements of a rational course of school study. In colleges and universities it appears to be the rule to give a liberal education rather than a professional training. Complaint is made that students enter college ill-prepared to do the work and those who have been brought up in towns are not so satisfactory as those who have been brought up in the country. English composition is taught in a large number of colleges and Prof. Armstrong is of the opinion that English colleges might introduce an element of literary study into their engineering courses, but if this is done an endeavour should also be made to correlate the literary work very closely with the practical work. Although supposed to be very practical people, the Americans devote a long period to study which leaves the student at an age bordering on 30 when he has completed his training. Over-teaching seems to be the bane of American schools, and there is grave danger that the work of education may be over-organised.

It would almost seem that higher education is being given mainly in the interests of those who are to occupy secondary positions. The industrial leaders in America, it is said, are mostly men who have not enjoyed the so-called advantages of a liberal education. They are men with minds unfettered by the traditions which education, as now given, is only too likely to impart, yet trained in the world of experience, possessed of common-sense. But there are exceptions which show that training in scientific methods may be of advantage: a number of the men now at the head of the metallurgical industries commenced their career as chemists—not as engineers, be it noted. The entire system of education, both here and in America, seems to require reconstruction from bottom to top: it would be well, if I might say so, if we could scrap the whole wretched academic show and start afresh, in order that it may be greatly improved in quality and shortened in duration. Two ideals should be kept in view we should aim at the development of individuality and encourage productivity. . . We need to introduce broader and more philosophical conceptions into our educational practice: it is almost impossible to keep pace with the growth of knowledge and absurd to add perpetually to the burden imposed upon the student. Moreover, it is unnecessary. If more attention were paid to teaching principles and their application, less to mere facts, many of the difficulties with which the student's path is now strewn would disappear and he would do effective work; our higher education is unfortunately afflicted with the disease of fact-megalomania; if the meaning of one-tenth of the facts we now lay before the student were properly taught the remaining nine-tenths might safely be jettisoned.

Although much attention has been devoted to research work of late years in America, Prof. Armstrong is of the opinion that it is not yet rated at its proper value, and those who are engaged in the work by no means enjoy the esteem they deserve. Work which has no commercial aim or value is not easily recognised as important. Regarding England:—

Something must be done to create a public belief in the value of knowledge, which will lead us to co-ordinate our scattered efforts. So long as our outlook is merely insular the future may appear to afford little promise; but if we consider the possibilities the Empire affords, there is no reason why our outlook should not be as hopeful as that of the United States. . . . Until higher ideals prevail and sober calculation takes the place of a somewhat emotional and superficial consideration of its problems, it will be difficult to introduce reforms. Here our difficulty is to break through academic, conservative traditions and to arouse an interest in education; that in reality it is the most important of all subjects to be seriously considered has never yet been made clear to us either by preacher or politician—the message awaits delivery, and we need more than anything else the man to make it heard.

The next report is by Prof. W. E. Ayrton, and is of special interest to our readers, since it deals exclusively with the education of the American electrical engineer. Prof. Ayrton is of the opinion that, as far as the training of the young electrical engineer is concerned, the United States are, on the whole, distinctly ahead of Great Britain. He formed this opinion because he saw that there existed a close bond of union between the industry and the teaching, and not because of superior laboratory equipment. Indeed, in New York, he found no electro-technical laboratory comparable in equipment with what may be seen in more than one London teaching institution. All the different engineers with whom he discussed the matter were of the opinion that "an engineering apprentice in a factory should be a colleged-trained man; an engineering professor in a college should be actively engaged in the practice of his profession." The Westinghouse Company at Pittsburg pay their apprentices, of whom they have about 150 and who must be first-class graduates of leading technical schools, 16 per cents. per hour during the first 2,808 hours and 18 cents. per hour for the second 2,808 hours, but many of them are earning £30 per month before they have been with the company nine months. Two of the chiefs of the staff visit all the principal universities, colleges and technical schools throughout the United States every year for the purpose of seeing students and choosing those most suitable to work with the Westinghouse Company. Similar conditions prevail at the Schenectady works of the General Electric Co., and at this place there is a college of long standing called Union College, at which lectures are given alternately by a member of the Faculty and by a member of the General Electric Co.'s staff. These lectures are open to all whom the Faculty considers suitable, but they are attended mainly by students and draughtsmen of the company. The Union College students have the free run of the General Electric Co.'s factory, which, with its 10,000 workmen and 6,600 H.P. combined turbines and dynamos in construction, &c., is practically a huge laboratory and lecture theatre. It appears to be a very common practice of manufacturers in America to loan large quantities of modern machinery to colleges, and frequently it is made a free gift. American engineering education is exactly what manufacturers desire, and that is one of the reasons why it is so successful.

It is not given by teachers, the terms of whose appointment divorce them from industry, by men who perhaps even learn to look down upon the manufacturer, the engineer, the manager, and the salesman, although these people are actually occupied in practising that very application of science to industry which the teacher preaches. No, engineering education in America is directed by those who are doing the engineering work of their country. There is no question about an engineering professor in America being *occasionally permitted* to do a small amount of outside work, he is practically *required* by the college authorities to be so actively engaged in practice that he becomes recognised in the world of affairs as the working authority on his subject.

Prof. Ayrton mentions an ingenious suggestion made by Mr. Walter C. Kerr, president of Messrs. Westinghouse, Church, Kerr & Co. Mr. Kerr has suggested to President Schurman of Cornell University that certain of the engineering chairs should be occupied by two professors who would serve alternate terms of two, three or four years each in the university and out in practice. This, it is thought, would overcome any tendency to become academic. The staff of the Stevens Institute Department of Tests is permitted to carry on any outside work in the Institute's laboratories, and may retain all but 10 per cent. of the fees received. The extra remuneration, of course, increases the income of the staff, and this is very desirable, as, allowing for the different value of money, teachers' salaries are often not higher in America than n England.

In America much less importance is attached to examinations than in Great Britain. Whether a student is worthy of a degree is left to the decision of his professors, without the intervention of outside examiners. They are greatly influenced, they told me, by their estimation of the value that the student would be to the world. On the other hand, America's judgment of a professor is based on his power of attracting students, on the demand shown by the industry for the men he turns out, and generally on the name he makes for his college.

There is apparently some difference of opinion as to whether 24 or 25 is not too advanced an age for a student to enter works after having completed his college training, but it must be remembered that American students, while at college, take part in outside work under practical engineers who are their college teachers, and that they are in a position to take special advantage of the works training. Many students who do not leave college until they are 24 or 25 years of age succeed in obtaining responsible positions before they are 30. Education is immensely valued in America, and large sums are contributed ungrudgingly by the public to its support. Prof. Ayrton is also under the impression that organisation is a marked feature in American undertakings; at one university the engineering teaching is sub-divided between several professors, each giving instruction in his particular branch, and, therefore, being able to keep his thoughts on one line of development.

Since want of funds will probably render it impossible for even the most important colleges in London to have a separate professor for each branch of electrical engineering, it is extremely important that all the chief London professors of that subject should be gathered together in one spot, and provided with an adequate staff and equipment, so that each may devote himself to the efficient teaching and development of a definite branch of the subject.

American educational authorities think that post-graduate students should work in the same buildings and under the

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same teachers with ante-graduate students, and all should be encouraged to develop creative faculties. The English student is apparently more scholarly and well-read than the American student, but the latter "has his knowledge in a better form to apply." In conclusion, Prof. Ayrton says:

The British system turns out a man full of knowledge and principles, while the American product is a business man with a scientific training. The characteristics of each nation have their advantages. To America we look for that rapid, bold and successful application of science to industry which has brought about the commercial invasion of the world, while to Europe we look for those scientific imaginings and creations which are apparently so unimportant to-day, but which to-morrow revolutionise old industries and give birth to new ones.

Mr. Robert Blair, assistant secretary for technical education in the Department of Agriculture and Technical Instruction, Ireland, in his report states that English evening technical schools are far in advance of anything of the kind in America, and he quotes statistics to substantiate his statement. After reviewing the conditions of engineering and other education in America, Mr. Blair concludes by setting forth, as his opinion, the three following principles:—

1. That the problem of technical education is not a side issue, but an integral part of the problem of education.
2. That the solution of the problem of technical education, as of that of education, will be partial and incomplete unless the problem is attacked from the psychological as well as from the industrial and commercial point of view.
3. That the establishment of a close connection between institutions for technical education on the one hand and industrial and commercial organisations on the other is an essential factor in a successful solution of the problem of technical education as of that of industrial and commercial progress.

Prof. T. Gregory Foster thinks that the American university professor is a more "live being" than the university professor of leading European countries, and, as a consequence, his influence upon the lives of his students is more direct. His attitude towards his students is that of a co-worker, not that of a dictator.

The American system of education requires elaborate daily care and the guiding, watching, and recording of students' progress, but that care probably does not involve a greater expenditure of energy than the organisation of the unwieldy examination system of this country. Moreover, as it is spread over a large period it cannot involve the terrible weariness that is brought about by the British system. From the point of view of the student, I have no hesitation in saying that the result is far better. When the American scheme is well carried out it ensures continuous and steady work. It makes "slacking" impossible, and thus prevents waste of time during some of the most critical and valuable years of a young man's life. The influence on the teacher is no less salutary; the American teacher thinks of his functions as a teacher and director of studies, while the British teacher is driven by force of circumstances to conceive and direct his work entirely in terms of examination. As long as examinations control the teaching, whether in universities or schools in this country, so long will the teaching continue to be academic in the worst sense of the word—cribbed, cabined and confined. From what I saw in America, I am convinced that in the free system of teaching that exists there, even the weak teacher gives stronger guidance to his pupils, and produces better educational results than he does here. The reason of this is obvious when we consider that in the American system the teacher is judged by the standard that he makes for himself, while with us the teacher has a standard imposed upon him by the external examining body, which is almost inevitably a standard that tests whether the pupils have obtained the information to be found in certain prescribed books. For the English teacher with a prescribed amount of work to be got through in a certain time, whether such work is suited to the ability of the class or to the teacher's powers, life is a continual rush. There is no time to deal in educational fashion with the mistakes of his pupils; they are simply told that they are wrong and one of the others is set to put them right. For the American teacher, life is in comparison a leisurely one. He makes as much, if not more, educational value out of the blunders of his weaker pupils as out of the correct answers of the stronger ones. He cares for the development of his class as a whole, and not mainly for that of those who will do him the most credit in answering the questions of an outsider. The degree to which examination by external bodies or examiners is regarded as baneful, both to the pupil and for educational organisation, is shown by the fact that it only exists for the purposes of professional qualifications in certain States and for the purposes of admission to universities and colleges in certain other States.

A striking feature of American universities is the strange mixture of rich and poor students. Many of the latter act as relief men from 6 p.m. to 8 p.m. on the trolley cars, others are waiters in hotels, while yet others, in universities which possess a common hall, wait upon their more fortunate brethren.

In conclusion, I may remark that the educational organisations of the United States are practically in their infancy. That they are already doing a great work for the country there can be no doubt; that they possess many of the defects of youth there can equally be no doubt; that they also possess characteristics of strength, I have already shown. Among these characteristics, those which specially augur well for the future are the freedom of the teacher and the taught—a freedom which makes it possible to try experiments, and while it allows the man who is better suited for doing so stick to the beaten path, yet enables the daring explorer to find his opportunity. These things, combined with the great hopefulness that naturally possesses a people living in a vast country, the resources of which have only just begun to be developed, make the possibilities of the nation almost limitless.

Mr. W. P. Groser, who was nominated by the Parliamentary Industry Committee, has written a lengthy report of 23 pages in length, and deals chiefly with the aspect of engineering education in America. He is of the opinion that the apprenticeship system is a bad one, and that it is being replaced by the development of professional schools. The industrial advantage of the United States over Great Britain lies in the attitude of the American people, and especially of the manufacturers and employers, towards commerce, employés and education. We are behind our American cousins in neither methods of construction nor in facilities for education, but English manufacturers have the remedy in their own hands, and they must spare no cost in finding out what is being done both at home and abroad. They must realise that in high positions the highest education is essential.

Prof. Magnus Maclean, F.R.S., calls attention to the fact that the present highly-developed educational system of America has only come into existence within very recent times. Further, inventors and others who mark out a new line are often found to be men of foreign blood. The history and environment of Americans have also had much to do with their characteristic alertness and energy. America, however, is still in a stage of transition so far as her educational aims and machinery are concerned, but more than we, she takes account of the changed conditions in which men live to-day, and seeks to adapt her training to the current need. Moreover, American employers appreciate the advantages to be derived from education, whereas English employers are apt to treat learning with a certain amount of scorn. Students in the United States are not in such a hurry to get started as in this country and they are, as a rule, better prepared for the work. In many instances the laboratories are over stocked with apparatus, but good teachers are obtained for small salaries owing to the laboratories being placed at their disposal.

Mr. W. Ripper, in discussing American secondary schools, observes that they are far in advance of those in this country, and that the students entering technical colleges are much better prepared for their work. It is in the direction of secondary education that the English system is deficient.

The reports by other members of the Commission are all interesting to those intimately concerned with education, but space only permits us to review those which deal with matters having a more or less close connection with electrical science and engineering. We are asked to state that a complete copy of the reports, bound in book form may be obtained for 1s. (post free 1s. 4d.) from the Co-operative Printing Society (Ltd.), Tudor-street, E.C., while educational authorities may obtain free copies by forwarding the cost of postage and stating qualifications.

EDDY CURRENTS IN CABLE SHEATHS.*

BY M. B. FIELD.

It is now generally recognised by engineers that single-core cables designed for carrying alternating currents of any magnitude cannot be laid in separate iron pipes, owing to the strong alternating magnetic field which will be created in the mass of the pipe by the current, and the hysteresis and eddy-current losses consequent thereon. On the other hand, it is considered quite permissible to lay concentric or three-core cables (for three-phase currents) in iron pipes or troughs, for wherever there is included in the same cable both the "go" and the "return" conductors so that at every instant the algebraic sum of the currents within the pipe or trough flowing in either direction is zero, there cannot be any closed magnetic lines entirely surrounding that cable created by the currents within

* "A Theoretical Consideration of the Currents induced in Cable Sheaths, and the Losses occasioned thereby." Paper read before the Institution of Electrical Engineers last night.

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it—a statement often otherwise expressed by the words that the line-integral of the magnetic force taken round any closed path whatever entirely surrounding the cable is zero.

As an example we may mention a case that came under our notice some little time since, where three cables of ample cross-section carrying alternating three-phase current of from 600 to 1,000 amperes per phase, the frequency of which was 25, were laid through short lengths of wrought-iron pipe 3¼in. inside and 3¾in. outside diameter. The temperature of the pipes soon rose to such a degree as to endanger the insulation of the cables, and it was quite evident that the seat of the generation of the heat was in the iron and not in the cable. These cables were subsequently withdrawn, and a three-core cable drawn into each pipe. The corresponding cores were connected in parallel at each end, with the result that the iron pipes remained quite cool under full load conditions.

Similarly, although two single-core cables for a single-phase system cannot be laid in separate pipes for the reasons explained, they may be laid in the same pipe or trough without fear of engendering very serious hysteresis or eddy-current losses in the iron.

This, however, does not in the least imply that there is no external magnetic field produced by a three-phase current in a three-core cable; indeed, a very considerable field may exist giving rise to telephonic disturbances in neighbouring circuits, eddy currents in the lead sheath or iron pipe itself, and even earth currents. Similarly, if the "inner" of a so-called concentric cable be not truly concentric with the "outer," an external field will result, while if several concentric or three-core cables be connected in parallel at both ends, and for any reason the resistance of one conductor be unduly increased (*e.g.*, through a bad connection) so that the algebraic sum of the currents included in this cable is not zero, not only will an external field exist, but there will be magnetic lines entirely surrounding the cable in question giving rise to losses if laid in an iron pipe.

In this connection we may call attention to a clause in Messrs. Constable and Fawssett's recent Paper read before the Institution of Electrical Engineers, where, in speaking on concentric cables, they say (Vol. XXXII., p. 721)*:—

> The fact that an external field exists round these cables is proved by the humming noise produced in the telephones connected to pilot wires laid parallel and close to the cables; that this noise is not due to leakage entirely is shown by the fact that it is slight during times of no load and very loud at times of heavy load.

In this communication we shall consider the external fields produced near single, concentric, three-core cables and the like, and investigate the losses occasioned thereby. We shall in every case consider the conductors to be of circular cross-section, and the currents in the same to be distributed either uniformly over the section or at least as a function of the radius from the centre of the section only (a distribution which I here describe for brevity as "cylindrical").

At first sight it may seem that this is an unwarrantable assumption in the case of cables containing an unsymmetrical arrangement of conductors. In such cases the mutual induction between the different cores will tend to disturb the otherwise uniform or cylindrical distribution of the current in each core. It must, however, be remembered that each core is built up of a number of strands laid together with an axial twist, so that all the strands forming any one layer successively pass through exactly similar positions with regard to the other cores. This, then, helps largely to maintain the uniform or cylindrical current distribution; indeed, when we think that in order for any other distribution to occur current would have to be continually passing from strand to strand, and remember the small area of contact and small differences of potential between contiguous strands, any apology for our assumption seems unnecessary. At the end of Appendix II. we indicate how the losses in cable sheaths enclosing cores of cross-sections other than circular may be dealt with. There is no intrinsic difficulty in such calculations, but the method is undoubtedly somewhat laborious.

The following theorems which we here merely enunciate, and which will be found discussed at length in text-books dealing with the subject, form the basis of this Paper:—

(1) The magnetic force at any external point due to a current flowing longitudinally in an infinite straight cylindrical conductor (or hollow cylinder) is the same as if the whole current were concentrated at the axis. The magnetic force is expressed by $2C/r$, where C is the current in C.G.S. units, and r is the distance of the point in question in centimetres from the axis.

(2) The line integral of magnetic force taken round any closed path surrounding a conductor carrying a current, C, is $4\pi C$.

(3) The total number of lines which have cut through or enclose any element of length (reckoned parallel to the conductors) due to any system of straight parallel conductors is equal to the algebraic sum of the lines due to each conductor taken separately which would surround the element in question, if it existed independently of the other conductors.

(4) No field exists in the interior of a hollow cylindrical conductor due to a longitudinally-flowing current.

If we consider a long straight single-core cable carrying an alternating current we know that the magnetic field naturally spreads out into space in the form of concentric circles, unless it penetrates a portion of space of varying magnetic permeability, in which case the magnetic lines will tend to concentrate along the path of lowest magnetic reluctance, giving rise to a general distortion of the magnetic field distribution from that of concentric circles.

Take the case of a cable laid in and lying at the bottom of an iron pipe. The greatest proportion of the magnetic field produced will follow circularly round inside the iron of the pipe, as shown by the dotted line, since this is the path of lowest magnetic reluctance; but there will also be some magnetic lines both inside and outside the pipe. Now, if c be the current in amperes in the cable, $4\pi c/10$ is the line integral of the magnetic force taken round the dotted line, and this, multiplied by the permeability and divided by the length of path in centimetres, gives the induction in C.G.S. measure inside the material. As an example, suppose the cable be carrying a current of 1,000 amperes, and the pipe have a mean diameter of 3½in. and a thickness of ¼in., the mean length of the magnetic path inside the iron will be 28cm. This magnetising force will be sufficient to bring the iron to a very high degree of saturation; if wrought iron, the induction will be in the neighbourhood of 16,000 lines, or if cast iron, 7,000 lines per square centimetre, while a current of only 140 amperes would be sufficient to produce an induction of 10,000 lines per square centimetre in wrought iron.

If now we assume that the current in the cable is alternating, having an effective value of 100 amperes, the magnetisation inside the pipe will likewise alternate with the same frequency. In this case, however, as we shall see later on, there will be induced in the pipe currents flowing longitudinally along the inner surface and back along the exterior surface. These currents will have the effect of choking back the magnetisation in the interior of the pipe-wall, and may even reduce it to zero in the centre, but will leave it unaffected at the interior and exterior surfaces. If, however, the pipe be so thin that its electric conductance be very low, the induced currents will not have a very great choking effect, and the induction will then reach the full value above indicated, and be practically constant over the cross-section of the pipe. The hysteresis loss with a maximum induction of 10,000 lines per square centimetre at a frequency of 50 ∿ per second in wrought iron is of the order of 1kw. per cubic foot. If the pipe be thicker, so that the induction be not sensibly constant over the cross-section, the hysteresis loss will be less, but to this we must add the eddy-current loss, which will then assume serious proportions. We shall refer to this subject later on.

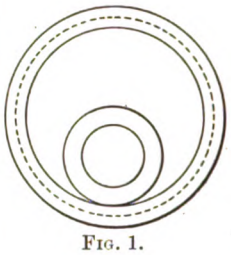

Fig. 1.

In the lead sheath of the cable, hysteresis losses do not, of course, occur, and we will now turn our attention to the eddy-current loss which does take place in the lead. If we consider the lead sheath as a number of longitudinal strips or wires arranged contiguously, we see that as the magnetic field spreads out into space in expanding circles each magnetic line of force cuts normally across each strip, generating therein a longitudinal E.M.F. If the cable be laid direct in the earth (so that no appreciable distortion of the magnetic field takes place), it is obvious that the longitudinal E.M.F. at all points around any circumference will have the same value and phase relation.

In order to get an exact idea of what takes place, let us consider the cable as laid on the solid system, the sheath being insulated in a bitumen trough, then we see that an alternating difference of potential will exist between the ends of the lead sheath, but practically no currents will flow along the sheath, as there will be no closed circuit. If now both ends of the sheath were effectually grounded, a return circuit would be afforded by the earth, and alternating earth currents would flow between the ends, spreading out to a great distance sideways in all directions. As a matter of fact, this case cannot actually occur in practice, because there must of necessity be a return conductor somewhere, and the earth currents this would give rise to would, to a large extent, neutralise those of the first conductor. If we consider a single conductor by itself as carrying current, we get landed in considerable difficulties, because we find mathematically that the sum total of the magnetic field throughout space is infinity, giving rise to an infinite longitudinal E.M.F. in the lead sheath, and requiring an infinite P.D. between the ends of the cable before any appreciable current could be caused to flow.

The reason of this seeming paradox is as follows:—If we do not consider the effect of the return conductor, we are really assuming

* *The Electrician*, Vol. L., p. 906.

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that it is lying at an infinite distance—*i.e.*, we are considering a circuit of infinite area; but we know that if such a circuit were possible, the coefficient of self-induction of the same would be infinite; in other words, the total magnetic flux interlinked with the circuit due to any finite current would be infinitely great.

We will therefore consider a more practical case—viz., a circuit made up of two long lead-sheathed cables lying parallel to one another. Let us picture them again as laid in bitumen troughs, and suppose the two sheaths connected together at either end. Clearly the E.M.F.s induced in the two lead sheaths will be in opposite directions, so that now we have a closed circuit in which the sheath currents can circulate.

It will be observed that we have practically an air-core transformer, both primary and secondary having but one turn. If now

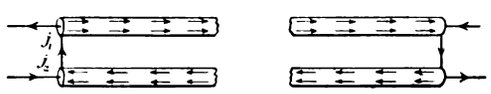

FIG. 2.

we can calculate the induced E.M.F. per unit length in the sheath, it will be a simple matter to determine the total loss in this secondary circuit.

If v = E.M.F. per centimetre length of sheath (in volts),
ρ = specific resistance of sheath (in ohms),
a = cross-sectional area of sheath (in centimetres),
l_1 = length of both cables together (in centimetres),

the total loss will be $\frac{v^2}{\rho} a l_1$ watts

If the cables be laid direct in more or less conducting soil it would seem at first sight as if the currents would leak across from sheath to sheath through the soil and thus render the problem indeterminate. This, however, is not the case, for if any two points on the sheath be at zero potential, and the same E.M.F. per unit length be induced at all places between these points, the current will adjust itself so that the drop per unit length equals the induced E.M.F. per unit length, and there will be no variation of potential along the sheath. This is the case we have above: we know that the points j_1 and j_2 are at zero potetial, therefore, the whole sheath will likewise be, and no currents will leak out into the earth. A proof of this theorem, if proof be needed, is as follows:—

Let j_1, j_2, j_3 be any uniform conductor, immersed in any medium of variable conductivity, and let the points j_1 and j_3 be at the same potential. In each unit of length is induced the E.M.F. v; c is the current at any point of the conductor; then considering any element $\hat{c}l$, the rise of potential along it will be $\hat{c}v_1 = v\hat{c}l - c\omega\hat{c}l$, ω being the resistance of unit length.

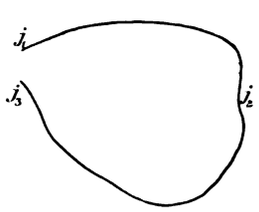

FIG. 3.

Integrating from end to end of the conductor, we have $vl_1 = \omega \int c dl$, where l_1 is the total length of the conductor.

Now, the power generated in the conductor is $\int vc dl = v^2 l_1/\omega$, but the power expended in the conductor is $\omega \int c^2 dl$.

Now $$c = \frac{1}{\omega}\left(v - \frac{dv_1}{dl}\right),$$

hence power expended is

$$\frac{1}{\omega}\int\left(v - \frac{dv_1}{dl}\right)^2 dl = \frac{v^2 l_1}{\omega} + \frac{1}{\omega}\int\left(\frac{dv_1}{dl}\right)^2 dl - \frac{2v}{\omega}\int dv_1.$$

Now, the last term is zero, and unless dv_1/dl be zero at every point along the conductor, the second term has a positive value. But a positive value would imply that the ohmic loss was greater than the total power generated in the cable. It follows, therefore, that $(dv_1/dl) = 0$ at every point—*i.e.*, there is no variation of potential along the conductor and, therefore, no currents can leak out into the surrounding mass.

(In Appendix I. we consider the case of the E.M.F.s induced in the walls of an iron pipe. These E.M F.s are longitudinal, having the same value for all points equidistant from the axis, but differing in magnitude and phase for points at different distances from the axis. From the above it follows that if the ends of the pipe are at the same potential longitudinal currents will flow, so that at every point the drop is equal to the induced E.M.F., and, therefore, all planes normal to the axis are not only equipotential surfaces, but all these surfaces are at the same potential.)

We have, then, a very simple rule for calculating the sheath loss (provided we know the induced E.M.F. per unit length), our rule being independent of the conductivity of the soil; it being only necessary to assume that the sheaths are connected together or well grounded at either end. Our rule is, the loss equals V^2/R, where V is total E.M.F. induced in the whole lead-sheath circuit, and R is the resistance of the same.

Before, however, we are in a position to calculate the actual E.M.F.s induced in the lead sheaths per centimetre length, we must make some assumptions *re* the conductivity of the soil in which the cables are laid. We must not lose sight of the fact that longitudinal E.M.F.s will be induced in all paths through the earth parallel with the cable along which earth currents will flow whose magnitude will depend on the conductivity of the soil, and that these earth currents will exert a choking back tendency preventing the free propagation of the magnetic field into the medium. For instance, if the cables were laid in a surrounding medium of perfect electrical conductivity, no magnetic field could penetrate into it, and therefore no E.M.F.s would be induced in the cable sheaths.

In the case of dry earth, on the other hand, the conductivity is extremely poor and the induced E.M.F. at any distance from the cable small. Then, again, these earth currents, owing to the high resistance of their paths, will be in quadrature with the currents in the cable cores producing them, and their effective reaction will be very small. We shall, therefore, in this investigation neglect the choking effects of these earth currents, and may say that our results will represent the higher limit—that is, the actual losses will, if anything, be somewhat less than those calculated. While for dry earth the error caused by this assumption will probably be negligible. the results obtained would quite possibly be wholly incorrect for such a case as a cable circuit laid in deep sea water.

We come now to the consideration of two lead-sheathed cables whose centres are separated by distance b, the mean radius of sheath in each case being a. At the moment current is going down the core on the right and coming up that on the left, let us consider the number of lines of force that cut across or enclose the point j. If we travel along axis XY from j to an infinite distance, the total number of lines due to the current C_2 will be the same as the number due to C_1, traversed in passing from the point j_2 to infinity, but of opposite sign, hence the total effective number of lines which surround the point j is equal to those due to C_1 which cut across the axis between the points j and j_2. This may be determined by a simple integration. Had we chosen the point j_1 instead of j, the

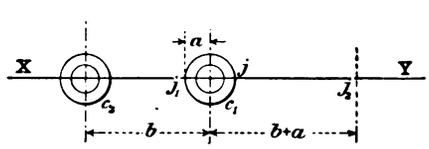

FIG. 4.

number would have been slightly less, but if b is great compared with a the difference will be inappreciable. The actual effect that this will have in our case will be that the E.M.F.s on the inside of the cables will be rather less than those along the outside, giving rise to a variable current density at different points of the sheath.

In any case, if r is the distance of the point in question from the centre of the other cable the total number of lines cut by it will be $0{\cdot}46c \log_{10}\frac{r}{a}$, c being the current in amperes flowing in each core.

Taking an actual case let b=12in., a=0·587in., $\sim$ =60, effective current =200 amperes, then the mean effective E.M.F. in the sheath in volts per mile will be

$$2\pi \times 60 \times 200 \times 0{\cdot}46 \log_{10}\frac{12}{0{\cdot}587} \times 10^{-8} \times 2{\cdot}54 \times 12 \times 5{,}280 = 73 \text{ volts}$$

approximately.

Taking the cross section of the sheath as equal to 0·46 sq. in., and the specific resistance of lead as 21 microhms, the sheath current will be 64·5 amperes, representing a loss of 4·7kw. per mile length of cable.

We have next considered the case of a cable laid in an iron pipe, but in order to avoid the presence of more algebraic symbols than necessary in the body of this communication, we have relegated the equations expressing the various conditions to appendix I. We have not thought it necessary to give the intermediate steps in this Appendix, but would refer those interested to the article of Prof. J. J. Thomson on the "Eddy Currents in Iron Plates," published in the issue of *The Electrician* of April 8, 1892, and to the subse quent issue containing some most important deductions by Prof. Ewing based upon Prof. Thomson's equations. We have compared our equations with those above cited, and though in somewhat different shape, they are in substantial agreement therewith. It is to be noted that the theory given in the appendix only holds good for pipes where the diameter is large in comparison with the thickness, for it assumes that the length of the path of all magnetic lines within the iron is equal to the mean circumference of the pipe. The assumption is similarly made that the total longitudinally flowing current in any hollow cylinder bounded by two cylindrical surfaces co-axial with the centre line of the pipe, whose difference of radius is $\hat{c}x$, is $LA_x\delta x$, where $L = \pi(d+h)$, and A_x is the current density in the hollow cylinder in question. Secondly, we have assumed the magnetisation at every point in the iron is directly

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in phase with the current producing it, or more strictly with the magnetic force existing at the point in question, and that the permeability is constant throughout.

It will be thus seen that the case is by no means a general one—a completely general mathematical solution we consider would be well-nigh impossible, but much valuable information may be gained by considering certain special cases which approximate to the truth.

As a matter of fact, we apply later on the results given in the appendix to the case of an iron pipe whose inside diameter is 3¼in. and wall thickness ¼in. In this case the maximum divergence of the length of the magnetic path from the mean is 7 per cent., hence we must consider the numerical results obtained as only indicating the order of the magnitude of the phenomenon. This after all, however, is sufficient for the purpose of this Paper.

Two cases are considered in Appendix I.: First, when the pipe is laid in dry concrete, so that all induced currents are confined to the pipe itself; secondly, when the pipe is well earthed, so that the ends may be assumed to be at the same potential. In this case the earth affords a return for the currents in the pipe.

Examining the equations deduced, we see that in case 1 the induction is a maximum at the interior and exterior surfaces of the pipe, being due at these places solely to the current in the cable. This is obvious, for since no currents leak out into the earth there must be the equivalent of two concentric current sheets, currents flowing longitudinally in one direction along the interior portion and in the opposite direction along the exterior portion of the pipe. The sum total of the current in each sheet must, moreover, be the same—in other words, the surface integral of current density over the section of the pipe must be zero; hence there can be no magnetic effect due to these currents at the interior and exterior surfaces. They do, however, produce a magnetic effect at the centre of the pipe wall, and this will be a demagnetising effect, so that if the pipe be moderately thick the induction at the centre of the thickness may be reduced to practically zero value.

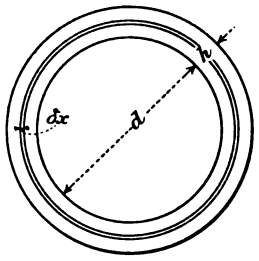
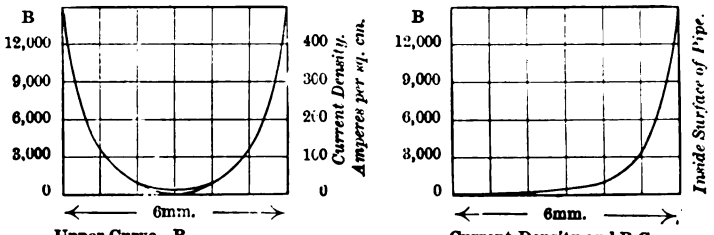


Fig. 5.

Fig. 6 shows the case worked out from the formulæ given in Appendix I. for a wrought-iron pipe as above enclosing an alternating current of 500 amperes at 25 ~ frequency.

The maximum induction reached at different radii, as also the maximum values of the density of the longitudinally flowing currents, are shown independent of their phase relation. The equations show that the phase of both induction and current density is continuously altering as one travels towards the centre of the pipe wall. The current at the inner face is exactly out of phase with the current at



Upper Curve—B.
Lower Curve—Current Density.

Current Density and B Curves practically coincide.

Fig. 6.

the outer face, but the phase of the induction is symmetrical on both sides of the centre of the pipe wall. It the pipe be sufficiently thick,* the total current of each current sheet is equal to the current in the cable provided the magnetisation in the outer and inner skins is not driven too near the saturation point on the magnetisation curve.

Profs. Thomson and Ewing, in the articles above mentioned, show that the eddy currents and magnetisation in iron plates under alternating magnetic forces do not penetrate beyond a certain distance below the surface. See also Fig. 6. The formulæ allow us to roughly calculate the total hysteresis and eddy current loss in the case in question; they are—

Eddy current loss per cubic foot 4·15kw. } For an effective current in
Hysteresis loss per cubic foot 0·125kw. } the cable of 500 amperes.

One cubic foot corresponds in the case we have taken to 55·5ft. length of pipe.

Appendix I. shows us that the magnetic effect within the pipe wall is equivalent to two waves entering into it simultaneously from the interior and exterior, the amplitude of the wave decreasing according to a logarithmic law in the direction of propagation.

The wave-length is $\lambda = 2\pi/m$. In the case under consideration* $1/m = 1/14$cm., hence $\lambda = 4{\cdot}5$mm., and the velocity of propagation radially will be 11·25cm. per second.

For very high frequencies we should expect to find magnetism only at the inner and outer faces of the pipe.

Summing up our deductions in case 1, we may say that in thin pipes we have the magnetic induction which we should expect due to the current in the cable, but in thicker pipes this value of the induction is only found at the interior and exterior surfaces. While, therefore, for thicker pipes the hysteresis loss somewhat decreases, we have to add to this the eddy-current loss, which then assumes serious magnitude. Anyone who is interested can draw his own deductions from the formulæ given for case 2, but enough has now been said to show the importance of avoiding the drawing of even

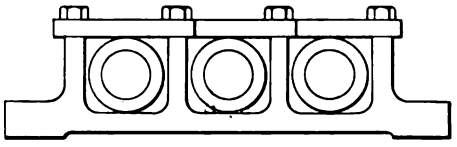


Fig. 7

short lengths of cable through iron pipes (perhaps more on account of the danger to the insulation of the cable than of the amount of the losses). It might be thought from the above that the use of cast-iron cable clamps, as, for example, illustrated in Fig. 7, should be avoided, but we did not find any heating in some we used on one occasion for clamping cables carrying 300 amperes at 25 ~.

(To be continued).

* In considering thicker pipes we must, of course, assume their diameters are correspondingly increased, or the theory becomes quite inapplicable

LOCALISATION OF FAULTS ON LOW-TENSION NETWORKS.†

BY W. E. GROVES.

The remarks which follow refer particularly to a three-wire low-tension network, with the neutral earthed at the generating station or sub-station, through a resistance of 2 ohms. The more closely a network is "netted" the more troublesome it is to localise faults, and from this point of view it is very desirable that each feeder should have its own defined network, and be only linked to other similar networks where necessary for balancing and equalising purposes. In the writer's opinion it is desirable, in addition to the feeder fuses in the station, to fuse at all points where it is found advisable to effect a junction between the networks supplied by different feeders, and generally *at these points only*. The obvious danger of connecting two or more feeders through a distributor without fusing is that in the event of a short circuit or bad fault, the faulty feeder fuse in the station may blow, and the "short" be fed through a small distributor of sufficient resistance to prevent another heavy feeder fuse from blowing immediately, but carrying enough current to overheat it and destroy it. The fuses at the inter-connecting points can be comparatively light, because, if the system is properly arranged, the balancing currents will be small. During summer it is usually no disadvantage to work with many of the linking points open, which provides an excellent opportunity for overhauling the various networks. The neutrals, at points where fuses are inserted on the outers, will of course be connected up solid. By the use of interchangeable blocks it is possible to fuse any line which may become an object of suspicion. A junction box, with interchangeable blocks of three types, is described in Appendix I.

The tests and trials the writer has found convenient are as follows:—

(*a*) Observance of reading of recording ammeter permanently connecting the neutral to earth through a low resistance.
(*b*) Joint insulation test by "Russell's method."
(*c*) Checking polarity of fault by observance of feeder ammeter when "flashed."
(*d*) Detection of faulter feeder by "flashing."
(*e*) Partial localisation by means of "transferring."
(*f*) Location by disconnection to shortest length.
(*g*) Final localisation by induction method.

Fig. 1 shows an arrangement of panels for the ready performance of tests (*a*) to (*e*) inclusive. The somewhat elaborate array of neutral switches is necessary to avoid the inadvertent disconnection of a neutral cable when testing.

(*a*) *Recording Ammeter.*—The reading and recording of this instrument is so far useful that it shows any alteration in the state of the insulation of the mains, and if the reading is

* $\mu = 2{,}000$, $\omega = 25$.

† Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers March 16th.

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considerable renders test (*b*) necessary. Its great weakness lies, as has been many times pointed out, in its readings being differential, and not less in the fact that it may be shunted by a neutral fault. These qualities render it wholly unreliable as an indicator of the state of the insulation of the mains. It is sometimes most useful in showing the nature of a fault (such as a defective motor armature by oscillations of the needle), also the records frequently indicate, by the time of the arrival and disappearance of a fault, whether or not it is controlled by a consumer's switch. If the recording ammeter is reading zero it indicates one of three conditions: (1) That the insulation is absolutely sound, (2) the outers are equally unsound, or (3) the instrument is shunted by a neutral fault. The first case is an imaginary one in stations of any size, the second of very infrequent occurrence, and the last always to be suspected.

(*b*) *Russell's Test.*—This is most convenient for a rapid and frequent test. The formula (vide Mr. Russell's communication, *Journal*, Vol. XXX., p. 326) is $F=(V_2-V_2')/c=(V_2/c)-R$. Referring to Fig. 1, R is the resistance in series with the recording ammeter A (say 2 ohms), so that the test resolves itself into the reading of C on the ammeter L in series with or substituted for A at the time of testing, and a momentary opening of the switch RS to read V_2 on the voltmeter V. For moderately high resistances the value of R may be ignored. V should, theoretically, be of infinite resistance—*i.e.*, electrostatic—but the results of this test are quite sufficiently accurate if any high-resistance voltmeter is taken.

The writer is experimenting with a combined instrument which, if satisfactory, would replace V and L on the panel, Fig. 1. The object of this instrument is to read F directly on an ohm scale when RS is momentarily opened. A diagram and description of the suggested arrangement is given in Appendix III.

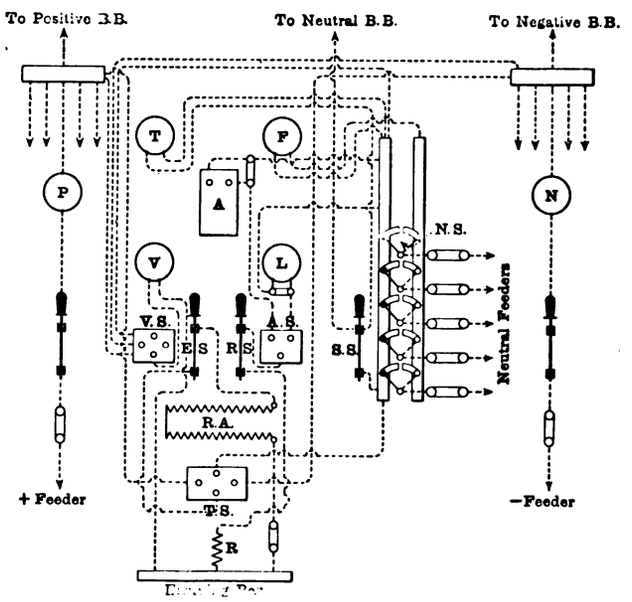

FIG. 1.

If the recording ammeter fails to notify any leakage, and the test (*b*) indicates that the insulation is "down," it is fairly safe to assume that the neutral is at fault, although occasionally a balance may occur. Under these conditions V_2 will be small and RS may be left open while the rough tests (*c*) and (*d*) are made. The opening of the switch RS avoids heavy local currents R and bad sparking at the switches.

(*c*) *Checking Polarity of Fault by "Flashing."*—A central zero ammeter T is provided, which can be cut in to take the total neutral current by opening the switch SS. Watching this instrument until a fairly steady deflection is shown, either of the outers may be connected to earth through the adjustable resistance RA by means of the switches TS and ES. If the neutral is faulty a "kick" will occur on T when ES is closed. It is sometimes necessary to make this trial when most of the motors on circuit are shut down on account of the unsteadiness of the deflection on T. In the case of a balanced fault the neutral ammeter T will be unaffected by this trial, the switch RS being open, and the faulty feeder will be indicated by "kicking" of one of the ammeters, P, N, on the opposite side to that earthed.

(*d*) *Detection of Faulty Feeder.*—If the last test has proved that the neutral is unsound an ammeter, F, may be cut into each feeder separately by means of the switch NS, and the last test repeated until the faulty feeder is detected. If considerable fault is shown on A the switch RS may be momentarily broken while close observation is made of the instruments P and N. Obviously, a heavy balanced leak is in the nature of a short circuit, and being beyond the control of R, makes itself sufficiently apparent on P and N. In extreme cases of this kind it may be necessary to cut out the faulty pole of one feeder while the fault on the other pole is being eliminated; but if the insulation generally is kept under close observation, this double fault should be of very rare occurrence.

(*e*) *Partial Localisation by Transference.*—It is usually the case that a junction can be made between the distributors branching from the various feeders (preferably through fuses, as mentioned above). By transferring the distributors from one feeder to another, and momentarily earthing one of the outer wires, if the neutral is faulty, and flashing the switch RS if an outer is "down," the fault may be very readily located to the shortest length the arrangement of the network will permit. So far consumers have in no way been interfered with unless operations may have blown the fuse of a faulty internal circuit.

The earthing of either pole through an adjustable resistance, RA, by means of the switches TS and ES is of great service in blowing out faults controlled by small-circuit fuses on consumers' premises. It may occur that the neutral is "held down" by a fault which may disappear on a very slight earthing of one of the outers. The consumer will have the fuse replaced, and it may be necessary to repeat the process until he thinks it worth while to investigate the cause of his trouble. It is probable that in this case a few lamps on the faulty circuit will be burnt up; it is the penalty of having a fault.

Of course if, in addition to the above-mentioned fault, a considerable fault on either outer develops, it will automatically affect this process; but should such a fault be absent, a defective single-light circuit may spoil the insulation records for days. There would be little satisfaction in finding, after a tedious search, a fault controlled by a 5-ampere fuse. The writer is assuming that there are no neutral fuses in the purely three-wire circuits, or that they are sufficiently heavy to be unaffected by such slight earthing as has been mentioned

(*f*) *Localisation by Disconnection.*—If disconnection can be resorted to without inconvenience to consumers, it may save the time and trouble of carrying test (*e*) to its extreme limits, the transfer method meaning frequent journeys to the station to study the feeder ammeter or time in fixing up instruments at the feeding points. If arrangements can be made for disconnection, tests may be made by means of lamps or instruments. If the fault be on either outer the volts between neutral and earth will be raised. Having connected up the lamp or voltmeter between neutral and earth at the nearest network box, the various lines or services are disconnected until the volt drops. When the fault is neutral (the earthing switch RS at the station being open), an earth connection may be made through a switch and fuse at the junction box where the test is being carried out, the switch being opened after each disconnection until the faulty line is detected by a rise of volts on an instrument connected between neutral and earth, when the faulty line is cut off.

As an alternative to the last trial, a lamp may be connected between either live outer and the faulty neutral, the latter and other outer being disconnected. The faulty line being at or near earth potential, the lamp will glow until the fault is made dead. It is well to make trials at the station before carrying out these rough street tests, in order that the results may be correctly interpreted.

(*g*) *Final Localisation by Induction Method.*—The tests described above having failed to indicate the exact position of the fault, final localisation may be made by means of an interrupter and induction coil. This generally well-known method consists in putting an alternating or interrupted current through the faulty cable, the circuit being completed through earth. A coil, in circuit with which is a telephone receiver, is taken over the route of the faulty cable, starting from the point from which the testing current is supplied. In a successful test, the receiver beats steadily until the point of the fault is reached, when the beat dies away more or less suddenly, owing to the test current going to ground. A description of an interrupter designed by the writer, and also of a convenient form of coil, will be found in Appendix II.

Figs. 2 to 6 represent various methods of connecting the interrupter. The small arrows indicate the interrupted earth current, large arrows the supply current, and double-headed arrows the fault current. Fig 2 represents the simplest case where the faulty line can be disconnected and the interrupter inserted in series with the fault—the fault being on one of the outers. Fig. 3 shows a method of localising a fault in a neutral. The faulty neutral and one outer are disconnected, and the interrupter connected between the "live" outer and the faulty line. In Fig. 4 the neutral is not "permanently" earthed, or the fault is so bad that the removal of the "permanent" earth connection has no appreciable effect on the pressure between neutral and earth. No interruption of supply is necessary in this case, the pulsating current being superimposed on the supply current. If the coupling is as shown in Fig. 5, no interruption of supply is necessitated, the pulsating current being superimposed on both the supply and the fault current.

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When iron ducts are in use or the cables are metal-covered, contact between the ducts or armour and a gas or other metal pipe sometimes leads to false indications, particularly if the surrounding soil be dry. The effect is shown in Fig. 6. The fault being at B (*i.e.*, the contact between conductor and metal cover), the current takes the lowest resistance path to earth at the point of contact with the pipe returning upon itself. In this case the telephone will cease beating at A, the effect of the pulsating current between that point and B being neutralised. The ground is opened at A and the pipe contact removed when, unless there are other similar contacts, a true indication is given. Proximity but not actual contact has the same effect in a less degree. The coil is, therefore, useful in indicating where the cable ducts and other pipes are too close together, but proper precautions should be taken to avoid such contiguity when the cables are laid.

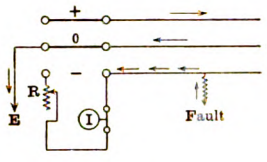

FIG. 2.

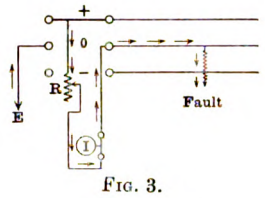

FIG. 3.

The writer has found the induction method of fault localisation very satisfactory. It is more definite in its indications at one time than another, and nearness of other mains or pipes running parallel is an embarrassment. At the same time the exact position of a fault has been indicated on a cable surrounded by a large number of live cables, and where a satisfactory result was to be least anticipated. An explanation of this and occasional converse cases would be of the greatest interest. Complete failure with single conductor cables is, in the writer's experience, almost unknown.

If the coil indicate a certain point it should be ascertained whether a service or T joint is taken off at such point, and if there is the coil will, of course, be taken along the branch line. If the telephone beat "tapers off," the fault is to be looked

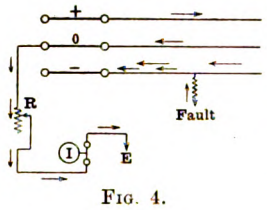

FIG. 4.

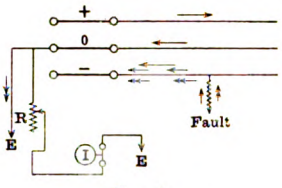

FIG. 5.

for where the "taper" commences. Dips in the main at road-crossings, &c., are to be carefully taken account of. As the distance from the cable under test affects the beat of the receiver, a deviation (which should certainly be found on the mains plans) has naturally the same effect on the telephone if the coil does not follow it as a true indication when the coil is over the fault. The loudest beat is not always the best. It is often accentuated by induction in parallel conducting media. It is sometimes necessary to earth artificially all mains and armourings running parallel to get satisfactory indications. There is no rule, and it is always well to try the test without earthing precautions in the first instance. The localisation of faults by the exploring coil when armoured or lead-

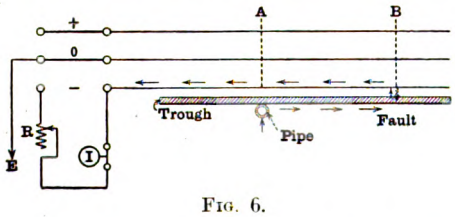

FIG. 6.

covered cables are employed is generally more troublesome than with single-core cables without metallic sheathing, by reason of the misleading effects of induction before referred to.

If a fault is partially localised on either outer, but cannot be eliminated before dark, the main may be cross-coupled in the nearest junction box, making the faulty cable neutral. This should preferably be done through a fuse, in order that the recording ammeter and earth resistance may not be cut out in the event of a bad fault turning up on either outer. There is risk of breaking lamps on the crossed circuit, but it is better to take this risk for a few hours than put many consumers in darkness. The meters of some consumers will also be temporarily reversed, but extinction is always the greatest evil, and the reputation of the supply business is of more value than the units unrecorded or cancelled by the meters.

APPENDIX I.

Fig. 7 shows a network box fitted with three types of blocks, as mentioned above, for (1) connecting solid, (2) fusing, or (3) isolating distributors or branches. In the illustration the distributors coming from feeder 1 are shown connected solid by means of the block B. The distributor from feeder 2 is connected by a fuse-block, A, and that from feeder 3 is isolated by the block C. The last-named block is inserted to hold the cables rigid to the bar, and thus prevent any sinking and displacement of the centres should the cables be left disconnected for a long period.

The fuse-block A is shown with the body constructed of vulcanised fibre. This is a convenient material, but if heavy currents are passing normally, an entirely non-inflammable material would be preferably employed. A copper fuse is inserted in the V-shaped fuse-way from the top, the ends of the wire being soldered into the ears at E. It is to be

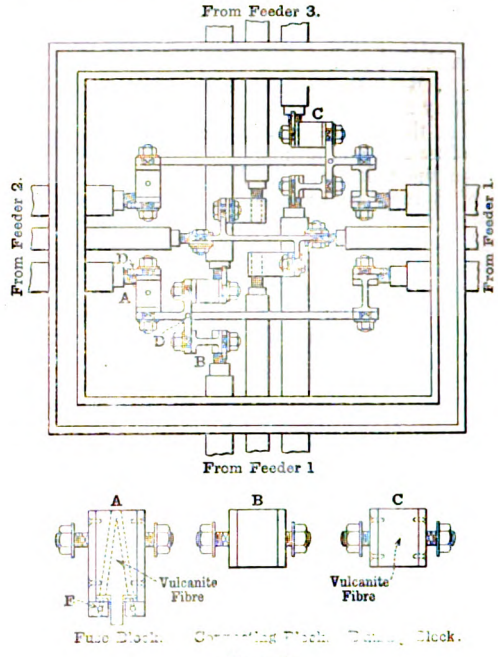

FIG. 7.

noted that the fuse-way is open at the top only in order that, if a fuse should blow, the metal and gases will be projected upwards, away from the fittings. Tapped holes are provided at DD in which thumb-screws are inserted as a means of connecting ammeter, or switch, when testing the block being removed. This is obviously useful in many ways. As all the fittings are rigidly held together, although some of the lines may be electrically isolated, the bars may be supported entirely by the cables, thus greatly improving the insulation. The joint box shown in Fig. 7 is of a type supplied by Callender's Cable and Construction Co. (Ltd.) slightly modified to take the interchangeable blocks.

APPENDIX II.

The interrupter and coil for fault localisation is indicated diagrammatically in Fig. 8. The interrupter consists of a double carbon and mercury

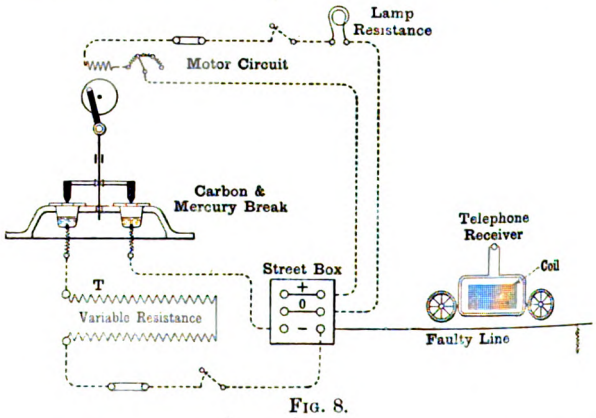

FIG. 8.

break, the carbon-holders being operated directly by the motor spindle by means of an eccentric pin and guide. The motor is run at about 150 revs. per min., and the current (usually about 10 amperes) through the break regulated by the adjustable resistance. The apparatus is packed in a box in such a way as to make it conveniently portable.

The coil is composed of a mile of No. 18 cotton-covered wire wound on a former, through which are placed charcoal iron plates to form a laminated core. The body of the apparatus is supported by two longitudinal beams fitting in grooves in the side of the core, and forming the

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carriage frame. The wheels have solid rubber tyres, and are set wide apart to admit of easy turning. The somewhat cumbersome construction is necessitated by the coil requiring to be as near the road surface as possible. The width of the wheel centres also enables the coil to be run over and along a trench. This is a great convenience if the fault-indication should be indefinite, and it is necessary to open ground in several places. The coil is a modification of one made and used by Callender's Cable and Construction Co. for the purpose of fault location.

APPENDIX III.

An arrangement suggested for reading the combined insulation resistance directly is shown diagrammatically in Figs. 9 and 10. It consists of an ammeter and voltmeter contained in one case. The needles move in two parallel planes and overlap. Between the ampere and volt scales an ohm scale is marked. The scale is plotted for $(V_2/c) - R$, the point of intersection of the needles overlying the required reading of F. As V_2 and C cannot coexist, a special attachment is made to the switch RS, which enables the ampere needle to be locked, while the volt needle deflects.

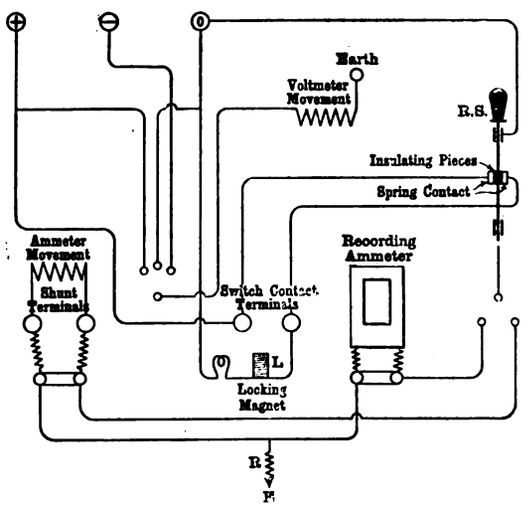

FIG. 9.—DIAGRAM OF CONNECTIONS.

An insulating wedge is fixed to the blade of the switch which separates spring contacts when the switch is closed, but when it is slightly pulled forward, and before the "earth circuit" is broken, permits the contacts to come together, thus completing the circuit of a locking magnet, which retains the deflection C after the switch is fully opened and the voltmeter has swung to V_2. The voltmeter and ammeter are entirely independent, and may be used for other tests if required. The voltmeter is provided with a three-way switch, but normally held on the neutral stud by a spring.

The instrument has been supplied by Messrs. Elliott Bros. The reading of F by Russell's test with an ordinary voltmeter and ammeter is very simple, but with the automatic arrangement embodied in the

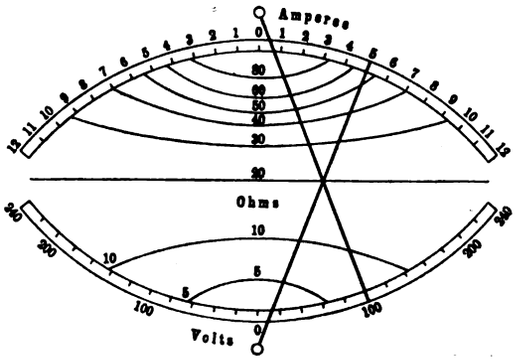

FIG. 10.—SKETCH DIAGRAM OF SCALE.

combined instrument a "switchboard attendant" at any station or sub-station can read F instantly (say twice daily) and report to the mains superintendent if the insulation is below the standard. As a voltmeter and ammeter are required in any case, it only means the combination of the two in one case with the addition of an ohm scale, so that it would seem that such an instrument might be usefully employed on a test panel.

A two-way switch is shown in the diagram Fig. 9, but the ammeter portion of the instrument might be coupled across the switch RS (provided with an additional contact), so that the test would be made by opening this switch only.

A brief discussion followed the reading of the Paper.

Dr. W. E. SUMPNER, who was in the chair, announced the receipt by Mr. Groves of a letter from Mr. Alexander Russell, showing how the curves on the scale of Mr. Groves' instrument could be obtained.

Mr. A. M. TAYLOR referred to his Paper on a similar subject read before the Birmingham Local Section last year, and repeated his view that the earth connection on the third wire should be made through a resistance.

Dr. SUMPNER, referring to Mr. Groves' instrument, said that so far as he knew it was the first time an instrument had been devised embodying the principle of overlapping pointers, and he thought the idea was capable of extension. Although Mr. Russell's test was really no more than an application of the old method of measuring the internal resistance of a battery, it would doubtless be of great utility for measuring the insulation resistance of mains in the manner Mr. Russell had pointed out, and Mr. Groves' instrument for carrying out the test would, he fancied, be of great service.

Mr. GROVES, in reply to Mr. Taylor, said that it was certainly asking too much of a mains engineer to require the neutral to be put dead to earth without a fuse or resistance, and of the two the resistance was preferable. When the leakage to earth was small, the resistance had obviously little effect in displacing the potential of the neutral. Without desiring to belittle Mr. Taylor's ingenious test, he was of the opinion that it was too elaborate for use by a switchboard attendant.

Three written communications were also received.

Mr. A. P. TROTTER recommended the employment of a separate machine for supplying part of a faulty network which had been disconnected from the rest by the linking fuses. It had the advantages of taking the leak off the 'bus bars and allowing a higher resistance to be put between the middle or neutral and earth. This resistance could be adjusted to suit the size of the network and need be no smaller than would hold down the sound main of the disconnected district to 250 volts from earth. Fig. 1 in the Paper was scarcely less complicated than the intricate diagrams in Mr. A. M. Taylor's recent Paper. Different diagrams for different tests would have been an advantage, using heavy lines showing the circuits and switches in use in each case, the others being shown lighter or dotted. From experience which he had gained by the investigation of explosions in street boxes the clearance in the box shown in Fig. 7 seemed rather small. He would have preferred three separate boxes instead of one—one containing A, B and D, another the neutral connections, and the third containing C and the mains connected to it. Short circuits in street boxes were too common, and explosions in them occurred with a frequency which was not creditable to English engineering. A small explosion not likely to have caused any injury to the public often broke or lifted the lid and let it drop into the box causing a serious short circuit. The employment of separate boxes avoided this. He also objected to the use of vulcanised fibre in the fuse block shown. A simple tin fuse shunted by a much smaller Mordey fuse, he understood, broke large currents very quietly in street boxes. It was not uncommon for the blowing of fuses to be reported by the police to the Board of Trade as explosions.

Mr. GEORGE BARNARD said he had had experience with the induction method of finding faults for the last 15 years. He had been successful with single cables of short length, but for cables of a mile or two long he did not consider the method satisfactory. Latterly he had carried out some tests in a similar manner to Mr. Groves without disconnecting the cable, breaking the current by hand and sending about 10 amperes through the fault. It was easy enough to localise faults in this manner in the case of cables without any metallic sheathing, or if they were in iron troughs with tile covers; but if the cables were lead sheathed or amoured, or if the iron troughing had a metal cover, or if the cable was laid in an iron pipe, it was difficult to locate faults by this means with any degree of certainty. He had tried another method with a certain amount of success. In this he had broken the current through a contact breaker at both ends of the faulty cable, the break being in one case slow and in the other quick, so as to give a different note on the telephone in each case. The position of the fault was indicated by both notes being at their largest.* However, for long lines and any system of mains, he preferred the loop test by the drop of potential method, as he had obtained better results from it.

Mr. F. C. RAPHAEL asked if Mr. Groves had actually fixed up a test panel such as he had described, and whether it answered in practice. There would be, he thought, some little danger of short-circuits if the switches were inadvertently manipulated in the wrong order, and, moreover, in a big network, one would imagine that the "kicks" of the middle wire ammeter mentioned in sec. (*c*) would always occur on earthing one of the outers. The main thing was, however, that Mr. Groves recommended daily tests by one of the earthed ammeter methods and in this he cordially supported him. With regard to the latter part of the Paper he explained why it was that Mr. Groves found the induction test inaccurate in the case of lead-covered and armoured cables, referring to the late Mr. R. C. Quin's 1897 Paper before the Municipal Electrical Association. He preferred the simple loop method of localising faults in such cables as there was less danger of inaccuracy, there being no reason why the results should not be correct to within a fraction of 1 per cent. of the length of the cable loop, even with the simplest instruments. He himself had carried out scores of tests by this method and had never known one to fail. He also briefly described the fault localising bridge made by Messrs. Nalder Bros. for the purpose (see *The Electrician*, Vol. LI., p. 268).

Mr. W. E. GROVES in reply to Mr. Raphael's communicated remarks, stated that the panel illustrated in Fig. 1 was a simplified form of one he had used for some considerable time. A short circuit could not occur unless an attempt was made to move the third wire switch TS with the switch ES closed and the resistance cutout, in which case an arc might

* This method was described in Mr. R. C. Quin's Paper before the Municipal Electrical Association in 1897 (*The Electrician*, Vol. XXXIX., p. 437). This Paper is also alluded to in Mr. Raphael's remarks which follow.—ED. *E.*

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bridge the contacts of TS. If the neutral was sound there should be no appreciable "kick" on the middle wire ammeter when either of the outers was earthed. Considerable experience led him to prefer the induction methods of fault localising, which had proved almost infallible on mains without armouring or lead covering. After writing the Paper he looked through the second edition of Mr. Raphael's book in which induction methods as well as loop methods were described, but had found no cause to alter his views. With regard to the double break method mentioned by Mr. Barnard, he thought if serious trouble arose in using the simple induction method, a loop test was to be preferred. Mr. Barnard's remarks corroborated what was a generally admitted fact and one which, perhaps, he could not sufficiently emphasise, that the induction test could not be universally employed and that it had many shortcomings when attempted on a system of mains other than a solid system without metallic sheathing. Coming to Mr. Trotter's remarks, he said that the interchangeable blocks in the network boxes were designed to make the system of mains more flexible without increasing the number of street boxes. Mains engineers would regret that Mr. Trotter's wide experience had caused him to form a generally unfavourable opinion of their ability to design satisfactory street boxes, but he was very glad to know that his remarks could not apply to the boxes shown in Fig. 7. He had had eight years' experience with some hundreds of these boxes, and could not recall a short-circuit in them except an occasional one, common to boxes of all types, and caused by carelessness of workmen when manipulating the connections. These, he took it, could hardly be classed as explosions even by the police. He would have liked to know the nature of Mr. Trotter's objection to the use of fibre in the construction of the fuse-block. The question of insulation did not occur, and it was not proposed to use this material where the fuses would be normally heated. It was mechanically superior to porcelain as a support for the bars, and was unaffected by the sudden blowing of a fuse. The fibre fuse block had been short-circuited across 440 volts without suffering any harm.

EXPERIMENTS WITH A NEW PRIMARY CELL.*

BY E. GEO. P. BOUSFIELD.

This cell was invented some four or five years ago by Mr. W. R. Bousfield, M.A., K.C., M.P., these experiments connected with it being afterwards carried out by myself. The cell consists of an inner porous pot containing nitric acid and a carbon pole, and of an outer vessel containing sodium hydrate solution and a metal pole, preferably zinc. Experiments show that the best results are obtained by using nitric acid of maximum conductivity—namely, a 31 per cent. solution, and sodium hydrate of maximum conductivity, or of a strength slightly below this—*i.e.*, a solution of from 12 to 15 per cent. Using these solutions with zinc and carbon poles on open circuit, an E.M.F. of 2·6 volts may be obtained. Not only does the cell possess this comparatively high E.M.F., but it may be short-circuited far longer than most cells before it runs down.

A cell containing about ½ litre of the dilute nitric acid and about 1½ litres of the sodium hydrate solution, the zinc having an immersed area of about 300 sq. cm., was short-circuited through an amperemeter. The resistance of the amperemeter was about 0·05 ohm, that of the wires, &c., about 0·05 ohm, and the resistance of the cell at starting about 0·51 ohm, making a total resistance of 0·61 ohm. The following were the results obtained:—

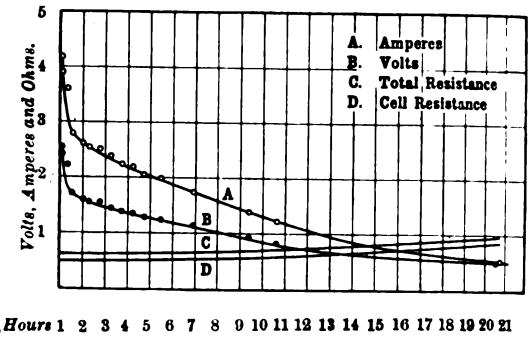
Time.	Amperes.	Volts.	Cell resistance. Ohms.	Total resistance. Ohms.
At start	4·18	2·55	0·51	0·61
1 minute	3·91	2·42	0·51	0·61
¼ hour	3·61	2·22	..	..
½ ,,	2·80	1·71	..	..
1 ,,	2·61	1·61	..	..
1¼ hours	2·55	1·57	0·52	0·62
1¾ ,,	2·51	1·55	..	..
2¼ ,,	2·38	1·45	..	..
2¾ ,,	2·24	1·39	..	..
3¼ ,,	2·19	1·36	..	..
3¾ ,,	2·05	1·29	..	..
4½ ,,	1·99	1·25	0·53	0·63
6 ,,	1·75	1·14	..	..
8½ ,,	1·39	0·94	0·58	0·68
9¾ ,,	1·22	0·84	0·59	0·69
10¾ ,,	1·04	0·73	0·6	0·7
20 ,,	0·52	0·516	0·89	0·99

These tables are represented in the accompanying curves (I.).

By using solutions of considerably higher resistances, the time during which the cell may be run is increased materially. The current, of course, is much less, and the character of the curve obtained is changed. In the following experiment I used a smaller cell than before, containing 35 per cent. nitric acid and 7 per cent. sodium hydrate solution. The cell was short-circuited through the same amperemeter. It will be seen that the current remains almost constant for the first 15 or 20 hours.

Time.	Amperes.	Time.	Amperes.
*At start	1·4	10 hours	0·78
½ hour	0·8	22 ,,	0·65
4 hours	0·8	28 ,,	0·5
8½ ,,	0·8	33 ,,	0·2

Acids other than nitric were experimented with. Some of them gave higher E.M.F.s than nitric acid, but no other acid possessed

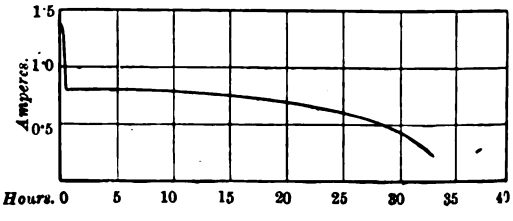


the same "lasting powers." The cell in all cases seemed to exhaust itself in the space of about half-an-hour when short-circuited through the amperemeter.

The effect of using various metals instead of zinc was also tried; some of these gave higher E.M.F.s than the zinc, but as in the cases of the different acids, the high readings were quite transitory. The following table shows some of the E.M.F.s obtained with these different acids and metals, the acids in all cases being of maximum conductivity†:—

Nitric Acid.		*Sulphuric Acid.*	
Metal.	E.M.F.	Metal.	E.M.F.
Copper	2·4	Copper	2·35
Zinc	2·6	Zinc	2·65
Iron	2·65	Iron	2·65
Magnesium	2·7	Magnesium	2·75
Aluminium	2·75	Aluminium	2·8
Hydrochloric Acid.		*Chromic Acid.*	
Copper	2·25	Copper	2·4
Zinc	2·4	Zinc	2·6
Iron	2·4	Iron	2·65
Magnesium	2·5	Magnesium	2·8
Aluminium	2·55	Aluminium	2·8

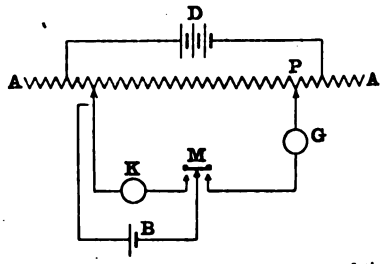
In all the above cases the aluminium and magnesium were very rapidly dissolved, with considerable gasing. With the zinc the



gasing was not nearly so marked. The zinc was slowly dissolved, forming a gelatinous precipitate which, on analysis, proved to be sodium zincate.

Experiments were also tried with two carbon poles, instead of using one carbon and one metal pole. As was to be expected, a

NOTE.—The accompanying sketch is a diagram of the apparatus used in these experiments. A....A is a resistance of about 100,000 ohms. B is the cell to be tested. D represents three small dry cells. K is the amperemeter in the short circuit. G is the galvanometer. By means of the Morse key M, I break the short circuit and simultaneously pass the current through the galvanometer and the resistance. In this way, by balancing the current from D against the current from B (by moving the



point P until there is no movement of G), one can read the voltage direct on A....A, suitable adjustments for so doing having been once made. By tapping the Morse key smartly the voltage can thus be read before it has had time to change substantially.

* About 20 intermediate readings were taken, but for the sake of brevity these are omitted.

† These readings were taken on "open circuit."

* Paper read before the Faraday Society on Wednesday.

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considerable E.M.F. was still present. This E.M.F., however, I did not succeed in obtaining very constant; it varied considerably with the carbons used, the extreme E.M.F.'s registered being 1·1 volts and 1 8 volts. The mean E·M.F. worked ort for a large number of experiments was 1·35 volts. This is no doubt an example of an E.M.F, which is commonly put down to the difference in velocity of the ions of the respective liquids.*

From the above results I think that we may conclude that the E.M.F. of the cell is made up thus: E.M.F. due to two liquids in contact, 1·35 volts; E.M.F. due to introduction of soluble zinc pole, 0·95 volt; total E.M.F., 2·6 volts.

CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

Radium Emanation.—J. A. McClelland investigates the important question as to whether the emanation given off by radium is charged, with a view to shedding some light on the genesis of the emanation. He comes to the conclusion that the emanation is not charged, and herein he corroborates Rutherford's result. He used an arrangement of two glass jars, one of which was used as a generator, and the other as a receptacle of radium emanation. Out of the latter the emanation passed through a tube packed with glass wool to another containing an electrode connected with an electrometer. The glass wool was there to intercept dust particles, which might be electrified by friction. The author found that the effect upon the electrometer remained the same whether the air admitted to the measuring tube contained emanation or not. The author next calculates the effect to be looked for, in order to determine whether it is below the limit of observation. He assumes that each emanation particle has a charge equal to that carried by the gaseous ion. A deflection of one scale division would then have been produced by admitting into the measuring vessel a charge of 24×10^{-14} electromagnetic units. From measurements of the ionisation produced by the emanation, the author shows that either the emanation must have been uncharged, or each emanation particle would require to emit 60,000 α-rays. Now, the mass of the α particle being of the same order as that of the hydrogen atom, and the emanation atom, having been produced by the disintegration of the radium each emanation particle could not possibly emit more than about 200 α-rays. The fact that the emanation is uncharged has an important bearing on our conception of the manner in which the radium atom breaks up. The radium atom certainly gives off positively charged particles—the α-rays. The emanation particles cannot be what remains of the atom after the emission of one or more α-rays, because in that case it would be negatively charged. The atom must have parted with an equal negative charge, either by the emission of negative particles or in some other way.

[J. A. MCCLELLAND, *Phil. Mag.*, April, 1904.

Radio-Activity applied to the Measurement of Capacities.—J. A. McClelland describes a method at once simple and accurate, suitable for the determination of capacities of any magnitude down to a few microfarads, or even less. The method is based on the fact that the ionisation current that can be obtained by the use of a radio-active substance like uranium is extremely constant, and can be made so small that the time taken to charge a condenser by it can be accurately measured. This small constant current is used, first, to charge one condenser to a given potential, and then a second condenser is charged to the same potential, and the time taken in the two cases observed. This gives the ratio of the two capacities by simply observing two intervals of time. To use the method it is not necessary to have a supply of radium. Uranium is better in some respects, and is found in every laboratory. A few grammes of uranium nitrate are spread on a sheet of paper and placed on an insulated metal plate surmounted by another insulated plate connected to a battery of some 200 test-tube cells. As soon as the difference of potential between the two plates has attained the maximum, the current becomes constant, and may be used for capacity measurements. Since the maximum current is a saturation current no ordinary change in the E.M.F. supplied will affect it. The author quotes some results to show the great accuracy and wide range of the method. The latter extends from about 1mfd. to 1 micro-microfarad. One of the chief advantages of the method is that, from the nature of the apparatus used, it is scarcely possible for any serious source of error to come in without detection. A faulty insulation, for instance, can easily be guarded against. The only quantity requiring to be measured is an interval of time, which can be done with great accuracy.

[J. A. MCCLELLAND, *Phil. Mag.*, April, 1904.]

Magnetic Effect of Electric Convection.—W. Sutherland points out that in the experiments carried out by the collaboration of Crémieu and Pender practically the whole of the difficulty in reconciling the apparently contradictory results obtained by Rowland and his pupils, and Röntgen, Himstedt and others on the one hand, and Crémieu on the other, concerning the magnetic effects of electric convection, was traced to the fact that Crémieu covered his metallic electrified surfaces with solid dielectric. The solid dielectric rotating with the charged metallic disc reduces the magnetic effect considerably, so as in some experiments to make it appear to vanish. In this connection, the author calls attention to a theoretical source of error in electrostatic theory owing to a neglected motion of the ether. According to the usual electrostatic principles, the work done in conveying a unit charge across a condenser having a dielectric of capacity K is $(E_1 - E_2)/K$. In reality, it is simply $E_1 - E_2$. The former value only gives the work due to a certain displacement of the unit charge relative to the matter of the two plates. But there has been also a displacement of the ether relative to the two plates, and the work due to this ether displacement is $(E_1 - E_2)(1 - 1/K)$. The expression for the displacement of the ether is just what is required by Fresnel's theory that the velocity of the ether in a moving transparent body is $1 - 1/\mu^2$ of that of the body, whose index of refraction is μ. Such an electrical case of Fresnel's law occurs in the phenomena of ionisation, and the Crémieu-Pender effect is another case. Experiment so far strengthens the theory that the magnetic effect of electric convection is due to the slip between electricity and ether, and not to the relative motion of electricity and remote ether.

[W. SUTHERLAND, *Phil. Mag.*, April, 1904.]

Differential Method of Observing N-rays.—In order to avoid subjective sources of error, J. Macé de Lepinay has devised a contrast method, by means of which a number of people who could see nothing before have been enabled to confirm the N-ray effects. The method is based upon Blondlot's observation that the impact of N-rays changes the distribution of the radiation from a sulphide screen, increasing it in a direction normal to the surface and diminishing it in a direction tangential to the surface. The author mounts two strips of sulphide close together, one of them being a narrow line 2mm. thick, and the other a strip 25cm. long, but inclined at an angle of 1deg. to the line of vision, so as to appear about the same thickness as the former. The two strips are mounted in such a manner that they appear to form the figure 7, the oblique branch being viewed normally. The strip viewed tangentially is made somewhat more luminous than the other, so that the two strips appear equally bright under normal conditions. If now they are simultaneously exposed to a source of N-rays such as a sounding body, the strip viewed normally is seen to shine out, while the other darkens, and sometimes disappears altogether. It is possible, and even advantageous, to employ a luminosity much greater than that ordinarily used in N-ray experiments. The surface viewed tangentially must have a very fine grain. The best way of mounting the sulphide powder is to fix it by means of collodion or a rubber solution on a copper plate slightly roughened by an electrolytic deposit. Radiation from one surface to the other must be intercepted by means of a lead screen.

[J. MACÉ DE LÉPINAY, *Comptes Rendus*, March 28, 1904.]

* Cf. Becquerel's cell, consisting of platinum plates in acid and caustic potash respectively.

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TESTING ELECTRICITY SUPPLY NETWORKS.

In the very early days of electric lighting, the average central station engineer's knowledge with regard to cables was limited. He had an intimate acquaintance with all the details of his system within the station itself, from the stoking floor to the switchboard, and he often constructed the latter piece of apparatus himself with the assistance of a carpenter. He knew that houses should be wired according to the then existing "Phœnix" rules, with wooden casing, rubber cables, and plenty of pure rubber, rubber tape and rubber solution. But with regard to the connection between the switchboard and the consumer, he left himself largely in the hands of the cable manufacturer. He knew that rubber was waterproof and that there was a race of cable jointers who could make watertight joints in rubber-covered cables. He distrusted cables insulated with impregnated fibre or paper, because these materials were not waterproof, and the lead that protected them had to be jointed by plumbers who might have no friendly feelings towards those endeavouring to supersede gas and gas-pipes by new methods. Lead was also regarded as a perishable substance, as in America it had been found that it was attacked by certain soils and by creosoted timber. There were, of course, some engineers well in advance of their times; but the majority preferred to order vulcanised rubber cables and vulcanised joints with a time guarantee, or else lead-covered or bitumen-insulated cables with a much longer time guarantee, and then to telegraph for the cable-maker's man if trouble occurred on the mains. But things have changed since then. Every electricity works engineer is now conversant with the properties of the various classes of cable and has some acquaintance with the materials of which they are manufactured, and he has had opportunities of forming an opinion from his own experience of the relative merits and demerits of the several methods of laying mains. Moreover, attached to the staff of every electricity works of large size is a mains engineer who possesses special knowledge of these matters, and who, as often as not, has been an employé of a cable manufacturing firm. In spite of this, however, there is one branch of electric light and power cable engineering which is much neglected, and that is the testing of the mains. No doubt in the largest works this is done regularly and systematically, and definite rules of procedure are in force in the event of faults developing on the network; but in the vast majority of

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electricity undertakings the testing of mains is almost disregarded, and so far as the localisation of faults is concerned, choice is still made between two methods, that known as the "cut-and-try," and the "telegram-to cable-maker" already referred to. It is too frequently forgotten that defects in any other part of the supply station plant and machinery are visible by inspection, while the position of a leak in an underground cable does not always assert itself automatically. No "testing" is necessary to localise a leaking steam joint, a hot bearing or a burnt-out armature coil, the position is usually immediately apparent to one of the five senses; but, on the other hand, even when a leak on the network is bad enough to blow a feeder or network fuse, this by no means indicates the precise spot at which the damage has occurred. We need not here enlarge upon what have almost become truisms, that the network is the only part of the system which is not duplicated and that the network nevertheless frequently represents about half the capital spent upon the whole undertaking.

The reason of this neglect is to be sought in the antipathy of the average station engineer, who prides himself on being a "practical" man, to anything resembling laboratory tests and any calculations more wasting of brain tissue than the division of the various items of his expenditure by the number of units he has sold. A reflecting galvanometer, a potentiometer, or any instrument with lacquered brass blocks and terminals is often merely kept for ornament, and as often such instruments are excluded from a station with as much rigour as an inquisitive and short-sighted science student would be kept away from the high-tension machinery. This attitude is regretable. Periodical tests of the insulation of a network—and by tests we mean actual quantitative measurements—can be carried out with instruments no more delicate than those which are erected on the switchboard of every modern electricity works, and by men possessing only a very limited knowledge of electrical engineering. True, it requires a little more than this to be able to appreciate to the full the exact nature and principle of the tests and the suitability of the instruments employed, and it is advisable to have this knowledge just as it is advisable for every station engineer to understand something of dynamo construction and the properties of steam. The same applies to fault localisation. By carrying out simple instructions there is no reason why even the shiftiest shift engineer should not be able, if it were necessary, to localise a fault in a network within a yard or two, and eliminate it with far less disturbance to the continuity of supply than by means of the cut-and-try method. Of course, there is room for refinements, and the engineer who is not above taking an interest in such matters should be able to discover and remove the fault before it has become bad enough to affect the supply at all or do any damage. For this more delicate instruments may sometimes be necessary, but the exact position of a fairly bad leak or short-circuit can be discovered without the use of any elaborate or costly instruments. All this should be common knowledge, for during the last ten years a number of articles and Papers, and some books, have been published on the subject. Still, additional Papers upon it are not unwelcome, for even if they do not suggest any new methods—and the old ones are now so fully developed as to answer almost every purpose in practice—they can still relate in what manner and with what success the existing methods have been applied in particular circumstances. Mr. GROVES' Paper and the discussion upon it—published in this issue of *The Electrician*—performs this useful function, and also serves to call attention once more to the importance of testing electricity supply networks and the ease with which these tests may be made.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Dynamo-Electric Machinery: A Manual for Students of Electrotechnics. By SILVANUS P. THOMPSON, F.R.S. 7th Edition. Vol. I. Continuous-current Machines. (London: E. and F. N. Spon; New York: Spon and Chamberlain.) 1904. 30s. net.

During the eight years which have elapsed since the last English edition of this work appeared, electric science and industry have progressed at an ever-increasing rate, and Prof. S. P. Thompson's book, being a truthful record of events past and present, has undergone a corresponding evolution. In bulk it has grown to an inconvenient size, containing, indeed, nearly 1,000 pages, and this notwithstanding the fact that the volume under review deals with continuous-current machinery only.

After some brief historical notes (which Prof. Thompson always knows how to make interesting), the author opens the subject by explaining the general principles of dynamo-electric machines. No student could wish for a clearer exposition of these, and the pages dealing with the process of commutation deserve special commendation. Then follows a full consideration of magnetism and magnetic fields, leading to their application to the magnetic circuit of dynamo-electric machines. Numerous curves and formulæ are given, often worked out for flux densities both per square centimetre and square inch. It is doubtless useful for the dynamo designer to have both sets of constants worked out ready for him, but it swells the size of the book. The meaning of a sentence on p. 137 is not quite clear. In giving the result of a detailed examination of the fluxes passing through the various parts of a six-polar dynamo, the author says:—"The yoke appears to be of insufficient section, as the flux through No. 8 [the yoke] is less than half of that through Nos. 5 or 6 [the poles]." Surely it *must* be less than half, as there must always be some magnetic leakage. Then follows an excellent chapter on "Copper Calculations," dealing with both theory and practice. A similar criticism, however, may be made as that mentioned in connection with the previous chapter, viz., that there is almost a superabundance of tables and data which are easily calculable from one another—all tending to increase the size and cost of the book. It may be added, by the way, that some dynamo designers may take exception to the statement on p. 185 that "in the case of enclosed motors, without any resort to artificial cooling, it is difficult to prevent the internal temperature from rising by as much as 100°C. above that of the surrounding air." The word "artificial" is unhappy; it is merely a question of design. Insulating materials are treated well in the next chapter and valuable information with regard to them is given.

Armature reactions and commutator phenomena are then lucidly explained. The elementary theory of the dynamo is treated in the next section in a manner which should quite fulfil requirements both of the student and the budding dynamo designer, and the following part of the book, dealing with the more usual forms of armature windings, also comes up to expectations, the various forms of windings being made very clear by a series of excellent diagrams, some of which are coloured. The latter part of the dynamo section of the book is given up largely to the practical side of dynamo construction and to the discussion of special types. The detailed examination of the design of several modern dynamos should be of particular value. Some space is devoted, though not quite as much as might be desired, to high-speed dynamos for direct driving by steam turbines, and a few designs of machines actually constructed are appended. Continuous-current motors, their regulators, rheostats, controllers and starters are then fully treated, and the book concludes with a well-written chapter on the testing and management of electric machinery. Mention must also be made of the collection at the back of the book of the beautifully-executed plates, representing, in section and elevation, a number of electric machines to scale. The detail construction of these appears quite up to date, and they are, therefore, of real value in aiding the designer in his work.

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To sum up, the book contains a vast amount of useful information, and appears free from serious errors, although a few misprints and repetitions are inseparable from a work of this magnitude. A feature of the book is the complete bibliography which covers a wide range of English, Continental and American publications, both ancient and modern.

The Depreciation of Factories, Mines and Industrial Undertakings, and their Valuation. By EWING MATHESON, M.Inst.C.E. 3rd edition. (London: E. and F. N. Spon.) 7s. 6d. net.

This is a clearly written, clearly arranged little volume dealing with a subject full of perplexities and debatable points. Indeed, an intelligent son of Japan, anxious to obtain a knowledge of the leading principles of Western industrialism, would rise from the perusal of a treatise such as Mr. Matheson's with a feeling akin to despair; he would of a surety conclude that it was easier far for a camel to pass through the eye of a needle than for the owner of machinery to "depreciate" it correctly, or for the intending buyer of a factory to appraise its value accurately. This is the fault of the subject, however, not of the author, who is throughout as lucid and to the point as the circumstances of the case permit.

The work is divided into two parts, relating respectively to "Depreciation" and "Valuation." In regard to the former a sentence in the preface to the second edition should be written over the portals of the board room of every industrial undertaking and solemnly recited at every meeting of directors called "to consider on a dividend." The sentence is as follows:—"Profits . . . are not gained until the loss by the wearing out of the machinery of production is provided for" and, as the author remarks further on in the work, "It must always be remembered that to depreciate plant is to provide for contingencies, as well as for the rate of wearing out which may be immediately visible." And the contingencies are many; obsolescence, change of fashion, decay of trade, removal of trade, varying tariffs, &c. We are inclined to think that limited liability companies more frequently yield to the temptation of shirking this all important question of depreciation than did the old individualistic, family or partnership concerns. A sensible business man sees very well that inadequate allowances for depreciation now mean inadequate allowances to his sons and daughters presently, and he is wise in time. Directors, on the other hand, have no such immediate and personal inducements to depreciate properly, and generally yield to the "natural tendency to write off for lepreciation in proportion to the profits rather than to the deterioration." And if profits range low over a long period, the *new* board has a nasty situation to face.

As the author rightly points out, a municipal trading undertaking requires, in addition to making proper provision for depreciation, to build up a substantial general reserve fund even more than a company does. Only a portion of a joint-stock company's capital is in debentures, whilst the whole of the trading capital of a municipality is of this character, and full interest must be paid regularly; this can only come out of present or past profits, or out of the pockets of the ratepayers.

The keynote to the section on "Valuation" is contained in the first sentence—"Value is a term which has different significations, according to the circumstances in which it is used." "Value" is not, indeed, peculiar in this respect, but we must confess we have never before seen the many significations of this little dissyllable treated of in such an interesting and instructive manner.

O'Gorman's Motor Pocket-Book. By MERVYN O'GORMAN. (London: Archibald Constable & Co., Ltd.) 7s. 6d.

This little book contains a large amount of reliable information relating to petrol cars, not much relating to steam cars, and nothing at all about electric cars. Arranged in alphabetical order, with the corresponding French and German equivalents to the various headings, it forms a most useful addition to the "stock-in-trade" of the amateur motor-car enthusiast. For the beginner it should not be left at home with the library, but should have a permanent place assigned to it along with spanners, oilers, spares and the rest of the paraphernalia inseparable from a motor car. It may prove a friend in need to many a novice, and even old and experienced motorists may find useful hints within its covers, but the latter have the advantage of practical experience, the equivalent of which can never be given by a book, no matter how good. In one item of electrical information volunteered, the author is just a little unfortunate, for, on p. 18, he counsels his readers to discharge accumulators before removing the acid if ever it should be necessary to send the accumulators by post! He even goes further and gives directions as to how this operation should be performed. On the whole, however, the book is an admirable one, and we can confidently recommend it to those persons for whom it is written.

POWER SCHEMES.

A discussion on "Power Schemes—Projected and in Operation" took place at the Leeds Local Section of the Institution of Electrical Engineers on March 24th:—

Mr. W. B. WOODHOUSE, in opening the debate in favour of power schemes, said his first argument was that the actual working results of electricity stations showed that the cost of generating electricity decreased as the size of the generating station increased, and his second argument was that an improvement in load-factor meant a decrease in generating costs. With any particular class of consumer there was a maximum load-factor beyond which it was impossible to go, and the only way of improving the state of affairs was by supplying other classes of consumers in addition; such consumers having different requirements, increased the load-factor because of the diversity of time of their maximum demands. Hence the generating costs varied inversely as the product of maximum load and load-factor. Regarding the influence of capital charges, the capital expenditure per kilowatt decreased with the size of generating unit, the proportion of spare plant was independent of load-factor and decreased in inverse ratio to the size of the station, and the capital charge on idle plant was therefore less in the case of a large station. The cost of transmission and distribution increased with distance, but decreased with an increase of pressure. All these conditions he considered to be in favour of supply from a power company, feeding a large area and giving a bulk supply to various districts. The real problem of electricity supply was not so much in the choice between one large station and a number of small ones as in the cost of energy to the consumers. This meant that cheap production and efficient distribution should be carefully studied, and this could be best done by one large central organisation. The Newcastle-upon-Tyne Company, although starting as an ordinary supply company, was the first actual power company in England, and its charges were lower than those of any other company in the United Kingdom which was not a power company. After briefly describing the Yorkshire power scheme, he said that any distinction between current used for power and current

Town.	Population.	Production cost.		Total cost per unit at switch-board.	Load-factor.	Yorks. Elec. Power Co. charge.
		Works cost.	Works cost and half management expenses.			
		d.	d.	d.		d.
Bangor	11,800	2·95	3·46	4·07	6·98	2·25
Barking Town	25,000	1·43	1·71	1·94	15·96	1·57
Barnes	20,000	1·39	1·84	2·51	12·22	1·87
Bray	8,000	3·01	3·34	3·57	16·78	1·62
Bury St. Edmunds	16,700	1·56	1·72	2·01	16·48	1·62
Buxton	11,000	2·61	2·98	3·97	8·26	2·27
Colne	23,000	2·13	2·90	4·43	12·48	1·92
Colwyn Bay	9,000	2·04	2·46	3·03	6·70	2·64
Dartford	18,600	2·07	2·58	3·11	16·54	1·62
Epsom	10,900	2·69	3·16	4·01	8·36	2·33
Fareham	8,200	2·17	2·59	3·28	13·00	1·81
Heckmondwike	9,500	0·87	1·46	2·32	8·67	2·29
Hereford	21,400	1·39	1·79	2·68	8·45	2·31
Horsham	9,400	2·87	3·52	4·52	8·07	2·38
Hoylake	10,900	2·36	2·74	3·38	11·55	1·90
King's Lynn	20,300	1·03	1·24	1·55	14·76	1·59
Llandudno	9,300	1·65	2·04	2·41	8·58	2·13
Monmouth	5,400	0·91	1·44	2·21	18·19	1·59
Morley	23,600	2·31	2·82	3·49	10·76	2·01
Rathmines	20,000	1·23	1·49	1·77	18·85	1·41
Redditch	13,500	2·07	2·29	2·52	13·67	1·73
St. Anne's	8,000	1·12	1·50	1·84	14·09	1·76
Stafford	20,900	1·30	1·47	2·01	14·44	1·70
Stirling	18,400	1·51	1·77	2·35	12·90	1·78
Sutton Coldfield	16,000	1·50	1·84	2·27	10·84	2·01
Thornton	21,800	1·05	1·29	1·63	12·77	1·62
Torquay	20,000	2·39	2·75	4·22	12·01	1·80
Whitby	11,800	2·74	3·93	5·04	5·33	3·10
Whitehaven	19,300	1·55	1·95	2·43	16·17	1·57
Wrexham	15,000	2·07	2·42	2·95	6·06	2·75

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used for lighting was an artificial one, which must in time disappear, as the governing factors in the costs of generating were quantity and load-factor. The Yorkshire Company made no such distinction. The above table was put forward as showing the prices charged for energy by different undertakings in districts of 20,000 and less inhabitants, and it would be seen in most cases the company's figures were lower than those of the local undertakings. In making this comparison, the works costs and half the general expenses should be added together to obtain the production costs, and to this had been added interest at 3½ per cent. on the money spent on the station, the resultant figures giving the total cost of current delivered at the switchboard just as it would be obtained from the company as a bulk supply.

Mr. W. EMMOTT, for the opposition, said he should discuss whether there was any necessity at all in this country for large power schemes. He took as an example the Yorkshire Electric Power Co. which was supplying an area of 1,800 square miles from four stations, the total number of municipal undertakings already at work in this area being 11, and any increase in the demand for energy for lighting and power could be met as well by the latter as by the Power Company. The mean value of the generating costs of 11 stations in the area was 0·89d. and the mean load-factor 12·89, which was very satisfactory. The total costs, 1·5d. per unit, did not come out quite so favourably owing to the separate rents, rates and management expenses which, in the case of a power company, would only occur at four stations instead of 11. The fact, however, of the supply being distributed over 11 centres with efficient management at each, was one of his soundest arguments against power schemes, as it provided the most perfect system of supply which it was possible to conceive, the liability to shut down for any length of time being very remote. The works costs of the municipal undertakings would be considerably reduced if they had an output such as the Power Company estimated, while any saving which might be effected by the Power Company in fuel costs would be swallowed up by the costs of transmission. In evidence given on behalf of the Power Company, it was stated that the cost of feeders might be taken at £1,000 per 500 H.P. per mile, which did not include the cost of laying. As for the argument that the Power Company was in close proximity to the Yorkshire coal fields, he need only mention that many municipal generating stations were equally well situated, and that the "generating station on a pit hill" boom had been dead for some time. The fact that the Newcastle-upon-Tyne Electric Supply Co. had grown by various increments in area from an electric light undertaking to a power undertaking of considerable magnitude proved that each municipal supply might become a relatively large power scheme. The argument that existing municipal stations were equipped with small and inefficient engines did not apply, as larger engines could easily be installed if only the load were forthcoming, and he did not doubt that any one of the stations in the area would be glad to supply at the rates quoted by the power companies.

Mr. FEDDEN said the question of the relative advantages possessed by an electricity supply from one large undertaking versus a number of small undertakings appeared to him to be somewhat analogous to the present naval question of "large ironclads versus torpedo boats or smaller fighting weights generally" and to judge from recent developments the advantage was with the smaller craft. The tendency of the large concern was to become so large that the head hardly knew what the tail was doing, and a sub-division of responsibility among smaller units was the proper solution to the difficulty. Industrial towns of 50,000 inhabitants and upwards and residential and commercial towns of somewhat larger size might embark with confidence on their own electricity supply undertakings. The comparatively small advantage to be gained in cost of production in a plant of, say, 25,000 H.P. over one of 5,000 H.P. was likely to be swamped in the excessive capital charges for distributing mains to which the big transmission schemes must always be subjected so long as they were compelled to use the present costly system of buried cables. He felt, however, that there was a great field for the bulk system of supplying energy to smaller communities and isolated works, mines, interurban railways, &c., and certainly for the supersession of the countless engines and boilers employed in industrial operations throughout the country.

Mr. E. H. CRAPPER said that the fact had not been mentioned that where power schemes had been adopted new trades had sprung up in the district. In all large power schemes he considered it was very difficult to see how they were going to pay.

Mr. A. B. MOUNTAIN said he was opposed to the idea of a power company supplying a large area from one central point, or even from three or four, but he thought a central authority controlling a number of small concerns would work very well. The Yorkshire Electric Power Co. was distributing over 1,800 square miles. In that area there was a population of 2½ millions, of which 1,700,000 was already supplied by different undertakings, thus leaving to the Power Company a population of only 800,000, scattered over 1,650 square miles.

Mr. WOODHOUSE, in reply to Mr. Emmott, stated that 600kw. could be transmitted through a cable costing £1,000 per mile laid. The small undertakings which had been pointed out did not pay for some years, one having run for 11 years, and was still losing £1,400 a year. He did not agree with Mr. Fedden that a power scheme might be too large to be properly managed, as the same argument might be applied to railway companies. He, personally, did not favour small stations, but the power companies had put down a number of small stations at first, and when the load had developed they removed the generating plant and linked up to one large power station. He regretted that the available population in the Yorkshire Company's district was only 800,000, but it must not be forgotten that the area included nearly all the collieries and many very large power users, so that an enormous demand might be expected even in sparsely populated districts.

A GENERAL DIAGRAM FOR ALTERNATORS.

Prof. F. Niethammer, referring to Mr. B. A. Behrend's article on "The Experimental Basis for the Theory of the Regulation of Alternators," published in the *The Electrician* of January 1st, sends us the following description of a general three-phase diagram which he developed some years ago. His method was published at the time in the German technical press, and Mr. Niethammer

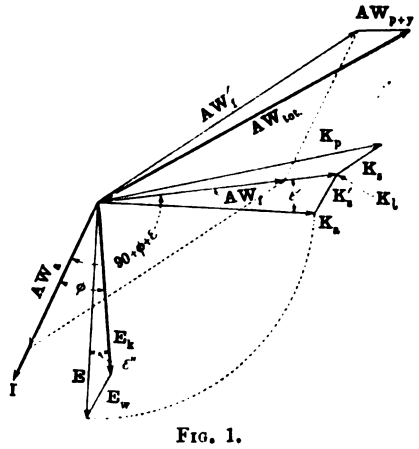

FIG. 1.

informs us that he used the method with success for determining the regulation and other characteristic properties of the alternating-current machinery made by the Union Elektricitäts-Gesellschaft when chief electrical engineer to this firm. By slightly modifying the method it may, he says, be used for all kinds of polyphase machinery—viz., asynchronous and synchronous motors, converters, double-current generators, potential regulators, &c.

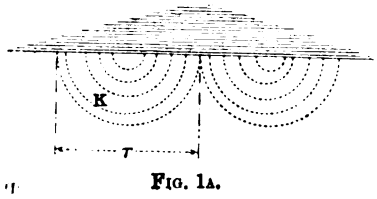

FIG. 1A.

In Fig. 1, which represents the generator diagram, E_k = terminal voltage per phase, I = armature current per phase, E_w = resistance drop per phase (in phase with I), and cos ϕ = power-factor of load.

AW_a = mean value of armature ampere-turns per pole = $2{\cdot}7c'\frac{\sin P/\tau}{P/\tau}\frac{IZ}{4p}$ (for three-phase gene rs), where P : τ = ratio of pole arc to pole pitch, Z = number of conductors per phase, $2p$ = number of poles, c' = a factor, decreasing with increasing circumferential breadth of the winding (usually between 1 and 0·95).

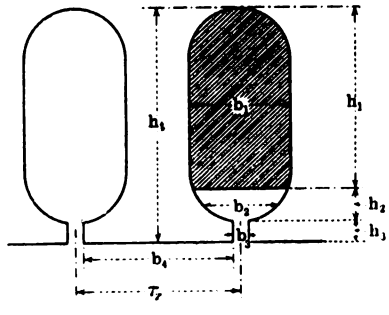

FIG. 2.

K_a = maximum magnetic flux in the armature, and E = E M.F. per phase = $cnZK_a10^{-8}$ (in which n = frequency and c = form-factor between 2 and 2·2, depending on the type of winding used).

K'_s = magnetic stray flux in the armature and in phase with I, and E_s = armature stray voltage = $2{\cdot}2nZK'_s10^{-8}$.

K_l = magnetic flux in the air-gap, and AW_f = ampere-turns required to drive the flux K_a through the armature, teeth and core and the flux K_l through the air-gap.

AW'_f = resultant of AW_a and AW_f.

K_s = primary stray flux between poles and pole shoes, proportional to and in phase with AW'_f. It may be calculated from well-known formulæ.

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K_p = resultant magnetic flux in pole and yoke, and AW_{p+y} = ampere-turns required to drive the flux K_p through pole and yoke, and in phase with K_p.

AW_{tot} = total ampere-turns on field necessary to produce the terminal voltage E_k with a current I and a power-factor cos ϕ.

E is easily deduced from the armature dimensions, and is $= 2\pi n L I 10^{-8}$.

L = coefficient of combined self and mutual induction in one armature phase $= (Z/2pq)^2 pq\Lambda(1+c+c_p)$, this formulæ being derived from fundamental principles; q = number of slots per pole and phase; Λ = magnetic conductivity for the armature stray field multiplied by $4\pi/10$; c = ratio of self-induction to mutual induction of the same phase; c_p = same ratio with regard to the other phases.

Let l_e = embedded length of one armature conductor; l_f = free length of one armature conductor (length of one end connection), then: $\Lambda(1+c+c_p)$ may be replaced by $l\,\lambda_\epsilon(1+C)+l_f\lambda_f(1+C')+\lambda_p$, where λ_ϵ = magnetic conductivity of stray field per centimetre length of armature; λ_f = the same per centimetre free length of end connection, C and C′ represent the influence of mutual induction, and λ_p = magnetic conductivity for the magnetic lines flowing from and to the end flanges (see Fig. 1A).

Where the end connections are wound closely together, it is preferable in many cases to put $1+C'=q$. Substituting the above values in the equation for E_s, we get:

$$E_s = k\frac{nIZ^2}{pq}[l_e\lambda_\epsilon(1+C)+l_f\lambda_f(1+C')+\lambda_p]10^{-8},$$

k being between 1·6 and 2. The former figure is the theoretical value, the latter figure has been obtained occasionally in experiments.

Very often the exact diagram Fig. 1 may be replaced by that of Fig. 3, in which the fluxes K are replaced by the corresponding E.M.F.s. The curve I represents the total ampere-turns AW for given values of the E.M.F.s at no load. $Oa = AW''_f$ = total ampere-turns for armature, air-gap and frame. All other vectors are similarly lettered to those in Fig. 1.

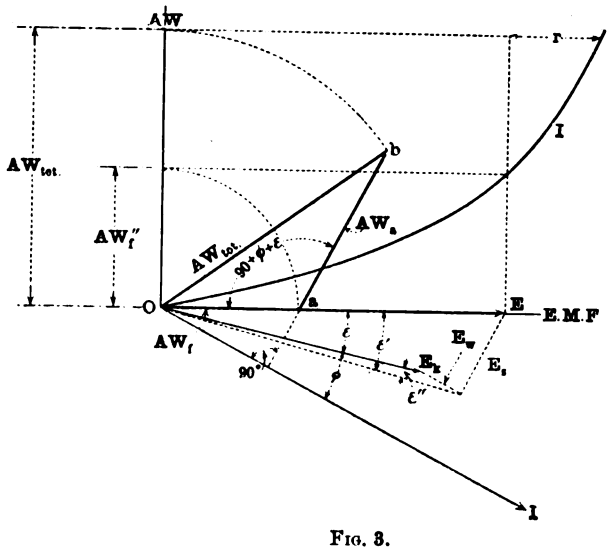

Fig. 3.

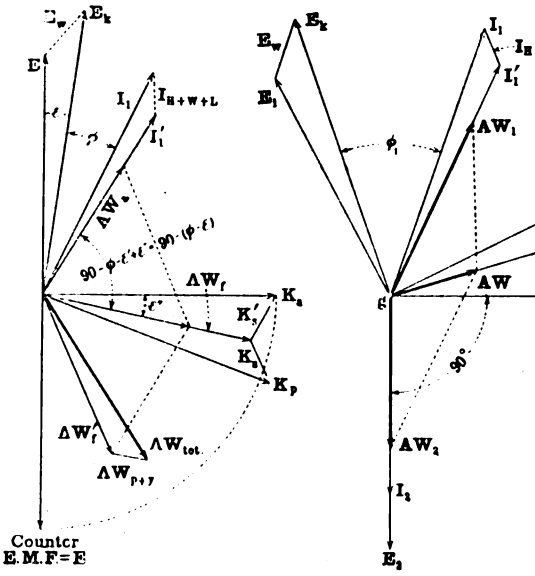

Fig. 4.

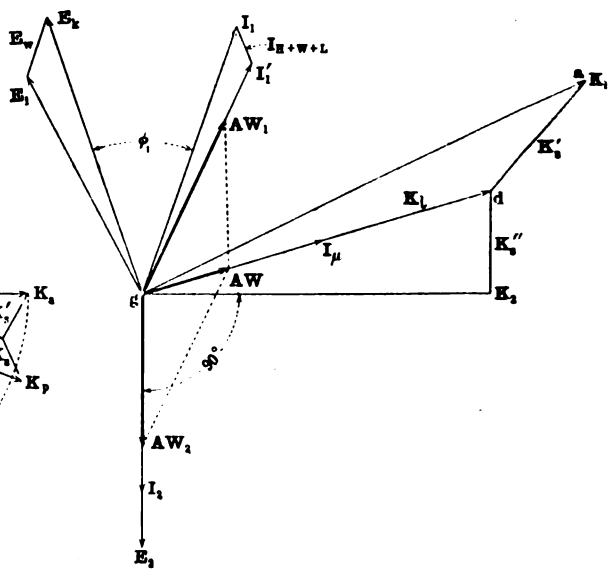

Fig. 5.

For the synchronous motor the diagram changes to that of Fig. 4. The letters have the same meaning as before with the only difference that E = counter E.M.F. and I_{H+W+L} = current corresponding to iron and friction losses $= \frac{\text{iron and friction loss}}{\text{terminal voltage } E_k}$.

From Fig. 4 a simplified diagram may easily be deduced, similar to that of Fig. 3. For converters, AW_a is equal to the resultant (geometric) armature ampere-turns, the watt component of the alternating current being partly neutralised by the continuous current. For double-current generators the armature reactions of the continuous and three-phase currents have to be added geometrically.

Fig. 5 shows the diagram of the usual asynchronous motor. All values corresponding to the primary (inducing) winding have the suffix 1, and those corresponding to the secondary having the suffix 2. K_2 = maximum of magnetic flux in secondary; K''_s = stray flux in secondary, in phase with secondary current I_2; K_l = magnetic flux in air-gap; K'_s = stray flux in primary winding; K_1 = main magnetic flux in primary winding; AW_2 = mean value of ampere-turns of secondary winding per pole (see explanations for Fig. 1) $= 2{\cdot}7c''I_2Z_2/4p$.

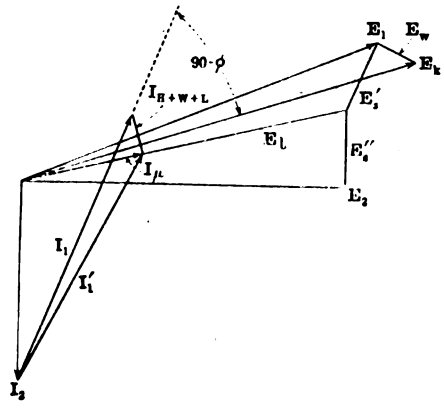

Fig. 6.

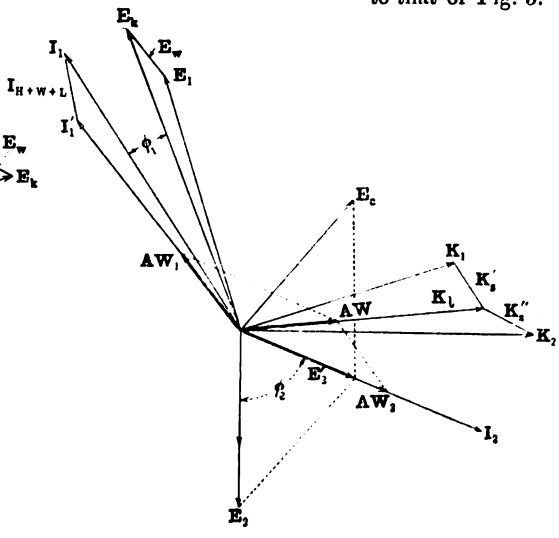

Fig. 7.

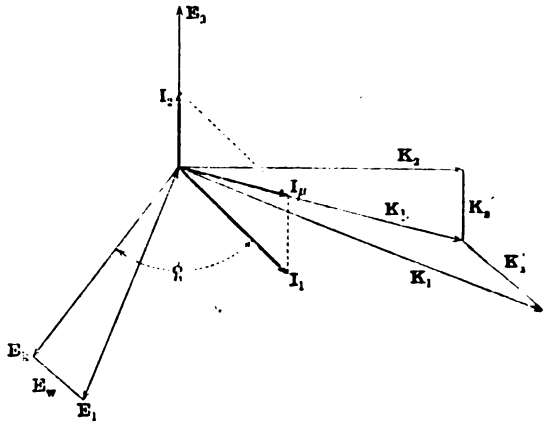

Fig. 8.

For a shape of slot as shown in Fig. 2 it may easily be shown that

$$\lambda_\epsilon = 0{\cdot}8\frac{h_1}{b_1} + 2{\cdot}6\left(\frac{h_2}{b_2}+\frac{h_3}{b_3}\right) + \frac{3b_4}{1{\cdot}6b_4+2b_3},^*$$

* For laminated pole-shoes add $0{\cdot}6b_4/\delta \times P/\tau$; ($\delta$ = air-gap).

$$\lambda = l_f(0{\cdot}4\log\frac{l_f}{s} - 0{\cdot}1); \quad \lambda_p = 0{\cdot}4h_1q;$$

in which s = diagonal of the rectangular section of the end connection.

The following values of 1+C and 1+C′ generally apply to three-phase generators:—

q (slots per pole per phase)....	1	2	3	4	∞
1+C=1+C′	1·2	1·8	1·9	2·0	2·2

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In this expression, Z_2 = conductors per secondary phase (three-phase), c'' depends upon the type of winding, and I_2 = secondary current.

AW_1 = primary ampere-turns = $2{\cdot}7c'I'_1Z_1/4p$, where Z_1 = conductors per primary phase, and I'_1 = primary current excluding losses.

AW = ampere-turns required to drive the main flux through air-gap, stator and rotor = $2{\cdot}7c'I\mu Z_1/4p$, where $I\mu$ = magnetising current.

I_{H+W+L} = iron losses + friction losses ÷ terminal voltage E_t per phase; I_1 = total primary current; E_2 = secondary E.M.F. per phase = $c_2n_sZ_2K_210^{-8}$, where n_s = slip per second, and c_2 = form factor, varying between 1·8 and 2·2, according to the type of winding used.

E_1 = primary E.M.F. = $c_1n_1Z_1K_110^{-8}$, where n_1 = frequency in primary and c_1 = form factor, same as c_2.

E_w = voltage drop due to ohmic resistance, E_t = terminal voltage per phase, ϕ_1 = phase difference between voltage and current in primary.

The stray fields K'_s and K''_s may be replaced by the corresponding stray voltages E'_s and E''_s. These two voltages are obtained in a similar manner to those for the generators, but the value of λ_ϵ has to be increased by an expression which takes account of the stray field between inner and outer slots. In the equation for the primary stray voltage E'_s, therefore, we have to put

$$\lambda\epsilon = 0{\cdot}8\,\frac{b_1}{} + 2{\cdot}6\left(\frac{h_2}{b_2}+\frac{h_3}{b_3}\right)+\frac{(\tau'_z - b_3 - b'_3)^2}{3\tilde{c}\tau'_z},$$

in which τ'_z = pitch of teeth in secondary, $\tilde{c}$ = air gap, and b'_3 = the value for the secondary slot corresponding to b_3 (Fig. 2).

With this modification, and assuming the primary part of the motor to be identical with that of the generator, we have

$$E'_s = k\,\frac{n_1I_1Z_1^2}{pq}\,[l_c\lambda_\epsilon(1+C)+l_f\lambda_f(1+C')+\lambda_p]10^{-8}.$$

E''_s, the secondary stray voltage, is obtained by substituting in the formulæ all primary values for the secondary ones. Diagram Fig. 5 may be simplified as shown in Fig 6.

For the first of two concatenated motors, the diagram of Fig. 5 has to be modified, as the secondary current I_2 is not in phase with the secondary E.M.F. E_2, but lags by an angle ϕ_2, depending upon the self-induction of the second motor. Otherwise the diagram remains unaltered.

For the compensated three-phase motor with commutator (the Görges motor), the diagram Fig. 7, drawn for a leading current, holds good. As compared with the ordinary asynchronous motor, the difference consists in the fact that the resultant has to be found of the induced secondary E.M.F. E_2 and the impressed E.M.F. E_c, led to the secondary winding by the commutator, which acts as a frequency changer and reduces the frequency from n_1 to n_s. The resultant of E_2 and E_c—*i.e.*, E'_2, produces the secondary current I_2, which is approximately equal to E'_2/r_2, if r_2 denotes the resistance in the secondary. In a similar manner, the diagram for the compensated generator is obtained.

Finally, the working of the asynchronous generator may be represented by Fig. 8, in which the lettering is the same as in Fig. 5.

Prof. Niethammer contends that all these diagrams may easily be kept in mind and may be used directly, without having to develop an endless number of circles and other auxiliary curves, which render the theory more complicated. It is also not necessary to develop a variety of stray field coefficients which only add to the difficulty.

CORRESPONDENCE.

DANGER OF ELECTROSTATIC SHOCKS.

The unfortunate incident at Bow-road, in which death was attributed to an electrostatic shock received from a cable after it had been discharged and disconnected, has appeared to us so remarkable that we have asked a few leading electrical engineers for their views on the matter, and whether they have experienced similar cases of electric shock from the residual charge creeping up in a cable after it had been connected to a source of alternating current and then discharged. Among the replies we have received are the following :—

TO THE EDITOR OF THE ELECTRICIAN.

SIR : It is certainly possible to leave a considerable residual charge in a cable when switching off an alternating current, and it frequently happens. Even from a length of 200yds. of cable having a capacity of about 0·035mfd., after testing with 10,000 volts, a decidedly unpleasant shock can be obtained. The amount of charge left in the cable of course depends on the value of the volts at the moment of switching off, and it as frequently happens that an inappreciable charge is left as that one of considerable value is present. The charge behaves exactly in the same way as a continuous-current charge—*i.e.*, it takes time to soak out of the insulation, so to speak, so that a cable can be short-circuited for a moment and a charge subsequently found to be present, although the second charge is always of small value compared with the first. Seeing that the complete charging of a cable with continuous current takes some minutes, I should expect that the potential at any time left in a cable by an alternating E.M.F., even when the circuit is interrupted at the maximum volts, could be only a fraction of the square root of the mean square volts on the circuit—say, not more than half.

Coming to the accident at the Charing Cross Company's works. I think it quite possible, seeing that a painful shock can be obtained from the residual charge left by 10,000 volts alternating in a cable only 200yds. long, that a man with a weak heart should be killed by the residual charge from 6 miles of core, this being, apparently, the amount in circuit when the fuse was opened from which the man was killed. On the other hand, there are several arguments against the static charge theory of the man's death. For even if the volts were switched off when at their maximum, the energy stored in this core could only have been about 16 foot-lbs., and this amount of energy could hardly have been sufficient to have given the report and flash that occurred at the moment the man was killed.

Moreover, we have it that the voltmeter showed zero before the accident, so proving no charge to have been present; and the evidence showed that the generator fields were reduced, the engines brought to "dead slow" speed, the generator fields broken and, finally, the main switches opened. Thus the switches were not opened until the potential was at a very low value indeed, and the charge left could only have been due to this value, and not that of the normal working pressure, because, of course, as the voltage died down each alternation would tend to wipe out its predecessor. It would seem, therefore, that the static charge, if present, could only have had an energy value of some small fraction of 16 foot-lbs.

At first sight the natural explanation that offers itself is that one of the mains had been left alive from the sub-station end, but this could not have been, as when the first fuse was removed an arc would have occurred owing to the breaking of the capacity current in that conductor, and this would certainly have been noticed. A possible explanation that offers itself to me is that one phase only of one cable had been accidentally left alive, perhaps by the failure of a switch at the sub-station; that the first six fuses removed were on the dead phases, and that the seventh fuse from which the accident took place was the first upon the live phase. The flash and report observed would be, of course, due to the breaking of the capacity current. I give this suggestion for what it may be worth, as I know nothing of the switchboard connections.—Yours, &c., G. H. NISBETT.

Prescot, April 12.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I may say that my own experience indicates that it is doubtful in the extreme whether there could be any strong residual charge creeping up after an alternating-current cable had been disconnected from the supply and discharge. I think I have had practical experience of every possible condition and working, and I never experienced any indication of this phenomenon. What I have heard would almost appear to me a symptom of an active source of supply. It occurs to me that some one of the motor-generators might have been spinning on and supplied the current observed. I have used both concentric and three-core cable in numerous power installations, and I have never seen any suggestion of a residual charge. The discharge of electricity, without exception, in my experience, has indicated some source of supply. —Yours, &c., H. F. PARSHALL.

London, E.C., April 12.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : When the 10,000-volt system was started with this company, the opinion was held that it was not safe to work on the E.H.T. cables until the cores had been discharged by con-

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necting them to earth; we had no trace, however, that this process was necessary.

You may be interested to know that on one of our runs where we have five E.H.T. cables in an iron trough, when four of these cables are working, it is quite possible to obtain sparks off the core of the fifth cable, which is insulated throughout its length; this charge must be, I think, of the nature of a static charge.

I will see if I can get you any further information, in which case you shall hear from me again.—Yours, &c.,

J. S. HIGHFIELD, Chief Engineer.

The Metropolitan Electric Supply Co. (Ltd.),
London, April 12.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest the account of the recent fatality at the Charing Cross Company's Bow works, and your remarks thereon.

In a case like this the question of evidence is one of supreme importance, and unless the phenomenon of the creeping up of a residual charge could be shown by experiment with the same machines and cables, I am inclined to think that the earthing through the machine was imperfect or that the machine was disconnected from the cables before zero pressure was reached. I have come across strong residual charges on cables after they have been disconnected from the system, but never after being discharged by earthing each core.

In one case a length of cable of three-quarters of a mile with a capacity of about 0·25mfd. was disconnected at both ends, some ten minutes afterwards a man handling the terminals received a severe shock, and it took something like half-an-hour to bring him round. This cable had not been discharged.

I am sorry that I have no definite figures to give you, but I would repeat that under such conditions as are said to have existed at Bow, I have never heard of a residual charge being found.—Yours, &c.,

W. B. WOODHOUSE, Resident Engineer.

Leeds, April 12.

SIR: It is deplorable that when accidents occur every effort seems to be made to throw obscurity upon the real facts at issue by representing the occurrence as possessing some elements of mystery or novelty. It is, of course, well known that cables will retain electrical charge, and, though the question possesses only theoretical interest, it is also well known, but has apparently not been thoroughly investigated, that in a system of distributing networks in a perfect condition of insulation from earth, a residual charge may be left in the network after cessation of an alternating supply, although the reversals should apparently act, and this charge is either positive or negative, depending on the balance existing in the characteristic wave-form of the alternators. But in the present case we have a statement that the generators were not disconnected from the mains until, firstly, the speed had been reduced to slow turning, and, secondly, the field circuit was broken, thus leaving the armature as a path to discharge the cables. We are therefore invited to presume that the dielectric was so thoroughly saturated with a charge, and had the ability of retaining it and of thus allowing it to accumulate after the cable was discharged through the generator armature. This presumption is, of course, capable of proof, and this proof being very easy and capable of being carried out at any time without expense or trouble, we must feel prejudiced against it if no effort has been made to state it as a fact rather than as a theory.

As the cables are extra high pressure it is clear that their insulation must be perfect, and it would therefore appear to be solely a question of the specific inductive capacity of the dielectric. As a condenser, the cable may possess unusual merits and be not only retentive but retardative, and show great reluctance to speedy discharge; but in spite of all this plausible theorising, it is incredible that any mere static discharge would take place accompanied by "a report and a flash."

All this, of course, is only destructive criticism, and other causes may be suggested which it was probably considered desirable not to investigate too closely. The motor-generators at the receiving end of the feeders are stated to have been switched off, but we cannot place much reliance on the alleged proofs—*i.e.*, firstly, that the voltmeter indicated zero pressure, and, secondly, no sparks were observed on the removal of the first six fuses. After switching off the receiving motor it would continue to rotate, and if the synchronising voltmeter transformer was left in circuit it is quite clear that the cables would continue to be charged, this inductive supply being probably of lower frequency, and being quite sufficient, not only to charge the cable, but also to cause the report and flash noticed at the scene of the fatality. The removal of the fuses may have been safely accomplished in the first six operations owing to the method of handling them, but this does not give any support to, or, on the other hand, does not negative either the residual charge theory or the back generation.

I do not know that all this talk is of the slightest use to you, and I send it from an anonymous being who desires to see truth prevail.—Yours, &c.,

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SIR: I cannot reconcile myself that the cause of death was due to a discharge on account of breaking a circuit where there existed residual charge, or even that the deceased's death was due to a very slight shock and a weak heart. As you properly point out in your article, the centre of the star winding is earthed, and, such being the case, if the alternator had no field and was practically shut down, it is impossible to conceive how any charge could remain in the cables with such a very low resistance connecting them to earth.

The theory of a weak heart is difficult to disprove when no post mortem has been made, and even if a post mortem discloses such, it is a matter of degree, and is very questionable as to what amount of shock an individual might require to cause death. I consider that in the interests of all connected with the electrical industry a post mortem examination should have been made and no stone left unturned to get at the bottom of the matter (although such minute investigations are very trying to the responsible individuals) rather than have such a matter as this unsolved and hardly knowing what to do in future to prevent a recurrence, or taking such precautions which may not only be absolutely unnecessary, but very costly.

Although I have no more before me than has appeared in the technical journals, I can but draw my own conclusions, and consider that the evidence does not accurately disclose the true condition of affairs at the time of the accident. This, of course, can only be attributed to the shock and possible confusion such an accident causes to all who are eye-witnesses of the fatality. My opinion is (assuming that the generator field be broken) that the alternator was running at a considerable speed at the time the accident occurred, and the main switches were not off. Owing to residual magnetism in the field, the alternator would have been generating electricity at a pressure which was probably hardly sufficient to show upon a 10,000-volt voltmeter on account of the graduations upon the scale for the lower readings being very indefinite (this applies whether the voltmeter is coupled directly across the 10,000-volt supply or to the secondary of a pilot transformer), but the pressure might have amounted to from 500 to 1,000 volts, such being the case. Breaking the circuit in which there is a large capacity, a very considerable discharge would take place, and a man receiving such a discharge from his forehead to his hands would undoubtedly be instantaneously killed, as the course of the discharge would be, most probably, through the brain.

There might be other solutions of the mystery, as, for instance, defective insulation between the alternator fields and the exciter, after the circuit is opened, and the alternator field receiving a weak excitation current due to such defect (which might occur between switch contacts), or leakage back through or over insulators from a motor-generator or rotary running at the distant end of the main at one of the sub-stations and being motored by the continuous-current supply.

As it might possibly occur to some people that the mains were fully charged by a motor-generator at the distant end, I consider that this is most improbable, as the charge-current of the mains alone would be such as to put a considerable load upon the motor without considering that there would be at the other end a large alternator and engine being motored from this source, and if such had been the case it is quite impossible for it to have occurred without some individual being acquainted with the fact, or by blowing of fuses as a consequence of excessive overloading.

One point appears to have been passed over without comment: In the evidence it was stated that the first six fuses were withdrawn without anything occurring, but, upon drawing the seventh (which would undoubtedly be the first of the third main) the accident occurred. It would be very interesting to know whether any discharge took place upon breaking circuit with the first six fuses, as it appears strange that one main should store up a "residual charge" for a longer period than similar mains under similar conditions. Was it only a mere coincidence that the man made contact with the metal of the third main, whereas he might have received the fatal shock from the first main if he had manipulated the fuses in the same way as when he received the shock?—Yours, &c.,

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A POINT OF LAW.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Where large buildings containing offices, shops or residential flats are let out to numerous tenants, it has in some cases been arranged by agreement to supply current in bulk through one meter and charge the total to the proprietor, who makes a proportionate charge, or supplies it through his own meters, to his tenants. The act leaves it open for any agreement to be made without showing any undue preference and the supply may be given to one or more consumers under special agreement, but consumers are entitled to object to any method of charging except by a recognised meter. Can any of your readers inform me whether any corporation in this country have acquired or are exercising powers to compel the landlord to pay in bulk for the supply taken by his tenants in large buildings?—Yours, &c., H. D. WILKINSON.

London, April 13.

[Perhaps some of our readers have had experience of such cases?—ED. *E.*]

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PRIORITY IN WIRELESS TELEGRAPH INVENTION.

[*Translation.*]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician* of February 12th, p. 661, appeared a note from the Marconi Wireless Telegraph Co. on the question of priority between Marconi and myself in the employment of the oscillatory circuit in the transmitting system of wireless telegraphy installations. In this note the following sentence from a lecture of Marconi is cited:—

Prof. Braun also has suggested the employment of a condenser associated with the aerial wire; but I am not aware that he recognised, before the date of my patents, the absolute necessity of the two circuits being in tune, without which condition it is impossible to transmit over considerable distances.

It is also added:—

". . . but that this part of Marconi's general arrangement was of no utility by itself, that there was no value in using the condenser unless certain further arrangements were made . . . unless that closed oscillatory circuit is tuned to the same period as the aerial wire

In the following I give some facts which will show that I possessed this knowledge at an earlier date than Mr. Marconi seems to imagine. The question as to what is to be understood by the term "tuning" has, however, first to be settled. In acoustics, two bodies are said to be tuned to each other when their natural periods of oscillation are identical. Helmholtz, for instance, in his book "Tonempfindungen," emphasised repeatedly that the natural note agrees with the resonance note, and the above designation of Mr. Marconi has no doubt to be taken in this sense. This law only holds good as long as the reaction of the resounding system on the exciting system is negligible. If this is not the case, then the whole has to be considered as *one* system in which several oscillations occur, the number of which depends on the degree of freedom of the system. This has been shown to be so especially for the inductively-coupled systems, such as are now under consideration, by Oberbeck (who assumed a combination of systems, each possessing a different natural period of oscillation), and in a different way also by Geitler, and especially by Max Wien.*

In our case there are, in general, always two oscillations which occur in each of the parts of the system and which differ from their natural oscillations. Speaking in the ordinary acoustical sense, *a resonance between these two oscillations would take place in all cases.* Only in the case of the very loosest coupling does one sole oscillation approximately exist, this oscillation being identical with the natural period of oscillation of each portion of the system. But it is just this case which need not be considered when discussing effects at a great distance.

These explanations have not been put forward by me with the object of teaching Mr. Marconi things which are nowadays generally known, nor are they intended to constitute a reproach against his conception or method of expressing it, for these no doubt follow the proper direction and approximate closely to truth. I merely wish to recall these facts to show that the circumstances are more complicated than might be supposed by reference to the term "resonance." The problem at first consisted in obtaining the best action of the system at a distance; and even to-day, when our knowledge and insight is much better, and at a time when our experimental methods have been much improved, the complexity of the problem (a series of further questions has, in addition, to be dealt with relating to the best place of excitation, the utmost use of the free length of the transmitter, &c.) necessitates frequently the amplification by an experiment or even a series of systematically conducted experiments.

It is, no doubt, obvious that no experimenter, after experiments conducted *ad hoc* have verified his expectations (which were based on general considerations), assumes then and there that he has hit upon the best conditions for his experiments. And this was the case with me.

Some have interpreted my work as if I had thought it possible to control the effect of the system solely by increasing the capacity of the condensers in the oscillating circuit. That this is not so is clearly shown by the fact that I at once searched for methods for increasing the available oscillating energy *without altering the frequency of oscillation.* The solution I found at the time (particulars of which I am submitting as an article for *The Electrician*) indicates surely that the way of solving the problem was not very easy, and that I should not have followed it up to the end if I had found other and more convenient ways.

I will submit a few other facts. Comparative experiments with my system of connection and that of Marconi were conducted at Easter, 1899, before a Commission of the German Patent Office, the conditions being in both cases the same. The results showed the superiority of my system over the simple Marconi system of connection (as did also later experiments, the results of which have been published in *The Electrician*, Vol. XLVI., p. 778, in the *Elektrotechnische Zeitschrift*, and in other publications). My experiments convinced me that I was on the right track in principle. Mr. Cantor, and later on Dr. Zenneck, continued the experiments in Cuxhaven, and always in the sense that with a given transmitter the number of *oscillations* of the jar circuit was varied, a subcondition being that the capacity of the condensers should be kept as large as possible. In Dr. Zenneck's experiments particularly the frequency of oscillation in the jar circuit was raised systematically in the first place, and then variations were made in what is now termed the degree of coupling (Koppelungsgrad). The series of experiments were conducted by him always until the maximum effect on the distant station had been passed. This was done in the winter of 1899-1900.

While Mr. Cantor continued the experiments in Cuxhaven, I discovered here, in Strassburg (June, 1899), another possibility of increasing the effects of the transmitter (see the *Elektrotechnische Zeitschrift*, XXII., p. 259, 1901) as soon as *one of the most advantageous sets of dimensions for the oscillating circuit with regard to the transmitter* had been experimentally determined. I demonstrated this arrangement in the same month to Major Klussmann, the head of the Balloon Corps, amongst others, on the occasion of a visit of this gentleman to Strassburg, and I pointed out to him that, since the oscillating circuit had to be adjusted to the transmitter, my arrangement was suited for antennæ of given dimensions, but was not suited for his requirements. I thought at that time, in fact, that the use of wireless telegraphy in connection with balloons was bound to the condition that it ought to be possible to work with continually varying lengths of the transmitter. The fact that I am not in a position to submit more definite proofs than those mentioned is because the patent experts thought it at that time self-evident that the general arrangement included also the special form which gave the best results, and that, therefore, this special form needed no special protection. Otherwise, a patent applied for in the summer of 1899 would now exist, containing also a definite proof.

In the winter of 1899-1900 I was requested by the German Admiralty and Post Office to report upon my experiments; and in the official documents which I correspondingly prepared (see Drude's *Annalen der Physik.*, 10, p. 665, 1903), the tuning of the transmitter to the oscillatory circuit (both for inductive and direct excitation of the transmitter) was repeatedly commented upon.

It was only very late that I published something about my work—*i.e.*, on November 16, 1900, on the occasion of a lecture before the "Naturwissenschaftlichen Verein" in Strassburg (see *Strassburger Post* of November 18, 1900), when I expounded the subject correctly, at least as far as was possible in such a lecture. A reference to the more correct view of the dependency on the coupling will be found on p. 51 of my pamphlet on "Wireless Telegraphy" (Leipzig: Veit & Co., 1901).

To recapitulate, the direction I had to pursue was clear to me. The only consideration, then, was the means by which it could be made practical in the quickest manner possible. The question of priority may be compared with the following parallel: Supposing someone to have stated that he had succeeded in making a telescope by combining two lenses; that

* Oberbeck, *Wied. Ann.*, 55, p. 623, 1895; Geitler, *Wied. Ann.*, 55, p. 513, 1895; M. Wien, *Wied. Ann.*, 61, p. 151, 1897; *Ann. d. Physik.* (4), 8, p. 686, 1902.

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he had convinced himself that with the instrument more was accomplished than with the naked eye, and that he had submitted the device to unbiassed experts, who affirmed its superiority. Supposing, further, that he, being of the opinion that the first attempt was not likely to produce at once the best results, continued to investigate the matter in a methodical manner. Assuming, then, that after two years someone else appears who—after having obtained negative results at first*—gradually convinces himself of the validity of the statements of the first investigator. He has discovered, moreover, that the lenses must not be chosen and combined arbitrarily, and that the instrument may even reduce instead of enlarge if one looks through it in the wrong direction. Then the question arises: Which of the two has invented the telescope?—Yours, &c.,

FERDINAND BRAUN.

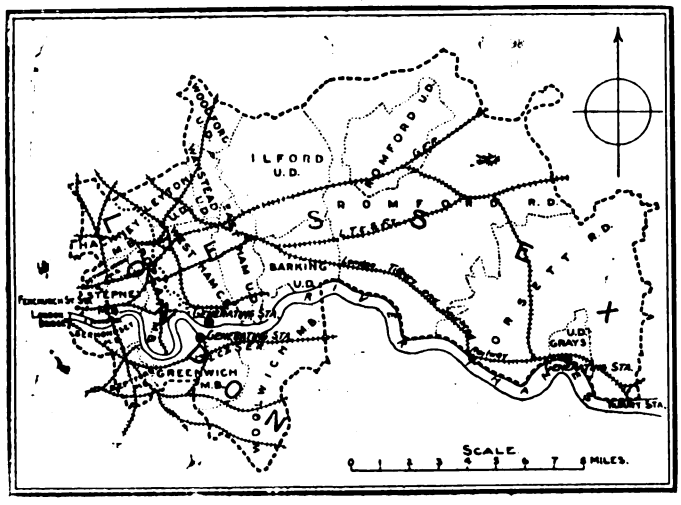
Strassburg, April.

PARLIAMENTARY INTELLIGENCE.

EAST LONDON AND LOWER THAMES ELECTRIC POWER BILL.

On Wednesday a Committee of the House of Commons commenced consideration of this Bill. The Committee are Mr. Cawley (chairman), Col. Denny, Dr. Hutchinson, and Mr. Remnant. The Cheshire Electricity and Power Gas and the North Western Electricity and Power Gas Bills will also come before the same Committee. The petitioners against the East London and Lower Thames scheme are Barking Town Council; the Borough Councils of Stepney, Woolwich, Hackney, Deptford, Bermondsey, Poplar and Greenwich; the Urban District Councils of Wanstead, Grays Thurrock, Woodford, Ilford and East Ham; Essex County Council; East London Waterworks Co.; Metropolitan District Railway Co; West Ham Corporation; Whitechapel and Bow Railway Co.; London County Council; London, Tilbury and Southend Railway Co.; the Charing Cross and Strand Electricity Supply Corporation; the County of London and Brush Provincial Electric Lighting Co.; and London Electric Supply Corporation.

Mr. BALFOUR BROWNE, K.C., who appeared for the promoters with Mr. Acworth and Mr. Lynden Macassey, said the bill proposed the incorporation of the East London and Lower Thames Electric Power



EAST LONDON AND LOWER THAMES ELECTRIC POWER CO. SKETCH MAP SHOWING PROPOSED AREA OF SUPPLY.

Co., and the proposal was to construct three generating stations for the supply of electrical energy, mainly for power purposes, to all persons requiring it in the 169 square miles of area shown on the sketch map. One generating station was on the river Thames in the south of West Ham, another on the south side of the Thames in the north of Greenwich, and the third would be in Grays Thurrock, also on the river Thames. He pointed out, in view of the large amount of opposition, that this was not the first time that the question of electric power supply over large areas had been contested. Throughout the country several large similar schemes had been very successful, especially that along the northern banks of the River Tyne. The main question involved in such schemes as this was whether a company should be allowed to supply electricity in a district where there was a supply already given by the local authority. In half-a-dozen local districts in the area scheduled by the bill such a supply existed, but mainly for lighting purposes, and the petitioners against the bill asked that Parliament should protect them against competition for power, which was only dealt with to a limited extent by the local authorities in question. With regard to competition, this matter had already been settled authoritatively by Parliament through the recommendations of the Joint Committee presided over by Lord Cross which sat some four years ago, and subsequently to this, Sir James Kitson's Committee of the House of Commons settled the conditions and clauses upon which such competition should take place. All these clauses had been embodied in the bill and they fully protected the local authorities with regard to their lighting undertakings, but the supply of electricity for purely power purposes was a trade, and not a municipal duty. He wished to bring forward the interests of the small consumers who could not afford to instal their own plant, and yet had no means of obtaining a supply at a cheap rate except from a company of this nature. Since 1901 no large town had ever been excluded from the areas of the large power companies. The promotions before 1901 voluntarily excluded certain large towns. The clause for the protection of the local authorities in the bill was practically identical with that in the Somerset Power Bill last year, and was as follows in clause 42:—(1) Energy shall be supplied by the company only (*a*) to authorised undertakers, (*b*) to persons requiring a supply for power. (2) The company shall not supply energy for lighting purposes except to authorised undertakers, provided that the energy supplied to any person for power may be used by such person for lighting any premises on any part of which the power is utilised, or any vessel, car, carriage or vehicle. Provided that where energy is supplied for power within the area of supply of any authorised distributors, the energy used by such person for such lighting purposes in any year, except with the consent in writing of the authorised distributors, shall not exceed the amount of energy used by such person for power. (3) The company shall not supply energy (except to authorised undertakers, or to any railway, tramway or water company or proprietors or trustees of any dock, harbour, canal or navigation, or any Government department for power), in any area which at the date of the passing of this act forms part of the area of supply of any authorised distributors without consent of those distributors, provided that where any authorised distributors refuse or withhold such consent the company may appeal to the Board of Trade as to whether the consent of such authorised distributors is unreasonably refused or withheld, and the Board of Trade may dispense with such consent if in their opinion it is unreasonably refused or withheld. The consent shall be deemed to be unreasonably refused or withheld if such authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time, and in considering what are reasonable terms and what is a reasonable time, the Board of Trade shall, among other things, have regard to the terms upon which, and the time within which, the company are willing and able to give the supply. (4) If at any time after the passing of this act any local authority, company or person become authorised distributors in any area within the area of supply of the company shall be subject to any provisions which may be made by the act or provisional order under which the distributors became authorised, as to the taking over of any supply then given by the company for use exclusively within the area of supply of the distributors or otherwise as to the powers of the company to supply within that area, and such provisions may be made in any such provisional order under the Electric Lighting Acts. In connection with the Somerset Bill the Committee of the House of Commons, called for the advice of the Board of Trade as to the policy of passing the measure with this clause in it. This settled the municipal opposition to the scheme, which, as he had endeavoured to show, was principally on the ground of competition. Then there was some opposition from electric supply companies, also on the ground of competition. The remaining opponents were asking mostly for clauses. One objection, however, by the City of London Corporation, was somewhat interesting—viz., that, inasmuch as the promoters proposed to compete with the two companies which supplied the City, this competition might increase the charge for electricity in the City.

The CHAIRMAN: Are you supported by any local authority?—I do not think we are. I have never heard of a power company being supported by a local authority.

In concluding his address, Mr. BALFOUR BROWNE said he had overwhelming testimony from private traders as to the necessity for a supply of electrical energy such as was proposed by this bill.

The CHAIRMAN: Have you any guarantee for capital?—No, sir, and no such undertaking can show a guarantee because no financier would think of backing a bill until he has seen what it is going to be after it has passed through Parliament. At this stage he could not put down two millions of capital.

Mr. JOHN COWAN, chairman and managing director of Messrs. Redpath, Brown & Co., a firm of structural steel engineers, which has works at Greenwich, said that at his Edinburgh works it was cheaper for him to throw out all his private generating plant and take current from the Corporation at 1½d. per unit. In London he was, until early this year, under an agreement with the Blackheath and Greenwich Company for a supply at 2d. per unit for all power taken up to 5 p.m., and between 5 p.m. and 10 p.m. 5d. per unit. This had been thought prohibitive, and a private plant was being put down. If this company were authorised, he would be willing to scrap his plant and take energy from them if he could get it at 1d. or 1½d. He was also subscribing to the preliminary expenses of the bill, and was further prepared to take shares in the company when it was incorporated.

After a lengthy cross-examination on behalf of the numerous petitioners, during which it was elicited that Mr. Cowan knew nothing of the promoters,

* I must assume that Marconi has only gradually conceived the real method of working of the oscillating circuit, the different possible uses of which I gave as long ago as 1898. At least this appears to me to follow from the circumstance that he applied for a patent for the inductive arrangement in 1900 and for the direct arrangement in the following year. In any case he cannot have succeeded in his first experiments, to which he has occasionally alluded, and it is not surprising that he abandoned it. At the time of his patent application my English application had already been published for several months.

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The Hon. J. D. FITZGERALD, K.C., for the Bermondsey Borough Council, asked that the promoters should be called upon at once to produce their financial evidence.

Mr. ACWORTH, for the promoters, objected to this, and said that no one supposed the promoters could find £2,000,000 to start with.

The CHAIRMAN said he would allow the bill to pursue its normal course for the day. The question raised would be decided later.

Mr. E. J. BOAG, who represented a large number of manufacturers in Stratford, said he had had an offer from the West Ham Corporation for a supply at 1½d. per unit, but he considered at this price it would not pay him to abandon steam working. He would not give up steam unless he could have electricity at 1d. per unit. He knew nothing about the promoters of the bill.

Mr. F. C. HILL, representing Messrs. Lock, Lancaster & Co. and the London Lead Smelting Co., with works at Poplar and Stepney, also gave evidence in support of the bill. He was paying 2½d. per unit to the Poplar Borough Council, but considered this prohibitive. He had had no communication with the promoters of the bill.

The CHAIRMAN here stated that the Committee would consider the financial evidence on the next morning.

Yesterday (Thursday) financial evidence was called.

Mr. FALCONER, a solicitor practising in Edinburgh, and chairman of the Mersey Railway Co., said that on the whole he had never come across a scheme with greater prospects of success. At the present moment, the cost of generating electricity for the Mersey Railway sent out of the generating station, but without depreciation and sinking fund, was 0·26d. per unit, but with this he was not satisfied. He himself was willing to go upon the board of the East London Power Company if the bill were passed in its present form, with the clause giving the Board of Trade power to dispense with the local consent in the event of its being unreasonably withheld. Other gentlemen who would go upon the board were Messrs. Cowan, Earle, and A. A. Campbell Swinton. Personally, he had no doubt that the capital could be raised for the scheme as it was promoted.

Under cross-examination, Witness said that the board would now consist of the gentlemen mentioned and Mr. Rigby, one of the original promoters. The gentlemen whose names were mentioned in the bill would not go on the board. He had made no arrangements with any financial house in connection with this bill.

Mr. BALFOUR BROWNE pointed out that all the gentlemen whose names appeared in the bill, with the exception of Mr. Ironside Bax, remained as promoters, but they had power to add any additional names.

In answer to the CHAIRMAN, Witness said his support was conditional upon the granting of the whole of the area scheduled, and would not hold good if any portions were struck out. If the Committee decided that supply should be given for power purposes only he would have to consider his position somewhat. It would be very difficult to get manufacturers to take supply for two purposes from two different sources. He agreed that it would be necessary to raise two-thirds of the capital at once, in order to give a supply both on the north and on the south of the Thames. Upon this basis he was convinced the necessary money could be raised, but this opinion was not formed upon actual promises.

Mr. LYNDEN MACASSEY, for the promoters, pointed out that it was the intention to lay cables across the river, so that only one generating station would be necessary at first, and, therefore, the amount of capital which would be required initially would not be so large as two-thirds.

Mr. PRITCHARD, of Messrs. Dolman and Pritchard, explained the history of the negotiations of the promotion.

Mr. H. A. EARLE, of Messrs. Mather and Platt, and also a director of the Yorkshire Electric Power Co. confirmed the views of the previous witness. With regard to the Yorkshire Power Company they had started operations with £450,000, and it was anticipated that 5 per cent. would be paid upon that. The area in Yorkshire was 1,800 sq. miles. When the Yorkshire Bill was before Parliament, no financial evidence had been demanded. The promoters had voluntarily left out of their area Sheffield, Leeds and Bradford.

It was here pointed out that the Yorkshire Act contained a clause preventing the company giving a supply in any area for which electric lighting powers had been granted to the local authority without the consent of the municipality, such consent not being subject to dispensation by the Board of Trade.

In answer to the CHAIRMAN, Mr. Earle stated that if such a clause were put into the East London Bill he considered the scheme would be worthless. The Yorkshire scheme was formed under special circumstances, as originally there were two competing schemes, each bidding for the support of the local authorities.

Under cross-examination he agreed that the contractors for the Yorkshire scheme received part payment in shares, and that only one-quarter of the capital had been found by the public. But this was often done in connection with such large undertakings.

The CHAIRMAN at this point asked that the room should be cleared, and after a short interval parties were re-admitted.

The CHAIRMAN said the Committee would like to have some witnesses who were prepared to substantially support the scheme, and not so many witnesses who were promoters.

Mr. BALFOUR BROWNE said he would call such a witness at once.

Mr. C. H. MERZ, consulting engineer to the Newcastle-upon-Tyne Electric Supply Co., said that he was prepared to financially assist the scheme personally, and also to recommend it to his influential friends on the Tyne who were interested in the Newcastle scheme. Some months ago he had been consulted about this scheme, but had then not been satisfied with the conditions attaching to it. As a scheme he had always felt that there was a large field for electric power distribution, and now that the promoters were not hampered by any conditions he was able to again support the scheme. He had no hesitation in saying that he could induce some 50 or 100 persons to place £2,000 or £3,000 each as a nucleus to the necessary capital. Such a fund would be a very strong recommendation to the public.

By the CHAIRMAN: If any of the area were struck out of the bill he he would not advise the promoters to proceed with the scheme.

Would you be prepared to support the scheme if we put a maximum of 1½d. per unit in the bill?—If it was an absolute decision by the Committee I would, but I should like to put reasons before the Committee why this should not be done.

That is not the question. I think I understand your answer.

The CHAIRMAN then asked what other witnesses were being called.

Mr. MACASSEY said he would call a director of the Thames Ironworks Company, which company required a large supply of power, and also offered to take a contract for the erection and equipment of the generating station at cost price and to take the profit in shares.

The Chairman objected to such a witness for the present.

The promoters then proposed to call Mr. Campbell Swinton, who was a director of the company, and the chairman agreed.

Mr. A. A. CAMPBELL SWINTON said he was connected with several electrical undertakings in connection with some of which he had arranged the finance. He could find a considerable sum of money himself, and he had many influential friends who were interested in electrical schemes. Probably he could underwrite or get underwritten £50,000.

The Chairman was still not satisfied that the financial evidence was that which the Committee desired, and adjourned in order that the promoters might put the principal promoter in the witness box.

We may point out that a supply of electricity by the municipality is given in the following districts which are included in the area of the bill:—Ilford, Hackney, Romford, Leyton, West Ham, East Ham, Stepney, Woolwich, Grays, Poplar and Barking. In Greenwich and Deptford a supply is given by companies, and a municipal scheme is in hand for Bethnal Green. There only remain, therefore, Woodford, Wansted, Romford (Rural) and Orsett, in which no supply is provided for.

OTHER ELECTRICAL BILLS.

In the House of Commons on Tuesday, the *Southill Nether Urban District Tramways Bill* was read a third time.

The Wandsworth Borough Council has deposited a petition in the House of Commons in favour of the *Electric Lighting (London) Bill*.

The *Lincolnshire and Yorkshire Electric Power Bill* has been withdrawn for this session owing, it is stated, to opposition by the local authorities. The bill proposed to supply electricity in "bulk" in large portions of Lincolnshire and Yorkshire, the capital being £990,000 in £10 shares, with borrowing powers to the extent of £533,000. Land was scheduled for three generating stations. It was also sought to empower the company to lay overhead cables with the consent of the public authorities.

PRIVATE BILL LEGISLATION.

In the House of Commons on Tuesday,

Mr. LEWIS asked the first Lord of the Treasury whether the Government would propose a revision of the standing order regulating the scale of House fees charged to public authorities in respect of bills and provisional orders introduced by them.

Mr. BALFOUR said it was hoped to initiate further reforms in the direction indicated, but the fees referred to formed a very small fraction of the total cost of bills.

GAS COMPANIES AND ELECTROLYSIS.

Barnet Gas and Water Company's Bill.

Captain Jessel's Committee of the House of Commons considered this bill yesterday. The chief objects are to raise extra capital and to construct additional works. Clause 49 is interesting however, and reads as follows:—

"If any injury or damage occur to the mains, pipes or works of the company by fusion or electrolytic action, caused by any electric currents generated or used by any county borough or district council or any other body, company or person for the purpose of electric traction or electric lighting or other analogous purposes, such council, body or person shall make full compensation to the company for any such injury or damage."

In discussing the method of procedure the Chairman decided to consider the clause by itself, and, in the meantime, the remainder of the bill is being proceeded with.

THE POST OFFICE AND WIRELESS TELEGRAPHY.

In the House of Commons yesterday (Thursday) Sir J. LENG asked the Postmaster-General if he could now state what arrangements had been made with the Post Office for facilitating the receipt and forwarding of Marconi telegrams.

Lord STANLEY: Negotiations on the subject are still in progress. It will, however, be quite impossible to give the information the hon. member seeks by way of question and answer, but I hope during the course of the session to make a statement on the subject of wireless telegraphy generally and the arrangements which I hope to conclude with the Marconi Company in particular.

Exhibition.—There is to be held on the Hampton Roads, Jamestown, Norfolk, U.S.A., in 1907, an international exhibition to celebrate the 300th anniversary of the first permanent settlement of Anglo-Saxons in America. It is stated that the exhibition is likely to prove an important naval function, as the United States Government will invite ships of all nations to assemble in the Roads.

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LEGAL INTELLIGENCE.

Legal Causes.

The following cases with an electrical interest have been set down for hearing at the Royal Courts of Justice, London, during the Easter sittings:—

COURT OF APPEAL.

CHANCERY DIVISION.—*General List.*

Patent Exploitation (Ltd.) *v.* American Electrical Novelty, &c. Co. (Ltd.) (Appeal of plaintiffs from order of Mr. Justice Buckley, dated June 24, 1903.) (S.O., not before judgment given in the House of Lords by the same petitioners *v.* Siemens Brothers & Co. Original motion stand over from Dec. 19, 1903, by order.)

Knight *v.* Isle of Wight Electric Light and Power Co. (Ltd.) (Appeal of defendant company from order of Mr. Justice Joyce, dated Jan. 20, 1904.)

KING'S BENCH DIVISION.

New Trial Paper.

Cole *v.* Isle of Thanet Electric Tramways and Lighting Co. (Ltd.). (Application of defendants for judgment or new trial on appeal from verdict and judgment, dated Nov. 6, 1903, at trial before Mr. Justice Bigham and a special jury.)

Exchange Telegraph Co. (Ltd.) *v.* The B.D. Syndicate (Ltd.) and others. (Application of defendants, Mellis and Wyman, for judgment or new trial on appeal from verdict and judgment, dated Dec. 3, 1903, at trial before Mr. Justice Walton and a special jury.)

Wethered *v.* Motor Mfg. Co. (Ltd.). (Application of defendants for judgment or new trial on application from verdict and judgment, dated Feb. 19, 1904, at trial before Mr. Justice Wills and a special jury.)

Telegraph Construction and Maintenance Co. (Ltd.) *v.* F. W. Berk & Co. (Ltd.). (Application of defendants for judgment or new trial on appeal from verdict and judgment, dated Feb. 12, 1904, at trial before Mr. Justice Lawrence and a special jury.)

CHANCERY DIVISION.

Before Mr. Justice Kekewich.

General Electric Co. (Ltd.) *v.* Fryer. (Action, with witnesses.)

Before Mr. Justice Buckley.—Companies winding up.—Petitions.

Electric Tramways Construction and Maintenance Co. (Ltd.) (Petition of A. J. Paine. S.O. from Jan. 12 until summoners disposed of.)

National Electric Traction Co. (Ltd.). (Petition of W. G. Skipworth. S.O. from March 1 to April 19.)

Ferranti Limited. (Petition of Estler Bros. S.O. from March 22 to June 28.)

H. Sutton & Co. (Ltd.). (Petition of James Hinks & Sons, Ltd. S.O. from March 30 to April 19.)

Court Summonses.

Electric Tramways Construction and Maintenance Co. (Ltd.) (To stay proceedings. S.O. from March 1 to 14 days after action disposed of.)

Before Mr. Justice Joyce.

Ward *v.* Isle of Wight Rural District Council. (Action, with witnesses.)

KING'S BENCH DIVISION.

Crown Paper.

New St. Helens Tramways Co. *v.* Prescot Union and others. (Quarter Sessions—special case under 12 and 13 Vict. c. 45, sec. 11 rating.)

Civil Paper.

National Electric Wiring Co. *v.* Miller. (County Court Appeal. Plaintiffs' appeal from judgment of Judge Smyly.)

Special Juries.

Craven *v.* British Automobile Commercial Synd. (Ltd.). (Detinue.)

Non-juries.

Barrow *v.* National Telephone Co. (Trespass.)

Copley v. Mayor and Corporation of Leeds.

On Wednesday a Divisional Court (the Lord Chief Justice and Justices Wills and Channell) heard the appeal of defendants from a judgment of Judge Greenhow at Leeds County Court. Plaintiff, who had been injured by a Corporation tramcar, sued defendants for compensation. The Public Authorities Protection Act, 1893, was pleaded, as the claim for compensation was not made within six months of the accident. The County Court judge held that the words in sec. 1, sub-sec. (*a*) of the act, "In case of a continuance of injury or damage," were not apt words to express a continuing or recurring cause of action, whilst they did exactly express the continuance of injury or damage resulting from the act complained of. His Honour considered it might well have been intended that the action need only be brought within six months of the cessation of injury or damage, since frequently the symptoms of really serious damage did not develop or even manifest themselves at all until many months after the original injury. His Honour found for plaintiff for £25, an agreed sum.

After argument, the LORD CHIEF JUSTICE, in delivering judgment, said the construction put upon the words of the act by the County Court judge, if upheld, would amount to there being no limit at all put to the time of bringing these actions. The learned judge was clearly wrong. The point had been fully discussed in "Carey *v.* The Mayor of Bermondsey," where the law was clearly laid down.

The appeal was allowed, and the action dismissed with costs.

Workmen's Compensation,

In the Court of Appeal on Wednesday (the Master of the Rolls and Lords Justices Romer and Mathew), the hearing was concluded of the appeal of the Failsworth Industrial Society against an award of the judge of Oldham County Court, under the Workmen's Compensation Act, 1897, in favour of the widow of a bricklayer who was killed by lightning while working on some buildings which were being erected by defendants. The facts were reported in our issues of Oct. 30 and Nov. 27, 1903. The question was whether the man's death was due to an accident arising out of his employment within the meaning of the act. The county court judge held that it was.

After hearing counsel for appellants, the MASTER OF THE ROLLS gave judgment, and said it was a perfectly clear case, not in itself, but from the extremely lucid judgment of the county court judge, who had properly stated the law in regard to the matter when he said that if he came to the conclusion that the position in which the man was employed was dangerous, and that in consequence of that dangerous position the accident occurred, he would be entitled to hold that the accident arose out of the employment. The learned judge came to the conclusion that in the position in which the man was his risk of being struck by lightning would be abnormal, and it seemed to him (the Master of the Rolls) that there was ample evidence to justify that finding.

The other Lords Justices concurred, and the appeal was dismissed, with costs. A stay of execution pending an appeal to the House of Lords was refused.

Shipley v. Bryan Donkin and Clench (Ltd)

In the Chancery Division on Tuesday Mr. Justice Joyce appointed a receiver and manager of this undertaking, with liberty to act at once.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Radio-Activity." By E. Rutherford, F.R.S. (Cambridge: University Press. London: C. J. Clay & Sons.) 10s 6d. net.

"Electricity and Matter." By J. J. Thomson, F.R.S. (London: Arch. Constable & Co., Ltd.) 5s. net.

"Proceedings of the Royal Society," No. 492. Vol. LXXIII. (London: Harrison & Sons.) 3s.

"Die Elektrolytische Raffination des Kupfers." By Titus Ulke. Translated by Viktor Engelhardt. (Halle: Wilhelm Knapp.) 8m.

"La Télégraphie sans Fils." By André Broca. (Paris: Ganthier-Villars). 4fr.

"The Assuan Reservoir and Lake Mœris." By Sir William Willocks. (London: E. and F. N. Spon.)

"Elektrische Kraftübertragung in Berg-und Hüttenwerken." (Berlin: Allgemeine Elektricitäts-Gesellschaft.) 1904.

"Some Features of American Education." By Robert Blair (Dublin: Alex. Thom & Co.)

"Technological and Scientific Dictionary." Part I. Edited by G. F. Goodchild and C. F. Tweney. (London: George Newnes.) 1s.

"Elementare Vorlesungen über Telegraphie und Telephonie." By Dr. Richard Heilbrun. No. 6. (Berlin: G. Siemens.)

MUNICIPAL, FOREIGN, & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Governors of Woolwich Polytechnic require a head of the department of mechanical and electrical engineering, also first and second assistant; acting head of department of mathematics and experimental physics, also senior and junior lecturers and demonstrators; head of department of chemistry and metallurgy and assistant lecturer and demonstrator. Further information is given in an advertisement. Particulars of duties and conditions of appointment from the principal, Mr. Wm. Gannon, M.A. Applications to the principal by April 26.

Preston Tramways committee require a chief assistant to act under the engineer and manager of their tramways department at a salary of £200 per annum. Applications to the engineer and manager (Mr. Walter H. Tittensor), 25, Burrow-road, Preston, by April 16. See also advertisement.

There is a vacancy for a pupil at the Cromer electricity supply station. Applications to the manager. See advertisement.

A competent designer of alternate-current generators, motors and transformers is wanted by Messrs. Vickers, Son and Maxim, River Don Works, Sheffield. Applications to electrical department. See advertisement.

An assistant lecturer and demonstrator in engineering is required at Merchant Venturers' Technical College, Bristol. Salary £170, which may raise to £220. Particulars from the Registrar, to whom applications by April 30. See advertisement.

A cable jointer is wanted for the Newport (Mon.) electricity works. Applications to Mr. H. Collings Bishop. See advertisement.

The Municipal Commissioners of Singapore (Straits Settlements) require an electrical engineer, with experience in the management

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of three-wire continuous-current supply station, and qualified to superintend the laying and maintenance of underground cables, &c. Appointment is for three years, at £360 for first, £390 for second and £420 for third year, with transport allowance. Applications to Mr. C. C. Lindsay, M.Inst.C.E., 217, West George-street, Glasgow, by April 19.

A lecturer and demonstrator in electrical engineering is required at the School of Engineering, Electricity and Technical Science, Canterbury College, University of New Zealand. The appointment will be for three years; salary, £300. Particulars, &c., from the Agent-General for New Zealand, 13, Victoria-street, London, S.W. Applications by 28th inst. See advertisement.

Yorkshire Electric Power Co. require an engineer to supervise laying of high and low-tension mains and take charge of distribution. Applications by 16th inst. to Mr. W. B. Woodhouse, Central Bank chambers, Leeds.

Mr. Percy Longmuir, of University College, Sheffield, has been appointed Junior Assistant in the metallurgical department of the National Physical Laboratory.

Mr. Longmuir is a pupil of Prof. Arnold, and has for two years been engaged in research as a Carnegie scholar of the Iron and Steel Institute. He will at present assist Dr. Carpenter in carrying on the work undertaken by the Laboratory for the Alloys Research Committee of the Institution of Mechanical Engineers.

Portsmouth Corporation have appointed Mr. A. A. Moncreaff chief inspector of weights and measures, gas examiner and electric meter inspector at a salary of £190 per annum.

Mr. E. Lafferty, of Bradford Corporation tramway department, has been appointed traffic manager of Preston Corporation tramways.

Mr. M. B. Henry, of Nelson, Lancs., has been appointed electrical engineer to Radcliffe District Council.

Hull Tramways committee has reorganised the staff at the power station. Mr. W. T. Robson, acting chief assistant, is appointed rolling stock electric assistant at £150 per annum; Mr. N. H. Dadson, outside electrical equipment assistant at £120; and Mr. C. D. C. Cummins power station electrical assistant.

Ayr.—The Council will apply for powers to borrow £15,000 for extensions of the electricity undertaking. The burgh electrical engineer (Mr. Roland Marshall) reports that during the past year the number of equivalent 8 c.p. lamps connected increased by 48 per cent. and that this year the increase so far had been greater than ever.

Barnes.—On Tuesday the Council decided to reduce the charge for electrical energy for power, heating, &c., from 3d. to 2d. per unit.

Belfast.—The directors of the Belfast Street Tramways Co. have replied to the recent offer of the Corporation to purchase their undertaking. They agree to accept the actual cost of the Sydenham and Ligoniel lines, plus 10 per cent., and to take 3¼ years' purchase for the unexpired term of the lease expiring in August, 1907. The directors insist that the average profits be calculated on the basis of the last seven, and not the last five, years, but agree to accept 4½ per cent. instead of 5 per cent. as originally asked for the purchase-money unpaid on Jan. 1. The Corporation offered 4 per cent., and have now submitted revised proposals.

The Council have received sanction to a loan for extensions of the electricity mains in the Knock district.

Birmingham.—At the meeting of the City Council on Tuesday, Mr. G. H. Johnstone moved the adoption of the report of the Electric Supply committee, abstracted in our last issue, and proposed—

"That the Local Government Board be asked to cancel their sanction to the loan of £251,973. 11s. 2d., authorised by the Council on July 31, 1901, so far as relates to the unexpended portion of such loan, amounting to £167,776. 14s. 1d; that the Finance committee be instructed to apply for the necessary sanction to the borrowing of £441,142 for the first equipment of Summer-lane generating station, sub-stations, underground cables and meters, and that, subject to such sanction being obtained, the Electric Supply committee be authorised to proceed with the work."

Mr. Johnstone reminded the Council that in July, 1901, having sanctioned the purchase of a site for the generating station, they sanctioned the borrowing of a large sum of money for the equipment of the site, the erection of one sub-station and the laying down of various mains, &c. It was then believed by the committee that they were providing for the supply of power for the tramways which fell in in 1906, but they soon found that that was not the case, and that they had only included the power for the Edgbaston and Harborne tramways, which the Tramways committee projected, and also for the short length of 1 mile on the Steelhouse-lane route. If the 1901 scheme had been proceeded with, the committee would have been obliged to come to the Council again with proposals for the larger mileage of tramways which fell in in 1906. Of the expenditure sanctioned in 1901, £41,909 had been spent on Water-street extensions, £23,174 was expended on the purchase of the Summer-lane property, £1,170 in clearing the site, &c., £58. 10s. on architects' commission, £2,021 for a sub-station in Court-road, £14,863 on mains and £1,000 on meters. As regarded the Summer-lane loan, only £1,170 of the authorised loan had been spent, and the committee now asked the Council to cancel everything else they had sanctioned in respect to that loan. Mr. Chattock, who succeeded Mr. J. C. Vaudrey, went to work on practically the same lines as Mr. Vaudrey, but on a wider basis. Between 1901 and 1903 the tramway ideas in the city were largely developed, and Mr. Chattock began by assuming that sooner or later all the main arteries out of Birmingham would become tram routes. The committee were strengthened by the Tramways committee asking them to provide for their requirements for tramway traction. They were advised that an expenditure of £510,000 would be ultimately necessary to thoroughly equip the Summer-lane site for electric power purposes. The only difficulty was in keeping distinct what was proposed to be spent on the equipment of the power station and what was proposed to be spent on the sub-stations, mains, &c. £510,000 was the ultimate figure for completing the equipment of the power station itself, and it was proposed to spend at present £260,620. The ultimate cost of the building was £130,000, leaving £380,000 for the plant, &c. Of the latter sum the committee were asking for sanction to expend £144,000, leaving £235,000 to be spent at some future time. He believed their electricity department was capable of great expansion. The city was only on the fringe of electric lighting, and the committee hitherto had only been restricted by the inadequacy of the output. When Mr. Chattock first presented his scheme the committee struck out all matters that were not urgent. The figures had been brought down to the lowest point, having regard to efficiency, and he believed that a good bargain was being made for the city.

Mr. Walthall drew attention to the great difference between the scheme of 1901 and the present scheme. He would like to know what the total cost of the present scheme was to be, and also the real reason of the vast difference in the amounts of the two schemes. Was it that the department now had a manager who was fully alive to the necessity for pushing forward electricity supply, and of making Birmingham an up-to-date city in every respect? He would support the scheme if that were so, but not if he thought the Gas committee intended to persist in their scheme for the expenditure of £500,000 which was rejected by Parliament last year. With regard to the tenders, he alluded to one particular case in which an outside firm was preferred, although their tender was £1,574 higher than that of a local competitor, and inquired why that preference should be given.

Mr. Tonks asked at what rate the money would be borrowed, and what probability there was of the electric supply making a profit.

Mr. Nettlefold asked if the surplus was obtained after writing something off for depreciation of machinery.

Mr. Kenrick inquired whether gas engines would be used for motive power in the new station.

In reply, Mr. Johnstone stated that the Gas and Electric Supply committees were working together in harmony. There was abundant room for both. There would only be finality in regard to the undertaking when there was finality in the growth of the city of Birmingham. As to the tenders, they accepted those which they thought would be most advantageous. Provision for the Edgbaston and Harborne tramways was not included in the scheme. They were going to borrow the money on favourable terms, although the present was admittedly not a good time to negotiate for loans. The committee felt that the undertaking was far too large to trust to gas engines. They were advised that steam plant was the safest. The present scheme might have been greatly curtailed, but if so the committee would in the near future be compelled to ask for authority for extensions.

The recommendation was then adopted, and the Electric Supply committee were empowered to engage Mr. E. Harper as architect for the buildings for the Summer-lane station, and the Finance committee received authority to borrow £5,356 for improvements at the Water-street generating station and for sundry lighting mains and services.

Blaydon.—The Council have had offers from the Priestman Power Co. and the County of Durham Electrical Power Distribution Co. to supply electrical energy in the district. Neither proposal has been accepted.

Bridgwater.—The corner-stone of the electricity station buildings was laid by Ald. Peace, the chairman of the Bridgwater and District Electric Supply and Traction Co., on Tuesday.

Brighton.—The Corporation have applied for sanction to a loan of £6,000 for purchasing electric motors, &c., to be let on hire.

Burslem.—The Council have applied for sanction to a loan of £21,000 for the erection of additional electricity works. The electrical engineer (Mr. Clarke) has reported in favour of steam-driven plant.

Cheltenham.—At the last meeting of the Council the borough electrical engineer (Mr. Hamilton Kilgour) presented his estimates for the current year as follows:—Income £17,200, expenditure £9,800, surplus £7,400 against £6,780 last year. There are now nearly 48,000 8 c.p. lamps connected to the mains.

A special meeting of the Council was held on Friday to consider recommendations from the Lighting committee to increase the charge for public lighting from 2·27d. to 3d. per unit, which represented an aggregate increase of £2,532 per annum for public lighting. The Council were also recommended to give notice to the Light Railway Co. to determine the agreement for the supply of current to the company for traction (at present 1·9d. per unit up to 100,000 units per annum), in order that a fresh agreement might be entered into.

The Chairman of the Committee (Ald. Norman) said that if money and coal remained at the price as when the undertaking was started 10 years ago more than £1,500 per annum would have been saved upon interest and £1,000 a year upon coal. They had decided to prevent further accumulations, and hence the necessity for a revision of the charges. Originally the committee resolved to increase the charge to private consumers

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as well as for street lighting, but they had dropped that part of their proposa's because they feared it might have the effect of lessening demand.

Mr. LEY WOOD criticised generally the management of the undertaking and suggested that the reasons for its comparative failure were: – (1) That certain of the provisional orders imposed undesirable obligations upon the Council in some respects, and therefore these should not have been asked for. (2) That there had been a reckless expenditure of capital. (3) That there had been reckless extravagance in street lighting; and (4) that there had been lack of management and forethought.

In reply, Ald. NORMAN described Mr. Wood's statement as a travesty of the facts.

The committee's recommendation were adopted.

Claremont (Western Australia).—The Council, who propose to raise a loan of about £7,000 for electricity supply, are recommended to accept the tender of Mr. J. Barre Johnston, Fremantle, at £5,385 for generating plant, &c. The price of current to private consumers is to be 8d. per unit.

Croydon.—The electric lighting mains are to be extended at a cost of about £300.

Dorchester.—The Council on Tuesday deferred consideration of a recommendation by the Lighting committee, "that, as the electric supply scheme is practically dead, the borough electrical engineer (Mr. W. J. U. Sowter) be given a month's notice of the termination of his engagement." Mr. Sowter claims compensation, as he left a former appointment on the understanding that the scheme would be carried out.

Dublin.—On Monday the Lighting committee submitted to the Council their report on the tests of the engines at Pigeon House electricity works. This report was referred to in our last issue (p. 974) and the chairman of the committee (Mr. Irwin) now moved:—

1. That this Council, having considered the Lighting committee's report, approve of their action in refusing acceptance of the engine portion of the generating plant, and hereby give the contractors a further period of nine months from this date, and such further extended period (if any) not exceeding in all 12 months from this date, as the Lighting committee may determine, to fulfil their contract, but subject in all other respects to the terms of the specification and general conditions of the existing contract, and provided that the contractors undertake at their own expense, and to the satisfaction of the committee, to maintain the plant in such a condition as to be capable of affording an uninterrupted supply of energy up to the full contract working capacity and output for the proper working of the system during the period hereby given for completion of contract, pending which the contractors shall be responsible for all loss and damage sustained by the Corporation by reason of any interruption of the supply or any portion thereof.

2. That the Lighting committee invite tenders for the supply and erection of a set of generating plant not exceeding 1,500kw., and that in case the committee consider any tender of the General Electric Co. the most favourable, this Council accept the terms contained in the paragraphs numbered (1), (2) and (3) of the contractor's letter of March 31, 1904, subject to the approval of the Local Government Board and to the said terms being carried out by a separate contract between the Council and the contractors, the committee to so vary clause 3 of the said letter as they may deem necessary to prevent any delay in completing the original contract, and so as to prevent any waiver of the terms of the original specification and general conditions of the existing contract.

3. If the terms of this resolution are not accepted in writing by the contractors and their sureties within seven days from this date, and all necessary contracts entered into by them as contemplated by this resolution within 14 days of the furnishing of the drafts of same (or within such further time as the committee may determine), or if such contracts when entered into are not fully carried out by the contractors, then the committee is hereby directed to put the terms of clause 41 (*b*) of the original conditions of contract in force.

4. The terms of the resolution (save the provision for putting clause 41 (*b*) of the conditions of contract into force should the terms of this resolution not be accepted, and all necessary contracts entered into as aforesaid are not to be of any force or effect whatever unless and until the sureties for the contractors shall agree to and be bound by the terms hereof in such a manner as shall be approved of by the committee and by the law agent, and so that such sureties shall not only not be discharged under the original bond, conditions and contract, but shall become and be sureties for the due performance by the contractors of the terms of this resolution, and the contracts to be executed in pursuance of such terms.

Mr. IRWIN said the committee received Mr. Hammond's report upon the tests at their meeting of March 22; nine days later they had arrived at a solution, and two days thereafter they had their report printed and posted to every member of the Council. Neither the committee nor its chairman was resposible for the particular make of engines selected in combination with the Oerlikon alternators. The General Electric Co., a firm of high standing and repute, offered to the original committee four different makes of engines (those of D. Stewart & Co., which were the cheapest; Combe, Barbour and Combe; Cole, Marchent and Morley, and Hick, Hargreaves & Co.) at prices for the combined plant ranging from £33,000 to £44,000. Mr. Hammond recommended the acceptance of the lowest of the offers, stating that under his very tight specification and the careful inspection which the plant would receive from him during the course of manufacture, he believed Messrs. Stewart & Co. could be relied on to turn out a satisfactory job. Accordingly, the then committee brought up report No. 107 (1900), which was adopted on August 27, 1900. The history of these engines from the time they were put to work was well known to some members of the Council, and to those who had them under almost daily observation there appeared to be no other course open to Mr. Hammond than to reject them. The question as to whether or not they can be so rebuilt or reconstructed as to bring them into exact compliance with the specification was one that they expressed no opinion upon, but they considered it only right that the contractors-in-chief (General Electric Co.) should be afforded an opportunity of themselves trying to do so under the direction of their own engineers, for they could not interfere with the sub-contractors, of whom the Council had approved until they had officially rejected the engines. They could entertain no proposal of reconstruction of the existing engines which did not include a provision for at once laying down a complete new set of plant of such capacity as would enable them, with whatever assistance they could get from those of the present sets as would not be dismantled at the time, to carry on without interruption the full supply required by the city, which, judging by the experience of last season and the number of consumers which were being connected, would be largely in excess of last winter. They had been advised by their law agent and town clerk that there were legal difficulties in the way of adopting the proposal of the General Electric Co. as it was set forth in their letter without publicly advertising for tenders. This point had been overcome by arrangement with the chief contractors. The General Electric Co. had met them fairly, and had admitted frankly that the committee were justified in rejecting the engines, and endorsed their want of confidence in their sub-contractors. The terms of the original contract still obtained, and ample provision was contained therein to indemnify the Corporation against any pecuniary loss sustained by reason of granting further time, carrying out fresh tests and so forth. It was only fair to state that the electric generating plant of Oerlikon make supplied by the General Electric Co. had given every satisfaction, and the General Electric Co. had undertaken to replace every single part of the engines which had been found to be defective, and, if necessary, re-design them. Of course, under Mr. Hammond's original agreement with the Corporation, he was still bound under his retainer and commission of 5 per cent. upon the value of the works executed under his scheme until each and every one of the original contracts had been carried out to the committee's satisfaction, including the reconstruction or replacement, as the case may be, of the four existing engines, and the Corporation would not be put to any additional expense in that connection by reason of granting that extension of time to the chief contractors.

After a brief discussion the report was adopted without a division.

Dundee.—As the estimates of the tramways department for the current year show a deficit of £620, the tramway manager (Mr. P. Fisher) has submitted observations on the question of the abolition of ½d. fares.

Mr. Fisher says that only seven corporations in the kingdom have ½d. fares over their whole system. A year's receipts on 13 of the principal provincial tramway systems, two of which took ½d. fares only on part of their lines and the remainder no ½d. fares, were £618,790 received from 115,523,504 passengers, but on the Dundee system the receipts were £42,005, whereas on the average given of the 13 places mentioned they should have been £56,991. Working costs per car-mile in Dundee were 4·80d., and in 18 other large towns mentioned by Mr. Fisher from 5·84d. at Blackpool to 4·03d. at Bolton. Dundee, however, had heavy gradients and a consequently considerable expenditure on brake testing and inspection. He suggested that current should be supplied to the tramways at cost. The annual payments to the tramway company (which would terminate in 1910) would be until 1907 £1,490. It might be considered whether these payments should not be made out of capital, and whether capital account should not be debited with similar payments already made from revenue. In this way it might be possible to continue the ½d. fares.

Electric Traction on Railways.—The chairman of the Belfast and County Down Railway Co. (Mr. Thomas Andrews) has asked Messrs. Dick, Kerr & Co. the contractors for the electrical equipment of the Liverpool-Southport section of the Lancashire and Yorkshire Railway, to submit estimates, &c., of the cost of converting the line between Belfast and Bangor (Co. Down) a distance of about 12 miles.

Messrs. T. R. Thompson and Robert Forrest (directors of the Barry Railway Co.), together with the general manager (Mr. R. Evans), the engineer (Mr. Waddell) and the locomotive superintendent (Mr. J. H. Hosgood) have started on a visit to the Continent to study electric traction on Continental railways.

Electrical Standardising, Testing and Training Institution.—As a result of the recent scholarship examination, Leonard Van Vestrant, of the Grammar School, Wellingborough, has been awarded a Faraday Scholarship of 80 guineas per annum, tenable for two years.

Electricity in Mining.—An arsenic mine, said to be the largest mine of the kind in the world, turning out 70 tons per month, is established at Floyd County, Virginia, U.S.A. The entire plant, which is of the most modern character, is driven entirely by electricity. The "camp" round the mine, which employs 125 persons, is lighted electrically.

In the report of the Ooregum Gold Mining Company for the past year the directors repeat the observations made by the directors of the Nundydroog Co., which appeared in our issue of April 1, p. 961, extolling the merits of the electricity supply from

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the Cauvery Falls, and expressing the view that the demand is likely to prove in excess of the supply for some time to come.

Electric driving plant is being installed in the Cathcart Proprietary Mine, Ararat, Victoria.

Elland.—An inquiry has been held into the application of the Council for sanction to borrow £4,000 for electric lighting extensions. The consulting engineer (Mr. W. Emmott) gave technical details. The local gas company opposed.

Fatality.—A young man was angling in the Peffry (Ross-shire) on Friday last, and climbed a pole to disentangle his line, which had caught on the Dingwall overhead electric lighting main, which transmits current at 3,000 volts. He accidently touched the main and was killed instantly.

Felixstowe.—The Council last week authorised extensions of the electricity works at a cost of £650, and the purchase and laying of two new feeders at a cost of £1,200.

Glasgow.—The convener of the Tramways committee (Mr. W. Paton) announced at the Corporation meeting last week that 12 covered tramcars would be placed on the streets as an experiment. These double-deck cars would carry 64 persons, and by occupying some of the standing room about 70 passengers could be carried. During the two or three weeks that an experimental double decked car had been running the fares taken amounted to £1 a day more than from any other car on the route. In Liverpool the drawings from covered cars worked out at an increase at the rate of £200 per car per annum compared with uncovered cars. That showed that there was a large source of revenue in the covered cars.

Glasgow and West of Scotland Technical College.—As a result of the recent final examinations the following diplomas have been awarded :—

In the department of electrical engineering—A. N. Aikman, G. B. Clerk, F. H. Downie, D. Money and C. Urquhart. Mr. Downie has also gained the Sir John Pender gold medal and bursary, which are awarded annually to the best student who obtains the college diploma of electrical engineering. This medal is of the value of £5. 5s. and the bursary is of the value of £40, tenable for one year at Glasgow University.

Gorton.—The District Council have agreed to hand over their electric lighting order to Manchester Corporation for £500.

Gosport.—In reply to an inquiry by the Board of Trade, the Council notify that steps are being taken to comply with the provisions of the Gosport electric lighting order 1900.

Heckmondwike.—On Monday the Council decided to purchase additional plant for the electricity works at a cost of about £5,000.

Hereford.—Sanction to a loan of £500 (repayable in 17 years) for electric lighting extensions has been obtained by the Council.

Hornsey.—Mr. J. R. Farquharson has been appointed chairman of the Electricity Supply committee. Sanction has been received to a loan of £37,333 for electric lighting extensions.

Hove.—The Council are recommended to light the western district electrically, taking current either from Brighton Corporation or the Hove Electric Lighting Co.

Huddersfield.—The municipal tramways have earned during the past year £63,045, an increase of £9,000 over 1902. There was a deficit of £4,000 on the year's working.

Islington (London).—The Lighting committee reported on Wednesday having considered a communication from the borough electrical engineer (Mr. A. Gay) on the means provided for locating faults on certain of the arc lighting cables.

Mr. Gay points out that, as these cables are on the high-pressure parallel system, it has been found a difficult and dangerous task to disconnect and re-connect them with the current on. To provide for the necessary switches at important points, junction or feeder pillars are about to be erected on other circuits, but the cost of, and the space taken up by, these pillars prevents their adoption in sufficient numbers to be of general service. It is, therefore, proposed to divide the arc circuits into sections, taking every sixth, seventh or eighth lamp column, removing the present transformer therefrom, placing it in a tank at the foot of the column, and using the space set free for the high-tension switches. The estimated cost of this work, including high-tension switch fuses, street transformer tank, fixing, cable connections, excavation and relaying in respect of six circuits, is £285.

The committee recommend that application be made for sanction to the borrowing of a loan for the above and other works, and for £1,519. 12s. for service lines (including terminal boxes, fuse boxes, meters, &c.) to be laid during the half-year ended Michaelmas, 1904.

Leeds.—The tramways manager (Mr. J. B Hamilton) has submitted figures relating to the past year's working of the Corporation tramways. 60,964,067 passengers were carried, made up of 7·28 per cent. halfpenny, 79 92 per cent. penny, 1·56 per cent. three-halfpenny, 9·5 per cent. twopenny and 1·7 per cent. threepenny fares. The increase of £15,000 is attributed to the introduction of overlapping stages and to the success of halfpenny fares. The amount paid for compensation was £765. 12s. 7d., compared with £2,197. 10s. 5d in the previous year. The construction of a loop line at Roundhay Park, to save the time now occupied in reversing cars, is contemplated.

Light Railways.—The Board of Trade have confirmed the Clacton on-Sea and St. Osyth, the Rugby and District, and the Leicester and District Light Railway Orders.

Sutton-in-Ashfield, Mansfield and Hucknall Huthwaite Councils will oppose the application of the Mansfield and District Light Railway Co. for an extension of powers.

Liversedge.—The Council are urging the British Electric Traction Co. to complete the Hightown tramways by connecting them, via Mainbottom, with the Cleckheaton system.

Negotiations are proceeding for a supply of electric energy by the Yorkshire Electric Power Co.

London County Council.—At the meeting on Tuesday a discussion arose upon the report of the Finance committee on the question of raising funds for capital expenditure. The estimate of £5,000,000 (including £25,750 for the expenses of issue) was approved, but of this sum £333,617. 18s. 9d. is in respect of expenditure to the year ended March 31, 1904, in the purchase, electrification and extension of tramways in the county of London. £32,620. 16s 8d. is required to pay off capital moneys raised for the purchase, electrification and extension of tramways to March 31, 1904, and £632,511. 4s. 7d. for the purchase, electrification and extension of tramways for the year ended March 31, 1905. Other items of expenditure in the latter period under the Council's Tramways and Improvements Acts, 1901-1902, include £90,000 and £150,000.

London Electrical Contractors' Association.—The third annual dinner was held at the Holborn Restaurant on Wednesday evening. Since its inauguration the Association has increased considerably in numbers, and there was a large attendance, including several representatives of the National Electrical Manufacturers' Association, who had been invited as guests. The toast of the evening was proposed by Mr. Benedict H. Rolfe, who referred, among other things, to the proposal to issue workmen's certificates. Mr. Ernest E. Berry, president, responded. Mr. R. Tweedy Smith gave the toast of "Kindred Associations," which was acknowledged by Mr. Walter Davenport (secretary of the National Electrical Manufacturers' Association) and Mr. Edwin C. Wallis (president of the Northern Section of the National Manufacturers' Association) ; and the health of the President was drunk with enthusiasm, the proposer of this toast being Mr. A. Rashleigh Phipps (past-president).

Louth.—The Council decided on Tuesday to enter into an agreement with the National Electric Construction Co. for the erection and working of electricity works. The Council will provide a site and will borrow £17,000 for the work, the company paying interest and sinking fund charges. The agreement is to be terminable at 10 or 20 years at the Council's option.

Ludlow.—A company has intimated intention to apply next session for a provisional electric lighting order.

Lytham.—The Council have decided, in consequence of the adverse vote of the ratepayers, to drop the municipal electricity scheme. The Council are, however, willing to consider any proposal which will not involve a burden on the rates.

Manchester.—On Wednesday the Corporation sanctioned, without discussion, a proposal to borrow £135,000 for electricity supply extensions.

Margam.—An inquiry has been held here into the application of the District Council to borrow £15,000 for electricity supply.

Mr. Ivor Bowen, for the Council, gave the required statistical particulars. The Council obtained an electric lighting order in 1898. Lighting at present is done by Aberavon Council, and, he urged, was unsatisfactory. An arrangement had been made for leasing a plot of ground for a generating station, and the Council had entered into negotiations with the South Wales Electrical Power Distribution Co. for a supply of electricity in bulk at three points in the district at 1½d. per unit. The whole of the loan asked for would only be required in the event of the negotiations with the company falling through.

The Borough Electrical Engineer of Swansea (Mr. C. A. L. Prusman) supplied technical details of the scheme.

The Inspector (Mr. R. H. Bicknell, M.Inst.C.E.) said it was highly improbable that the Local Government Board would sanction the loan of £15,000 upon the present terms, and he could not see his way to recommend it ; but he recognised that it was necessary that the town should have their own lighting. But if there was a breakdown in the supply, what would they do, as the Board would not grant £15,000 to experiment with ? As far as he was concerned, the Board would not sanction the larger scheme.

Marylebone (London).—At the meeting of the Council last evening, the mayor said he hoped for a full attendance of councillors at the next meeting of the Council (April 28), when he had to put before them an important report from the delegates appointed to negotiate with the Metropolitan Electric Supply Co. with regard to electric lighting, and he hoped to be able to put before the Council the final possibilities of a compromise with the Metropolitan Company. With regard to the Marylebone Electric Lighting Bill, 1904, the Electric Supply committee reported that the Council's bill had passed the Select Committee of the House of Commons with certain modifications, which may be summarised as under :—

1. The London County Council having agreed to advance the sum of £1,365,000 for the purchase of the Metropolitan Company's undertaking

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in Marylebone, the financial provisions of the bill have been modified. The power to issue stock has been struck out, and all provisions for loans are made subject to the approval of the London County Council, except the loans for the purchase of the undertaking, and for paying the costs of the order and act of 1901. With regard to the London County Council loans, the usual appeal to the Local Government Board is provided for. The period of 38 years has been allowed for the repayment of the above sum, and allocations to the sinking fund for the payment of this sum and also for the repayment of the loan for the generating station are to be suspended for a period of three years from the dates of borrowing. The Select Committee have not, however, permitted Marylebone Council to pay interest during the first two years out of capital, and consequently, according to Mr. Arthur Wright's estimate, there will be a deficit of £8,000 a year on the undertaking, when acquired by the Council, for the first two years, and for this it will be necessary to levy a rate. Regarding new works the County Council will lend the money, and have made arrangements to advance £100,000 during the current financial year. Forty-two years is allowed for the repayment of this sum, and the sinking fund is suspended for the first three years.

2. The Select Committee, upon the opposition of the Metropolitan Electric Supply Co. and of the Gas Light and Coke Co., struck out the clause approved by the Borough Council giving power for the Council to enter into working agreements, so that the Council has no power to grant a lease of the undertaking; and it is even doubtful whether they can enter into an agreement with a company to work the undertaking on their behalf.

3. A clause has been inserted in the bill requiring the Council to have laid before them annually a statement and balance-sheet of the accounts of the undertaking, and to so fix the charge for current that the revenue may be sufficient to meet the expenditure. This clause was inserted by agreement with the Great Central Railway Co., and does not come into operation for the first three years.

4. Negotiations are in progress for the purchase of certain properties in the borough, the owners of which have withdrawn their opposition to the bill on consideration of such purchases coming into effect.

The bill was read a third time in the House of Commons last night.

Middlesbrough.—Sir Raylton Dixon & Co. are negotiating with the Corporation for a supply of electric power for the whole of their Cleveland Dockyard. About 400,000 units would be required per annum, equal to the whole output of the electricity works last year.

On the recommendation of the borough electrical engineer (Mr. H. M. Taylor) the Works committee have agreed to adopt a flat rate of 4d. per unit for current supplied to private consumers as an alternative to the maximum demand system at 6d. and 2d.

Municipal Insurance.—Glasgow Tramways committee reported last week that they had considered the subject of insurance for third-party risks and risks under the Employers' Liability and Workmen's Compensation Acts, and that the Electric and General Assurance (Ltd.) were prepared to undertake for one year third-party risks for a premium of £14,000, payable in quarterly instalments, and, in addition to the security offered by them, to have their policy covered at Lloyd's, the limit for any one accident to be £2,500, and the indemnity for the year to be £25,000. As the offer was £5,000 less than the sum asked by the General Accident Assurance Corp., and was £2,500 less than would be charged by that corporation if they were allowed the same rates as were paid to them this year, the committee unanimously agreed to recommend that the offer be accepted, subject to adjustment of details.

The convener (Mr. Paton) moved the approval of the minute. They had contemplated considering the question of taking the insurance into their own hands, but they subsequently got the offer from the Electric and General Assurance. It would be a serious matter for the Corporation to take the insurance into their own hands, as there were risks connected with it which should not be lightly undertaken. They therefore recommended the acceptance of the offer.

The recommendation was adopted.

Municipal Telephony.—At Brighton Corporation meeting last week, Ald. Carden moved the confirmation of the minutes of the Telephone committee, with the exception of a recommendation as to preparing specifications and for advertising for tenders for extension of the works.

The committee recommended that the Telephones department carry out extensions of cable, &c., at a cost of £4,200.

Ald. CARDEN said that, owing to the rapid increase in the business of the department, it was necessary to provide additional communications. They had a loan of £46,000, of which they had spent £33,000, including work ordered and not carried out, so they had £13,000 unexpended, and out of that they proposed to take the £4,200. Within a short time the Corporation, instead of an exchange of 2,000 subscribers, would have one of nearly double that number, for the telephone had been a much greater success than had been anticipated. During the last six months they had connected 950 subscribers, and there were 800 more in process of being connected.

The minute was confirmed.

New Zealand.—Wellington City Council are raising a loan of £75,000, chiefly for the extension of their electric tramways.

Nottingham.—Ald. Brownsword, chairman of the Tramway committee, in proposing an extension of the tramways system, said that between 52,000,000 and 53,000,000 passengers had been carried on the electric tramways since their opening two years ago, and there had only been one serious accident.

Obituary.—Mr. Chas. A. Wells, A.M.Inst.E.E., Etna Works, Lewes, died on April 6 in his 78th year. He was a member of the Town Council for seven years, and was instrumental in introducing electricity supply into Lewes.

Oldham.—The Council have opened a showroom for electric radiators, cookers and other domestic appliances.

Paisley.—The eastern section of the new electric tramways is now ready for Board of Trade inspection.

Plymouth.—The salary of the tramways manager (Mr. C. R. Everson) has been increased to £225, with an ultimate increase to £300 by yearly increments of £25.

Presentation.—Mr. D. J. Horn, of the General Electric Co., Glasgow, was recently presented with a dressing case by his colleagues on his leaving for Bombay, where a branch of the company's business is to be started.

Queen's Engineering Works, Bedford.—In connection with part of the new scheme of the Lords Commissioners of the Admiralty for the training of officers in His Majesty's Navy, a visit of inspection was paid by the torpedo lieutenants of H.M.S. "Vernon," at present stationed at Portsmouth, to the Queen's Engineering Works, Bedford (Messrs. W. H. Allen, Son & Co.), on the 24th ult. The course of instruction given on the "Vernon" is intended for a certain number of selected candidates who wish to further qualify in the service as torpedo lieutenants, and consequently much of the time occupied by the course is devoted to the study of torpedoes, mines and electrical appliances connected therewith. The object of such visits is primarily to enable those who will eventually be responsible for the proper working of various types of machinery when afloat to obtain a thorough practical acquaintance with the most modern methods of construction and design of such high-class machinery as is employed in the equipment of the modern man-of-war, and a series of visits has been made to some of the principal engineering works in the United Kingdom where extensive contracts for the Admiralty are carried out. Messrs. Allen have during the last 10 years supplied the complete electrical equipment for many of our largest liners of the Atlantic service. The party of officers from the "Vernon" numbered 22, and after being received by the directors of the company commenced their tour of inspection of the works. Particular attention was given to the electrical department, and great interest was evinced in the different stages in the evolution of the modern dynamo-electric machine, and especially to the machines of the company's Admiralty types, which represent the most recent and highest developments in modern machine-shop practice. All work has been done to limit gauges, so that all parts of the company's standard types of machinery are interchangeable, and manual labour has been thus reduced to a minimum.

Sheffield.—At the Corporation meeting on Wednesday, Councillor Muir Wilson inquired of the town clerk (Mr. H. Sayer) whether the notice limiting the liability of the Corporation for accidents on the electric tramways to £25 had been issued under his advice, and, if so, did he consider the same binding upon the Corporation, and upon what authority.

In reply, Mr. SAYER said the condition had been imposed on his advice, and he considered the same binding on any person who became a passenger on the Corporation tramways. He was supported in that opinion by Mr. Danckwerts, K.C.

Councillor WILSON then asked the chairman of the Tramway committee (1) when the bye-law limiting the Corporation liability to £25 was made, and, if by resolution of committee, the date of such resolution; (2) by whose order had the notice been placed on the Sheffield tramcars.

In reply, Ald. CLEGG said it was not by bye-law, but a resolution of the committe passed on Oct. 20, 1903, and subsequently confirmed by the Council, that the condition was imposed. The notice had been placed by the committee with the approval of the Council.

South Africa.—A bill is before the Cape Parliament, promoted by the local authorities of Queenstown, seeking power to construct, among other works, telegraph and telephone lines. The municipal council of Aliwal North seek electricity supply powers.

Southend.—The Corporation electric tramways carried 3,421,601 passengers during the year ended 31st ult., an increase of about 750,000 over the previous year.

Stockport.—In future the Corporation will supply electric current to places of worship at a flat rate of 4d. per unit.

Swansea.—The Electric Lighting and Tramways committee decided last week to obtain tenders for pole bases and for engine foundations at the destructor works.

The electrical engineer (Mr. C. A. L. Prusman) is to report on the questions of prepayment meters and "free" wiring.

Tanfield (Co. Durham)—The Council having decided to take part in a conference to consider the question of promoting a scheme of electricity supply for the whole county, Mr. J. Gilliland intends to raise the question of the erection of electricity works by the Council itself.

Torquay.—A recent meeting of ratepayers urged the Council to petition against the bill empowering the construction of tramways on the Dolter surface-contact system.

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Wakefield.—The Electric Lighting committee recommend that from July 1 the charge for electric energy be reduced to a flat rate of 4d. per unit and that meter rents for lighting be abolished.

Wednesbury.—The Council have asked the Board of Trade not to sanction the further use of steam traction on the South Staffordshire Tramway Co.'s lines, but to compel them to convert the whole system to electric traction.

Worcester.—At Tuesday's Council meeting it was reported that all questions in dispute with the local tramways company had been settled, the company agreeing to pay £1,500 to the Corporation for current which the company omitted to take according to agreement from the new generating station during the first 12 months, and also to forthwith complete the Bath-road tramways upon some concessions being made by the Council as to the completion of the tramways in St. John's and Lowesmoor. The conditions of settlement were approved.

Workhouse Lighting.—Dalziel Parish Council have approved a recommendation to adopt electric lighting for the new poorhouse.

Worsley.—Negotiations are proceeding between the District Council and the Lancashire Electric Power Co. as to the supply of electricity in bulk by the company.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

London County Council require tenders for the following switchgear—viz., (*a*) one extra high-tension three-phase board with operating table and instrument board, (*b*) one low-tension combined direct-current and three-phase board, (*c*) one combined extra high-tension and low-tension sub-station board, and (*d*) one extra high-tension and low-tension transformer board, and for the erection and connecting up of the same at the Council's electricity generating station at Greenwich. Further information is given in an advertisement. Drawings, &c., from County Hall, Spring-gardens, S.W., or full particulars may be obtained and specifications and drawings seen at the Tramway Offices, 303, Camberwell New-road, S.E. Tenders to the clerk to the Council (Mr. G. L. Gomme), County Hall, Spring-gardens, S.W., by 10 a.m. May 17.

The Council of the Metropolitan Borough of *Hammersmith* invite tenders for the supply of two 1,500kw. turbine or slow-speed engine generating sets with condensers, and high-pressure steam boilers with superheaters capable of evaporating 40,000lb. of steam per hour. Specifications, &c., from the engineer (Mr. G. Gilbert Bell), Electricity Works, 57, Fulham Palace-road, London, W. Tenders to the Town Hall, Broadway, Hammersmith, by 4 p.m. May 18. See also advertisement.

Dublin Lighting committee invite tenders for the supply and erection of a steam-generating three-phase extra high-pressure set of plant, consisting of Belliss engine and condensing plant combined with Dick-Kerr, E.C.C., Oerlikon or Westinghouse alternator (size 1,000kw., 1,250kw. or 1,500kw.), steam and exhaust piping and extension to switchboard. Specifications, &c., may be seen at the offices of the city engineer (Mr. Spencer Harty), City Hall, Dublin, and at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., after 22nd inst. Tenders to the chairman, 3, Cork-hill, Dublin, by noon May 9. Further particulars are given in an advertisement.

The Urban District Councils of *Royton* and *Crompton* invite tenders for permanent way construction. Specifications, &c. (after 16th inst.), of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. Tenders (addressed chairman of Tramways committee, Town Hall, Royton) by noon 30th inst. See also advertisement.

The directors of the *Great Western Railway Co.* require tenders for the supply and erection of four 200kw. and 10 400kw. motor-generators (three-phase h.-t. to continuous-current l.-t.); four natural-draught cooling towers, each capable of dealing with 180,000 gallons of condensing water per hour; electrically and hand-driven overhead travelling cranes and runways; and coal and ash conveyors, coal hoists and ash hoppers. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London, W., by April 26.

Manchester Waterworks committee invite tenders for the supply, delivery and erection at their Longdendale works of one 90 B.H.P. turbine with direct coupled dynamo, switch and distribution boards, sluice and regulating valves, &c.; four electric motors with starting switches, lead-covered feeders, junction boxes, &c.; overhead equipment of existing railway track, rail bonds, electric locomotives, &c.; switch and distribution boards, conductors, incandescent lamps, &c. Specifications, &c., from the secretary, Waterworks Offices. Tenders to the chairman, Town Hall, Manchester, by 28th inst. See also advertisement.

Kilmarnock Corporation invite tenders for tramway permanent way construction, excavations, concrete foundations, steel rails, fish-plates, and special work, paving, &c. Copies of specification, forms of tender, &c., after April 18, from the town clerk, Mr. W. Middlemas. Specifications and drawings can be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, London, S.W. Tenders to the town clerk's office before noon May 17. See also advertisement.

Govan Town Council invite tenders for 12 months supply of engine room stores, oil, &c., cables, cable accessories, bitumen, meters, house fuse-boxes, arc-lamp carbons, joint-boxes, motors, motor starters, iron castings, cast-iron pipes, ironmongery, paints, &c. Schedules and forms of tender from the burgh electrical engineer (Mr. T. C. Parsons), Helen-street. Tenders to the town clerk (Mr. A. Macdonald), Town Hall, Govan, by April 26. See advertisement.

Aberdeen Electric Lighting committee invite tenders for the supply and erection of surface condensing plant, air pump and piping. Specifications, &c., from the city electrical engineer (Mr. J. Alex. Bell), Electricity Works, Millburn-street, Aberdeen, to whom tenders by noon April 30. See advertisement.

Heckmondwike (Yorks.) Electric Lighting committee invite tenders for feed pump and pipe work, steam traction generator, water-tube boiler, main switchboard panels, induced draught apparatus and underground feeders. Plans, &c., from and tenders to the consulting and resident engineer (Mr. G. H. Carter, A.I.E.E.) by April 26. See also advertisement.

Bray District Council invite tenders by May 2 for 12 months' supply of cables, carbons, house wires, switches, lamps, holders, &c.

Wallasey District Council invite tenders by 27th inst. for 12 months' supply of meters, cable and junction boxes, switches, cutouts, &c.

Colima (Mexico) Municipal Council desire to enter into a contract for the public and private electric lighting in the city. Particulars from Governor Enrique O. Madrid, Colima, Estado de Colima.

Wigan Corporation invite tenders for steel framework for electric tramcar sheds. Tenders by noon 23rd inst.

Glasgow Corporation invite tenders by 10 a.m. 21st inst. for electric light installation, &c., for Woodside District Library.

Antwerp Municipal Council will on 26th inst. consider tenders for lighting the Flemish Theatre. A deposit of £200 is required from tenderers. Copy of the specification may be seen at the Commercial Intelligence Branch of the Board of Trade, London.

Moral de Calatrava Municipality (*Spain*) seek tenders up to May 8 for the electric lighting of the district. Particulars are given in the "Madrid Gazette" of April 6.

The Direction General of Posts and Telegraphs, *Madrid*, invite tenders up to April 24 for 32,400 pine telegraph poles. Tenders to the Inspector General of Telegraphs, 10, Calle de Corretas, Madrid. Further particulars in the "Madrid Gazette" for April 9.

TENDERS RECEIVED AND ACCEPTED.

The following contracts have recently been placed with Messrs. Belliss and Morcom, Ledsam-street Works, Birmingham:—

For Alexandra Water Co., two engines and condensing plants and one Witton dynamo (by General Electric Co.).

For Woking Electric Supply Co. (by Electric Construction Co.), one 685 H.P. engine for direct coupling to E.C.C. 400kw. generator.

For Cunard ss. "Carmenia" (by John Brown & Co.), four engines for direct coupling to Clarke-Chapman dynamos.

For Hornsey (by General Electric Co.), three engines for direct coupling to G.E.C. dynamos.

Hereford Council have accepted the tender of W. J. Fryer & Co. for re-wiring the asylum at £2,187, that of the Alphons Custodis Chimney Construction Co. for chimney shaft at £229, and that of E. Danks & Co. for a boiler at £252. 10s.

Canterbury Council have placed with Pritchetts and Gold an order for a new battery of accumulators at £565, the company to maintain the battery at 90 per cent. of its original capacity for 10 years for £80 per annum.

Poplar (London) Council have accepted the tender of Carrick and Ritchie for two 15-ton hand travelling cranes for electricity sub-stations at £560. There were seven tenders, varying from £512 to £690. This is in addition to the tenders for plant, &c., given in our last issue.

Aberdeen Electric Lighting Company have accepted the tender of Messrs. Babcock and Wilcox for two water-tube boilers and accessories. Tenders were also submitted by Richardsons, Westgarth & Co., the Stirling Company and Willans and Robinson.

Glasgow Corporation have accepted the tender of Mr. A. Low for mains, cables, switchboard, distribution boards, wiring and accessories for transmission of electric power to motors and for lighting the Dalmuir outfall works at £2,705. 2s. 5d.

Leek District Council have accepted the tender of the Reason Mfg. Co. for electricity meters of 3, 5 and 10 amperes at £1. 17s. each, and that of Chamberlain and Hookham for 15 and 25-ampere meters at £2. 15s., 50-ampere at £3 and 100-ampere at £3. 5s. each.

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Dick, Kerr & Co. have secured from the Provincial Tramways Co. contracts for the construction for electric traction of tramways (1) at Gosport, (2) from Gosport to Hoeford, (3) from Hoeford to Fareham and (4) from Gosport to Alverstoke, and for the supply of feeder cables, &c.

Broughty Ferry (N.B.) Council have accepted the tender of the St. Helens Cable Co. for cables at £202 and that of W. H. Keys for bitumen at £7. 5s. per ton.

The tender of the Tudor Accumulator Co. has been accepted by Dewsbury Council for the renewal of one side of the battery at the electricity works.

The Secretary of State for India has placed a contract with the Sir Hiram Maxim Electrical and Engineering Co. for high-voltage lamps.

Hull Council have accepted the tender of the International Electrical Co. for a switchboard for the Trippett telephone exchange, and that of the Hart Accumulator Co. for accumulators.

The tender of Mr. H. C. Sweetland has been accepted by the Provincial Tramways Co. for the erection of a power station for the Gosport and Fareham electric tramways at £9,970.

Fareham District Council have accepted the tender of J. Fraser & Son for a boiler at £360.

Warrington Corporation have accepted the tender of the British Thomson-Houston Co. for one year's supply of electric motors.

Belfast Improvement committee have accepted the tender of Wm. Coates & Son for wiring the new city hall.

For wiring the West Kent General Hospital the tender of Haynes Bros. at £96 has been accepted.

Dublin Corporation have accepted the tender of the Hammond-Lane Foundry Co. for dredging Pigeon House Harbour at £1,825.

BUSINESS NOTICES.

The Reason Mfg. Co., Brighton, having decided to enlarge greatly their street lighting department, have, as previously announced in these columns, engaged Mr. Haydn T. Harrison, M.I.E.E., to manage the department. Offices have been opened at 11, Victoria-street, London, S.W., where all inquiries should be sent. The company intends to undertake all classes of electric street lighting, and will shortly issue a pamphlet illustrating many novelties for increasing the efficiency and reducing the cost of street illumination by electricity.

The telegraphic address of Mr. H. F. Parshall, M.Inst.C.E., consulting engineer, Salisbury House, London Wall, E.C., has been changed to "Parshalite London."

Messrs. Barry, Head & Co., 26, Lombard-street, London, E.C., have made arrangements to act as sole agents for Mr. J. Blake, Middlesbrough-on-Tees, in London and district, for the "Blake" vertical multi-tubular boiler.

Mr. Harry Snowdon, A.M.I.E.E., has taken larger offices at Balfour House, Finsbury-pavement, London, E.C. His new telephone number is 9,960 London Wall.

Messrs. D. L. Selby Bigge, R. G. Bell and G. H. Bowden (trading as D. Selby Bigge & Co.), electrical engineers, have dissolved partnership. Debts by Messrs. Bigge and Bell, who continue.

Mr. E. W. Smith is retiring from the business hitherto carried on by him in partnership with Messrs. E. G. W., W. B. and J. M. Smith (trading as Warren Smith & Co.), electrical engineers, &c., 66 and 68, College-street, Chelsea, London, S.W. Debts by the remaining partners, who continue.

Messrs. W. T. Glover & Co. have appointed Mr. John Ardrey, Granville-buildings, 43, High-street, Belfast (telephone 1,134), to represent them in Ireland. Mr. Ardrey will keep a large stock of vulcanite wires and cables

Mr. William Lowry has resigned his position as engineer to the Electric Light Insurance and Maintenance Co. (Ltd.) and has been appointed to represent Messrs. Edwards and Armstrong, of Bristol and Cardiff, at their new London offices, 18, Bury-street, W.C. This firm have recently secured the contract for lighting the Manchester Hotel, London, E.C., and are carrying out the electric lighting, telephones, &c., at the new Town Hall and Law Courts, Cardiff.

LIQUIDATIONS, BANKRUPTCIES, &c.

A first and final dividend of 1s. 6¾d. is payable at 17, Hertford-street, Coventry, in the failure of W. H. Hooley and J. W. Talbot, electrical engineers and contractors, Regent-street, Rugby.

A. S. Redick, electrical engineer, Market-street, Dewsbury, has executed a deed of assignment. Claims by 16th inst. to Mr. A. Greenwood, Market-street, Dewsbury.

A meeting of the Auxiliary and Light Railways and Tramways Co. (Ltd.) will be held on May 11 at 20, Victoria-street, London, S.W., to receive an account of the winding-up.

Electric Generating Stations (Ltd.) is being wound up voluntarily.

Sheffield Electric Advertisements (Ltd.) is being wound up voluntarily. Mr. J. W. Naylor, 4, York-street, Sheffield, is liquidator.

A meeting of Electric Lighting Boards (B.M. Co.), Ltd., will be held on May 13 at 75, Aldermanbury, London, E.C., to receive an account of the winding-up.

Sales by Auction.—Mr. Henry Sherley-Price (of Wheatley Kirk, Price & Co,) has been appointed by the Court to sell by public auction in one lot as a going concern, at the Mart, Tokenhouse-yard, London, E.C., early in May, the extensive freehold and well-equipped car-building works known as the Castle Car Works, Hadley, near Wellington, Salop, together with the fixed plant and machinery and trade connection. The works have been erected within the last five years, and were specially designed for turning out at lowest cost between 600 and 700 tramcars per annum. The plant is by eminent makers, and was laid down with every regard to efficiency and economy. An electric power station supplied the whole of the electric drive throughout the works, and elaborate heating, ventilating and lighting services are installed. There is a railway siding into the works, and a canal adjoins. The loose plant, with stock, stores, &c, must be purchased at a valuation. Further information from the receiver and liquidator (Mr. H. D. Eshelby, F.C.A., of Messrs. Harmood, Banner & Son), 24, North John-street, Liverpool; of Messrs. Gribble, Oddie, Sinclair and Johnson, solicitors, 38, Bedford-row, London, W.C., or of the auctioneers, 46, Watling-street, London, E.C., and Albert-chambers, Albert-square, Manchester. An advertisement contains further particulars.

By direction of the receiver for the debenture holders (Mr. J. J. B. Arter), Messrs. Edwards, Son and Bigwood will sell by public auction at Chester-street, Aston, Birmingham, on April 27, at 11 a.m. prompt, leasehold property covering an area of 2,045 sq. yds., practically the whole of which is covered by recently-erected substantial one-storey buildings held on lease for 69 years at a ground rent of £42. 12s. 1d.; also the whole of the nearly new plant and machinery, including 150 H.P. inverted type compound condensing steam engine, two Lancashire boilers, steam pump, &c., several dynamos by well-known makers, an 18 B.H.P. Taunton electric motor, two motor-driven centrifugal pumps, electric travelling crane, main switchboards, plating vats, polishing lathes, drilling machines, screw cutting lathes, shafting, pulleys, arc and incandescent lamps, &c. Plans and particulars from the receiver (Mr. J. J. B. Arter, C.A.), Norwich-chambers, Edmund-street, Birmingham; from Messrs. Beale & Co., 12, Newhall street, Birmingham; or from the auctioneers, 17 and 19, Colmore-row, and 94, High-street, Bromsgrove. See also advertisement.

Plant for Sale.—East Ham Urban District Council invite tenders for the purchase of one 150 I.H.P. cross-compound Musgrave engine, direct coupled to a 100kw. Dick-Kerr direct-current generator. The plant may be seen at work at the generating station, and is being disposed of in consequence of alterations at the works. Information from the engineer and manager (Mr. W. C. Ullmann), Nelson-street, East Ham. Tenders to the clerk to the Council (Mr. C. E. Wilson) by noon May 3. See also advertisement.

Premises for Sale.—A long lease of spacious premises situated in centre of large town, 6 minutes from station (three railway companies) and within 1 hour of London, is for disposal. See advertisement.

Offices to Let.—Exceptionally well-lighted drawing offices on ground floor in Westminster, also five rooms on second and third floors, are advertised to be let. Applications to Messrs. Fox and Preece, solicitors, 15, Dean's-yard, Westminster, S.W.

Powdered Coal.—For many years past efforts have been made to secure a successful method of utilising powdered coal for firing purposes. The Central Cyclone Co., 345, Cable-street, London, E., have recently fitted one of their powdered coal plants to a boiler at Portsmouth Dockyard. The Admiralty authorities are reported to have tested this plant with various qualities of coal, and to have obtained good results. The pulveriser apparatus adopted by the Cyclone Company reduces the coal to a fine powder, which is mixed with a proportionate amount of air, and then passes into the combustion chamber of the boiler. Among the advantages claimed for the system is absence of smoke, the capacity to consume all classes of bituminous and small coals, and a quick method of steam raising.

"Electro-chemist and Metallurgist."—With the current number this publication has been reduced in price to 1s. per copy, without any reduction in the volume of its contents.

Electro-Therapy.—The advance of electro-therapy is shown by the extensive new catalogue of apparatus for this branch of electrical work prepared and published by Messrs. Isenthal & Co., of 85, Mortimer-street, London, W., who claim that this is the most up-to-date and comprehensive publication of the kind yet issued. 150 pages of text and illustrations are devoted to particulars of a great variety of apparatus dealing with Röntgen rays, photo- and thermo-therapy, high frequency, &c. The accompanying illustrations show (A) a simple form of electrolytic interrupter devoid of moving parts. The example shown has three anodes, and the current required varies from 10 to 30 amperes according to the size of coil used. (B) is a

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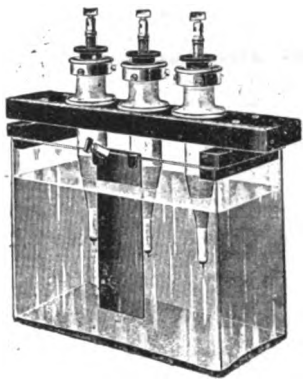
switchboard for weak currents and surgical lamps. The example shown is a universal board fitted with galvanometer, current reverser, combiner, Faradic coil, voltage regulator, switch, lamps and rheostat complete. This type of apparatus is also supplied in

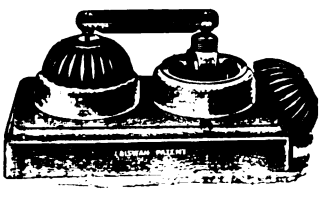


(A)

(B)

boxes of crystal glass, so constructed that all switches, rheostats, coils and instruments are inside the box, which may be thoroughly sterilised for use in galvanisation, electrolysis, faradisation and surgical lamp work.

Catalogues.—The Edison and Swan United Electric Light Co., Ltd., are issuing a binder containing some of the latest leaflets relating to Ediswan lamps, flexibles, shades, switches, &c. A new shape of Ediswan lamp is illustrated and described. Our illustration No.1 shows a 5amp. "Wedge" Tumler switch of the coupled pattern, and, No. 2, a 2-way pattern of the same switch designed for bedrooms, staircases, &c. The loose-key pattern of this switch is shown in No. 3, the flush pattern, with fancy brass cover, in No. 4, and the ceiling-pull pattern in No. 5. The latter class is designed for use in factories, offices and warehouses where it is handy to operate the switch from below by means of cords. This type consists of a "Wedge" switch provided with a tilted lever and two cords.



No. 1.

No. 5.

No. 2.

No. 3.

No. 4.

A new pamphlet of "Luna" flame arc lamps is issued by the Electrical Company, 121-125, Charing Cross-road, London, W.C., and copies can be obtained by the trade on request. The list is well illustrated with the various types of these lamps now on the market.

Mr. G. Braulik has ready a new sheet list relating to "Miniature" arc lamps for alternating-current circuits.

In the General Electric Co.'s "Progress Sheet" for March the "Pedestal" type of cut-cut in cast iron case is illustrated and described. This cut-out has been designed to meet the demand for a high voltage main cut-out, and can be supplied with either plain or spring-clip terminals, the latter to take a "Mordey" fuse. The terminals are mounted on porcelain insulators fixed to the inside of the base of the box; a porcelain bushing is also supplied to the leading-in holes. Radiators, a new and cheap form of lamp-testing ammeter, and "Geeko" storage batteries, are also dealt with in this sheet.

The Electric and Ordnance Accessories Co. are issuing further particulars of the convenient set of "Stellite" intercommunication telephones manufactured and supplied by the company, suitable for installations of from five to 30 lines.

J.P. Plant.—An excellent illustration of the plant and apparatus installed at Kendal central station by Messrs. Johnson and Phillips is being issued by that firm.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical machinery, which is not separately specified) from April 1 to 12, with the ports of destination:—

Africa—Alexandria, £167; Cape Town, £881 (including £101 telegraph material); Durban, £2,365 (including £1,867 telegraph material); East London, £300; Port Elizabeth, £394; Suez, £225 (telegraph material). *Argentina*—Buenos Ayres, £85. *Australasia*—Adelaide, £92; Auckland, £20; Fremantle, £102; Melbourne, £141; Perth, £87; Sydney, £903 (including £210 telegraph material); Wellington, £2,079 (including £1,417 telegraph material). *Borneo*—Sarawak, £135. *Brazil*—Rio Janeiro, £370 (telegraph material). *Ceylon*—Colombo, £42. *China*—Cheefoo, £120. *Cochin China*—Saigon, £150. *France*—Paris, £1,360. *Germany*—Hamburg, £86 (including £26 telegraph material). *Gibraltar*, £655. *Holland*—Amsterdam, £180; Flushing, £51; Rotterdam, £57. *India*—Bombay, £2,075; Calcutta, £1,342 (including £35 telegraph material); Madras, £243. *Italy*—Genoa, £100. *Japan*—Nagasaki, £177; Yokohama, £1,668. *Portugal*—Lisbon, £205. *Russia*—Odessa, £270; St. Petersburg, £400 (telegraph cable). *Spain*—Vigo, £165 (telegraph paper). *Straits Settlements*—Singapore, £281. Total £17,973 (for 12 days), against £10,779 (for one week) last year (April 8 to 14).

COMPANIES' MEETINGS AND REPORTS.

Notting Hill Electric Lighting Co. (Ltd.)

The seventeenth ordinary general meeting was held on Monday under the presidency of Sir WILLIAM CROOKES, F.R.S.

The SECRETARY (Mr. R. G. Rawkins) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: Gentlemen, during the past year the statement of share capital has undergone no change, the amount issued being £144,000, and unissued, £56,000. The statement of loan capital account is slightly different, an additional £5,000 of 4 per cent. debentures having been issued to meet capital expenditure. It has been found practicable to carry out all extensions with the aid of borrowed capital, it being obviously undesirable to increase the share capital until it is absolutely necessary. This left us with remaining borrowing powers of £17,000, but since the close of the year a further £4,000 has been issued, so that the balance for future use stands at £13,000. Part of this probably will be issued to meet capital account payments on increasing the capacity of the mains and works, rendered necessary by the steadily growing demand for current. Our total expenditure is £216,000, the outlay last year being only £6,077, mainly for the purchase of additional converters. It may be necessary in future to increase the capacity of the mains, so as to deal with the larger amount of current taken in bulk from the Wood-lane works, and perhaps also to increase our storage power. The revenue account is the one in which shareholders take most interest. If all the circumstances are taken into consideration, this must be considered satisfactory. The cost per unit has decreased, and the economies effected range over all the items in the account. We paid £6,012 to the Wood-lane account for 1,567,674 units, which is at the rate of less than a 1d. per unit, while the previous year we paid only £192 less for 1,228,900 units, so for this extra £192 we obtained considerably over a quarter of a million additional units. These costs do not include interest on debenture stock and sinking fund, as these are dealt with in the net revenue account. By adding those amounts, the total cost amounts to just over 1½d. per unit for the year 1902, and rather over 1¼d. per unit for last year. We have spent £777 in repairing and maintaining the plant and mains, and these have been found on examination to be in thoroughly good order. The £1,816 paid for rates is an important item, being now nearly ½d. per unit sold, the local authority deriving an enormous amount from the different electric lighting companies in the Royal borough of Kensington. The total management expenses amounted to £3,444, being about £120 in excess of the previous year. The output, however, being nearly a quarter of a million units more, the cost per unit is reduced from 0·68d. to 0·60d. This item in total can almost be said to remain stationary, and shows only the slightest increase for years past, although the output in units for the same period has nearly doubled, and this proportionate diminution will continue as we progress. The total of the expenses charged against revenue account for the year was £14,425, against £14,228 the previous year, and the total costs per unit were respectively 2·52d. against 2·97d —a decrease this year of practically ½d. per unit. The credit side of this account shows that the total revenue was £29,443, being £616 in excess of the previous year. This must be considered highly satisfactory, in view of the fact that by reducing the charge from 6d. to 5d. a unit we lost about £5,000 in revenue. Although this concession in price involves at the outset a considerable diminution of revenue, it will assist materially in building up a larger business. It might be asked why was this reduction made when most of the West End companies are still charging 6d. The reduction was agreed on with the local Council two or three years ago—one of the inducements for them to withdraw the application they were then making for a competitive provisional order over our Company's district. At that time the decision had not been given in the case of the Marylebone Council and the Metropolitan Company, a decision which has created an equitable precedent that no local authority can be granted an electric lighting provisional order until they have bought out the undertakers who may have Parliamentary powers of supply over the district. The example of reducing the price per unit to 5d. also had been set already by a neighbouring company, and in consequence of our Company agreeing to reduce the price and making other concessions, the Kensington Borough Council did not oppose our bill for the purchase of their land on which the Wood-lane works have been built, and gave us favourable consideration in fixing the purchase price of that land. The items in the next account (net revenue account) are very similar to those of last year, and include the balance of the cost of the

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current taken in bulk from Wood-lane, £1,966 being our proportion of the interest on the debenture stock and £1,030 contributed to the sinking fund. The result against the previous year is an increase in the net profit of £287, notwithstanding the tremendous loss in revenue through the drop in the price charged per unit. To depreciation, renewal and reserve fund account we have transferred out of the profits £1,250 for last year, bringing the total to £17,750. It is probable this may be considered by some to be insufficient, but I would ask you to examine the figures of the capital account, because on a right appreciation of these figures depends the policy the Company should adopt in order to ensure that, when in 1931 the local authorities have the right to buy us up at a valuation which will allow nothing for goodwill, our shares will be worth their face value and possibly more. But in considering this policy we must not overdo it and sacrifice income rightly earned for future benefit. Our loan and share capital stands at £199,000. Of this, the loan capital must actually be redeemed at par, and any profit or loss falls on the share capital of £144,000. Against this £199,000 we have property valued at £216,335, nearly the whole of which is represented by visible assets. £13,500 represents the provision for depreciation up to the present on the property liable to depreciate—namely, the machinery, accumulators, and other chattel property, which are valued at £58,500, and such part of the mains as may depreciate; and considering that these mains are in absolutely good condition, we have only a moderate amount to provide for them. This, then is the exact position, *pro* and *con*, with one important exception—the sinking fund in connection with our share of the Wood-lane works. This sinking fund has been so fixed that at 3 per cent. net we shall receive in 1931, our share of the Wood-lane property, probably £60,000, free of all encumbrance. But owing to circumstances we had not anticipated we are investing at a very much higher rate than 3 per cent.—more like 4 per cent. Any shortage in future years will be made up by what we earn on what we are investing now. The various comments that have been made on our sinking fund are based, I think, on want of detailed knowledge of the factors concerned—firstly, the actual amount of depreciation to be provided for, then the fact that what we have stands at prime cost, then the actual present value of our assets for each pound of share capital after deducting all liabilities and all unrepresented capital, and finally the reserves and reversions owned by the Company. Suggestions have been made—I mention this because they have been the subject of comment—that we might make great economies in working if we were to modify our system in certain directions. We are continually watching for means of economising, and I think not unsuccessfully, and although every one of the proposals has been before us previously, we decided, in deference to the gentleman of experience who suggested them—who, however, possessed no detailed knowledge of our internal affairs or our relations with our consumers—to test their value by adopting them—*on paper*. The result worked out that, to save some £500 or £600 a year, we should be forced to expend some £30,000 fresh capital, and then we should be working under conditions which would increase appreciably the risk of a breakdown or even of a serious accident, and would cause, probably, a modification in our pleasant relations with our customers. It is satisfactory to be able to note that in the course of the inquiry an outside examination of our machinery and mains took place, with results which are highly satisfactory and reflect great credit on our manager and chief engineer, Mr. Schultz. The general balance-sheet summarises the whole of the foregoing accounts, and calls for no special mention from me. The following table shows the progress of the Company:—

Year	Houses conn'ct'd	Lamps connected	Units sold.	Revenue.	Expenses.	Profit or loss.		Div. on ord. shrs.
1891	77	6,056	30,162	£1,623	£2,178	Loss	£554	nil
1892	124	9,438	75,667	3,513	3,301	Profit	112	nil
1893	173	12,153	107,580	4,329	2,848	do.	1,481	nil
1894	234	15,669	130,266	5,123	3,021	do.	2,101	1%
1895	307	20,307	182,327	6,940	3,712	do.	3,227	2%
1896	396	25,716	230,787	8,552	3,816	do.	4,736	4%
1897	571	33,000	354,969	11,625	4,771	do.	6,854	6%
1898	816	46,066	455,871	13,571	6,320	do.	7,251	6%
1899	1,012	59,154	665,129	17,935	7,574	do.	10,360	7%
1900	1,191	68,505	782,215	19,963	10,107	do.	9,856	7%
1901	1,445	82,054	947,491	24,195	11,149	do.	13,046	6%
1902	1,784	99,497	1,148,991	28,837	14,228	do.	14,609	6%
1903	2,052	116,360	1,372,642	29,443	14,425	do.	15,018	6%

The number of lamps added last year, it will be seen, was 16,863, against 17,443 the previous year—a satisfactory increase, but not quite so great as might have been expected on the reduction in the price of current. It is found, however, that the drawback to the general use of the light is not the cost of the current itself so much as the outlay necessary to provide the wires and fittings. We have already experimented with a system of "free wiring," but it was not found to be a success. The Directors are now considering other schemes of assisting would-be customers to meet the installation expenses. Everything, in fact, is being done to push the business, and we have recently completed a house-to-house canvass of the entire district where mains are laid. I am glad to be in a position to tell you that the rate of increase in new lamps connected at the present time shows no signs of diminishing. This should result this year in an additional revenue of nearly £4,000. Practically the whole of this should be profit. I therefore consider our future is most hopeful, and the balance of profit for division must rapidly increase, as it cannot be expected that any further large reduction in the charge for current can be made for some considerable time. I now move the adoption of the report and accounts and the payment of the dividends therein recommended.

Mr. J. W. SWAN seconded.

A lengthy statement was then read by Mr. G. Kitchin from Mr. Shaw-Kennedy, criticising the policy of the Board as to depreciation, and expressing the view that generating costs in the Notting Hill Company are too high. Mr. Kitchin's and Mr. Shaw-Kennedy's comments were endorsed by Mr. Dawes. To these criticisms, chiefly of a financial character, Mr. A. E. Franklin replied very fully. [Mr. Franklin's remarks were of a very interesting character, but were of necessity too lengthy to be reproduced in the limited space at our disposal for such matter.]

The motion was then carried unanimously, as were resolutions re-electing the retiring Directors, Mr. J. W. Swan and Sir William Crookes, and the auditors. A very cordial vote of thanks to the Chairman terminated the proceedings.

Willans and Robinson (Ltd.)

The half-yearly ordinary general meeting was held on Wednesday, Mr. Mark Robinson presiding.

The SECRETARY (Mr. C. S. Essex) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN then said: Gentlemen, I have to ask your attention to an analysis of the causes which have led us to our present position, as well as to the remedies which may be applied to it. Three separate causes have combined to place us in our present position, and they need to be carefully studied separately. Important as are the issues of the Queen's Ferry undertaking, it is not, in our opinion, the present non-success of those works which threatens us the most seriously. We ask your attention in the first place to the serious falling-off in our original business of engine-building. The Willans engine is not less good than it was, but it has rivals now on its own plane, which was not the case formerly, so that over and above the general depression from which we suffer in common with others, we have experienced a far more effective competition, which has diminished both the volume of our orders and the rate of our profits. From these causes the Rugby business has done badly. The second cause of our troubles—namely, the serious loss at Queen's Ferry, has swallowed up the profit at Rugby, and gives us a debit balance. It is not unreasonable to expect a loss in the beginning of any new business; and it is usual to deal with it by a suspense account, under some such name as preliminary expenses. But we feel that when we have dealt in this way with the expenses at Queen's Ferry up to June, 1903, and to the extent of £15,591, we have charged the future with as much as is justifiable; all later operations, however little in the nature of commercial working, must be treated as trading which has resulted in a loss, even though those operations should some day come to be recognised as a remunerative outlay for the sake of future profit. As you will see, we have further swelled the loss by a debit for depreciation, commencing from the same date, for deterioration of plant and buildings clearly commences with their use whether it is profitable or not. The primary cause of the loss has been the repeated postponements of the commencement of work on a commercial scale, due to difficulties in technical points of manufacture in a somewhat special branch, namely, that of large tube-drawing, which lies a little outside the common operations of engineering. All difficulties of importance have now been overcome, but in the process a great expenditure, which we must treat as a loss, has been incurred. Queen's Ferry contains another department, which includes the steel works and steel foundry. The making of the special quality steel (of tube-making quality) we desired to produce proved to require a great deal more experimenting than we had foreseen, and so did the difficult art of steel founding, and we have only reached manufacturing success at a very recent date. We were then able to say that we could produce English steel at a moderate cost per ton, indistinguishable from the best Swedish steel, and at the same time we had begun to turn out steel castings of really remarkable quality, and were in possession of processes, peculiar to our works, which made these results possible. We have also succeeded in producing a high-tensile strength steel of remarkable quality, which has lately aroused much interest. In both departments, certainly in steel making, there was, and is, a prospect of remunerative business. But here also the trade still needs to be made, and so much money would have to be sunk in making steel for stock, while the trade was being established, that we have preferred under present circumstances to close the steel works in order to stop the drain of money. The third cause of our difficulties, is that, in finishing the extensions at Rugby and the new works at Queen's Ferry, and in the experimental working at Queen's Ferry, we have had to incur liabilities, or make actual expenditure, nearly up to the amount of the shares which, three years ago, you authorised us to issue. It had been intended to issue them last year, and we should then have had the reserve fund at our disposal. Unfortunately we yielded to the suggestion to postpone the issue and to borrow from the bank in consequence of the unfavourable state of the money market. That state is now worse, and an issue of shares cannot be entertained. In addition to a debt of £54,000 to the bank we have liabilities amounting to £20,000. We have, therefore, to provide at least £74,000, but obviously there must be a further sum for working capital, and to provide for that lock-up in ledger accounts which has always a tendency to increase in times of depression, apart from the additional working capital which will be wanted as soon as we begin to send out boilers. In our judgment we should within a short time obtain about £83,000. Our third difficulty is, therefore, the most urgent, because the money has to be raised. Some time back the directors decided to confer, informally, with some of our largest shareholders, and invited the 25 largest holders (excluding directors) to meet them. As an informal advisory committee, these gentlemen visited Rugby and Queen's Ferry, and eventually reported in the sense that the steel works and foundry at Queen's Ferry, but especially the foundry, should be closed; that no

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dividend should be paid; that every economy should be practised, and that we should seek powers to borrow the necessary sum upon the security of the reserve fund investments. Fully adopting these recommendations, the directors have given orders to close the steel works and foundry, so far as is consistent with the completion of orders in hand, and are asking for power to borrow about £83,000. Fortunately we do not depend upon the reserve fund alone. We have, in addition, a fire insurance fund, invested in securities which cost £26,005, and which, even in these times, should fetch not much under £23,000, which gives a margin beyond our liabilities amply sufficient to ensure the financial credit of the company. As regards stopping the loss at Queen's Ferry, and trying to turn it into a profit, it is unfortunate that financial stress forces us to close the steel works just as they begin to promise great results, but as regards the boiler works proper, these are working to the full capacity of the machines, and to double or treble the capacity of the tools, &c., would only require a comparatively small outlay. But the boiler business bears no comparison, in its importance to us, without old business of engine building. When that is depressed, our mainstay is gone; if it flourishes, we can bear a great deal of trouble from other quarters. Its present position has been already stated. Trade is depressed, and the Willans engine must share what there is with many competitors. For two years past this question has had our anxious consideration, and we have studied the gas engine, and the steam turbine, both formidable and growing rivals, and not to the Willans engine only. The gas engine is a difficult subject, in which we expected no easy walk-over, but after no more than a fair share of troubles, I believe we may claim to be working to the best gas engine designs in existence, and those having the greatest assurance of success upon a large scale. We have no really large gas engines at work yet, but have fast-running engines of the vertical pattern, up to about 250 B.H.P., running with great promise of success—in fact, with actual success, so far as success can be claimed for a new type of machine before it has had long continued use. The larger engines will be horizontal, and of simpler construction, and we believe they will solve the question, which is still an open one, whether really large gas engines can be made to work really well. The steam turbine is on a different footing. Its reputation is made and its dominion fast advancing. We have taken up a well-tried type of it, but in the details of construction have introduced novel modes of manufacture, perhaps natural to works where the interchangeable system is widely adopted and where exact methods of manufacture are followed in almost everything. It is not desirable to publish all we might say about our new trade in steam turbines, but it may be said that the horse-power of turbines on order is already astonishing, and that it seems to be no extravagant hope that in a few months we may do so much business in this department as to make even the initiation of work at Queen's Ferry an easy burden. There is one other new departure of which we desire to say less—not because we are not hopeful of it, for its success is more a proved thing than anything we have yet done with turbines, but because we prefer to keep details to ourselves. This is an improvement in the Willans engine itself which will restore to it, if tests are to be trusted, much of the relative superiority it formerly enjoyed. I now move the adoption of the report and accounts.

Mr. GOFF seconded the motion, and expressed his belief that the misfortunes of the company were of a temporary character only.

Sir R. SANKEY, the remaining trustee for the debenture holders, said that they were naturally all greatly disappointed with the results of the last half-year's working, but what he might call the transparent honesty with which the board had disclosed the present condition of matters afforded to his mind the very best guarantee that they knew the worst.

The motion was then carried, and the board received authority to borrow any sum or sums up to an amount not exceeding 50 per cent. of the present paid-up capital of the company.

The CHAIRMAN announced that a special meeting should be convened to formally elect Mr. Peache and Mr. Anderson as directors.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—At the meeting on Tuesday, H. Doughty Browne presided, and said that the directors' report was one of the most extraordinary that had ever been submitted to shareholders. The gross traffic receipts for 1902 were £254,000, and in the past year £328,000, an increase of £74,000. That was principally the result of electric traction. Notwithstanding the great increase in receipts, the working expenses had actually decreased by nearly £16,700. The principal factor was the great success of the conversion from horse traction to electricity. The company had not been a great success previously, and the issuing of shares to secure the necessary funds for the conversion had been a matter of great anxiety to the directors. Eventually the Argentina Electric Traction Co. found the money for the conversion. Over and above the income necessary for paying the ordinary shareholders (£65,000) there was a sufficient balance to allow them to place £15,000 to reserve and depreciation, carry forward £6,220, and declare a dividend of 6 per cent. on the ordinary shares created to represent the money which the Traction Company had spent on the undertaking.

BIRMINGHAM AND MIDLAND TRAMWAYS CO. (LTD.)—The directors' report states that the revenue for 1903 was £86,399. 12s. 2d., and after deducting all expenses (including repairs, maintenance and debenture interest) the profit was £19,652. 11s. 2d. Deducting preference dividend and adding £1,979. 10s. 9d. from previous account, the available balance was £21,409. 11s. 11d. £9,000 is placed to depreciation and reserve, a dividend of 6 per cent. on the ordinary shares (since converted to 7 per preferred ordinary shares) is declared, and £695. 15s. 11d. carried forward. The company has purchased from the British Electric Traction Co. for £760,000 their interests in the Dudley, Stourbridge and District Electric Traction Co., the South Staffordshire Tramways (Lessee) Co., the Wolverhampton District Electric Tramways (Ltd.) and the City of Birmingham Tramways Co., and also the benefit and liabilities contained in certain agreements in connection with the tramways and light railways owned by these four companies. Negotiations are now proceeding with a view to the various tramways and light railways owned, leased or controlled by these four companies being worked as one undertaking. The joint undertakings operate over 94 miles of tramways and light railways, and about 40 miles of omnibus routes, with powers to operate, when constructed, approximately another 23 miles of tramways and light railways. All the lines are of a uniform gauge of 3ft. 6in. Abour 53 miles are being worked by electricity, and 8 miles are being converted to electric traction. Some of the lines belonging to or leased by the City of Birmingham Co. are still worked by cable, steam and horse traction. This company's lease within the city of Birmingham expires in 1906, and the leases of the lines of the City of Birmingham Co. within Birmingham expire as to part in 1906 and as to the remainder in 1911. A contract has been entered into with Rowley Regis Council for the construction and electrical equipment by the company on behalf of the Council of 3 miles 6 furlongs single line of tramway, and a lease for the working will be granted to the company when the lines are completed. It is proposed to make an issue of debenture stock. The registered office will be transferred to Birmingham. Mr. B. Kingsford (for some years secretary to the Potteries Electric Traction Co.) has been appointed secretary, and Mr. J. A. Lycett managing director.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LTD.)—At the meeting last week the chairman (Mr. J. B. Concannon) said: For the first time in the history of the company a dividend of 3 per cent. was declared on the ordinary shares, The traffics for the year showed an increase of £14,447 over those for 1902. About £2,300 of that amount was, however, exceptional. When they transformed the line from horse traction to electricity there was a considerable section of rails which was comparatively new and heavy; but it was not one which their engineers considered would last very long with electric traction, owing to the fact that the groove was very shallow. On the advice of their engineers they decided to cast-weld them, making a continuous joint. The total cost of that, together with an outlay of £2,500 for small dynamos, which they had to put up temporarily, was about £9,000, and the remainder would probably be written off out of the current year's profits. They spent during the year on construction and equipment £20,249, owing chiefly to the construction of nearly 3 miles of additional line, which left 1½ miles (now being constructed) to complete their obligations.

CALCUTTA TRAMWAYS CO. (LTD.)—The chairman (Mr. E. C. Morgan) at the meeting on Tuesday said the traffic receipts for 1904 continued to improve, the aggregate to date being £35,998, an increase of £4,125 over the corresponding period for 1903. Negotiations were in progress for the construction of additional lines of tramways connecting up the system with populous districts. Mr. Martyn Wells, the company's managing agent in India, said there was no doubt as to the success of electric traction from the traffic point of view. The number of passengers carried on the company's lines was from 8,000,000 to 9,000,000 more in the past year than in the last year of horse traction.

ELECTRO PEAT COAL SYND. (LTD.)—At the statutory meeting, the chairman (Mr. Rowe) gave a synopsis of the progress made since the registration of the syndicate. He said they had spared no expense in putting up a trial plant, which had been acknowledged to have demonstrated the advantages and utility of Mr. Bessey's electrical process. They were fortunate in securing the co-operation of Messrs. Johnson and Phillips to assist them in carrying out a complete demonstration of the process, but that firm was not financially interested in the syndicate. The demonstrations had proved an unqualified success for the process. It would not be judicious for him to state the payments that had been made and that had been agreed to be made for the right of working the process for some foreign countries, but the arrangements made for dealing with only four of their patents represented enormous profit to the shareholders, with continuing rights in the conduct of the business in the countries referred to. The parent company would shortly issue its prospectus, and an initial plant would be set up within the next two or three months for dealing with large quantities of material. It was not too much to expect that 200 subsidiary companies would be formed within the next two or three years, and there was not a district in England, Ireland or Scotland that could not be served with electro-peat coal. One of the novelties and important factors was that the application of an electric current to the mass of peat set up a chemical action between the natural constituents of the peat, and the result was not only the expelling of moisture, but the natural consolidation of the peat into a hard solid block of fuel. They claimed without hesitation that electro-peat coal could be produced at 5s. per ton. There was no reason why the consumer in the neighbourhood of peat bogs should not be supplied with a materil which they claimed would answer all purposes of a good-class coal at a considerable reduction on the price of the latter fuel. The peat coal had many other advantages besides economy. Mr. J. McGregor (Johnson and Phillips) said he was pleased to have had the opportunity of attending this meeting. The many demonstations which had taken place at their works at Charlton were under his personal supervision, and he had no hesitation in saying that those trials had entirely satisfied him that the process which Mr. Bessey had patented entirely fulfilled its claims and had demonstrated beyond doubt that ordinary peat could be converted at a minimum cost into a commercially useful fuel, and he had satisfied himself also that the electric current was the useful and necessary agent that brought about that result. The calorific power of the fuel had been proved by experts; but they had burnt electro peat coal in various furnaces and grates at the works, and it had proved as good as, if not better than, ordinary coal.

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INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors' report for 1903 states that the company's foreign concessions have all been extended up to the end of 1924. Terms of the agreement for the leasing of land lines in this country and submarine cable wires from Lowestoft to the German coast have been agreed between the Postmaster-General, the Imperial German Post Office and the company. The company's lines continue to work efficiently, and the direct Wheatstone working between London and Teheran, which has been completely satisfactory, has been extended to Manchester and Liverpool. With regard to the arbitration on the question of the incidence under the cis-Indian joint purse of certain higher "paid-outs," for which the company is liable under its extended concessions, the report states that the award was substantially in favour of this company, and that consequently a certain sum, provisionally retained on suspense account, is now released. The retirement scheme for the officers and general staff of the company proposed by the directors has been in operation since Oct. 1 last, and the directors propose to allocate to this scheme the sum mentioned above as available in consequence of the arbitration award (£12,394. 10s. 9d.), and trust this course will commend itself to the shareholders; the directors further propose to ask the consent of the shareholders to an alteration in the articles of association to enable them to form a trust fund, and to hand over to the trustees the £5,000 voted by the shareholders last year (with interest at 3½ per cent.), the sum of £12,394. 10s. 9d. now proposed to be voted (also with interest at 3½ per cent.), and any sums to be voted hereafter.

The company's revenue from all sources for 1903 amounted to £139,094. 10s. 1d., compared with £134,305. 4s. 1d. for 1902, increase £4,789. 6s. The expenses were: On commercial and general account £42,443. 9s. 2d., on maintenance account £26,450. 7s. 3d., total £68,893. 16s. 5d., against £64,351. 19s. 10d. for 1902, increase of £4,541. 16s. 7d. Deducting these expenses, the balance is £70,200. 13s. 8d. Income tax (£3,542. 1s. 2d.) has been deducted, leaving £66,658. 12s. 6d. Adding £17,207. 4s. 9d. brought forward and £12,394. 10s. 9d. held in suspense and now transferred, the total is £96,260. 8s. The interim dividend has absorbed £10,625, leaving available £85,635. 8s. The directors propose to add £15,000 to the fund for equalisation of dividends; to hand over £12,394. 10s. 9d. to the retirement trust fund; to write off a further £10,000 for depreciation of reserve fund investments, and to declare a dividend for the six months ended Dec. 31 last, of 17s. 6d. per share (making 6 per cent.), and a bonus of 20s. per share (both tax free), making in all 10 per cent. for the year, carrying forward £16,365. 17s. 3d.

PERTH (W.A.) ELECTRIC TRAMWAYS (LTD.)—At the meeting on Tuesday the chairman (Mr. E. Heasman) referred to the passing of the Tramways Act Amendment Act, 1903, by which the company would be able to substitute a double line of rails for a single one, subject only to the consent of the local authority. The tedious and inconvenient practice of having to apply for special Acts of Parliament when a duplication of the track was required would be obviated. The retirement of the managing director in Western Australia (Mr. E. E. Rogers) had decided the directors to appoint a local board to assist the manager and engineer Mr. Somerset) in conducting the company's affairs in Western Australia.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—Mr. G. F. M. Corwallis-West at the meeting on Friday said on the new tramway route between Stoke and Newcastle, completed within the last six weeks, traffic receipts were steadily increasing. They had several light railways authorised which were not yet constructed, but the directors were anxious to keep capital expenditure within the narrowest possible limits. The result of the working of the parcels department was satisfactory, and the figures showed that with proper organisation it was possible for tramway companies to cope successfully and profitably with what he was convinced had been, and was still, a long-felt want in many thickly populated districts. The directors intended to put on a service of motor omnibuses in certain districts, there being many roads along which it would not pay to lay down a tramway.

READING ELECTRIC SUPPLY CO. (LTD.)—The directors' report for 1903 states that the capital expenditure now amounts to £119,275. 13s. 7d. During the year it was necessary to order additional plant, including power gas plant for the manufacture of gas on the premises. To defray cost of this plant and necessary extensions of buildings it is proposed to issue the remaining 6,000 shares of the authorised capital of £150,000 and to offer these to existing shareholders. The total revenue for the year was £13,662. 5s. 3d., and generation and distribution expenditure, management and £1,500 written off to depreciation amounted to £8,050. 3s. 11d., leaving a profit of £5,612. 1s. 4d. An interim dividend at the rate of 5 per cent. per annum, tax free, was paid on Nov. 1, and the directors now recommend a similar balance dividend. The directors have underlet a portion of the works premises on lease to the Industrial Storage Battery Synd. (Ltd.), who, it is expected, will be large consumers of electrical energy. The total present capacity of the generating plant is 1,675kw., which will be increased, when the engines on order are supplied, to 2,675kw. There are 700 consumers, representing an equivalent of 70,297 8 c.p. lamps connected, against 608 consumers and 61,454 lamps in the previous year. Since Dec. 31 last the number of 8 c.p. lamps added and applied for is 5,289, making 75,586, in which is included the equivalent of 763 H.P. of electric motors.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—At the meeting on Saturday the chairman (Mr. R. Forrest, J.P.) said that for the short time that the station at Bridgend had been at work it had shown good results, and the business was constantly increasing. The stations at Pontypridd and Cwmbran were ready to supply current; the buildings at Neath station had been completed, the plant was in course of erection and it was anticipated that this station would be at work in about three months. The Treforest station was delivering current to a customer for resale, and general consumers would within the next few weeks be connected up for supply. The Cwmbran station was practically in the same position, although it would be a little longer before current would be available. Already the prospects were that the customers secured and those with whom they were negotiating would be more than sufficient to absorb the whole of the power which could be generated at that and the two stations at Brigend and Cwmbran. A few months ago it would have been said by almost any engineer that if there was one thing for which electricity was not suitable it was for coal winding, but they were glad to report that whatever difficulty there was had been solved with advantages which were greatly in excess of those obtained from the use of steam engines. They found, in fact, that whereas a steam engine was required at times to generate, say, 2,000 H.P., to do a given work in coal winding, this could now be done, with certain arrangements, by a 500 H.P. electric motor. This fact should largely increase the demand for electric current from their station, practically the whole business of which would certainly be in the first place to supply collieries. In the Little Rhondda, so far as their mains were at present laid, the colleries with one exception, and they were negotiating here, would take current from them. Practically the same thing obtained in the larger Rhondda, with the exception of two collieries, with which they were also still negotiating. It was also pretty certain that in the near future some of the many railways in South Wales—and there was no part of the country where there were more of them than in that district—would require to use electricity for the cheap propulsion of their trains and this company would be in a position to supply more cheaply than anyone else.

THAMES IRONWORKS, SHIPBUILDING AND ENGINEERING CO. (LTD.)—The chairman at the meeting on Monday said the company's electrical engineering department had been busy. The policy of the Admiralty now was to equip their boats with electrical auxiliaries, and their contracts in that respect were four times what they were last year. It was probable that considerable extension of the company's electrical department would have to be made during the current year. They had found running their presses and plant by steam to be exceedingly wasteful as compared with driving them by electricity, and he hoped before the year was out that they would have all their outlying plant driven electrically from a central station instead of by steam. Their relations with their workmen had been of a most satisfactory character. Provision was made to write off £10,000 for depreciation, in addition to the £10,000 already written off since the formation of the company. The accounts for the year showed a profit of £34,015, and after deducting interest, &c., the balance was £22,434. It was proposed to pay the balance preference dividend, to place £5,000 further to reserve and to carry forward £2,778.

CITY NOTES.

MEMORANDA.—Bank rate 3½ per cent. (April 14, 1904). Price of silver 24⅝d. per oz. (April 14). Consols 88¼—88⅜ for money, 88⅜—88½ for account; 2½ per cent. annuities 88—88½ (April 14). Consols Pay Day May 5; Stocks and Shares Continuation Days, April 26 and May 10; Ticket Days, April 27 and May 11; Pay Day, April 28; Mining Share Carry-over Days, April 25 and May 9.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have resolved, after placing £6,000 to renewal fund, to declare an interim dividend for the quarter ended March 31 of 12s. 6d. per cent. on the ordinary and £1. 5s. per cent. on the preferred stock, less tax, payable 30th inst.

BERLIN ELECTRIC RAILWAY.—The official returns have been issued relating to the working results for 1903 of the first electric railway established in Berlin, the initial section of which was opened for traffic in February, 1902, the remaining sections being inaugurated subsequently in the same year. Thus the results for 1903, although showing satisfactory progress, are not comparable to the incomplete period of nearly 11 months, during which only only one portion of the railway was in operation. The overhead and underground sections of the line carried 29,628,463 persons in 1903, compared with 18,813,994 passengers in 1902, while the short level section carried 2,507,649 persons, as against 1,227,010 in the preceding period. The total working receipts were £190,903 and the expenses £100,126. After providing for interest and making provision for reserve and renewal funds, there remains a net profit of £57,523. It is proposed to pay a dividend at the rate of 3½ per cent. for the year on the share capital of £1,500,000. In the preceding year the railway was worked by the contractors, who guaranteed and paid 4 per cent. interest on the share capital for 1902, when the railway was transferred to the proprietary company.

DEUTSCH-ATLANTISCHE TELEGRAPHENGESELLSCHAFT.—With reference to the City Note appearing in our last issue, the statement that the laying of the second section of the German Atlantic cable would commence on the 16th inst. was incorrect, as the c.s. "Stephan" is expected to leave Nordenham on the 16th inst. for New York in order to commence laying the cable from the American side.

ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD).—In addition to the preference dividend, a final dividend of 3½ per cent. on the ordinary shares (tax free), making 6 per cent. for the year, is recommended.

RICHARDSONS, WESTGARTH & CO. (LTD.)—The directors have declared an interim dividend at the rate of 6 per cent. per annum on the ordinary shares for half-year ended Feb. 25.

VULCAN BOILER AND GENERAL INSURANCE CO. (LTD.)—Mr. George Comber has been elected chairman and Sir Joseph Leigh, M.P., deputy-chairman of this company.

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BARNSLEY AND DISTRICT ELECTRIC TRACTION CO.—The revenue for the past year amounted to £9,737, and the net profit £2,388. A dividend of 4½ per cent. on the ordinary shares declared.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of the second debenture stock will be closed from 18th to 30th inst. inclusive preparatory to payment of interest due May 1.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—The shareholders will shortly consider a proposal to transfer the company's undertaking to the Cheshire Electricity and Power Gas Co.

REDUCTION OF CAPITAL.—The Chancery Court of Lancaster has confirmed the reduction of the capital of the Blackpool, St. Anne's and Lytham Tramways Co. from £150,000 to £125,000.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed April 20 a special settling day in 109,251 ordinary £1 fully-paid and partly-paid shares of the *Consolidated Electrical Co. (Ltd.)* and have granted quotations to 59,394 5 per cent. cumulative fully-paid £1 preference shares and 75,606 preferred ordinary fully-paid £1 shares of the *Bath Electric Tramways (Ltd.)*.

URBAN ELECTRIC SUPPLY CO. (LTD.)—The report for 1903 states that, although only seven stations were running for the whole year, the profit amounted to £13,874. The balance profit was £12,181. Guaranteed dividends required £16,069, and £3,887 was required to be provided by Edmundson's Electricity Corp. under the terms of their agreement.

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended March 31, 1904. The following statement, dated March 9, shows the condition of the company at the close of the quarter ended Dec. 31, 1903:—

Surplus Oct. 1, 1903, as per last quarterly report ...		$13,863,602 81
Net revenues, quarter ended Dec. 31, 1903		2,000,060 66
		$15,863,663 47
From which deducting for—		
Dividend of 1¼ per cent. paid Jan. 15	$1,217,017 50	
Interest on bonded debt	286,300 00	
		1,503,317 50
Left a surplus Jan. 1, 1904, of		$14,360,345 97
The net revenues of the quarter ending March 31, based upon nearly completed returns for January, partial returns for February, and estimating the business for March, will be about		1,750,000 00
		$16,110,345 97
From which appropriating for—		
Interest on bonds		286,300 00
		$15,824,045 97
It requires for a dividend of 1¼ per cent. on capital stock issued, about		1,217,017 50
Deducting which leaves a surplus, after paying dividend, of		$14,607,028 47

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared.

NEW COMPANIES, STATUTORY RETURNS, LIENS REGISTERED, &c.

NEW COMPANIES.

ANDERSON, BOYES & CO. (LTD.)—Reg. in Edinburgh April 5, capital £10,000 in £1 shares, to acquire business carried on by Anderson, Boyes & Co., electricians and engineers, at Flemington, near Motherwell. First directors, A. Anderson (manager), D. Burns, T. Boyes, J. Anderson, jun., and J. Shield (secretary). Reg. office, Flemington, near Motherwell.

LOWNE ELECTRIC CLOCK AND APPLIANCES CO. (LTD.)—Reg. March 30, capital £8,000 in £1 shares, to adopt an agreement with Messrs. R. M., R. J. M., and B. T. Lowne, and to carry on the business of automatic electric clock pendulum makers, electrical recording vane and anemometer makers, electric signal makers, clock, watch and chronometer makers, scientific instrument makers, electricians, electrical engineers, &c. First directors R. M. Lowne, B. J. M. Lowne and B. T. Lowne. Reg. Office, Ravenscroft, Bromley-road, Catford.

MINIATURE ARC LAMPS (LTD.)—Reg. March 30, capital £2,000 in £1 shares, to adopt agreement with A. E. Parker and P. E. V. G. Plater, to manufacture and deal in lamps, dynamos, cables, insulating materials, accumulators, telephones and other apparatus, and to carry on the business of electricians, engineers, suppliers of electricity, &c.

TRACTION AND POWER AGENCY (LTD.)—Reg. March 31, capital £500 in £1 shares, to carry on business of omnibus, carriage, vehicle and boat builders, tramway and railway proprietors, electrical and general engineers, &c. Reg. office, 92, Victoria-street, London, S.W.

MORTGAGES AND CHARGES.

HYDE ELECTRICAL MFG. CO. (LTD.)—£900 debentures created and dated March 15, 1904, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. Holders, Miss S. Harrison and A. H. Davies.

LONDON ELECTROMOBILE SYND. (LTD.)—£996. 19s. debentures, created March 22 and dated March 29, 1904, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

MADRAS ELECTRIC TRAMWAYS (1904), LTD.—Trust deed dated March 18, 1904, to secure £50,000 first mortgage debenture stock, has been registered. Property charged, freehold land in Madras and company's undertaking and property, present and future, including uncalled capital. Trustees, Anglo-Indian Debenture Corp.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 9	1,206	+ 272	45	54,079	+ 10,907
Airdrie	,, 1	185	...	8	1,456	...
Ayr Corporation.....	,, 2	184	— 1	46	12,511	+ 161
Barnsley	,, 1	176	+ 1	13	1,987	- 105
Barrow	,, 1	188	+ 126	8	1,167	+ 705
Bexley District Council.....	,, 7	360	...	26	4,182	...
Birkenhead	,, 10	1,060	— 11	...	...	...
Birmingham Corporation ..	,, 9	319	...	13	4,082	...
*Birmingham Tramways Co.	,, 9	6,153	+ 1,120	14	72,178	+ 4,027
*Blackburn Corporation.....	,, 8	1,122	+ 64	2	2,130	+ 650
Blackpool Corporation	,, 7	1,445	+ 1,069	§1	1,445	+ 1,067
Blackpool and Fleetwood....	,, 9	631	+ 49	15	3,401	+ 84
Blackp'l,St.Anne's&Lytham	,, 7	601	+ 601	†23	3,886	+ 3,307
Bolton Corporation	,, 10	‡1 810	- 580	2	2,986	- 328
Bournemouth Corporation..	,, 6	1,565	+ 715	1	1,565	+ 715
*Bradford Corporation	,, 9	4,805	+ 1,004	§2	6,215	+ 1,226
Brighton Corporation	,, 10	979	...	¶1	1,462	+ 253
Brisbane Tramways	Feb. 24	2,234	— 110	8	18,116	- 216
*Bristol Trams & Carriage...	April 8	5,782	+ 1,010	20	91,967	+ 4,058
*Buenos Ayres & Belgrano...	...	...	...	...	...	...
Burnley Corporation.....	,, 9	971	- 57	2	2,204	+ 370
Burton Corporation	,, 10	363	...	36	12,100	...
Calcutta Tramways Co.....	,, 9	R32,172	+ R3,294	15	R519,977	+ R31,181
Camborne-Redruth	,, 11	104	...	23	2,499	...
Cardiff Corporation	,, 9	2,194	+ 321	§1	2,838	— 180
Carlisle Tramways Co.....	...	...	...	...	...	...
Central London Railway ...	,, 9	6,673	+ 160	15	104,795	+ 319
Chatham & Dist. Lt. Rys....	,, 7	773	+ 282	14	7,202	+ 1,366
City & South London Rly..	,, 10	2,822	+ 109	15	46,940	- 811
Cork Electric Trams Co. ...	,, 7	462	- 17	14	5,471	- 147
Darwen Corporation	...	...	...	...	...	...
Devonport & Dist. Trams...	,, 1	520	+ 88	13	5,933	+ 864
Dover Corporation.....	,, 9	245	- 1	2	349	- 27
Dublin & Lucan Railway...	,, 10	144	+ 18	15	1,403	+ 108
Dublin Southern District...	,, 2	918	+ 93	¶14	61,195	+ 862
Dublin United.....	,, 2	4,018	+ 283			
Dudley—Stourbridge.....	,, 1	791	+ 11	13	9,549	+ 406
Dundee Corporation	,, 6	861	+ 38	...	...	...
East Ham Council.....	,, 9	835	+ 110	§1	1,105	+ 72
Gateshead & Dist. Trams...	,, 1	910	+ 54	13	11,211	+ 654
Glasgow Corporation.....	,, 9	14,045	+ 778	45	610,693	+ 56,827
Gravesend—Northfleet.....	,, 1	239	+ 47	13	2,764	+ 411
Gt. Northern & City Rly....	,, 9	990	+ 7	8	7,555	...
Greenock & Port Glasgow..	,, 1	478	— 18	13	6,021	+ 597
Halifax Corporation	Mar. 30	1,178	+ 88	52	68,181	+ 6,889
	April 6	1,825	+ 692			
Hartlepool Tramways	,, 1	275	+ 43	13	3,198	+ 852
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 9	2,213	+ 211	1	2,956	- 153
Ilkeston Corporation.....	,, 6	187	...	21	2,615	...
Ipswich Corporation.....	,, 9	524	...	§1	726	...
Isle of Thanet Co.	,, 9	596	+ 13	...	...	...
Kidderminster & District...	,, 1	103	- 2	13	1,229	- 72
Kirkcaldy Corporation	,, 6	234	...	6	1,189	...
Lanarkshire Trams Co.....	,, 7	605	...	14	8,029	...
Leeds Corporation.....	,, 9	6,185	+ 827	2	12,612	+ 2,199
Liverpool Corporation	,, 2	9,933	+ 248	14	133,121	+ 3,323
*Liverpool Overhead Rly. ...	,, 10	1,776	+ 91	15	23,113	+ 349
*London County Council ...	Mar. 31‡	7,182	...	§52	515,947	+ 90,409
Lowestoft.....	...	...	...	...	...	...
Manchester Corporation ...	April 9	12,127	+ 64	1	12,127	+ 64
Mersey Railway	,, 9	1,651	+ 549	14	20,505	+ 5,174
Merthyr	,, 1	215	+ 22	13	2,473	+ 195
Middleton	,, 1	303	+ 41	13	3,213	+ 219
Nelson Corporation	,, 9	107	+ 23	2	243	+ 117
Newcastle-on-Tyne Corp....	,, 9	8,791	+ 454	14	48,890	+ 6,515
Newport (Mon.)	,, 9	561	+ 127	2	763	+ 151
Oldham, Ashton & Hyde ...	,, 1	595	+ 57	13	6,480	- 317
Oldham Corporation.....	Mar. 27	1,061	...	4	4,301	...
	April 3	1,135				
Perth (W. A.) Elec. Trams.	,, 8	1,444	+ 328	14	19,457	+ 2,756
Peterborough	,, 1	143	+ 5	13	1,458	- 177
Poole and District.....	,, 1	268	+ 24	13	2,979	- 58
Portsmouth Corporation ...	,, 9	2,468	+ 616	§1	3,169	+ 616
*Potteries	,, 1	1,702	+ 188	13	21,264	+ 1,558
Reading Corporation.....	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rothesay	,, 1	56	+ 2	13	582	+ 49
Salford Corporation	,, 11	3,771	- 292	2	6,510	- 234
Sheerness	Mar. 30	46	...	13	582	...
Sheffield Corporation	April 10	4,887	+ 410	§2	10,692	- 497
*Southampton Corporat'n	Mar. 31	855	- 85	...	...	...
	April 7	1,074	+ 166			
Southend Corporation	...	...	...	...	...	...
Southport Tramways	,, 1	801	+ 49	13	3,111	+ 274
S. Staffordshire Trams. ...	,, 1	748	- 57	13	9,535	+ 275
Stockport Corporation.....	,, 8	568	+ 155	1	568	+ 155
Sunderland Corporation ...	,, 10	1,249	+ 25	2	1,771	- 218
*Swansea Trams	,, 1	518	+ 72	13	5,950	+ 218
Taunton Trams	,, 1	47	- 31	13	595	- 66
Tynemouth and District ...	,, 1	256	+ 29	13	2,686	- 56
Tyneside Trams Co.....	,, 6	422	+ 150	14	4,027	+ 745
Wallasey District Council..	,, 11	789	+ 126	†2	1,009	...
Warrington Corporation...	...	...	...	...	...	...
West Ham Corporation ...	,, 7	807	...	6	2,113	...
Weston-super-Mare	Mar. 30	30	- 1	13	310	- 25
Wigan Corporation	...	...	...	...	...	...
Wolverhampton District ...	April 1	349	- 22	13	4,608	- 198
Worcester	,, 1	255	+ 100	8	1,956	+ 703
Wrexham.....	,, 1	118	...	13	1,281	...
Yorkshire Woollen District	,, 1	557	+ 351	13	6,592	+ 2,521

(a) These comparisons are with the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. ¶ Plus 3 days. § Plus 2 days

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., April 13.	Rate per Cent. Yielded.	Dividend Due	Business, Week to April 13.		Share.	Last Dividend	Name.	Price Wed., April 13.	Rate per Cent. Yielded.	Dividend Due	Business Week to April 13.	
						Highest.	Lowest.							Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.						**TELEPHONES.**		£ s. d.			
5	2/6	Anglo-Arg'tine Sh(1to260,007)5%Cm.Pf.	4¾—5¾	4 17 7	April, Oct	5⅝	5	5	3/0	Chili Telephone (fully paid)	4¾—5¾	5 14 3	August		
St.	6%	Do. Permanent 6% Deb. Stock	127 —132	4 11 11	..	..	..	St.	6%	National Co. Pref. Stock	103 —105	5 14 10	..	104½	103
St.	3½	Auckland Elec. Trams 5% Deb. (red.)	98 —100	..	..	..	..	St.	5%	Do. Def. Stock	86 —88	5 13 9	..	87½	86
10	10/0	Barcelona Tramways Ord.	6 —8	6 5 0	..	..	..	10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	12⅜	10
10	5/0	Do. 5% Cum. Pref.	9 —10	5 0 0	..	..	..	10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 —95	4 14 9	..	..	..	5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	4⅞—5½	4 17 7	Feb, Aug	4⅝	..
100	5%	Do. 5 per Cent. Debs.	95 —98	5 2 0	..	..	..	St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 —99	3 11 5	June, Dec	98	97½
1	..	Bath Elec. Trams Pref. Ord.	⅜—⅝	..	..	..	..	St.	4%	Do. 4 per Cent. Deb. Stock (red.)	100 —102	3 19 5	..	100½	..
1	..	Do. 5% Cum. Pref.	⅜—1	..	..	..	..	1	0/7½	Oriental	⅛—1⅛	6 6 8	April, Oct	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—2½	..	..	..	..	1	..	Do. 6 per Cent. Cum. Pref.	1 —1½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	5 17 8	..	4	..	5	3/0	United River Plate	5½—6	5 16 8	July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 —102	4 8 3	..	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	4½—5½	4 15 3	June, Dec	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 —20	4 10 0	Feb, Aug	..	..	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 —105	4 15 3	June, Dec	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 18 0	..	..	..			**ELECTRICITY SUPPLY.**					
St.	4%	Do. 4 per Cent. Debs.	106 —108	3 14 0	Feb, Aug	..	..	1	..	Blackheath & Gr'nwich. Dist. Ord.(f.p.)	⅝—¾	..	..	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	99 —102	4 18 1	..	100⅝	99	1	0/5⅞	Do. 7% Cum. Pref.	1⅛—1⅜	..	..	..	..
St.	5%	Do. Pref. Ord. Stock	99 —102	5 0 0	..	101	100⅜	St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	113 —116	3 17 7	..	..	..
10	5/0	Do. 5% Cum. Perp. Pref.	10½—10¾	5 11 7	..	..	..	10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12 —13	6 3 2	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝—105⅝	4 7 0	..	..	..	10	4/6	Do. 4½ per Cent. Cum. Pref	9½—10½	4 5 9	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 —101	4 9 1	..	..	..	10	6/0	Do. 6% Cum. Second Pref.	10½—11½	5 4 4	..	10⅝	10⅜
10	6/0	British Electric Traction Ord.	8½—9½	8 8 6	..	9½	8⅞	St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 —104	4 6 7	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10½—10¾	5 11 7	Feb, Aug	11	10⅝	St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	102 —105	4 7 8	..	104	102½
St.	5/0	† Do. 5 per Cent. Perpetual Debs	116 —119	4 4 0	..	118	117	5	5/6	Brompton & Kensington Elec. Sup. Ord.	10½—11	4 10 11	..	10⅝	..
5	..	Buenos Ayres and Belgrano Ord.	2⅜—3	..	..	2⅝	2⅜	5	3/6	Do. 7 per Cent. Pref.	10½—10¾	3 5 1	Mar, Sept	..	..
5	3/0	Do 6 per Cent. "A" Cum. Pref.	5⅛—5⅜	5 4 0	..	5⅜	..	5	3/0	Calcutta Electric Supply Ord.	6½—7	4 12 10	..	6⅝	..
5	3/0	Do. "B"	5 —5½	5 9 1	..	..	..	St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 —109	3 13 8	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —107	4 13 6	..	..	..	5	4/0	Charing Cross & Strand Electric Sup.	7 —7½	5 6 8	Feb, Aug	7⅜	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 —101	4 19 6	..	..	..	5	2/3	Do. 4½ per Cent. Pref.	5½—5¾	4 5 9	Feb, Aug	5⅝	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 —100	5 0 3	..	..	..	5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½—5	4 10 0	..	..	..
5	2/6	Calcutta Tramways	6¾—7¼	4 9 8	..	7 1/16	6 15/16	5	1/7	Do. Do. (1903)	4⅜—5	..	..	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 4 0	..	103	..	St.	4%	Do. 4% Deb. Stock (red.)	102 —104	3 17 10	..	103	..
1	1/0	Cape Electric Tramways Shares	1⅞—2⅛	8 0 0	..	..	..	5	3/6	Chelsea Electric Supply Ord.	6 —6½	4 4 7	March	6⅝	..
St.	4%	Central London Ordinary Stock	90 —93	4 6 6	June, Dec	94	93	St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 3 1	Jn, Dec	..	..
St.	4%	Do. 4 per Cent. Pref. Stock	98 —101	3 19 9	..	..	..	10	5/0	City of London Electric Lighting Ord.	10¼—10¾	4 13 0	Feb, Aug	10⅜	10¼
St.	4%	Do. Deferred Stock	85 —88	4 11 3	..	86	85	10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 9	Jan, July	..	..
100	4%	Do. 4 per Cent. Debs.	110 —113	3 11 8	..	110½	110	St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 —126	3 19 4	Jn, Dec	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4¾—5¼	4 15 3	..	..	..	St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 7	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 19 0	..	..	..	10	4/0	County of London & Brush Prov. Ord.	7 —8	5 0 0	..	..	..
St.	2%	City and South London Rly. Con. Ord.	49 —52	4 11 4	Feb, Aug	50½	50	10	6/0	Do. 6 per Cent. Cum. Pref.	11 —12	5 0 0	Mar, Sept	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 —125	4 0 8	Feb, Aug	..	..	St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	103 —109	4 2 11	..	107	106
St.	5%	Do. (1896)	120 —123	4 2 2	..	122½	..	St.	27/6	Do. Second Deb. Stock Prov. Certs.	99 —102	..	..	104	101
St.	5%	Do. (1901)	110 —122	4 2 10	..	..	..	5	2/0	Folkestone Electricity Supply Co. Ord.	5¾—6¼	4 0 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 —112	3 11 7	May, Nov	..	..	St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 —103	4 8 0	..	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 —104	4 18 1	..	102½	..	10	..	Havana Electricity Co. Shares	9½—10½	..	..	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12½—13½	4 1 6	..	..	..	5	3/6	Hove Electric Lighting Ord.	7½—8½	5 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 —16	3 15 0	..	..	..	St.	..	I of W. Elec Lt. & Power 4½% Db St (red.)	102 —105	..	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	1½—2½	12 0 0	..	..	..	1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛—⅜	..	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 —97	5 3 1	..	..	..	5	7/0	Kensingtn & Knghtsbdge Ord.	11 —12	5 0 0	..	11⅞	..
10	..	Gt. Northern & City Rly. Prf. Ord. (4%)	5½—6½	4 12 2	..	..	..	5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	9 —10	..	..	..	..	St	4%	Kensingtn. & Knghtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —104	3 16 11	..	103½	..
10	10%	‡ Imperial Tramways Ord	18½—19½	4 12 4	Mar, Sept	..	..	3	..	London Electric Supply Ord.	1 —1½	..	..	1⅛	..
10	6%	‡ Do. 6 per Cent. Pref.	14 —14½	4 2 10	Mar, Sept	..	..	5	3/0	Do. 6 per Cent Pref.	4½—5	6 0 0	..	4⅝	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	108 —110	4 1 10	Jan, July	..	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 —97	4 3 7	Mr, Jn, S, D	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½—4	6 5 0	..	..	..	10	9/6	Metropolitan Electric Sup. Ord.	18 —19	4 12 1	April, Oct	18⅜	18
St.	4%	Do. 4 per Cent. Deb. Stock	90 —93	4 6 0	..	..	..	5	1/4½	Do. 4½ per Cent. Cum. Pref.	5⅛—5⅜	4 3 9	..	5⅜	5⅛
10	1½%	†Liverpool Overhead Railway Ord.	4⅛—4⅜	2 16 5	Feb, Aug	..	..	St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	3 19 6	Jn, Dec	111½	..
10	5%	† Do. 5 per Cent. Pref.	10 —10¼	4 15 3	Feb, Aug	..	..	St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —98	3 11 9	..	..	..
St.	4%	† Do. 4 per Cent. Deb.	98½—100½	3 19 10	Jan, July	..	..	100	4⅛	Midland Elec. Corp. for P.D. 1st Mort. Db.	95 —98	4 11 9	..	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11¼—11¾	4 5 2	..	11⅜	11⅛	10	6/0	Notting Hill Electric Ord.	13 —14	4 5 9	March	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 —103	3 18 5	..	102⅞	102	100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 —102	3 18 5	..	..	..
St.	..	Mersey Con. Ord. Stock	6 —9	..	..	..	..	5	4/0	Oxford Electric Ord.	5½—6	5 8 4	March	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 —15	..	..	..	..	St.	4%	Do. 4% Deb. Stock	96 —99	4 0 9	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..	1	..	Rand Electric	⅞—1	..	..	..	..
1	..	Metropolitan Electric Trams Def	¾—1	..	..	..	..	100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb.	98 —101	4 9 1	April, Oct	..	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	..	..	..	5	9/6	St. James' & Pall Mall Elec. Ord.	14 —15	4 16 8	Feb, Aug	14⅞	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 —105	4 16 0	..	..	..	5	3/6	Do. 7 per Cent. Pref.	8 —9	3 17 9	Feb, Aug	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 —107	4 5 0	..	..	..	St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 —100	3 10 6	..	..	..
5	..	New General Traction Ord.	⅛	..	..	..	..	5	4/0	Smithfield Markets Electric Sup. Ord.	3 —3½	5 14 3	..	3⅝	3½
5	..	Do. 6 per Cent. Cum. Pref.	1 —2	..	May	..	..	St.	4%	Do. 4 per Cent. Deb. Stock	85 —90	4 9 6	..	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 —102	4 18 0	..	101	99½	5	3/0	South London Electric Supply Ord.	3 —3½	4 5 8	..	3⅝	..
10	10/0	Potteries Electric Traction Ord.	8½—9½	5 5 3	..	..	..	5	2/6	Urban Electric Supply Ord.	4⅛—4⅜	5 2 6	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 —10	5 0 0	Feb, Aug	..	..	5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 11	..	106½	..	5	7/0	Westminster Electric Supply Ord.	12½—13½	5 0 0	Mar, Sept	12⅝	12½
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	6 —6½	3 16 11	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..			**ELECTRIC MANUFACTURING &c.**					
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..	1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½—½	10 0 0	..	..	..
St.	3%	Waterloo and City Ord.	89 —92	3 8 4	June, Dec	..	..	1	..	Aron Electric Meter 6% Cum. Pref.	⅝—¾	..	Mar, Sept	..	..
								5	4/0	British Insulated & Helsby Cables Ord.	5¾—6¼	6 8 0	July, Feb	..	..
		TELEGRAPHS.						5	3/0	Do. 6 per Cent. Pref.	5½—5¾	5 4 4	Jan, July	..	..
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 —102	3 18 5	Jan, July	98	..	St.	4½%	Do. 4½ 1st Mort. Deb. (red.)	102 —107	4 4 1	..	..	..
10	..	Amazon Telegraph	2½—3½	..	Jn, Dec	..	..	St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 —103	4 4 7	..	3⅝	3½
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..	5	3/0	British Westinghouse 6% Pref.	3¾—4¼	7 1 2	..	92	91
St.	16/0	Anglo-American	48 —51	5 18 8	F, My, Ag, N	..	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock	91 —94	4 6 3	..	..	..
St.	30/0	Do. Preferred	91 —93	6 9 0	F, My, Ag, N	92⅝	91	2	..	Brush Electrical Engineering	⅛—⅜	..	March	..	..
St.	2/0	Do. Deferred	7¼—7¾	1 5 10	F, My, Ag, N	7⅝	7⅜	2	2/4⅛	Do. 6 per Cent. Pref. Non-Cum.	¾—1⅛	9 12 0	Mar, Sept	..	..
100	8%	Commercial Cable Capital Stock	175 —185	4 6 6	Ju, Ap, Jy, O	175	..	St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —99	4 10 11	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 —92	4 7 2	Jn Ap, Jy, O	91⅛	91	St.	4½%	Do. Perpetual 2nd Deb. Stock	72 —77	5 18 4	Jan, July	..	..
10	7/0	Cuba Submarine Ord.	7½—8½	8 8 5	Feb, Aug	..	..	5	5/0	Callender's Cable Construction Ord.	10½—11½	6 10 5	Jan, July	..	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 3	Feb, Aug	..	..	5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 6 11	Jan, July	5⅝	..
5	2/0	Direct Spanish Ord.	2¾—3⅛	5 14 4	April, Oct	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 —108	4 3 3	Nov, May	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 —8	6 5 0	April, Oct	..	..	1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝—¾	6 17 2	..	⅞	..
50	4½%	Do. 4½ per Cent. Deb.	99⅝—102⅝	4 9 3	Jan, July	..	..	St.	4½%	Do. 4½ 1st Mort. Deb. (red.)	88 —93	4 14 9	..	..	..
20	3/0	Direct United States Cable	10 —10¼	6 3 10	Ja, Ap, Jy, O	..	..	1	0/7½	Chadburn's Ship Telegraph Ord	3—1	8 0 0	March	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —101	4 9 1	Jn, Dec	..	..	3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅞—2	7 10 0	Jan, July	..	..
St.	25/0	Eastern Ordinary	120 —125	5 12 0	Ja, Ap, Jy, O	124	119½	100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 2 0	Jan, July	..	..
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 —89	3 19 1	Ja Ap, Jy, O	90½	..	5	..	Dick, Kerr & Co. Ord.	7⅞—8¼	..	..	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 —107	3 15 8	May, Nov	..	..	5	3/0	Do 6% Cum. Pref.	5 —5½	5 9 1	..	..	..
10	2/6	Eastern Extension	11¼—11¾	5 19 2	Ja, Ap, Jy, O	11⅞	11⅝	St.	..	Do. 4½% Deb. Stock	102—104	4 7 2	..	..	..
8	4%	Do 4 per Cent. Deb. Stock	103 —106	3 16 0	Feb, Aug	..	..	5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	½	..	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 —102	3 19 0	Feb, Aug	100	..	5	..	Do. (£5 paid)	½—1½	..	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100⅝—103⅝	3 19 0	May, Nov	..	..	St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 —77	5 3 11	June, Dec	74	73
10	5/0	Great Northern of Copenhagen	25 —26	4 16 2	Jan, July	..	..	5	2/6	Do. 5 per Cent. 2nd Deb. Stock	74 —79	6 6 7	..	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —101	4 9 6	June, Dec	..	..	5	3/6	Edmundson's Elec. Corp. Ord.	5½—6½	5 12 0	Half-yearly	6⅛	..
25	12/6	Indo-European	40 —43	5 16 3	May, Nov	41⅜	..	5	3/6	Do. 6 per Cent. Cum. Pref.	5½—6½	4 16 0	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 —100	4 0 0	June, Dec	..	..	St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 —107	4 5 2	..	106	..
10	2/0	West African Telegraph Shares	5 —6	1 13 4	..	..	..	5	3/6	Electric Construction Co.	1⅝—1¾	6 71 2	Jan, July	1⅝	..
5	..	West Coast of America	⅛—⅜	..	..	..	..	5	3/6	Do. 7 per Cent. Cum. Pref.	2½—3	4 13 4	July	..	..
100	4%	Do. 4 per Cent. Debs.	97 —100	4 0 10	Jan, July	98	..	St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 —100	4 0 0	Jan, July	..	..
10	..	West India and Panama	⅜—½	..	May, Nov	..	..	1	7/0	Electrolytic Alkali Ord.	½—¾	..	..	..	..
10	8/0	Do. 6 per Cent 1st Pref.	5½—6½	9 12 0	May, Nov	..	..	1	7/0	Do. 7 per Cent. Cum. Pref.	½—1	..	..	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..	St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 —95	5 5 8	..	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..	10	5%	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 5	..	..	..
20	3/0	Western Telegraph	12 —12½	5 12 0	Mr, Jn, O, D	12⅝	12⅜	St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —95	4 1 8	..	..	..
100	5%	* Do. 5% Debs. 2nd Series, 1936	101 —104	4 17 9	June, Dec	..	..	5	2/6	Henley's Telegraph Works Ord.	11½—12½	6 0 0	Feb, Aug	12⅛	..
St.	4%	Do. 4% Deb. Stock (red.)	99 —102	3 19 5	..	..	..	5	2/6	Do. 4½ per Cent. Pref.	5 —5½	4 1 10	Feb, Aug	..	..
								St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 —111	4 1 5	Feb, Aug	..	..
		FINANCIAL, INVESTMENT, &c.						10	5/0	India Rubber, Gutta Percha, &c., Wrks.	15 —19	5 5 3	Feb, Aug	15⅝	15
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 —5½	5 9 1	..	..	..	100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	99 —102	3 18 5	Mar, Sept	101	..
10	2/0	Globe Telegraph and Trust	8¼—8¾	4 11 5	Ja Ap Jy O	8⅝	..	10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10 —11	4 10 11	Mar, Sept	..	..
10	3/0	Do. 6 per Cent. Pref.	12¼—12¾	4 14 2	Ja Ap Jy O	12⅜	12⅛	10	5/0	Telegraph Construction & Maintenance	34 —37	6 9 10	Mar, July	37	..
10	4/-	Reuter's	6⅜—7⅛	5 6 8	April, Oct	..	..	100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —104	3 17 8	Jan, July	..	..
10	6%	Submarine Cables Trust (Cert.)	11⅝—12⅜	5 0 0	April, Oct	12⅛	..	5	..	Williams and Robinson Ord.	2 —3	..	Apr, Oct	..	..
								5	3/0	Do. 6 per Cent. Cum. Pref.	3 —4	..	Apr, Oct	..	..
								St.	4½%	Do. 4 per Cent. 1st Mort. Debs.	90 —95	4 5 9	May, Nov	..	..

In calculating the yield allowance has been made for accrued interest but not for [illegible]. † Ex dividend. ‡ The London Stock Exchange Committee [illegible].

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ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend.	Name.	Price Wed., April 13.	Rate per Cent. Yielded.	Dividend Due.	Business Week to April 13. High-est.	Low-est.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	2/6	Anglo-Arg'tine Sh (1to260,007) 5% Cm. Pf.	4⅞–5⅛	4 17 7	April, Oct	5⅛	5
St.	6%	Do. Permanent 6% Deb. Stock	127 –132	4 11 11	..	..	..
St.	34/2	Auckland Elec. Trams 5% Deb. (red.)	98 –100	..	..	..	..
10	10/0	Barcelona Tramways Ord.	6 –8	6 5 0	..	..	..
10	5/0	Do. 5% Cum. Pref.	9 –10	5 0 0	..	..	..
St.	4½%	Do. 4½% Deb. Stock (red.)	90 –95	4 14 9	..	..	..
100	5%	Do. 5 per Cent. Debs.	95 –98	5 2 0	..	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅜–⅞	..	..	..	..
1	..	Do. 5% Cum. Pref.	⅜–⅞	..	..	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½–2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4½	5 17 8	..	4	..
St.	4½%	Do. 4½ per Cent. Deb. Prov. Certs.	97 –102	4 8 3	..	..	..
10	8%	Bristol Tramways and Carriage Ord.	19 –20	4 10 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10 –10½	3 18 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	106 –108	3 14 0	Feb, Aug	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	99 –102	4 18 1	..	100⅝	99
St.	5%	Do. Pref. Ord. Stock	99 –102	5 0 0	..	101	100⅜
10	5/0	Do. 5% Cum. Perp. Pref.	10½–10⅜	5 11 7	..	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103⅝–105⅝	4 7 0	..	..	..
100	4½%	Do. Vancouver Power Debs.	98 –101	4 9 1	..	..	..
10	6/0	British Electric Traction Ord.	8½–9½	8 8 6	..	9¼	8⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	10½–10⅝	5 11 7	Feb, Aug	11	10⅝
St.	5/0	† Do. 5 per Cent. Perpetual Debs	116 –119	4 4 0	..	118	117
5	..	Buenos Ayres and Belgrano Ord.	2⅜–3	..	..	2⅝	2⅜
5	3/0	Do 6 per Cent. "A" Cum. Pref.	5⅛–5⅜	5 4 0	..	5⅜	..
5	3/0	Do. "B"	5 –5⅛	5 9 1	..	..	..
St.	5%	Do. 5 per Cent. Debs.	104 –107	4 13 6	..	..	..
St.	5%	Do. 5% 2nd Deb. Stock Prov. Certs.	98 –101	4 19 6	..	..	..
St.	5%	Buenos Ayres Elec. Trams Co. (1901) 5% Deb. Stk. (red.)	98 –100	5 0 3	..	..	..
5	2/6	Calcutta Tramways	6¾–7⅛	4 9 8	..	7 1/16	6 15/16
100	4½%	Do. 4½% 1st Deb. Stock (red.)	105 –108	4 4 0	..	103	..
1	1/0	Cape Electric Tramways Shares	1⅞–2⅛	8 0 0	..	..	..
St.	4%	Central London Ordinary Stock	90 –93	4 6 6	June, Dec	94	93
St.	4%	Do. 4 per Cent. Pref. Stock	98 –101	3 19 9	..	..	..
St.	4%	Do. Deferred Stock	85 –88	4 11 3	..	86	85
100	4%	Do. 4 per Cent. Debs.	110 –113	3 11 8	..	110½	110
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅜–5⅛	4 15 3	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 19 0	..	..	..
St.	2%	City and South London Rly. Con. Ord.	49 –52	4 11 4	Feb, Aug	50⅛	50
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	122 –125	4 0 8	Feb, Aug	..	..
St.	5%	Do. (1896)	120 –123	4 2 2	..	122½	..
St.	5%	Do. (1901)	110 –122	4 2 10	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	109 –112	3 11 7	May, Nov	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Db. (rd.)	101 –104	4 18 1	..	102½	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12¼–13¼	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	15 –16	3 15 0	..	..	..
5	6/0	Electric Lgt. & Tract. of Aust. 6% Cm. Prf.	1½–2½	12 0 0	..	..	..
	5%	Do. 5 per Cent. Deb. Stock (red.)	92 –97	5 3 1	..	..	..
10	..	Gt. Northern & City Rly. Prf. Ord. (4%)	5½–6½	4 12 2	..	..	..
10	3/4	Gt. Northern, Piccadilly & Brompton Ord., &per Cent. Bros. Scrip Certs.	9 –10	..	..	..	..
10	10%	† Imperial Tramways Ord.	18½–19½	4 12 4	Mar, Sept	..	..
10	6%	† Do. 6 per Cent. Pref.	14 –14½	4 2 10	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Debs.	108 –110	4 1 10	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	3½–4	6 5 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –93	4 6 0	..	..	..
10	1½%	†Liverpool Overhead Railway Ord.	4⅜–4⅝	2 16 5	Feb, Aug	..	..
10	5%	† Do. 5 per Cent. Pref.	10 –10½	4 15 3	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb.	98½–100½	3 19 10	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	11¼–11⅜	4 5 2	..	11⅜	11⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	101 –103	3 18 5	..	102⅝	102
St.	..	Mersey Con. Ord. Stock	6 –9	..	..	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	12 –15	..	..	..	..
St.	..	Do. 4 per Cent. Perp. Debs.	..	..	..	..	..
1	..	Metropolitan Electric Trams Def	⅛–¼	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	⅛–1	5 0 0	..	..	..
100	5%	Montreal St. Rly. St'g 5% Mrt. Dbs. (1908)	102 –105	4 16 0	..	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	105 –107	4 5 0	..	..	..
5	..	New General Traction Ord.	½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1 –2	..	May	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Db. Stk.	99 –102	4 18 0	..	101	99½
10	10/0	Potteries Electric Traction Ord.	8½–9½	5 5 3	..	..	..
10	5 0	Do. 5 per Cent. Cum. Pref.	9 –10	5 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 –106	4 5 11	..	106¼	..
1	..	South Lancs. Elec. Trac. & Power Ord.	..	..	..	..	..
1	..	Do. 6% Pref. (£1 paid)	..	..	April, Oct	..	..
St.	..	Do. 4½% Deb. Stock (100% paid)	..	..	Jan, July	..	..
St.	3%	Waterloo and City Ord.	89 –92	3 8 4	June, Dec	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98 –102	3 18 5	Jan, July	98	..
10	..	Amazon Telegraph	2½–3½	..	Jn, Dec	..	..
100	..	Do. 5 per Cent. Deb.	..	..	..	..	..
St.	16/0	Anglo-American	48 –51	5 18 8	F, My, Ag, N	..	..
St.	30/0	Do. Preferred	91 –93	6 9 0	F, My, Ag, N	92⅝	91
St.	2/0	Do. Deferred	7¼–7½	1 5 10	F, My, Ag, N	7⅝	7⅛
100	82	Commercial Cable Capital Stock	175 –185	4 6 6	Ju, Ap, Jy, O	175	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 –92	4 7 2	Jn Ap, Jy, O	91½	91
10	7/0	Cuba Submarine Ord.	7½–8½	5 8 5	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15½–16½	6 1 3	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	2¼–3½	5 14 4	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	7 –8	6 5 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99⅝–102⅜	4 9 3	Jan, July	..	..
20	3/0	Direct United States Cable	10 –10¼	6 3 10	Ja, Ap, Jy, O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 –101	4 9 1	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	120 –125	5 12 0	Ja, Ap, Jy, O	124	119½
St.	17/6	Do. 3½ per Cent. Pref. Stock	86 –89	3 19 1	Ja Ap, Jy, O	86½	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	104 –107	3 15 8	May, Nov	..	..
10	2/6	Eastern Extension	11¼–11⅝	5 19 2	Ja, Ap, Jy, O	11⅞	11⅝
6	4%	Do 4 per Cent. Cons. Debs.	103 –106	3 16 0	Feb, Aug	..	..
100	4%	* Eastern & S. African 4% Mrt. Deb, 1909	99 –102	3 19 0	Feb, Aug	100	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–103⅜	3 19 0	May, Nov	..	..
10	5/0	Great Northern of Copenhagen	25 –26	4 16 2	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 –101	4 9 6	June, Dec	..	..
25	12 6	Indo-European	40 –43	5 16 3	May, Nov	41½	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	97 –100	4 0 0	June, Dec	..	..
10	2/0	West African Telegraph Shares	5 –6	1 13 4	..	..	..
5	..	West Coast of America	⅛–¼	..	..	..	..
100	4%	Do. 4 per Cent. Debs.	97 –100	4 0 10	Jan, July	98	..
10	..	West India and Panama	⅝–¾	..	May, Nov	..	..
10	8/0	Do. 6 per Cent 1st Pref.	5¼–6¼	9 12 0	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	4¼–5¼	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
20	3/0	Western Telegraph	12 –12½	5 12 0	Mr, Jn, O, D	12⅝	12
100	5%	* Do. 5% Debs. 2nd Series, 1936	101 –104	4 17 9	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 –102	3 19 5	..	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	5 –5½	5 9 1	..	..	..
10	2/0	Globe Telegraph and Trust	5¼–5⅝	4 11 5	Ja Ap Jy O	5⅝	..
10	3/0	Do. 6 per Cent. Pref.	12¼–12½	4 14 2	Ja Ap Jy, O	12⅝	12½
5	4/0	Reuter's	6⅜–7⅛	5 6 8	April, Oct	..	..
10	6%	Submarine Cables Trust (Cert.)	118 –123	5 0 0	April, Oct	123	..

Share.	Last Dividend.	Name.	Price Wed., April 13.	Rate per Cent. Yielded.	Dividend Due.	Business Week to April 13. High-est.	Low-est.
		TELEPHONES.		£ s. d.			
5	3/0	Chili Telephone (fully paid)	4½–5½	5 14 3	August	..	..
St.	6%	National Co. Pref. Stock	103 –105	5 14 10	..	..	..
St.	5%	Do. Def. Stock	86 –88	5 13 9	..	..	..
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 –12	5 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 –12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	4⅛–5⅛	4 17 7	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –99	3 11 5	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	100 –102	3 19 5	..	..	..
1	0/7½	Oriental	1⅜–1⅝	6 6 3	April, Oct	..	..
1	..	Do. 6 per Cent. Cum. Pref.	1 –1⅛	..	..	..	..
5	3/0	United River Plate	5½–6	5 16 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝–5⅛	4 15 8	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	102 –105	4 15 8	June, Dec	..	..
		ELECTRICITY SUPPLY.					
1	..	Blackheath & Gr'nwich. Dist. Ord. (f.p.)	⅛–¼	..	..	..	..
1	0/5⅛	Do. 7% Cum. Pref.	1⅛–1⅜	..	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Prv. Cts. (rd. & con.)	113 –116	3 17 7	..	..	..
10	16/0	Bournemouth & Poole Elec. Sup. Ord.	12 –13	6 3 2	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10½	4 5 9	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½–11½	5 4 4	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 –104	4 6 7	..	..	..
St.	4½%	Bromley (Kent) El. Lt. & Power 1st Debs.	102 –105	4 7 8	..	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	10½–11	4 10 11	..	..	..
5	3/6	Do. 7 per Cent. Pref.	10½–10⅜	3 5 1	Mar, Sept	..	..
5	3/0	Calcutta Electric Supply Ord.	6½–7	4 12 10	..	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	106 –109	3 13 8	..	..	..
5	4/0	Charing Cross & Strand Electric Sup.	7 –7½	5 6 8	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5½–5⅝	4 5 9	Feb, Aug	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4½–5	4 10 0	..	..	..
5	1/7	Do. Do. (19.3)	4½–5	..	..	..	..
St.	4%	Do. 4% Deb. Stock (red.)	102 –104	3 17 10	..	..	..
5	3/6	Chelsea Electric Supply Ord.	6 –6½	4 4 7	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 3 1	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10½–10⅝	4 13 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 9	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	121 –126	3 19 4	Jn, Dec	..	..
St.	4½%	* Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 7	..	..	..
10	4/0	County of London & Brush Prov. Ord.	7 –8	5 0 0	..	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11 –12	5 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	103 –109	4 2 11	..	..	..
St.	27/6½	Do. Second Deb. Stock Prov. Certs.	99 –102	..	..	..	..
5	2/0	Folkestone Electricity Supply Co. Ord.	5⅜–6½	4 0 0	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	100 –103	4 8 0	..	..	..
10	..	Havana Electricity Co. Shares	9½–10½	..	..	..	..
5	3/6	Hove Electric Lighting Ord.	7½–8½	5 0 0	..	..	..
St.	..	I of W. Elec. Lt. & Power 4½% Db St (red.)	102 –105	..	..	..	..
1	..	Kalgoorlie Elec. Power & Ltg. 6% Cm Prf.	⅛–¼	..	..	..	..
5	7/0	Kensingtn & Knghtsbdge Ord.	11 –12	5 0 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –104	3 16 11	..	103¾	..
3	..	London Electric Supply Ord.	1 –1½	..	..	..	1½
5	3/0	Do. 6 per Cent Pref.	4½–5	6 0 0	..	..	4½
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	94 –97	4 8 7	Mr, Jn, S, D	..	..
10	9/6	Metropolitan Electric Sup. Ord.	18 –19	4 12 1	April, Oct	18½	18
5	1/4½	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅜	4 3 9	..	..	5⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	3 19 6	Jn, Dec	..	111½
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –98	3 11 9	..	..	..
100	4%	Midland Elec. Corp. for P.D. 1st Mort. Db.	95 –98	4 11 9	..	..	..
10	6/0	Notting Hill Electric Ord.	13 –14	4 5 9	March	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	99 –102	3 18 5	..	..	..
5	4/0	Oxford Electric Ord.	5½–6	5 8 4	March	..	..
St.	4%	Do. 4% Deb. Stock	96 –99	4 0 9	..	..	..
1	..	Rand Electric	⅞–1	..	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mt. Deb.	98 –101	4 9 1	April, Oct	..	..
5	9/6	St. James' & Pall Mall Elec. Ord.	14 –15	4 16 8	Feb, Aug	14⅞	..
5	3/6	Do. 7 per Cent. Pref.	8 –9	3 17 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	97 –100	3 10 6	..	..	3⅜
5	4/0	Smithfield Markets Electric Sup. Ord.	3 –3½	5 14 3	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	85 –90	4 9 6	..	..	3⅞
5	3/0	South London Electric Supply Ord.	3 –3½	4 5 8	..	..	..
5	2/6	Urban Electric Supply Ord.	4⅛–4⅜	5 2 6	..	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	..	..	..
5	2/6	Westminster Electric Supply Ord.	12½–13½	5 0 0	Mar, Sept	12⅝	12½
5	2/6	Do. 5 per Cent. Cum. Pref.	6 –6½	3 16 11	..	..	..
		ELECTRIC MANUFACTURING &c.					
1	6d.	Alliance Electrical Co. 5% Cum. Pref.	½–½	10 0 0	..	..	..
1	..	Aron Electric Meter 6% Cum. Pref.	⅜–⅝	..	Mar, Sept	..	..
5	4/0	British Insulated & Helsby Cables Ord.	5½–6½	6 8 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½–5⅝	5 4 4	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –107	4 4 1	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	101 –103	4 7 5	..	..	3⅛
5	3/0	British Westinghouse 6% Pref.	3⅜–4½	7 1 2	..	..	92
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	91 –94	4 6 3	..	..	..
2	..	Brush Electrical Engineering	⅛–¼	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	⅜–1½	9 12 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –99	4 10 11	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	72 –77	5 18 4	Jan, July	..	..
5	5/0	Callender's Cable Construction Ord.	10½–11½	6 10 5	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5⅞	4 6 11	Jan, July	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	104 –108	4 3 3	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co. (fully paid)	⅝–¾	6 17 2	..	⅞	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	88 –93	4 14 9	..	..	..
1	0/7½	Chadburn's Ship Telegraph Ord	¾–1	8 0 0	March	..	..
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½–2	7 10 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96 –99	5 2 0	Jan, July	..	..
5	..	Dick, Kerr & Co. Ord.	7¾–8¼	..	..	..	..
5	3/0	Do 6% Cum. Pref.	5 –5½	5 9 1	..	..	..
St.	4½	Do. 4½% Deb. Stock	102–104	4 7 2	..	..	..
5	..	Edison & Swan United ("A" Sh.) (£3 pd.)	¼	..	Feb, Aug	..	..
5	..	Do. (£5 paid)	½–1¼	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	72 –77	5 3 11	June, Dec	74	72
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	74 –79	6 6 7	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	5½–6½	5 12 0	Half-yearly	6⅛	6
5	3/0	Do. 6 per Cent. Cum. Pref.	5⅜–6¼	4 16 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	104 –107	4 5 2	..	104	..
2	2/4½	Electric Construction Co.	1½–1⅝	6 71 2	Jan, July	1⅝	..
2	2/4½	Do. 7 per Cent. Cum. Pref.	2½–3	4 13 4	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	97 –100	4 0 0	Jan, July	..	..
1	1/0	Electrolytic Alkali Ord.	¼–½	..	..	..	..
1	7½	Do. 7 per Cent. Cum. Pref.	½–1	..	..	..	..
St.	5%	Ferranti 5% 1st Mort. Debs. (red.)	90 –95	5 5 8	..	..	..
5	5/0	General Electric (1900) 5% Cum. Pref.	9 –9⅝	5 5 3	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –98	4 1 8	..	..	..
10	5/0	Henley's Telegraph Works Ord.	11½–12½	6 0 0	Feb, Aug	11⅝	..
10	2/6	Do. 4½ per Cent. Pref.	5 –5½	4 1 10	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Mort. Deb. Stock (rd.)	107 –111	4 1 5	Feb, Aug	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	18 –19	5 5 3	Feb, Aug	..	..
100	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	99 –102	3 18 5	Mar, Sept	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	10 –11	4 10 11	Mar, Sept	..	..
10	5/0	Telegraph Construction & Maintenance	31–37	6 9 10	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –104	3 17 8	Jan, July	..	..
2	..	Williams and Robinson Ord.	2 –3	..	Apr, Oct	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 –4	..	Apr, Oct	..	..
St.	4½	Do. 4 per Cent. 1st Mort. Debs.	90 –95	4 14 8	May, Nov	..	..

In calculating the yield allowance has been made for accrued interest but [illegible] ... † The London Stock Exchange Committee [illegible]

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